100% PROJECT MANUAL

COMMERCE 2.0 MGD GROVE CREEK WPCP

COMMERCE, GEORGIA

for

CITY OF COMMERCE

BID DOCUMENTS

March 2025

Prepared By

Goodwyn Mills Cawood, LLC
6120 Powers Ferry Road NE
Suite 200
Atlanta, GA 30339
T: 770.952.2481
www.gmcnetwork.com

GMC PROJECT NUMBER: CATL230033

STATE OF GEORGIA
GOODWYN MILLS CAWOOD, LLC
No.PEF007898
Exp.06.30.2026
CERTIFICATE OF AUTHORIZATION

GEORGIA
REGISTERED
No. PE051452
PROFESSIONAL
Graham Sizemore
03.19.2025
ENGINEER
GRAHAM S. SIZEMORE

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Goodwyn Mills Cawood, LLC
Post Office Box 242128
Montgomery, AL 36124-2128
and
Birmingham, Alabama
Andalusia, Alabama
Auburn, Alabama
Daphne, Alabama
Eufaula, Alabama
Huntsville, Alabama
Mobile, Alabama
Vernon, Alabama
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COMMERCE 2.0 MGD GROVE CREEK
WATER POLLUTION CONTROL PLANT

FOR

CITY OF COMMERCE

COMMERCE, GEORGIA

GMC PROJECT NO. CATL230033

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe penetrations.
2. Restrained joints.
3. Braided flexible connections.
4. Expansion joints.
5. Expansion loops.
6. Sleeve-type couplings.
7. Wall sleeves.

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications
2. Section 09 96 00 – High-Performance Coatings
3. Division 40 – Process Interconnections

C. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
2. AWWA C227 Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain-End Pipe.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

C. ASME International:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.
2. ASME B31.3 - Process Piping.
3. ASME B31.9 - Building Services Piping.
4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding, Brazing, and Fusing Qualifications.

D. ASTM International:

1. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
3. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
4. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

E. Expansion Joint Manufacturers Association, Inc.:

1. EJMA Standards.

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 1479 - Fire Tests of Through-Penetration Firestops.
3. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

PART 2 - PRODUCTS

2.1 PIPE PENETRATIONS

A. Flashing:

1. Metal Flashing:

a. Material: 304 stainless steel.
b. Thickness: 26 gage.

2. Metal Counterflashing:

a. Material: 304 stainless steel.
b. Thickness: 22 gage.

3. Flexible Flashing Materials:

a. Material: Butyl sheet, PVC sheet, or Compatible with service conditions.
b. Thickness: 47 mils.

4. Caps:

a. Material: 304 stainless steel.
b. Minimum Thickness: 22 gage, and 16 gage at fire-resistive elements.

B. Sleeves:

1. Sleeves for Pipes through Non-fire-rated Floors:

    a. Material: 304 stainless steel.
    b. Thickness: 0.0625 inch minimum

2. Sealant:

    a. As specified in Section 07 92 00 - Joint Sealants.

C. Mechanical Sleeve Seals:

1. Manufacturers:

    a. Flexicraft Industries, PipeSeal
    b. GPT (Link-Seal)
    c. Or Approval Equal

2. Description:

    a. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
    b. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.2 RESTRAINED JOINTS

A. Flange Adapter (Set Screws)

1. Manufacturer:

    a. EZ Flange Adapter (EBAA Iron, Inc.)
    b. Uni-Flange, series 400 (0R series 420)
    c. Ford Meter Box Company, Inc. (Nappco, Inc.)
    d. Star Pipe Series 400
    e. Or Approved Equal.

2. Description:

    a. The uniflange assembly shall be used only in instances shown on the drawings. If the Contractor proposes to use uniflanges at other locations, he shall first obtain approval from the Engineer.
    b. The uniflange shall consist of a Ductile Iron ASTM A536 Grade 65-45-12 flange with ANSI B16.1 Class 125 & 250 or ANSI B16.5 Class 150 & 300 drillings.
    c. The standard gasket of Buna S for water and wastewater shall be supplied.
    d. The uniflange class shall be suitable for the pressure service. (2”-12” = 250 psi, 14”-24” = 150psi, >24” = 100 psi)

B. Flange Adapter-Restrained

1. Manufacturer:

a. SERIES 2100 MEGAFLANGE adapter, as produced by EBAA Iron, Inc.,
b. StarFlange Series 3200
c. Or Approved Equal.

2. Description:

a. Restrained flange adapters may be used in lieu of threaded, or welded, flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
b. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
c. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
d. Flange Adapters shall be fully restrained and shall incorporate a wedge style grip.
e. Allowable working pressures shall have a minimum as follows: 3"-16" = 350 psi, 18"-24" = 250 psi, 30"-48" = 150 psi.

C. Adapter with Wedge Restraints for Mechanical Joint pipe.

1. Manufacturer:

a. Uni-Flange Series 1400, by Ford Meter Box Company
b. StarGrip 3000 by Star Pipe Products
c. Megalug Series 1100 by EBBA Iron Sales, Inc.
d. Or Approved Equal.

2. Description:

a. Restraint for standardized mechanical joints shall be incorporated into the design of the follower gland and shall impart multiple points of wedge action against the pipe, increasing its resistance as the pressure increases.
b. The restrained joint shall incorporate a wedge style restraint system. Restraints with set screws will not be acceptable.
c. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action.
d. Restraining glands shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12.
e. Wedges shall be contoured to properly fit on the pipe, and shall be manufactured of ductile iron, heat treated to a minimum hardness of 370 BHN. Dimensions of the glands shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53 of latest revision.
f. Twist-off heads shall be incorporated in the design of the wedge actuating screws to ensure proper torque.
g. The mechanical joint restraining device shall have a water working pressure rating of 250 psi minimum with a safety factor of at least 2:1 against separation when tested in a dead-end situation

h. Allowable working pressures shall be as follows: 3”-16” = 350 psi, 18”-36” = 250psi.

2.3 BRAIDED FLEXIBLE CONNECTIONS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal.

B. Steel or Stainless Steel Piping:

1. Inner Hose: Corrugated stainless steel as indicated.
2. Exterior Sleeve: Braided or stainless steel as indicated.
3. Pressure Rating: Minimum 150 psig at 50 ºF and sufficient for service condition.
4. Fittings: Flanged, unless otherwise noted.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4inch on each side of installed center line.

C. Copper Piping:

1. Inner Hose: Corrugated Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: Minimum 150 psig at 70 ºF and sufficient for service condition.
4. Fittings: Threaded with union, Soldered, or as specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4 inch on each side of installed center line.

2.4 EXPANSION JOINTS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal

B. Performance and Design Criteria:

1. Bellow Design: According to Section C of EJMA Standards.

C. Stainless-Steel Compensator Type:

1. Pressure Rating: 50 psig WOG at 250 ºF for aeration air piping, all others shall be 200 psig WOG at 250 ºF.
2. Maximum Compression: 1-3/4 inches.
3. Maximum Extension: 1/4 inch.

4. Joint: Flanged, unless otherwise noted.
5. Size: Use pipe-sized units.
6. Application: Aeration air piping 4-inch and larger or steel piping 3 inches and smaller.

D. External Ring-Controlled Stainless-Steel Bellows Type:

1. Pressure Rating: 200 psig WOG at 250 ºF.
2. Maximum Compression: 1-1/4 inches.
3. Maximum Extension: 3/8 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: Flanged.
6. Size: Use pipe-sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inches and larger.

E. Single-Arch Rubber Type:

1. Body: Neoprene with nylon fabric reinforcement.
2. Working Pressure: 150 psig.
3. Maximum Temperature: 200 ºF.
4. Maximum Compression: 1 inch.
5. Maximum Elongation: 5/8 inch.
6. Maximum Offset: 1/2 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: 304 stainless steel tapped backing rings.
9. Size: Use pipe-sized units.
10. Accessories: Control rods.
11. Application: Steel piping 2 inches and larger.

F. Bronze Compensator Type:

1. Description: Bronze with anti-torque device, limit stops, and internal guides.
2. Pressure Rating: 200 psig WOG at 250 ºF.
3. Maximum Compression: 3 inches.
4. Maximum Extension: 1/4 inch.
5. Size: Use pipe-sized units.
6. Application: Copper piping.

2.5 EXPANSION LOOPS

A. Provide expansion loops as indicated on Shop Drawings.

2.6 SLEEVE-TYPE COUPLINGS

A. Manufacturers:

1. Dresser Piping Specialties
2. The Macomb Group
3. US Pipe Fabrication

B. Description:

1. Comply with AWWA C219.
2. Middle Ring: Epoxy Coated Steel.
3. Followers: Epoxy Coated Steel.
4. Gaskets:

   a. Material: Buna-N, EPDM, or Compatible with service conditions.
   b. Comply with ASTM D2000.

5. Bolts: AWWA C111, Epoxy Coated Steel.

2.7 WALL SLEEVE

A. Manufacturers:

1. Sigma – Omni-Sleeve.
2. American
3. Or Approved Equal.

B. Description:

1. Wall and floor pipe penetrations of ductile iron piping systems shall be made by means of a sleeve capable of being bolted directly to the formwork to prevent misalignment. Seal of annular space shall be by means of a confined rubber gasket, so as not to be affected by vibration and capable of withstanding up to 100 psig. Sleeve shall be manufactured from Ductile Iron with an integrally cast water stop.

2.8 FINISHES

A. Prepare ferrous metal piping appurtenances for field finishes as specified in Section 09 96 00 – High-Performance Coatings.

2.9 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

1. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

C. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves.

E. Verify that pipe plain ends to receive sleeve-type couplings or flange adapters are smooth and round for 12 inches from pipe ends.

F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Cleaning: Thoroughly clean end connections before installation.

C. Close pipe and equipment openings with caps or plugs during installation.

D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to ASME B31.3 for process piping and ASME B31.9 for building services piping.

B. Coating: Finish ferrous metal piping appurtenances as specified in Section 09 96 00 – High-Performance Coatings for service conditions.

C. Pipe Penetrations:

1. Flashing:

a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
c. Fasten flashing to drain clamp device.

2. Sleeves:

a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
b. Set sleeves in position in forms and provide reinforcement around sleeves.
c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
d. Extend sleeves through floors 1/2 inches above finished floor level and calk sleeves.
e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with insulation and calk airtight.
f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
g. Install stainless-steel escutcheons at finished surfaces.

D. Firestopping:

1. Placement: Place intumescent coating in sufficient coats to achieve rating required.
2. Fire-Rated Surfaces:

a. Seal opening at floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve, allowing minimum of 1 inch void between sleeve and building element.
d. Pack void with backing material.
e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.

3. Non-rated Surfaces:

a. Seal opening through non-fire-rated floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve to allow minimum of 1 inch void between sleeve and building element.
d. Install type of firestopping material recommended by manufacturer.
e. Occupied Spaces:

1) Install escutcheons, floor plates, or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.

f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
g. Interior Partitions:

1) Seal pipe penetrations at where indicated.
2) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

E. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Shop Drawings.

F. Expansion Joints:

1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

G. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment.

H. Backflow Preventers:

1. Install with nameplate and test cock accessible.
2. Install according to local code requirements.
3. Do not install in vertical position.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

END OF SECTION 40 05 06

SECTION 40 05 07 - HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Structural attachments.
4. Pipe guides.
5. Guides
6. Anchors
7. Elbow and Flange Supports
8. Concrete Duct Spacers
9. Carrier Pipe Spacers Within Carrier Pipe

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete
2. Division 05 – Metals
3. Section 07 92 00 – Joint Sealants
4. Section 09 96 00 – High-Performance Coatings
5. Section 26 05 33 – Raceways and Boxes
6. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
3. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
4. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
5. ASTM F512 – Standard Specification for Smooth-Wall PVC

C. National Electrical Manufacturers Association

1. NEMA TC-2 – Electrical Polyvinyl Chloride (PVC) Conduit

2. NEMA TC-6 & 8 – Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
3. NEMA TC-10 – Polyvinyl Chloride (PVC) Plastic Communications Duct and Fittings for Underground Installation

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code Steel - Reference Manual.

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

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacturer, Selection, Application, and Installation.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog data including load capacity.

C. Shop Drawings: Indicate system layout with location - including critical dimensions, sizes, and pipe hanger and support locations - and detail of trapeze hangers, anchors, and guides.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX or AWS D1.1, verifying qualification within previous 12 months.

F. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
2. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
3. Submit sizing methods or calculations sealed by a registered professional engineer.

G. Manufacturers' Instructions: Submit special procedures and assembly of components.

H. Qualifications Statements:

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

1.6 QUALITY ASSURANCE

A. Perform Work according to applicable authority and/or AWS D1.1 for welding hanger and support attachments to building structure.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum five (5) years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum five (5) years' documented experience.

C. Installer: Company specializing in performing Work of this Section with minimum five (5) years' documented experience and approved by manufacturer.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State in which the project is located.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.

C. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.9 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls

B. Provide ventilation in areas receiving solvent-cured materials.

1.10 EXISTING CONDITIONS

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

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Description:

1. Horizontal Piping Hangers and Supports

a. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports of MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information; size hangers and supports properly for piping including insulation (if any). Provide copper-plated hangers and supports for uninsulated copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

2. Vertical Piping Clamps

a. General: Except as otherwise indicated, provide factory-fabricated vertical piping clamps of MSS type and size indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size clamps properly for piping, including insulation (if any). Provide copper-plated clamps for copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

3. Hanger Rod Attachments

a. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of MSS type and size indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size attachments properly for piping, including insulation (if any). Provide copper-plated hanger-rod attachments for uninsulated copper-piping

systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

4. Structural Attachments

a. General: Except as otherwise indicated, provide factory-fabricated building attachments of MSS type and load-rating indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or load-rating is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size units properly for the piping loading.

B. Performance and Design Criteria:

1. General

a. Design, size and locate piping support systems throughout facility, whether shown or not.
b. Piping smaller than 30 inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
c. Piping 30 inches and Larger: N/A
d. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this Section.

2. Pipe Support Systems

a. 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.
b. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.

3. 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.
4. Vertical Sway Bracing: 10-foot maximum centers or as shown.
5. 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. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
6. Provide linkage to permit lateral or axial movement where anticipated.
7. Where horizontal pipe movement is greater than ½ inch, or where hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.
8. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
9. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
10. Point Loads:

a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.

b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.

2.2 HANGERS

A. Clevis: MSS SP 58, Type 1

1. Shall be used for the suspension of non-insulated pipe or insulated with B3151 shield or Anvil ISS

a. Shall be used for the suspension of non-insulated pipe or insulated with B3151 shield or Anvil ISS

1) B-Line; Figure B3100, 1/2 inch to 30 inches
2) Anvil: Figure 260 for steel pipe and Figure 590, 1/2 inch to 30 inches
3) Insulated Steel Pipe; B-Line; Figure B3100 with B3151 shield, ½ inch through 16 inches
4) Insulated Steel Pipe; Anvil; Figure 260 with insulated saddle system (ISS), ½ inch through 12 inches
5) Or Approved Equal

b. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6

a. Shall be used for suspension of non-insulated stationary pipe

1) B-Line; Figure B3171, : ¾ inch through 8 inches
2) Anvil; Figure 104, : ¾ inch through 8 inches
3) Or Approved Equal

c. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43

a. Shall be used to support pipe where movement may occur due to thermal expansion

1) B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.
2) Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches and Figure 171 for sizes 1 inch through 30 inches
3) Or Approved Equal

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

a. Shall be used to support pipe where movement may occur due to thermal expansion when ceiling suspension is impractical

1) B-Line; Figure B3120, sizes 2 inches through 24 inches
2) Anvil; Figure 175, sizes 2 inches through 30 inches
3) Or Approved Equal

2.2 HANGER RODS

A. Hanger Rods:

1. ASTM A576, steel.
2. Threaded both ends or Threaded one end or All-thread.
3. Diameter: ASME B31.1; as indicated on Drawings.

2.3 STRUCTURAL ATTACHMENTS

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.
3. Or Approved Equal

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

1. Anvil; Figure 67, sizes ½ inch through 8 inches.
2. B-Line: Figure B3690, sizes ½ inch through 8 inches.
3. Or Approved Equal

C. Channel Type

1. General Use

a. Unistrut
b. Anvil: Power Strut
c. B-Line; Strut System
d. Or Approved Equal

2.4 PIPE SADDLES

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

1. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Figure 2000.
2. Or Approved Equal

B. Saddle Supports, Pedestal Type

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt

a. B-Line; Figure B3090, sizes 3/4 inch through 36 inches with B3088S base
b. Anvil: Figure 259; sizes 4 inch through 36 inches with Figure 63C base
c. Or Approved Equal

3. Adjustable Saddle: MSS SP 58, Type 38 without clamp

a. B-Line; Figure B3093, sizes 1 inch through 36 inches with Figure B3088S base.
b. Anvil: Figure 264, sizes 2-1/2 inch through 36 inches with Figure 62C base.
c. Or Approved Equal

2.5 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. General Use

a. B-Line; Strut System.
b. Unistrut
c. Anvil; Power-Strut.
d. Or Approved Equal

2.6 CLAMPS AND BEAM ATTACHMENTS

A. Beam Clamps:

1. Shall be used for suspending hanger rod from flanged beam and shall distribute the load equally on both sides of the beam.
2. MSS SP-58 Type 21, Type 28, Type 30
3. ASTM A36, steel or ASTM A181, forged steel.
4. Clamp Size: Based on load to be supported and load configuration.
5. Anchoring: Locknuts and cup-point set screws.
6. Reversible top or bottom flange.
7. Manufacturers:

a. B-Line;
b. Anvil;
c. Or Approved Equal

B. Offset Clamps:

1. Shall be used to support pipe offset from the floor or wall.
2. Double leg, two-piece.

a. B-Line; B3148; sizes ¾ inch through 12 inches
b. Anvil; Figure 103; sizes ¾ inch through 8 inches
c. Or Approved Equal

C. Welded Beam Attachment: MSS SP 58, Type 22

1. B-Line; FigureB3083, sizes 3/8”-16 through 2”-4 ½ rod
2. Anvil: Figure 66, sizes 3/8 inch through 3-1/2 inch

2.7 ELBOW AND FLANGE SUPPORTS

A. Elbow and Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base or approved equal

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or 63B base or approved equal.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89 or approved equal.

2.8 CONCRETE DUCT SPACERS

A. Carlon Snap-N-Stac Spacers

1. Can be installed: horizontally, vertically, or turned up-right
2. Fits duct sizes: 2”, 3”, 4”, 5”, 6”, and 8”
3. Material is: Nonmetallic, noncorrosive, and nonconductive

    a. Carlon is NOT responsible for Snap-Loc Spacers used in direct bury applications, but it is the responsibility of the design engineer and contractor

B. Carlon Snap-Loc Spacers

1. Provides: stability, constant separation, and relieve direct stress for duct materials encased in concrete and direct bury applications
2. Side dovetail rail and groove design

    a. Allows for interchangeability of conduit spacer sizes while maintaining horizontal stability

3. Nonmetallic Snap-Loc Spacers designed for nonmetallic duct with maximum outside dimension (O.D.) as specified in NEMA: TC-2, TC-6 & 8, TC-10 and ASTM F512

C. Carlon Snap-Loc Reducers

1. 1” and 2” Snap-Loc Reducers allow fixturing of 1” or 2” conduit inside larger spacers

D. Suggested Specification

1. Duct/Conduit Bank shall be encased in concrete with at least 3” of concrete at top and bottom, with 2” of concrete on each side. A horizontal and vertical separation between the ducts of (1”, 1.5”, 2”, 3”) shall be maintained by installing Carlon high-impact spacers with horizontal and vertical locking intervals of (8, 9, or 10) feet.

2.9 CARRIER PIPE SPACERS WITHIN CARRIER PIPE

A. Casing spacers are configured for pipe clusters that carry several pipes through the same casing and are used to center: water, sewer, gas, and other fluids in the casing

1. Westatlantic Tech Corp

a. WA-NM-M Casing Spacers

a. Non-metallic casing spacers with wheel rollers are available
b. Carrier pipes separated in holding cluster, roller wheels provide friction-reducing features for the pull through casing
c. The casing chamber remains dry and the ends are sealed by EDPM or NBR elastomer with stainless steel compression plates

b. Bundle Pipe Casing Spacers

a. Multi-pipe casing spacers for larger pipe clusters
b. Casing spacer clamp band material is 304L stainless steel or galvanized steel
c. Steel containment bands are combined with non-metallic wheel roller elements

2. Advance Products and System (APS)

a. Stainless Steel Band Spacers and Insulators (Model SSI)

a. SSI 8 Model: Width = 8”, recommended for carrier pipe 4”-36”
b. SSI 12 Model: Width = 12”, recommended for carrier pipe 36”-120” and larger
c. Stainless steel band spacers are recommended for every 6-8 feet of pipeline
d. Bands are constructed of 14-gauge stainless steel (304-grade) with a standard 0.09” PVC or EPDM liner

b. Steel Band Spacers and Insulators (Model SI)

a. SI 8 Model: Width = 8”, recommended for carrier pipe 4”-36”
b. SI 12 Model: Width = 12”, recommended for carrier pipe 36”-120” and larger
c. Steel band casing insulators are ideal for heavy pipe
d. Band is constructed of 14-gauge steel
e. Thermoplastic powder coating and fusion-bonded coating provide corrosion resistance (10-15 mils with 90 mil thick PVC liner)
f. Long casing sections are recommended every 6-8 feet

c. Polyethylene Casing and Insulators (Model CI)

a. Good for: most sizes of schedule 40 & 80 PVC, C900, SDR 21 & 26 plastic pipe, metal pipe up to 60”, and 12” or smaller ductile iron
b. Two halves are used to construct 1”-12” spacers, while 14” and above are multi-segmented
c. Polyethylene casing insulators are recommended for every 5 feet of pipe
d. Sizes are available for 1”-60” pipe, with a standard runner height of 1”

e. APS polyethylene casing insulators must not exceed 35 in-lbs of torque

2.10 PIPE GUIDES

A. Intermediate Guides:

1. Type: Hold down pipe guide

a. Shall prevent longitudinal or lateral movement of pipe

a. B-Line; Figure B3256 sizes 2 inch through 30 inches
b. Or Approved Equal

2. Type: U-bolts with 4 hex nuts to provide nominal 1/8 inch to ¼ inch clearance around pipe; MSS SP 58 Type 24

a. Shall be used for support, anchor, or guide of pipe

a. B-Line; Figure B3188 and Figure B3188NS, sizes ½ inch through 30 inches
b. Anvil; Figure 137 and Figure 137S, sizes ½ inch through 36 inches
c. Or Approved Equal

B. Alignment Guides:

1. Type: Spider

a. Shall direct thermal expansion of insulated or non-insulated pipe in direction permitted by expansion joints or loops
b. Two or more guides shall be used on both sides of expansion joint or loop

a. B-Line; Figure B3281 through B 3287, sizes 1-1/2 inch through 24 inches
b. Anvil; Figure 255, sizes ½ inch through 24 inches
c. Or Approved Equal

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap

1. Shall be used to anchor pipe to structure

a. B-Line; Figure 3147A and 3147B, sizes ½ inch through 24 inches
b. Or Approved Equal

2.12 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: ½-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:

    a. B-Line; B1999 Vibra Cushion.
    b. B-Line; Iso Pipe, Isolation Tape.
    c. Or Approved Equal

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers:

    a. B-Line; Figure B3151, sizes ½ inch through 24 inch.
    b. Anvil; Figure 167, sizes ½ inch through 24 inches.
    c. Or Approved Equal

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers:

    a. B-Line; Figure Series B3160, sizes ½ inch through 24 inches.
    b. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
    c. Or Approved Equal

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing
2. Manufacturer

    a. B-Line; Figure Series B3106V, sizes ½ inch through 6 inches with Figure B3106 Vee bottom hanger.
    b. Or Approved Equal

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

G. Attachments:

1. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
2. Concrete Attachment Plates:

    a. B-Line; Figure B3084, Figure B3085, or Figure B3086 with B3201 to attach center lug.

b. Anvil: Figure 47, Figure 49, or Figure 52.
c. Or Approved Equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Verify field dimensions as indicated on Drawings.

3.2 INSTALLATION

A. Obtain permission from Engineer before using powder-actuated anchors.

B. Obtain permission from Engineer before drilling or cutting structural members.

C. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 in and larger.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of or recessed into and grouted flush with slab.

D. Pipe Hangers and Supports:

1. Install according to: MSS SP 58.
2. Support horizontal piping as indicated on Drawings.
3. Install hangers with minimum 1/2 in space between finished covering and adjacent Work.
4. Place hangers within 12 in of each horizontal elbow.
5. Use hangers with 1-1/2 in minimum vertical adjustment.
6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
7. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
9. Support riser piping independently of connected horizontal piping.
10. Provide copper-plated hangers and supports for copper piping or sheet lead packing between hanger or support and piping.
11. Design hangers for pipe movement without disengagement of supported pipe.
12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.

13. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
14. Support no pipe from pipe above it.
15. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
16. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
17. Do not use adhesive anchors for attachment of supports to ceiling or walls.
18. Use beam clamps where piping is to be suspended from building steel.
19. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
20. Install lateral supports for seismic loads at changes in direction.
21. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
22. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
23. Use offset clamps where pipes are indicated as offset from wall surfaces.
24. Repair mounting surfaces to original condition after attachments are completed.

E. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.
2. Conform to 40 42 13 - Process Piping Insulation.

F. Equipment Bases and Supports:

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
3. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with

G. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 09 96 00 – High-Performance Coatings.
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 ATTACHMENTS

A. Standard Pipe Supports

1. Horizontal Suspended Piping:

a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
b. Grouped Pipes: Trapeze hanger system.

2. Horizontal Piping Supported from Walls:

    a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
    b. Stacked Piping: Wall mounted framing system and "J" hangers acceptable for pipe smaller than 3-inch.
    c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

3. Horizontal Piping Supported from Floors/Roof:

    a. Saddle Supports:

        a. Pedestal Type, elbow and flange.
        b. Provide minimum 1-1/2-inch grout beneath baseplate.

    b. Floor Mounted Channel Supports:

        a. Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
        b. Attach channel framing to floors with baseplate on minimum 1-1/2-inch non-shrink grout and with anchor bolts.
        c. 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. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration

B. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:

    a. Single point attachment to ceiling allowed for only ¾-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: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:

    a. Single point attachment to ceiling is allowed only for ¾-inch rod and smaller (8 inches and smaller pipe).
    b. Where there is a 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.

        a. These lines include air operated diagram pumps and other lines.

c. Steel Beams: I-beam clamp or welded attachments.
d. Wooden Beams: Lag screws and angel clips to members not less than 2-1/2 inches thick
e. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
f. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

C. 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.

D. 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.

E. 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 and 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.

F. Pipe Hanger Spacing:

1. Pipe Material: Ductile Iron Pipe

a. Size: 8 Inches and Under
b. Maximum Hanger Spacing: Maximum span limited to that for standard weight steel pipe for water service.

a. MSS SP 58 Table 3

c. Hanger Rod Diameter: MSS SP 58 Table 4

2. Pipe Material: Ductile Iron Pipe

a. Size: 10 Inches and Larger
b. Maximum Hanger Spacing: Maximum span limited to 20 feet.

a. MSS SP 58 Table 3

c. Hanger Rod Diameter: MSS SP 58 Table 4

3. Pipe Material: ABS.

a. Maximum Hanger Spacing: 4 feet.
b. Hanger Rod Diameter: 3/8 inch.

4. Pipe Material: Aluminum.

a. Maximum Hanger Spacing: 10 feet.
b. Hanger Rod Diameter: 1/2 inch.

5. Pipe Material: Cast iron.

a. Maximum Hanger Spacing: 5 feet.
b. Hanger Rod Diameter: 5/8 inch.

6. Pipe Material: Cast Iron, with 10-foot length of pipe.

a. Maximum Hanger Spacing: 10 feet.
b. Hanger Rod Diameter: 5/8 inch.

7. Pipe Material: CPVC.

a. Size: 1 inch and smaller.
b. Maximum Hanger Spacing: 3 feet.
c. Hanger Rod Diameter: 1/2 inch.

8. Pipe Material: CPVC.

a. Size: 1-1/4 inches and larger.
b. Maximum Hanger Spacing: 4 feet.
c. Hanger Rod Diameter: 1/2 inch.

9. Pipe Material: Copper tube.

a. Size: 1-1/4 inches and smaller.
b. Maximum Hanger Spacing: 6 feet.
c. Hanger Rod Diameter: 1/2 inch.

10. Pipe Material: Copper tube.

a. Size: 1-1/2 inches and larger.
b. Maximum Hanger Spacing: 10 feet.
c. Hanger Rod Diameter: 1/2 inch.

11. Pipe Material: Fiberglass:

a. Maximum Hanger Spacing: 4 feet.
b. Hanger Rod Diameter: 1/2 inch.

12. Pipe Material: Polybutylene.

a. Maximum Hanger Spacing: 2.7 feet.
b. Hanger Rod Diameter: 3/8 inch.

13. Pipe Material: Polypropylene.

    a. Maximum Hanger Spacing: 4 feet.
    b. Hanger Rod Diameter: 3/8 inch.

14. Pipe Material: PVC.

    a. Maximum Hanger Spacing: 4 feet.
    b. Hanger Rod Diameter: 3/8 inch.

15. Pipe Material: Steel.

    a. Size: 3 inches and smaller.
    b. Maximum Hanger Spacing: 12 feet.
    c. Hanger Rod Diameter: 1/2 inch.

16. Pipe Material: Steel or Stainless Steel.

    a. Size: 4 inches and larger.
    b. Maximum Hanger Spacing: 12 feet.
    c. Hanger Rod Diameter: 5/8 inch.

END OF SECTION 40 05 07

SECTION 40 05 13 - COMMON REQUIREMENTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements common to pipe and tube of all material types used on the Project.
2. Accessories.

B. Related Requirements:

1. Section 09 96 00 – High-Performance Coatings
2. Division 31 – Earthwork.
3. Division 40 – Process Interconnections

1.2 COORDINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.

C. Shop Drawings: Indicate layout of piping systems, including equipment, fittings, critical dimensions, sizes, and material lists.

D. Submit manufacturer’s certification and certified test reports that the pipe and linings and coatings were manufactured and tested in accordance with the ASTM and ANSI/AWWA Standards specified. Submittal shall be at least 7 days prior to each shipment of pipe.

E. Material Certificates

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizing methods and calculations used.

G. Qualifications Statements:

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

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, invert and centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work according to all applicable Federal, State and Local standards and these specifications.

B. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

C. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

1.6 QUALIFICATIONS

A. Manufacturer: For each pipe material type, a company specializing in manufacturing products of the material shall be used. The manufacturer shall have successfully manufactured and delivered products of the diameters used in this project for a minimum of 15 projects over the past 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging; include handling instructions.

C. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in a manner as to prevent damage to the exterior surface or internal coasting or lining of the pipe. If any part of the coasting or lining is damaged, the repair shall be made by the Contractor.

D. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

E. Store piping and appurtenances according to manufacturer instructions.

F. Protect piping and appurtenances from oxidation by storing off ground.

G. Stored pipe shall be kept safe from damage and away from traveled ways. The interior of all pipe, fittings and other appurtenances shall be kept free from water, dirt, or foreign matter at all times.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 ACCESSORIES

1. Couplings, Adapters, Specials for Process Piping: As specified in Section 40 05 06 - Couplings, Adapters, Specials for Process Piping
2. Hangers and Supports for Process Piping: As specified in Section 40 05 07 - Hangers and Supports for Process Piping.
3. Process Piping Insulation: As specified in Section 40 42 13 - Process Piping Insulation.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. All pipe and fittings to be installed under this Contract shall be of new manufacture.

C. The manufacturer is responsible for the performance of all inspection requirements as specified.

D. Owner Inspection:

1. The manufacturer is responsible for performance of all inspection requirements as specified. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by the Owner, by an independent testing laboratory selected by the Owner, or by other representative of the Owner.

E. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on the Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Ream ends of threaded pipes and file smooth.

C. Cleaning: Thoroughly clean pipe and fittings before installation.

D. Surface Preparation:

1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 - High-Performance Coatings.
2. Solvent-clean surfaces that are not shop primed.
3. Clean surfaces of metallic pipe to remove loose rust, mill scale, and other foreign substances by power wire brushing or commercial sand blasting; SSPC SP 6/NACE No. 3. Do not sand blast or power wire brush thermoplastic pipe.
4. Prime surface as specified in Section 09 96 00 – High-Performance Coating.

3.3 INSTALLATION

A. Buried Service: Install pipe as specified in the Section appropriate to the pipe material.

B. Exposed Service - Install according to ASME B31.3.

C. Provide required upstream and downstream clearances from devices as indicated.

D. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

E. Support piping as specified in Section 40 05 07 - Hangers and Supports for Process Piping.

F. Provide expansion joints as specified in Section 40 05 06 - Couplings, Adapters, and Specials for Process Piping and pipe guides as specified in Section 40 05 07 - Hangers and Supports for Process Piping to compensate for pipe expansion due to temperature differences.

G. Dielectric Fittings: Provide between dissimilar metals.

H. Field Cuts: According to pipe manufacturer's recommendations.

I. Finish primed surfaces according to Section 09 96 00 – High-Performance Coating.

J. Run pipelines straight and true, parallel to building lines with a minimum use of offsets and couplings. Provide only such offsets as may be required to provide necessary headroom or clearance and to provide necessary flexibility in pipe lines.

K. Changes in direction of pipelines shall be made only with fittings or pipe bends. Changes in size shall be made only with fittings. Miter fittings, face or flush bushings, or street elbows shall not be used. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

L. Provide flanges or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

M. Use full and double lengths of pipe wherever possible.

N. Unless otherwise indicated, install all supply piping, including shut off valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at inlet to control valve or pump. Install supply piping from outlet of control valve at full size to connection of equipment served.

O. All pipe shall be cut to exact measurement and installed without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment, or building elements with piping connections or piping supports.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.

B. Laying Tolerances: Unless otherwise specified, laying tolerances will be within 5/8”.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspection:

1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new, undamaged pipe.
3. After installation, inspect for proper supports and interferences.

D. Damage:

1. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new undamaged pipe.

E. Pressure Testing:

1. Unless otherwise specified or indicated on the drawings, all pipe shall be pressure tested prior to acceptance.
2. Conduct pressure testing in according to AWWA C600 and following:

a. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping, based on elevation of lowest point in piping corrected to elevation of test gage or based on maximum pressure of pump in force mains.
b. Conduct hydrostatic test for at least two hours.
c. Slowly fill with water section to be tested; expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
d. Observe joints, fittings, and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
e. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate. Maintain pressure within plus or minus 5 psi of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
f. Compute maximum allowable leakage by following formula:

1) L = SD x sqrt(P)/C.
2) L = testing allowance, in gph.
3) S = length of pipe tested, in feet.
4) D = nominal diameter of pipe, in inches.
5) P = average test pressure during hydrostatic test, in psig.
6) C = 148,000.
7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

g. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
h. Correct visible leaks regardless of quantity of leakage.

F. After installation, inspect for proper supports and interferences.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep pipe interior clean as installation progresses.

C. All piping shall be cleaned, flushed, and tested prior to use.

D. All water lines shall be flushed out under full treated water pressure; potable water piping shall be flushed with potable water; air piping shall be thoroughly blown out with air. All filters, control valves and gages shall be removed from lines or bypassed during the blowout period.

E. Following the blow through, all dirt legs and other low points in lines shall be disassembled and all residual material thoroughly removed. All stop valves shall be removed and cleaned.

F. The Contractor shall provide all water required for cleaning, and flushing at no additional cost to the Owner.

END OF SECTION 40 05 13

SECTION 40 05 19 - DUCTILE IRON PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductile-iron pipe and fittings.
2. Accessories.

B. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping

C. Related Requirements:

1. Section 09 96 00 – High-Performance Coating
2. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe.
6. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
8. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B31.3 - Process Piping.

C. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.

D. SSPC - The Society for Protective Coatings:

1. SSPC SP 6/NACE No. 3 - Commercial Blast Cleaning.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Manufacturers:

1. US Pipe.
2. American.
3. Or Approved Equal.

B. Piping:

1. Comply with AWWA C151.
2. Diameter and Class: As indicated below:

Pipe Size (in)	Pressure Class
12” and Smaller	350
14” – 24”	250
30” and Larger	150

C. Joints:

1. Pressure Rating: Same as that of connected piping.
2. Mechanical:

    a. Comply with AWWA C110 and AWWA C111.
    b. Glands: Ductile iron with asphaltic coating.
    c. Use Tee-head or non-hex head bolts and head nuts for joint makeup and gasket seating. Bolts & Nuts shall be carbon steel coated with corrosion inhibiting fluoropolymer composite material.
    d. Mechanical joint fittings hall be furnished with sufficient quantities of accessories as required for each joint.
    e. All mechanical joints shall be restrained.

3. Push On: Comply with AWWA C111.
4. Flanged: Comply with AWWA C115 with gaskets and bolts conforming to AWWA C115, Appendix A.
5. Gaskets for mechanical and push-on type joints shall conform to ANSI A21.11 and AWWA C111, Gaskets shall be SBR, neoprene, or EPDM.
6. Gaskets for flange joints shall conform to ANSI A21.15 and AWWA C115. Gaskets shall be neoprene or EPDM.
7. Gaskets for air piping shall be high temperature compressed gasketing consisting of organic fibers (Aramid) with SBR binder, Garlock “BLUE-GARD” Style 3200 or equal.
8. Gaskets for joints above 250 psi shall be Toruseal gaskets as manufactured by American specially designed for a working pressure of 350 psi.

D. Fittings:

1. Comply with AWWA C153, ductile iron.
2. Pressure Rating, Pipes 12 Inches and Smaller: 250 psig.

2.2 FINISHES

A. Interior Coating

1. Cement-mortar lining, AWWA C104; standard thickness.
2. Glass-lined SR-14 or equal for grit and scum piping.
3. Ceramic epoxy for gravity and pumped raw wastewater.
4. Ductile Iron Pipe and Fittings used for air service shall be unlined pipe

B. Outside Coating:

1. Buried: Asphaltic; 1-mil thick, minimum, in accordance with AWWA C151 / ANSO A21.51.
2. Exposed: As specified in Section 09 96 00 - High-Performance Coatings.

2.3 ACCESSORIES

A. Jackets:

1. AWWA C105, polyethylene jacket.
2. All buried ductile iron pipe shall receive polyethylene jacketing.

B. Dielectric Fittings: Provide between dissimilar metals.

C. Pipe Identification Labels

1. Identification for Process Piping: As specified in Section 40 05 53 - Identification for Process Piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 40 05 13 – Common Requirements for Process Piping

3.2 INSTALLATION

A. Buried Service: Install pipe as specified in:
1. Section 40 05 13 – Common Requirements for Process Piping.
2. AWWA C600 – Installation of Ductile Iron Water Mains and their Appurtenances.

B. Exposed Service: Install pipe as specified in:

1. Section 40 05 13 – Common Requirements for Process Piping.
2. Install according to ASME B31.3.
3. Fittings:

    a. Clean gasket seats thoroughly and wipe gaskets clean prior to installation.
    b. Install fittings according to manufacturer instructions.
    c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer recommendations.

4. Provide required upstream and downstream clearances from devices as indicated.

C. Tap ductile-iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.

D. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means acceptable to the Engineer.

E. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe.

F. Where pipe is laid on a grade of ten (10) percent or greater, the laying shall start at the bottom and shall proceed upward with the bell ends of the pipe upgrade.

3.3 JOINING OF PIPE

A. Flanged Joints

1. Flanges conforming to AWWA C110 can be joined with Class 125 B16.1 flanges shown in ANSI B16.1 but not with Class 250 B16.1 flanges.
2. Flange joints should be fitted so that the contact faces bear uniformly on the gasket. The joint should be made with relatively uniform bolt stress.
3. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts such that those 180 degrees apart or directly opposite are torqued in sequence.

B. Push-On Joint

1. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends upstream.
2. Pipe 8 inches in diameter and larger shall be socketed by fork tools or jacks.
3. Pipe cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. The spigot ends of field cut pipe shall be tapered back 1/8 inch at an angle of about 30 degrees to the barrel of the pipe with a coarse file or portable grinder. All sharp or rough edges that may injure the rubber gasket shall be removed in this operation.
4. Whenever it is desirable to deflect push-on joint pipe, the amount of deflection shall not exceed the maximum limits according to Table 4 in AWWA C600.

C. Mechanical Joints:

1. Mechanical joints shall be in accordance with AWWA C600 and the manufacturer's instructions.
2. Bell ends shall be laid upstream.
3. Bolts shall be tightened to the specified torque. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to obtain greater leverage.
4. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.
5. Bolts shall not be over-stressed to compensate for poor assembly.

3.4 PLACEMENT OF FITTINGS

1. Pipeline fittings, plugs, and caps shall be furnished and installed of the type indicated and at the location shown on the Drawings or as directed by the Engineer. It shall be the responsibility of the Contractor to furnish and install all proper size pipe bends for both horizontal and vertical deflections that are required to construct the pipeline to the line and grade as shown on the construction drawings or as set by the Engineer.

3.5 POLYETHYLENE ENCASEMENT

A. The Contractor shall use Method A of ANSI/AWWA A21.5/C105 to install polyethylene encasement.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Test Pipe (other than air lines) per Section 40 05 13 – Common Requirements for Process Piping.

C. Pressure Testing - Air

1. All pressure pipelines conveying process air, flume air or primary air shall be tested by the Contractor in a manner satisfactory to and witnessed by the Engineer.
2. The section under test shall be isolated by airtight plugs or valves from the air blowers and the diffuser headers which shall be tested separately.
3. The pressure and leakage test shall first consist of filling the test section with compressed air to a pressure of 12 psig. The air inlet point shall be sealed and with no further introduction of air, the pipeline shall maintain a pressure of 12 psig for one hour. A pressure gage supplied by the Contractor and scaled to twice the test pressure shall be used to indicate the pressure.
4. If the pipeline fails the above test, the Contractor shall locate and correct all leaks and retest the pipe section until it satisfactorily passes the test.

3.7 DISINFECTION OF POTABLE WATERLINES

A. Following the testing procedure and after all corrections and adjustments have been made, all potable waterlines, both hot and cold water systems, shall be disinfected in strict accordance with the following procedure:

1. Water shall be introduced with a chlorine concentration of at least 50 mg/L. Chlorine shall be added with either a solution feed chlorinator or a hypochlorite feeder. Chlorine application shall continue until the system is filled with the chlorine solution.
2. The chlorinated water shall remain in the system for a minimum of 24 hr while all valves along the system are operated to insure their disinfection. Following the 24 hr period, a residual chlorine test shall be conducted on a fresh sample taken at a point farthest from the point the solution was introduced. If less than 25 mg/L of chlorine is indicated, the system shall be drained and the disinfection procedure repeated.
3. After a chlorine residual of at least 25 mg/L is obtained, the system shall be flushed until the chlorine concentration is equal to or less than 1 mg/L.
4. Disinfection shall conform to ANSI/AWWA C-651, latest revision. The Engineer and Owner shall be notified 48 hr in advance of the disinfection procedure. Also, the flushed solution shall be disposed of as directed by the Engineer and Owner.

END OF SECTION 40 05 19

SECTION 40 05 23 - STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stainless-steel pipe, tube, and fittings.
2. Stainless-steel cam and groove couplings.
3. Accessories.

B. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping.

C. Related Requirements:

1. Section 09 96 00 - High-Performance Coatings: Finishes as specified by this Section.
2. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

B. ASME International:

1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
4. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping.
8. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

4. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
5. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
6. ASTM A632 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service.
7. ASTM A778 – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
8. ASTM A789 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service.
9. ASTM D3308 - Standard Specification for PTFE Resin Skived Tape

D. AWWA

1. AWWA C220 – Stainless-Steel Pipe, ½ In. and Larger
2. AWWA C223 – Fabricated Steel and Stainless Steel Tapping Sleeves
3. AWWA C226 – Stainless-Steel Fittings for Waterworks Service, ½ In. Through 72 In.
4. AWWA C228 – Stainless-Steel Pipe Flanges for Water Service – Sizes 2 in. through 72 in.

E. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

F. The Society for Protective Coatings:

1. SSPC SP-6 - Commercial Blast Cleaning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Felker Brothers.
B. Brismet.
C. TW Metals.
D. Or Approved Equal.
E. All cam and groove couplings shall be as manufactured by PT Coupling, USA.

2.2 STAINLESS-STEEL PIPE, TUBE AND FITTINGS

A. All materials shall be new and unused.

B. Unless otherwise indicated on the drawings, stainless steel pipe shall be Type 304 stainless steel, schedule 10 conforming to AWWA C220.

C. Stainless steel tube shall be Seamless Type 304 stainless steel conforming to ASTM A269.

1. In the event plans/schedule indicate Type 304, the requirements for Type 316 shall be interchangeable with Type 304.

D. All welded pieces shall be shop fabricated.

E. Pipe shall be field assembled using flanges and gaskets where necessary. Field welding will not be allowed without written approval from the Engineer.

F. Fittings shall conform to AWWA C226. Shop-fabricated fittings made from flat-rolled stock, in accordance with ASTM A240 shall be in a solution-annealed condition. Shop fabricated fittings made from pipe shall be in accordance with AWWA C220, ASTM A312 and ASTM A778.

G. Flanges shall conform to AWWA C228.

1. Flanges shall be made from castings, seamless forgings, rolled and welded bar rings, segmented and welded plates, or cut from plate as a single piece.
2. Flanged joints shall be made with bolts, bolt studs with nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same Standard as the flanges.
3. Flanges shall be grade 316, Slip on type, minimum Class D. If service pressure is greater than 150 psi, class shall be rated for the same service pressure as the pipe.
4. Flange faces shall be raised except when bolted to flat face cast iron flanges.
5. Bolting:

    a. Bolts and nuts shall be Type 316 stainless steel.
    b. Bolts: Comply with ASTM A193, Grade B8M; square head.
    c. Nuts: ASTM A194, Grade 8M; hex head.
    d. Bolt studs and studs shall be of the same quality as machine bolts.
    e. Washers on mating flanges or equipment connections: Same material as bolt

2.3 ACCESSORIES

A. Pipe-Thread Tape:

1. Material: PTFE.
2. Comply with ASTM D3308.

B. O-Ring Seals: EPDM.

C. Flange Gaskets:

1. Gaskets for flat face flanges shall be full face type. Gaskets for raised face flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Gaskets shall be 1/8 in. thick minimum and of following types:

    a. Water, Sewage, Sludges (up to 175°F): Red rubber, heavy duty type, by John Crane Co., Morton Grove, IL, - Style 555.
    b. Air: High temperature compressed gasketing consisting of organic fibers (Aramid) with SBR binder, Garlock “BLUE-GARD” Style 3200 or equal.

D. Connections with Dissimilar Pipes

1. For stainless steel to ductile iron connections, a weld neck flange can be used on the stainless steel and a megaflange may be used on the ductile iron side. Sufficient gaskets should be used between the nuts or bolts and stainless steel in order to protect the stainless steel.
2. End welding of longitudinal seams shall be performed by manual welding in accordance with AWWA C220-12 Section 4.4.3.4 and 4.4.3.4.1.

2.4 CAM AND GROOVE COUPLING

A. All cam and groove couplings shall be 316 stainless steel and designed for lightweight strength and long lasting durability.

B. Cam and groove couplings shall allow for hose connection without the need for threading tools, lugs, twisting, springs or snaps.

C. Locking arms shall be provided to prevent couplers from leaking or pulling apart during operation.

D. Gaskets and materials shall be selected based on the manufacturer's recommendation and the material being conveyed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASME B31.3.

B. Comply with Section 40 05 13 - Common Requirements for Process Piping.

C. Field Cuts: According to pipe manufacturer instructions.

D. Field welding of stainless steel is **not** permitted, without written permission from the Engineer.

3.2 TOLERANCES

A. Piping tolerances shall be per AWWA C220.

3.3 TESTING

A. Test installed components Per Section 40 05 13 – Common Requirements for Process Piping.

END OF SECTION 40 05 23

SECTION 40 05 31 - THERMOPLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe, tube, and fittings.
2. Chlorinated polyvinyl chloride (CPVC) pipe and fittings.
3. Acrylonitrile-butadiene-styrene (ABS) pipe and fittings.
4. High Density Polyethylene (HDPE) pipe, tube, and fittings.
5. Accessories for plastic piping and fittings.

B. Related Requirements:

1. Section 40 05 07 – Hangers and Supports for Process Piping
2. Section 40 05 13 – Common Requirements for Process Piping
3. Section 40 05 51 – Common Requirements for Process Valves

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. ASTM D1527 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.
4. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
5. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

6. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
7. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
8. ASTM D2321 – Standard Practice for Underground installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
9. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
11. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
12. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
13. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
14. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
15. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
16. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
17. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
18. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
19. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
20. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
21. ASTM D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
22. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
23. ASTM D3892 - Standard Practice for Packaging/Packing of Plastics.
24. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
25. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
26. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
27. ASTM F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
28. ASTM F442 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
29. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
30. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
31. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
32. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

33. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
34. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing.
35. ASTM F1290 - Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.
36. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

C. American Water Works Association:

1. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
2. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
3. AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In.
4. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.

D. NSF

1. NSF / ANSI 14 – Plastic Piping and Components and Related Materials
2. NSF/ANSI 61 – Drinking Water System Components – Health Effects.

E. PVC Pipe Association

1. UNI-B-06-Recommended Low-Pressure Air Testing of Installed Sewer Pipe.

1.3 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temperature: Do not install pipe when temperature is below 40 degrees F (4.4 degrees C) or above 90 degrees F (32.2 degrees C) if pipe is exposed to direct sunlight.

C. Ultraviolet (UV) Protection: Provide pipe installed above ground or outside with UV protection.

PART 2 - PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

A. Manufacturers:

1. Eslon Thermoplastics; Charlotte, NC
2. R&G Sloane, Sun Valley, CA
3. Harvel Plastics, Easton, PA
4. LCP Chemicals & Plastics, Colfax, NC
5. Bristol Corp., Bristol, IN.

6. Or Approved Equal.

B. PVC Pipe and Fittings (for non-potable service):

1. PVC Pipe shall be ASTM D2241, SDR-21 for pressure service and SDR-26 for gravity service, calculated according to ASTM D2837.
2. Fittings: ASTM D2466, Schedule 40 for gravity service and ASTM D2467, Schedule 80 for pressure service.
3. Joints:

   a. Above ground service will be solvent-welded per ASTM D2855 or threaded or flanged if later removal is required.
   b. Below ground service will be gasketed joint per ASTM D-3139, and the gasket shall be per ASTM F477.

4. Materials: ASTM D1784, minimum cell classification 12454.

C. PVC Pipe and Fittings (for potable water service)

1. Pipe: AWWA C900 / AWWA C905, Class 235.
2. Fittings: AWWA C111, cast iron.
3. Joints: ASTM D3139, compression gasket ring.
4. Materials: ASTM D1784, minimum cell classification 12454-C per ASTM D1784.

D. PVC Tube and Fittings:

1. Tube:

   a. Clear.
   b. Size and Wall Thickness: schedule 80.

2. Fittings: Compression type; materials suitable for application.
3. Threads: Straight; ASME B1.1.

E. Pipe shall be colored based on applications as follows:

1. Purple – Reclaimed Water
2. Green – Sanitary Sewer Force Main and Gravity Lines
3. White – Non-potable Water
4. Blue – Potable Water

2.2 CPVC PIPE AND FITTINGS

A. Manufacturers:

1. Eslon Thermoplastics; Charlotte, NC
2. R&G Sloane, Sun Valley, CA
3. Harvel Plastics, Easton, PA
4. LCP Chemicals & Plastics, Colfax, NC
5. Bristol Corp., Bristol, IN.
6. Or Approved Equal.

B. CPVC Pipe and Fittings:

1. Pipe: ASTM F442, SDR 13.5 minimum.
2. Fittings:

a. Flanged: ASME B16.1, ASME B16.5, Class 125.
b. Socket Welded: ASTM F439, Schedule 80.
c. Threaded: ASTM F437, Schedule 80; ASME B1.20.1.

3. Joints: Flanged for above ground service, Push-on for below ground service; threaded or flanged if later removal is required.
4. Materials: ASTM D1784, minimum cell classification 23447.

2.3 ABS PIPE AND FITTINGS

A. Manufacturers:

1. Mueller Industries
2. NIBCO Inc.
3. Or Approved Equal.

B. ABS Pipe and Fittings:

1. Pipe: ASTM D1527, Schedule 40 for up to 4” and Schedule 80 for diameters greater than 4”.
2. Fittings:

a. ASTM D2661; molded; solvent cemented.
b. Flanged Fittings: ASME B16.1, ASME B16.5, Class 125.
c. Threaded Fittings: ASME B1.1.

3. Joints: Solvent welded; flanged if later removal is required.
4. Materials: ASTM D3965, minimum cell classification 42222.

2.4 PE PIPE, TUBE, AND FITTINGS

A. Manufacturers:

1. Performance Pipe
2. United States Plastic Corporation
3. Or Approved Equal.

B. Polyethylene Pipe and Fittings (for non-potable service):

1. Pipe: ASTM D2447, SDR 9, calculated according to ASTM D3035.
2. Fittings: Molded; ASTM D3261, butt welded or ASTM D2683, F1056, socket welded.
3. Joints: Socket heat fusion or Butt fusion; threaded or flanged if later removal is required.
4. Materials: ASTM D3350, manufactured from virgin resins with minimum cell classification 324433-C. No recycled compound shall be used except that generated in the

manufacturer's own plant from resin of the same specification from the same raw material supplier.

C. Polyethylene Pipe and Fittings (for Potable Water Service):

1. Pipe: AWWA C901 /AWWA C906, DR 13.5 for 160 psig pressure rating.
2. Fittings: AWWA C901, AWWA C906, molded or fabricated.
3. Joints: Butt fusion; threaded or flanged if later removal is required.
4. Materials: ASTM D3350, minimum cell classification 324433-C.

D. Polyethylene Tube and Fittings:

1. Tube:

a. AWWA C901.
b. Size and Wall Thickness: ASTM D2737 or; as indicated on piping schedule.
c. Pressure Rating: As indicated on Drawings or piping schedule.

2. Fittings: Compression type; materials suitable for application.
3. Threads: Straight; ASME B1.1.

2.5 HDPE PIPE, AND FITTINGS

A. Manufacturers:

1. ISCO.
2. JM Eagle.
3. Or Approved Equal.

B. HDPE Pipe and Fittings:

1. Pipe: ASTM F714 or ASTM D3035. DR as shown on the Drawings.
2. Fittings: ASTM D3261, butt welded and fully pressure rated for the same service condition as the pipe.
3. Joints: Butt fusion per ASTM F2620; threaded or flanged if later removal is required.
4. Materials: ASTM D3350, manufactured from virgin resins PE4710 cell classification PC445474C.
5. All HDPE pipe and fittings for potable water service shall be of nominal DIPS (ductile iron pipe size) outside diameter per AWWA C900/C905. The nominal size and DR shall be as shown on the Drawings.

2.6 ACCESSORIES

A. Flange Bolting: Stainless steel, ASTM A193 Grade 8B hex head bolts and ASTM A194 Grade 8 hex head nuts.

B. Flange Gaskets: Full faced, ethylene propylene diene monomer (EPDM), according to ASME B16.21.

C. Push-On Joint Seals:

D. Solvent Cement:

1. PVC Piping: ASTM D2564.
2. CPVC Piping: ASTM F493.
3. ABS Piping: ASTM D2235

E. Insert Fittings for PE Piping: ASTM D2609.

F. Couplings for PE Piping: ASTM F1055.

G. Tracer Wire: #12 AWG copper clad steel insulated wire, insulation color per pipe service.

H. Detectible Underground Marking Tape: underground marking tape shall be a minimum 3" width, detectable marking tape, with a minimum 5.0 mil overall thickness. Tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 mil solid aluminum foil core, and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed using a diagonally striped design for maximum visibility, and meet the APWA Color-Code standard for identification of buried utilities. Detectable marking tape shall be Pro-Line Safety Products or approved equal and made in the USA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping and components according to the following:

1. Section 40 05 13 – Common Work Results For Process Piping
2. ASME B31.3 for above ground service
3. AWWA C605 for potable water service
4. ASTM D2774 for non-potable underground pressure service
5. ASTM D2321 for non-potable underground gravity service

B. Joining:

1. HDPE pipe sections shall be joined on the jobsite above ground into continuous lengths by the Butt-Fusion Method in accordance with ASTM F2620, and in strict accordance with the Manufacturer's Recommendations. Maximum joined drag length is 600-ft.
2. HDPE pipe shall be joined to ductile iron valves and fittings with a DIPS size MJ Adapter Kit. Pipe Stiffeners shall be used to maintain roundness of the pipe. MJ adapter and stiffeners shall be installed in strict accordance with the manufacturer's instructions.
3. Perform heat joining according to ASTM D2657.
4. Perform electrofusion joining according to ASTM F 1290.
5. Primers and Cleaners: ASTM F402.
6. PVC Solvent-Cemented Joints: ASTM D2855.

C. Tracer Wire shall be installed on all non-metallic lines. The contractor shall perform a continuity test on all tracer wire in the presence of the engineer. Tracer wire shall be run along the top of the pipe and secured at intervals of 10' with wire or tape. The tracer wire shall be brought up into

all valve and meter boxes so as to be readily accessible to system operators. All wire splices and connections shall be tied and tightly taped with insulated electrical tape.

3.2 A detectable marking tape shall be installed over all nonmetallic lines by the CONTRACTOR. Care will be taken to insure that the buried marking tape will bear the words "CAUTION-PIPE LINE BURIED BELOW." The detectable marking tape will be buried 4 to 6 in. below finish grade. The tape should be placed into backfill and allowed to settle into place in the backfill.

3.3 TESTING:

A. Clean lines by flushing or other means before testing begins.

B. Testing may be dangerous if a line is improperly prepared. The Contractor shall develop and put in place proper safety procedures when performing testing.

C. PE and HDPE pipe for pressure service will be tested in accordance with ASTM F2164-13.

D. PVC pipe for pressure service will be tested in accordance with AWWA C600.

E. Tests for Gravity Service shall include:

1. Infiltration Test:

   a. All lines below the water table shall be checked for infiltration
   b. If at any time prior to expiration of the correction period stipulated in the General Condition, infiltration exists, that is any inflow, and the pipe fails.
   c. The Contractor shall locate the leaks and make repairs as necessary to remove the infiltration.

2. Deflection Testing

   a. Conduct deflection test prior to low-pressure air test.
   b. Perform deflection testing after the final backfill and compaction has been in place at least thirty (30) calendar days and prior to placing lines into operation.
   c. Each reach of pipe shall be checked for excessive deflection by pulling a mandrel through the pipe. The mandrel shall be cylindrical in shape and constructed with 9 evenly spaced arms. The critical dimensions of the mandrel shall have a +/- 0.01 inch tolerance.
   d. Deflection shall not exceed 5% of initial diameter
   e. Pipe failing the deflection test shall be uncovered, and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.

3. Low Pressure Air Testing

   a. Test each reach with maximum 5 psi
   b. The time elapsed for a 0.5 psi drop in air pressure shall be not less than 10 minutes or as specified in ASTM F1417 or UNI B-6-90 whichever is greater.

4. Joint Testing

a. For pipes large enough to enter (27” in diameter or larger), individual joints may be pressure tested with a portable tester to 5 psi maximum, with air or water in lieu of low pressure air testing.
b. Joint Testing shall be performed in accordance with ASTM C1103.

END OF SECTION 40 05 31

SECTION 40 05 51 - COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.
2. Valve actuators.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 05 50 00 – Metal Fabrications
3. Section 09 96 00 – High-Performance Coatings
4. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

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

B. ASTM International:

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

C. Manufacturers Standardization Society:

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA:

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

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:

1. Equipment Directory.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information for actuator with model number and size indicated.
2. Submit valve cavitation limits.

C. Shop Drawings: Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, and control system schematics.

D. Valve Schedule: Indicating the service, size, and connections, make, model number and any special features such as chain wheel operators, etc.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Certification of Valves Larger than 12 Inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.

H. Manufacturer Instructions: Submit installation instructions and special requirements.

I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

K. Qualifications Statement:

1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves and actuators.

1.6 QUALITY ASSURANCE

A. Maintain clearances as indicated on Drawings and Shop Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

D. The manufacturer shall be required to furnish at the time of delivery an affidavit of compliance stating the valve and all materials used conform in every respect to the applicable performance of the appropriate AWWA Standard, and these supplementary specifications and that all tests have been performed with test requirements having been met. Test requirements shall be performed and test records furnished to the engineer prior to shipment.

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Prepare valves and accessories for shipment according to latest edition of AWWA C500, Section 31 and:

1. Seal valve ends to prevent entry of foreign matter into valve body.
2. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign matter.

D. Store materials according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
3. Provide additional protection according to manufacturer instructions.

1.9 TOOLS AND SPARE PARTS

A. Provide to the OWNER, one operating wrench for every 10 valves of each type (but not less than 2 wrenches per type), not equipped with hand wheels or levers.

B. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.

B. General:

1. All packing, gaskets, discs, seats, diaphragms, lubricants, etc., shall conform to recommendations of the valve manufacturer for the intended service.
2. All valves shall be manufacturer's standard of the design which the manufacturer recommends for the service intended.
3. Each valve shall bear the maker's name or trademark or reference symbol to indicate the service conditions for which it is guaranteed.
4. All valves for use with copper tubing shall have solder type connections.
5. All screw end valves shall be threaded according to the American Standard for Pipe Threads No. B2.1.
6. Flange end valves shall have connecting end flanges in accordance with the B16.1, Class 125 Series of the American Standards Association for type valves covered in the Standard, and in accordance with the Manufacturer's Standardization Society Standard Practice for bronze valves corresponding to the maximum pressure and service for which the valve is to be used.

C. Valve Ends: Compatible with adjacent piping system.

D. Operation:

1. Open by turning counterclockwise; close by turning clockwise.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

E. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
2. Labeling: As specified in Section 40 05 53 - Identification for Process Piping.

F. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
2. Bonnets:

   a. Flanged to body and of same material and pressure rating as body.
   b. Furnish glands, packing nuts, or yokes as specified in valve Sections.

3. Stems and Stem Guides:

   a. Materials and Seals: As specified in valve Sections.
   b. Bronze Valve Stems: According to ASTM B584.
   c. Space stem guides 10 feet o.c.
   d. Submerged Stem Guides: Type 304 stainless steel.

4. Nuts and Bolts: As specified in Section 05 50 00 - Metal Fabrications.

G. Valve Type:

1. Plug Valves: As specified in Section 40 05 62 – Plug Valves.
2. Ball Valves: As specified in Section 40 05 63 – Ball Valves.
3. Butterfly Valves: As specified in Section 40 05 64 – Butterfly Valves.
4. Swing and Disc Check Valves: As specified in Section 40 05 65 – Swing Check Valves.
5. Air Release Valves for Wastewater Service: As specified in Section 40 05 78.21 – Air Release Valves for Wastewater Service.

2.2 VALVE ACTUATORS

A. Description: Manual, pneumatic and electric motor actuators.

B. Provide actuators per specification Section 40 05 57 – Actuators for Process Valves and Gates

2.3 INSULATION

A. As specified in Section 40 42 13 - Process Piping Insulation or as indicated on Drawings.

2.4 FINISHES

A. Valve lining and coating: Comply with AWWA C550.

B. Exposed Valves: As specified in Section 09 96 00 – High-Performance Coatings.

C. Do not coat flange faces of valves unless otherwise specified.

2.5 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 – Project Management and Coordination: Requirements for installation examination

B. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Valves shall be installed with the stems positioned in the horizontal or above the centerline of the pipe unless otherwise shown on the Drawings.

D. Operators shall be positioned so that they do not interfere with pedestrian traffic.

E. Valve operators which are 7 ft 0 in. or more above the operating floor or platform shall be chain wheel operated.

F. Where necessary for operations as described above, valves shall be bevel or spur gear operated. Plug valve 6 in. and larger shall be gear operated.

G. Coat studs, bolts and nuts with anti-seizing lubricant.

H. Clean field welds of slag and splatter to provide a smooth surface.

I. Install valves with stems upright or horizontal, not inverted.

J. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

K. All buried valves shall have a 2” operating nut and handwheels for all exposed valves.

L. Install 3/4-inch ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

M. Install valves with clearance for installation of insulation and to allow access.

N. Provide access where valves and fittings are not accessible.

O. Pipe Hangers and Supports: As specified in Section 40 05 07 - Hangers and Supports for Process Piping.

P. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

Q. Install insulation as specified in Section 40 42 13 - Process Piping Insulation and as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Valve Field Testing:

1. Test for proper alignment.
2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
3. Architect/Engineer will witness field testing.

END OF SECTION 40 05 51

SECTION 40 05 53 - IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Requirements:

1. Section 09 96 00 – High-Performance Coatings
2. Division 40 – Process Interconnections
3. Division 43- Process Gas and Liquid Handling, Purification and Storage Equipment
4. Division 46 – Water and Wastewater Equipment

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit one tag, label, and pipe markers for each size used on Project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirement.

G. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish one container of spray-on adhesive.

C. Tools: Furnish special tools and other devices required for Owner to reinstall tags.

1.6 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.7 QUALIFICATIONS

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

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

1. Craftmark Pipe Markers
2. Kolbi Pipe Marker Co.
3. Seton Identification Products
4. Or Approved Equal

B. Description: Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or drive pins. Nameplates shall at a minimum contain manufacturers name and address, year of manufacture, serial number, speed (if applicable) and other applicable information.

2.2 TAGS

A. Plastic Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description:

a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square.

B. Metal Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description:

a. Aluminum or Stainless-steel construction; stamped letters.
b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square with finished edges.

C. Information Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description:

a. Clear plastic with printed DANGER, CAUTION, WARNING, and message.
b. Minimum Tag Size: 3-1/4 by 5-5/8 inch.
c. Furnish grommet and self-locking nylon ties.

3. Tag Chart: Typewritten, letter-size list of applied tags and location, in anodized aluminum frame.

2.3 STENCILS

A. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Seton Identification Products
c. Or Approved Equal

B. Description:

1. Clean-cut symbols.
2. Letters:

a. Up to 2-inch Outside Diameter of Insulation or Pipe: 1/2-inch-high letters.
b. 2-1/2- to 6-inch Outside Diameter of Insulation or Pipe: 1-inch-high letters.
c. Over 6-inch Outside Diameter of Insulation or Pipe: 1-3/4-inch-high letters

C. Stencil Paint: As specified in 09 96 00 - High-Performance Coatings; semigloss enamel.

D. Color-Coding and Lettering Size: Conform to ASME A13.1.

2.4 PIPE MARKERS

A. Color-Coding and Lettering Size: Conform to ASME A13.1.

B. Plastic Pipe Markers:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Seton Identification Products
d. Or Approved Equal

2. Description:

a. Factory-fabricated, flexible, semirigid plastic.
b. Preformed to fit around pipe or pipe covering.
c. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:

1. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Seton Identification Products
c. Or Approved Equal

2. Description:

a. Brightly colored, continuously printed plastic ribbon tape.
b. Minimum 6 inches wide by 4 mil thick.
c. Manufactured for direct burial service.

2.5 LABELS

A. Manufacturers:

1. Brady ID
2. Seton Identification Products
3. Or Approved Equal

B. Description:

1. Aluminum or Laminated Mylar construction.
2. Minimum Size: 1.9 by 0.75 inches.
3. Adhesive backed, with printed identification and bar code.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

a. Brady ID
b. Master Lock Company, LLC
c. Or Approved Equal

2. Description:

a. Anodized aluminum or reinforced nylon construction.
b. Furnish hasp with erasable label surface.
c. Minimum Size: 7-1/4 by 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

a. Brady ID
b. Master Lock Company, LLC
c. Or Approved Equal

2. Description:

a. Nylon or Steel construction.
b. Furnish device preventing access to valve operator and accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Prepare surfaces as specified in Section 09 96 00 – High-Performance Coatings for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting as specified in Section 09 96 00 - High-Performance Coatings.

B. Install identifying devices after completion of coverings and painting.

C. Identify equipment with nameplates.

D. Identify inline pumps and other small devices with tags.

E. Identify control panels and major control components outside panels with plastic nameplates.

F. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

G. Labels:

1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
2. For unfinished covering, apply paint primer before applying labels.

H. Tags:

1. Install tags using corrosion-resistant chain.
2. Number tags consecutively by location.

I. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

J. Identify valves in main and branch piping with tags.

K. Piping:

1. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers and/or stenciled painting.
2. Use tags on piping 3/4-inch diameter and smaller.
3. Identify service, flow direction, and pressure.
4. Install in clear view and align with axis of piping.
5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

L. Ceiling Tacks:

1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 40 05 53

SECTION 40 05 57 - ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual actuators
2. Electric motor actuators

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications
2. Section 09 96 00 - High-Performance Coatings
3. Division 40 - Process Interconnections

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings

B. American Water Works Association:

1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service
2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates

C. NFPA:

1. NFPA 70 - National Electrical Code

1.3 COORDINATION

A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination

B. Coordinate Work of this Section with installation of valves and accessories.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals

B. Product Data: Submit manufacturer information for actuator with model number and size indicated.

C. Shop Drawings:

1. Indicate parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, control system, and control system schematics on assembly drawings.
2. Submit actuator Shop Drawings with valve and gate submittal.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special procedures and placement requirements.

F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:

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

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and types of actuators.

1.6 QUALITY ASSURANCE

A. Valve Actuators in NEC Class I, Group D, Division 1 for areas where flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.

B. Valve Actuators in NEC Class I, Group D, Division 2 for areas where flammable gases, vapors or liquids are not likely to exist under normal operating conditions.

C. Locations: Comply with NFPA 70.

1.7 QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Furnish gear and power actuators with position indicators.

2.2 MANUAL ACTUATORS

A. Gate Valves: Gave valves shall be fitted with cast iron hand wheels of suitable size or gear and hand wheel operators in accordance with AWWA C500.

B. Butterfly Valves: Butterfly valves 6 inches and smaller shall be lever and locking ratchet operated. Butterfly valves larger than 6 inches shall be equipped with gear and hand wheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operator shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used.

C. Plug and Ball Valves: Plug and ball valves 6 inches and smaller shall be lever and locking ratchet operated. Plug and ball valves larger than 6 inches shall be provided with gear and hand wheel operators.

D. Provide gear and power actuators with position indicators.

E. Gear-Assisted Manual Actuators:

1. Drive Type: Worm gear except where otherwise shown or specified
2. Provide totally enclosed gears.
3. Gearing: Designed for 100 percent overload.
4. Bearings:

    a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
    b. Permanently lubricated bronze.
    c. Minimum L10 Life: 100,000 hours.

5. Maximum Operating Force: 60 lbf.
6. Handwheel: Minimum 12-inch diameter.
7. Packing: Accessible for adjustment without requiring removal of actuator from valve.

F. Chain Actuators:

1. Description:

    a. Chain actuators for shutoff valves mounted 7 feet and greater above operating floor level.
    b. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.

2. Chain Wheels: Sprocket rim type.
3. Furnish chain storage if chains may interfere with pedestrian traffic.

G. Buried Valves:

1. Comply with AWWA C500.
2. Floors:

    a. Furnish extension stems to grade, and square nuts or floor stands with position indicators.
    b. Cast-iron/Steel pipe extensions with valve boxes, covers, and operating keys.
    c. Floor Boxes: Hot-dip galvanized cast iron or steel, with bronze cover.
    d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

3. Valve Boxes:

    a. Material: Cast iron.
    b. 12 Inch Diameter Valves and Smaller: Two-piece, screw type.
    c. Valves larger than 12 Inch Diameter: Three-piece, screw type.
    d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

2.3 ELECTRIC MOTOR ACTUATORS

A. Manufacturers:

1. Auma Actuators, Inc.; Canonsburg, PA

2. Harold Beck and Sons

3. Limitorque
4. Approved Equivalent

B. Description:

1. Motor, reduction gearing, torque switches, limit switches, auxiliary hand wheel, starter, mechanical position indicator, and accessories.
2. Comply with AWWA C542.
3. Open-close operation or modulation, as specified, or as shown on the Drawings.
4. Valve closing time will be 60 seconds, unless otherwise noted.
5. Actuators will be capable of operating in an ambient temperature range of -20 to +175 ºF.
6. All actuators in open/close service will be furnished with integral, motor controls consisting of reversing starters, control transformer, phase discriminator, monitor relay, positioner, "open-stop-close" pushbuttons, "local-off-remote" selector switch in addition to red and green indicating lights. The positioner shall be capable of accepting a 4~20 mADC signal from the controller and positioning the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer mounted inside the actuator. The positioner shall be field adjustable to fail in the "open", "closed" or "last" position on loss of 4~20 mADC command signal.

C. Enclosure:

1. Minimum NEMA 250 Type 4. When specified, motor and all electrical enclosure shall be available to meet NEMA 6 submersible, or NEMA 7 hazardous requirements.
2. Mounting: Attached actuator housing using flanged motor adapter.

D. Motors:

1. Type:

a. Reversing or modulating, as specified, or as shown on the Drawings.
b. Totally enclosed, non-ventilated, high starting torque, low starting current.
c. Full-voltage starting.

2. Electrical Characteristics:

a. Connections: As specified in Division 26 – Electrical.
b. Torque: A running torque per valve manufacturer's recommendation.
c. Sufficient horsepower to open or close a valve against the maximum specified differential pressure when voltage to the motor is ±10% of nominal voltage with a factor of safety of 1.5.

d. Voltage: 480 V, three phase, 60 Hz, or 120 V, one phase, 60 Hz (see electrical drawings). An Internal step-down transformer must be provided by manufacturer if Harold Beck and Sons Electric Actuators are utilized.
e. Lubrication: Pre-lubricated.
f. Bearings Type: Anti-friction
g. Motor Rating: 30 minute duty.

E. Reduction Gearing:

1. Description: Single- or double-reduction unit of spur or helical gears and worm-gearing.
2. Lubrication: Grease or oil.
3. Bearings:

a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
b. Minimum L10 Life: 100,000 hours.

F. Limit Switches:

1. Type: Heavy duty, open contact.
2. Actuation: Rotor cam.
3. Compartment: Totally enclosed and equipped with a heater and thermostat to prevent build-up of moisture and contamination.
4. Switches shall be SPDT and rated 10A at 120 VAC or as specified.
5. Actuating Point: Adjustable at any point of valve between fully open and fully closed.
6. Adjustment: Capable of quick adjustment requiring no more than five (5) turns of the adjustment spindle.
7. Contacts: One set of normally open and one set of normally closed contacts will be furnished and available for use by the plant control system at each end of travel where indicated. Contact shall be of silver and capable of reliably switching a low voltage DC source from the control system furnished by other.

G. Torque Limiting Switches:

1. Torque limiting switches shall be provided.
2. Torque limiting switches shall be responsive to the mechanical torque developed in seating, backseating, or by obstruction.
3. Accuracy: Within ±5%
4. Calibration: The use of torque wrenches for calibration shall not be required. Calibrated by use of a dynamometer in order to accurately predict the output of the actuator.
5. A calibration tag stating the maximum torque output of each torque switch at 100% setting shall be permanently affixed to the torque switch dial.

H. Extended Shafts

1. Bonnets/shaft enclosures for valve shafts that extend through grating shall be connected to the valve body. No force shall be applied to the grating to actuate the valve.

I. Hand Wheel Operation:

1. A permanently attached hand wheel shall be provided for emergency manual operation.
2. A seized or inoperable motor shall not prevent manual operation.

3. The hand wheel shall not rotate during electrical operation.
4. Maximum Torque Required: 60 lb-ft.
5. Maximum Force Required: 60 lbs.
6. Inscription: An arrow and either the work OPEN or CLOSE shall be cast in the hand wheel to indicate the direction to turn hand wheel.
7. Minimum Diameter: 8 inches.

J. Handwheel Mechanism:

1. Handwheel shall be spoke free and less than 7-inches in diameter, capable of being operated with a single hand. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assemblies.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

3.2 INSTALLATION

A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.

B. Extend chain actuators to 5-1/2 feet above operating floor level.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating as specified in Section 09 96 00 - High-Performance Coatings.

END OF SECTION 40 05 57

SECTION 40 05 59 - ALUMINUM SLIDE GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Aluminum slide gates.

B. Related Requirements:

1. Section 03 30 00 – Cast-In-Place Concrete
2. Section 05 50 00 – Metal Fabrications
3. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
2. AWWA C542 - Electric Motor Operators for Valves and Slide Gates.
3. AWWA C562 - Fabricated Aluminum Slide Gates.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination

B. Coordinate Work of this Section with Work of other Sections.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's product information for system materials and component equipment.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation and anchoring requirements, fasteners, and other details.
3. Indicate gate identification number, location, service, type, size, design pressure, operator details, stem details, and loads.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certify that installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer's instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

I. Qualifications Statements:

1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed slide gates and components.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

C. Tools: Furnish special tools, wrenches, etc. and other devices required for Owner to maintain equipment.

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging, and inspect for damage.

C. Store materials according to manufacturer's instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from areas involved in construction operations.
2. Provide additional protection according to manufacturer's instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

C. Furnish five year manufacturer's warranty that clear plastic stem covers will not crack, discolor, or become opaque.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Seating/Unseating Pressure:

1. Measurement: From maximum water surface to centerline of gate.

B. Minimum Vertical Loading: 50 percent of force on the gate from operating head acting on horizontal centerline of gate, multiplied by effective gate area, plus weight of slide and stem.

C. Gate Reinforcement: As required for deflection not greater than 1/360 of span.

D. Operating Head:

1. Safety Factor: Design gate to operate under specified operating head with safety factory of three.

2.2 ALUMINUM SLIDE GATES

A. Manufacturers:

1. Whipps, Inc.
2. Waterman Industries
3. Hydro Gate
4. Golden Harvest, Inc.
5. Or Approved Equal

B. Description:

1. Comply with AWWAC562.
2. Self-contained aluminum slide gate, with extended frame, stiffeners, yoke, lifting stem attached to yoke, lift and lift support, stem, stem guide, and stem block.
3. Non-self-contained aluminum slide gate, with limited frame, lifting stem, lift and lift support, stem, stem guide, and stem block.
4. Size, Operating Head, Closure and Opening are as indicated on Gate Schedule in Drawings.

C. Gates:

1. Location: See P&ID drawings and P&ID valve schedule drawing.

2. Configuration:

   a. One piece.
   b. Removable.

3. Material:

   a. Type 6061-T6 aluminum.
   b. Comply with AWWA C562.

4. Minimum Thickness: 1/4 inch.
5. Size: As indicated on Drawings.

D. Yokes:

1. Material: Structural steel.
2. Mounting: Bolted to gate frame.

E. Seats:

1. Impacted into dovetail slots and held in position without use of screws or other fasteners.
2. Maximum Clearance between Seating Faces: 0.004 inch when gate is fully closed.

F. Wedges:

1. Description: Machined brass blocks with angled faces and secured with a stud bolt to prevent slippage during operation.
2. Provide side, top, and bottom wedges.

G. Frames:

1. Configuration: One piece.
2. Material:

    a. Type 6061-T6 extruded aluminum.
    b. Comply with AWWA C562.
    c. Bearing Bars: Ultra-high-molecular-weight polymer.

3. Mounting: As indicated on Drawings.
4. Minimum Thickness: 1/4 inch.
5. Liner: One-piece, extruded polymer channel or Neoprene rubber seal.
6. Bottom Flush Closure: Resilient seal securely attached to frame along invert.
7. Seal: UHMW seat / seal.

H. Lifting Devices:

1. Description: Stem, lifting nut, supports, bushings, stem cover, position indicator, gear-assisted handwheel, handwheel, gear-assisted crank, crank, pneumatic actuator, hydraulic actuator and electric-motor actuator.
2. Mounting: Fabricated 304 stainless steel pedestal.
3. Powered Lift Devices:

    a. As specified in Section 40 05 57 – Actuators for Process Valves and Gates.
    b. Comply with AWWA C541 and AWWA C542.

4. Hand-Lifted Gates: Provide PVC grip for hand hole or stainless-steel lifting handle.

I. Handwheel:

1. Material: Cast aluminum.
2. Diameter: 18 inches, minimum.
3. Fully lubricated.
4. Configuration: Removable.
5. Mounting: Locate center of handwheel 36 inches above operating floor.

J. Lifting Nut:

1. Material: Brass.
2. Furnish grease fitting.
3. Furnish polymer bearing pads above and below lifting nut.

K. Lifting Stem:

1. General:

    a. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 lbs. effort on the crank or handwheel. The L/r ratio of the unsupported stem shall not exceed 200.
    b. Stem guides, where required to limit the unsupported stem length, shall have a polymer or bronze bushings.

2. Material: Type 304 stainless steel.
3. Configuration:

    a. Rising or Nonrising.
    b. Removable.

4. Thread:

    a. Acme, double lead.
    b. Cut threads are not acceptable.

5. Fully lubricated.
6. Diameter: 1-1/8 inch
7. Maximum Number of Turns: 16 per foot of travel.
8. Stem Covers: Provide rising stem gates with clear polycarbonate or methacrylate plastic covers, capped, vented, and of a length to allow full travel of gate.

2.3 FINISHES

A. Stainless-Steel Surfaces: Mill finish.

2.4 ACCESSORIES

A. Hardware: Type 316 stainless steel.

B. Nameplates: As specified in Section 40 05 53 - Identification for Process Piping.

2.5 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assemblies.

C. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

    1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that facilities are ready to receive slide gates.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Clean surfaces according to manufacturer's instructions.

3.3 INSTALLATION

A. Install slide gates according to manufacturer's instructions.

B. Ensure that products are installed plumb, true, and free of warp or twist.

C. Locate operators to avoid interference with handrails and other work.

D. Guides:

1. Surface and Flange Mounted:

    a. Install guides with expansion anchors.
    b. Position guides at elevation as indicated on Drawings.

2. Recessed:

    a. Cut slot in concrete to receive guides.
    b. Position guides at elevation as indicated on Drawings.
    c. Aluminum frames in contact with concrete or grout shall be coated with bitumestic.
    d. Grout guides in place according to manufacturer's instructions.

E. Sealant:

1. Apply 1/8-inch-thick layer of elastomeric sealant to back of frame.
2. Tighten nuts snug until sealant begins to flow beyond frame.
3. Remove excess sealant.
4. Cure sealant for minimum seven days.
5. Tighten nuts to their final positions.

F. Lubricants: Provide oil and grease as required for initial operation.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspection:

1. Verify alignment of gate and components.
2. Verify that gate operates smoothly and does not bind or scrape.

D. Testing:

1. Comply with AWWA C501.
2. Leakage: Not exceeding 0.1 gpm/ft. of seating perimeter under 20 feet of seating head and not exceeding 0.21 gpm/ft. under 20 feet of unseating head.

E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) days on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

F. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and re-inspect.
2. Make final adjustments to equipment under direction of manufacturer's representative.

G. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Adjust slide gates to provide smooth operation.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate equipment operation, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 05 59

SECTION 40 05 62 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Eccentric plug valves.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
4. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.

C. ASTM International:

1. ASTM A536 - Standard Specification for Ductile Iron Castings.
2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

PART 2 - PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:

1. Dezurik
2. Milliken; Henry Pratt Company
3. GA Industries
4. Or approved equal

B. Description:

1. Type:
   a. Non-lubricated.
   b. Eccentric.
   c. 90 Degree Turn
   d. Resilient faced Plug

2. Working Pressure: 175 psig for valves through 12” and 150 psig for valves for 14” through 72”.
3. Ports:

   a. Configuration: Round or rectangular
   b. Minimum Port Area: 80 percent of nominal pipe area for round port, 100% of nominal pipe area for rectangular port valves.

4. Stem Bearings: Self-lubricating.
5. Stem Seals:

   a. Type: V-rings or multiple U-cups
   b. Material: Buna-N

6. End Connections:

   a. Flanged: Comply with ANSI 125/150 lb. Standard
   b. Mechanical Joint

C. Operation:

1. As specified in Section 40 05 57 Actuators for Process Valves and Gates.

D. Materials:

1. Body:

   a. Cast iron, ASTM A126 Class B or ductile iron, ASTM A536 Gr 65-45-12.
   b. Lining: As recommended by valve manufacturer for service conditions.

2. Plug:

   a. Cast iron, ASTM A126 Class B or ductile iron, ASTM A536 Gr 65-45-12.
   b. Lining: Buna-N

3. Seats: 1/8”, welded, 90% pure Nickel.
4. Stem Bearings: Type 316L stainless steel.
5. Seals: Buna-N.
6. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

C. Testing: Test gate valves according to AWWA C509.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

B. According to AWWA C517.

C. Horizontal Piping: Stem horizontal.

D. Vertical Piping: Plug at top when closed.

E. Plugs: On top when open and on pressure side when closed.

END OF SECTION 40 05 62

SECTION 40 05 63 - BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-seated ball valves.
2. Plastic ball valves (BA).

B. Conform to requirements of Section 40 05 51 – Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C507 - Ball Valves, 6 In. Through 60 In.

B. ASME International:

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

C. ASTM International:

1. ASTM D1784 - Standard Specification for Rigid PolyVinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
2. ASTM D3222 - Standard Specification for Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

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

1. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

PART 2 - PRODUCTS

2.1 RUBBER-SEATED BALL VALVES

A. Manufacturers:

1. Henry Pratt Company; Aurora, IL
2. APCO
3. GA
4. Or approved equal

B. 4 Inches through 48 Inches:

1. AWWA C507, Class 150.
2. Body:

    a. Material: Ductile iron, ASTM A536.
    b. Seats: Rubber.

3. Ball:

    a. Material: Cast iron, ASTM A126 or Ductile iron, ASTM A536.
    b. Bearing Seal, O-Rings, and Packing: Buna-N.

4. Shaft and Attachment Pins: Type 316 stainless steel.
5. Bearings: PTFE-lined with fiberglass backing.
6. Shaft Seals: Self-lubricating and self-adjusting.
7. Connecting Hardware: Type 316 stainless steel.
8. End Connections:

    a. Flanged: Comply with ASME B16.1.

9. Operator: Handwheel.

C. Smaller Than 4 Inches:

1. Comply with MSS SP 110.
2. Body:

    a. Type: Two piece.
    b. Material: Bronze.

3. Ball: Stainless steel.
4. Port: Full.
5. Seats: PTFE.
6. Stem: Blowout proof.
7. End Connections: Threaded, with union.
8. Operator: as scheduled
9. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 PLASTIC BALL VALVES

A. Manufacturers:

1. Hayward
2. Or approved equal.

B. Description:

1. Working Pressure: 232 psig at 68 deg. F.
2. Ports: Full size.
3. End Connections:

a. Socket Union
b. Threaded Pipe Union.

C. Operator: Manual unless otherwise specified or shown.

D. Materials:

1. Body and Ball: PVC, CPVC, PP as specified, shown on drawings, or recommended by the manufacturer for the service conditions specified.
2. Seats: PTFE.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

C. Testing: Test ball valves according to AWWA C507.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

B. According to AWWA C507

END OF SECTION 40 05 63

SECTION 40 05 64 - BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber-seated butterfly valves.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves.

B. ASME International:

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

C. ASTM International:

1. ASTM A536 - Standard Specification for Ductile Iron Castings.
2. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D3222 - Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
4. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

PART 2 - PRODUCTS

2.1 RUBBER-SEATED BUTTERFLY VALVES

A. Manufacturers:

1. DeZurik
2. Milliken; Henry Pratt Company

3. GA Industries
4. Or approved equal

B. Description:

1. Comply with AWWA C504, Class 150.
2. Minimum Working Pressure: 150 psig.
3. Shaft: Bearings shall be non-metallic and permanently lubricated.
4. Seats:

    a. Mounting: On body for valves 24 inches and smaller.
    b. Type: Field replaceable for valves larger than 30 inches.

5. Packing: V-type packing with a minimum of 4 sealing rings or multiple U-cups.
6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

C. Operator:

1. As specified in Section 40 05 57 – Actuators for Process Valves and Gates
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or ductile iron, ASTM A536 Grade 65-45-12.
2. Stem: Stainless steel.
3. Disc: Cast iron, ASTM A48, Class 4C or ductile iron, ASTM A536 Grade 65-45-12
4. Seats:

    a. Type: Resilient.
    b. Material: Buna N or EPDM for water, or as required for other services

5. Seating Surfaces: Type 316 stainless steel.
6. Bearings: Non-metallic and permanently lubricated.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 09 96 00 – High-Performance Coatings.

2.2 BUTTERFLY VALVES FOR AIR SERVICE

A. Manufacturers:

1. DeZurik
2. Henry Pratt Company
3. M & H
4. GA Industries
5. Or approved equal

B. Description:

1. Comply with AWWA C504, Class 150.

2. Minimum Working Pressure: 175 psig.
3. Shaft: Bearings shall be non-metallic and permanently lubricated.
4. Seats:

    a. Mounting: On body for valves 24 inches and smaller.
    b. Type: Field replaceable for valves larger than 30 inches.

5. Packing: V-type packing with a minimum of 4 sealing rings or multiple U-cups.
6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

C. Operator:

1. As specified in Section 40 05 57 – Actuators for Process Valves and Gates
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or ductile iron, ASTM A536 Grade 65-45-12.
2. Stem: Stainless steel.
3. Disc: Cast iron, ASTM A48, Class 4C with welded nickel edge or ductile iron, ASTM A536 Grade 65-45-12 with 316 stainless steel edge.
4. Seats:

    a. Type: Resilient.
    b. Material: EPDM for up to 250F air service.

5. Seating Surfaces: Type 316 stainless steel.
6. Bearings: Non-metallic and permanently lubricated.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

C. Testing: Test butterfly valves according to AWWA C504.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

B. According to AWWA C504.

END OF SECTION 40 05 64

SECTION 40 05 65.23 - SWING AND DISC CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Swing check valves three (3) inches and larger.

B. Conform to the requirements of Section 40 05 51 – Common Requirements for Process Valves.

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm through 600-mm) NPS.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.

PART 2 - PRODUCTS

2.1 STANDARD SWING CHECK VALVES

A. Manufacturers:

1. DeZurik
2. Milliken; Henry Pratt Company
3. APCO

4. GA Industries
5. Or Approved Equal

B. Description:

1. Type: Swing, resilient seated with outside lever and adjustable weight.
2. Comply with AWWA C508.
3. Swing check valves shall be used for water and wastewater service.
4. Minimum Working Pressure: 200 psig for 2” - 12” and 150 psig for 14” - 30”
5. Flow area: Full open, equal to connecting nominal pipe diameter.
6. Check valves 6 inches and larger: Furnish with adjustable air cushion chambers.
7. Mounting: Horizontal or vertical.
8. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation.

C. Materials:

1. Body and Disc: Ductile iron, ASTM A536 or cast iron, ASTM A126 Class B.
2. Cover: Ductile iron, ASTM A536 or steel, ASTM A36.
3. Disc, Disc Arm: Ductile iron, ASTM A536.
4. Body Seat: Replaceable, Type 316 ASTM A276 with Buna-N renewable seat ring.
5. Shaft: Type 303 Stainless Steel ASTM A582.
6. Disc Seat: Buna-N.
7. Lever and Counterweight: Ductile Iron, ASTM A536.
8. Hinge Pin and Key: Type 316 Stainless Steel.
9. Rubber Components: Buna-N .
10. Connecting Hardware: Type 304 Stainless Steel.

D. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 SYNTHETIC DISC CHECK VALVE

A. Manufacturers:

1. Valmatic
2. APCO
3. GA Industries
4. Or approved equal.

B. Description:

1. Comply with AWWA C508
2. Minimum Working Pressure: 200 psig for 2” - 12” and 150 psig for 14” - 30”
3. Type: Swing, flexible disc check valve, full body flow type.
4. Mounting: Horizontal or vertical.
5. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation

C. Materials:

1. Body and Cover: Ductile iron, ASTM A536.
2. Disc: Precision molded Buna-N ASTM D2000
3. Epoxy Coated Interior
4. Screw-Type Stainless Steel backflow actuator
5. Mechanical Position indicator
6. Open-Close position indicator limit switch (if required per P&ID drawings)

D. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:

1. Hydrostatically test check valves at twice rated pressure according to AWWA C508.
2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves.

B. According to AWWA C508.

END OF SECTION 40 05 65.23

SECTION 40 05 78.21 - AIR RELEASE VALVES FOR WASTEWATER SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Air release valves for wastewater treatment facilities.

1.2 SUBMITTALS

A. Product Data: Manufacturer catalog information.

B. Shop Drawings: Assembly drawings indicating materials, dimensions, weights, and end connections.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Manufacturer Instructions: Special procedures and setting dimensions.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Qualifications for manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section with five (5) years' experience. Valve shall be manufactured per ANSI/ AWWA C512.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.5 WARRANTY

A. Furnish five (5) year manufacturer's warranty for air release valves.

PART 2 - PRODUCTS

2.1 AIR RELEASE VALVES FOR WASTEWATER SERVICE

A. Manufacturers:

1. GA Industries, APCO Valve Corporation, Crispin, Henry Pratt, or Val-Matic.
2. Substitutions: Permitted.

B. Description:

1. Stems and Bodies: Long-float type.
2. Furnish blowoff valve, inlet shutoff valve, water inlet valve, quick-disconnect couplings, and minimum 5 feet of hose.

C. Materials:

1. Body and Cover: ASTM A126 Class B cast iron, or ASTM A536 Grade 65-45-12 ductile iron.
2. Float, Seat, and Trim: Type 316 stainless steel.

D. Working Pressure: 150 psig.

E. Size: 2 – 4 Inch.

F. End Connections: NPT inlets and outlets.

2.2 INSULATION

A. As specified in Section 40 42 13 - Process Piping Insulation or indicated.

2.3 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 09 96 00 – High Performance Coatings

2.4 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field dimensions are as indicated.

B. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flanges mate properly.

3.2 PREPARATION

A. Thoroughly clean end connections before installation.

B. Close pipe and equipment openings with caps or plugs during installation.

C. Cleaning: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to manufacturer instructions.

B. Provide access for operation, removal, and maintenance, and to avoid discharge to occupied areas or other equipment.

3.4 FIELD QUALITY CONTROL

A. Inspection: After installation, inspect for interferences and proper supports.

B. Testing:

1. Demonstrate operation without undue noise or vibration.

C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.5 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 05 78.21

SECTION 40 42 13 - PROCESS PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Process piping insulation.
2. Jacketing.
3. Accessories.

B. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
18. ASTM D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedule 40, 80, and 120.
19. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

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

1. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit product description, thermal characteristics, list of materials, and thickness for each service and location.

C. Manufacturer's Instructions: Submit manufacturer's published literature indicating recommended installation procedures.

1.4 QUALITY ASSURANCE

A. Comply with ASTM C585 for inner and outer diameters of pipe insulation.

B. Factory-fabricated fitting covers according to ASTM C450.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on-Site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Inspection: Accept insulation on-Site in manufacturer's packaging. Inspect for damage.

D. Store insulation according to manufacturer's instructions.

E. Protect insulation from weather and construction traffic, dirt, water, chemicals, and damage by storing in original wrapping.

1.6 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Install insulation only when ambient temperature and humidity conditions are within ranges as recommended by manufacturer.

C. Maintain recommended temperature and humidity before, during, and after installation for minimum of 24 hours.

1.7 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Type P-1:

1. Description: Molded glass fiber.
2. Comply with ASTM C547. Comply with ASTM C795 for application on austenitic stainless steel.
3. Thermal Conductivity: 0.23 Btu-in./h-ft.-ºF at 75°F.
4. Operating Temperature Range: 0 to 850 °F.
5. Vapor Barrier Jacket:

    a. Description: Factory-applied, reinforced foil kraft with self-sealing adhesive joints.
    b. Comply with ASTM C1136, Type I.

6. Jacket Temperature Limits: -20 to 150 °F.

B. Type P-5:

1. Description:

    a. Flexible, closed-cell elastomeric.
    b. Tubular.

2. Comply with ASTM C534, Type I.

3. Thermal Conductivity: 0.27 Btu-in./h.-ft.-ºF at 75°F.
4. Operating Temperature Range: -70 to 180 °F.

2.2 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:

1. Description:

   a. One-piece, molded-type fitting covers and sheet material.
   b. Color: Off-white.

2. ASTM D1785.
3. Thickness: 15 mils.
4. Connections: Brush-on welding adhesive.

B. Acrylonitrile Butadiene Styrene (ABS) Plastic Pipe Jacket:

1. Description:

   a. One-piece, molded-type fitting covers and sheet material.
   b. Color: Off-white.

2. Minimum Service Temperature: Minus 40°F.
3. Maximum Service Temperature: 180°F.
4. Water Vapor Permeance:

   a. ASTM E96.
   b. 0.02 perms.

5. Thickness: 30 mils.
6. Connection: Brush-on welding adhesive.

C. Stainless-Steel Pipe Jacket:

1. Comply with ASTM A240 or ASTM A666.
2. Material: Type 304 stainless steel.
3. Thickness: 0.016 inch.
4. Finish: Smooth.
5. Metal Jacket Bands:

   a. Width: 3/8 inch.
   b. Thickness and Material: 0.020 inch, stainless steel.

2.3 PIPE INSULATION ACCESSORIES

A. Closed-Cell Elastomeric Insulation Pipe Hangers:

1. Description: Polyurethane insert with stainless-steel jacket single-piece construction and self-adhesive closure.

2. Thickness: Match pipe insulation.

B. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12-inch centers.

C. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that piping and equipment has been tested before applying insulation materials.

C. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Fire-Rated Penetrations:

1. Continue insulation through penetrations of building assemblies or portions of assemblies having fire-resistance rating of one hour or less.
2. Provide intumescent firestopping when continuing insulation through assembly.
3. Finish at supports, protrusions, and interruptions.

C. Piping Systems Conveying Fluids below Ambient Temperature:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies and expansion joints.

2. Jacketing:

a. Furnish factory-applied or field-applied vapor-retarder jackets.
b. Secure factory-applied jackets with pressure-sensitive adhesive with self-sealing longitudinal laps and butt strips.
c. Secure field-applied jackets with outward-clinch expanding staples, and seal stapled penetrations with vapor-retarder mastic.

3. Fittings, Joints, and Valves:

a. Insulate with molded insulation of like material and thickness as adjacent pipe.
b. Finish with glass cloth and vapor-retarder adhesive or PVC fitting covers.

D. Glass-Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation.
2. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface; on cold equipment, use vapor-retarder cement.
4. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Inserts and Shields:

1. Piping 1-1/2 Inch Diameter and Smaller: Install stainless steel shield between pipe hanger and insulation.
2. Piping 2-Inch Diameter and Larger:

    a. Install insert between support shield and piping, and under finish jacket.
    b. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    c. Insert Material: Compression-resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller-Type Pipe Hangers: Install stainless steel shield between roller and inserts.

F. Closed-Cell Elastomeric Insulation:

1. Push insulation onto piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. If application requires multiple layers, apply with staggered joints.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

G. High-Temperature Pipe Insulation:

1. Install in multiple layers to meet scheduled thickness.
2. Attach each layer with bands, securing first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Cover with stainless-steel jacket with seams located on bottom side of horizontal piping.

H. Piping Exposed in Equipment Rooms or Finished Spaces (less than 10 feet above Finished Floor): Finish with PVC jacket and fitting covers or ABS jacket and fitting covers.

I. Piping Exterior to Building:

1. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass-mesh-reinforced, vapor-retarder cement.
2. Cover with stainless-steel jacket with seams located at 3- or 9-o'clock position on side of horizontal piping, with overlap facing down to shed water, or on bottom side of horizontal piping.

J. Buried Piping:

1. Insulate only where insulation manufacturer recommends insulation product may be installed in trench or tunnel, or direct buried.

2. Install factory-fabricated assembly with inner all-purpose service jacket, with self-sealing lap, and asphalt-impregnated open-mesh glass fabric with 1-mil-thick aluminum foil sandwiched between three layers of bituminous compound.
3. Face outer surface with polyester film.

K. Heat-Traced Piping Interior to Building:

1. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe.
2. Size large enough to enclose pipe and heat tracing.

L. Heat-Traced Piping Exterior to Building:

1. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe.
2. Size insulation large enough to enclose pipe and heat tracing.
3. Cover with stainless-steel jacket with seams located at 3- or 9-o'clock position on side of horizontal piping, with overlap facing down to shed water.

M. Prepare pipe insulation for finish painting as specified in Section 09 96 00 – High-Performance Coatings.

3.3 ATTACHMENTS

A. Process Piping Insulation Schedule:

1. Potable and Non-potable Water (where exposed):
2. Chemical Feed Piping (where exposed)

a. Type P-1 or P-5.
b. Thickness:

1) Pipe Sizes 1-1/4 Inches and Smaller: 1/2 inch.
2) Pipe Sizes 1-1/2 Inches and Larger: 1 inch.

END OF SECTION 40 42 13

SECTION 40 70 00 - INSTRUMENTATION DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Primary elements.

B. Transmitters.

C. Receivers.

D. Analytical instruments.

E. Devices.

F. Cables.

1.2 SYSTEM DESCRIPTION

A. System consists of all field and panel mounted instrumentation devices as noted, complete with all necessary signal converters, isolators, amplifiers, power supplies, cables and other appurtenances necessary for interfacing with other components.

B. Except as noted, scale all indicators in engineering units.

1.3 SUBMITTALS

A. Submit product data.

1.4 MAINTENANCE AND TEST EQUIPMENT

A. In addition to the tools and test equipment, provide the following complete with carrying cases, patch cords, etc.

1. One portable admittance tester with rechargeable batteries as manufactured by Drexelbrook or equal, to calibrate the admittance instruments provided.
2. One pneumatic calibrator as manufactured by Wallace & Tiernan, Meriam Instrument, or equal.
3. One (1) hand held smart transmitter calibrators shall be provided by the transmitter manufacturer to calibrate all smart field transmitters provided.

B. Spare Parts

1. Miscellaneous Spare Parts
   a. One year supply of items recommended by the Manufacturer of the equipment for each component.
2. The spares shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.
3. Provide other spare parts as indicated on the individual device specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTS AND DEVICES

A. Level Transmitters (Flow Measurements) – Ultrasonic

1. Type: Microprocessor based ultrasonic level transmitter. Unit shall have input or output filter capability.
2. Sensor: Sensors shall have minimum 26 foot range and shall be supplied with sufficient cable length for arrangement indicated. Sensor shall have a NEMA 4X (minimum) enclosure. Unit shall be supplied with automatic temperature compensation as required below. Sensor face material shall be Kynar or Teflon as required.

3. Accuracy: ± 1.0 percent of calibrated range or better for ranges greater than 25-inches (with temperature compensation).

4. Output: Isolated 4-20 mADC into loop loads of 0 to 500 ohms (minimum), two (2) Form "C" Relay Contacts rated at 5A, 250 VAC, non-inductive.

5. Enclosure: NEMA 4X, polycarbonate or fiberglass.

6. Power Supply: 120 VAC

7. Mounting: The System Manufacturer shall coordinate mounting to ensure that the sensor is mounted away from vessel walls and other obstructions in accordance with the manufacturer's recommendations. All chemical storage tank sensors shall have Teflon face suitable for 4" flange mounting. The System Manufacturer shall provide appropriate standoff distance for sensor face from the highest liquid level to accommodate blanking distance.

8. Acceptable Manufacturers: Equal to Milltronics (Hydro-Ranger 200), Endress & Hauser (Prosonic), Systematic Controls, or STI.

B. Level Transmitter (Submersible Head-Type)

1. Type: Pressure sensor
2. Transmitter: Control box with Local LED display of level in Feet and built-in power supply to convert 110/1/60 to 24 VDC for pressure sensor loop power. Control box to have one or two displays as required.
   a. Outputs: one or two 4-20 mA outputs
   b. Accuracy: 0.3% of full range
   c. Enclosure: NEMA 4X, polycarbonate housing
   d. Power Supply: 120VAC, 1 PH, 60 HZ
3. Sensor: 316SS sensor housing and pressure sensor diaphragm with 33' of viton cable. Polarity independent leads for 24 VDC powered loop from transmitter. Atmospheric compensation tube built into cable. Range as specified on instrument chart.
4. Cleaning: Not required
5. Transmitter (Control Box) Mounting: mounted to 1/8" aluminum mounting plate with drip lid and SS hinged opaque sun shield.
6. Sensor Mountings:

a. PVC hanger with minimum of 4" of cable contact and SS cable for hanging to eye bolt on side of tank or as specified on instrument chart.

b. Slide Rail Mounting: Sensor supplied with two SS clips and 19" long SS Slide rail for wall mounting

7. Start-Up: provide minimum of 2 hours/meter of service by factory-authorized representative for system start-up plus ½ day of training.

8. Acceptable Manufacturer: Endress & Hauser Waterpilot FMX 21 model of approved equal.

C. Level Switch (Float Type)

1. Type: Submersible coated 316 stainless steel, polypropylene, or polyethylene body; non-mercury switch contact rated 4 amps at 120 VAC; normally open, normally closed, or Form C (N.O. and N.C.) contact configuration as indicated. Mercury float switches are unacceptable.

2. Cable: Minimum 18 gauge, 300 volt (minimum) rated; heavy-duty type SOW or equivalent. Provide sufficient length for mounting at the elevations indicated.

3. Junction Box: Provide NEMA 4X stainless steel junction box, mounted near the switch, for terminating vendor supplied cable and discrete control wiring to control panel.

4. Switch Mounting: The System Manufacturer shall provide 3/4 or 1 inch Schedule 40 PVC, 316 stainless steel pipe, or 1.25 inch cable for mounting the floats for a particular tank or well. The pipe shall extend from two feet above the highest switch setting (up to the top of the vessel) to two feet below the lowest level setting (down to the vessel bottom) for the vessel or well and allow for adjustment of the switch or switches anywhere along the length of the pipe. The method for fixing the float to the pipe shall be easily adjustable and shall provide for protection and strain relief for the float switch cable. Provide a minimum of two mounting brackets for fixing the pipe to the vessel wall while maintaining appropriate standoff distance. The System Manufacturer shall ensure mounting is in accordance with the manufacturer's recommendations.

5. Spare Parts: Provide 2 spare float switches.

6. Acceptable Manufacturers: Equal to Warrick Series M, Anchor Scientific.

D. Pressure and Vacuum Gauges

1. General: Pressure and vacuum gauges shall, unless otherwise specified, conform to the following. Gauges shall be of the stem-mounting type unless panel-mounted type is shown on the Schedule.

2. Construction: Gauges shall be of the bourdon tube or bellows type with 270 degrees clockwise pointer travel. Dials shall be white with black numerals. Dial size shall be 4 1/2-inch. Panel-mounted gauges shall have round bezels for flush mounting and rear connection, others shall have a stem-mounting bottom connection. Connections for all gauges shall be male 1/2-inch NPT with square wrench flats. Wetted parts shall be corrosion-resistant to the process fluid shown in the Table A and unless specified in the Table A shall be the manufacturer's best quality standard. All dials shall be glycerin filled, hermetically sealed. Cases shall be black phenolic. Accuracy shall be ±0.5% of span.

3. Chemical Seal: Where used for sewage or sludge service, the gauge shall be furnished with a diaphragm seal unless specified elsewhere. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its

measuring element from the process fluid. The space between the diaphragm and the instruments pressure element shall be completely filled with a suitable fill liquid – defaulting to silicone oil. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch or any other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit the servicing of the need to refill. All exposed surfaces, top and bottom housings, and diaphragm shall be constructed of Type 316 stainless steel as a minimum and shall be compatible with the process fluid. The process connection shall be a 3/4-inch threaded connection with a flushing connection.

4. Manufacturers: The gauges shall be as manufactured by Ashcroft Duraguage, U.S. Gauge, or user approved equal. The diaphragm seals shall be as manufactured by Ashcroft 200 series, Mansfield and Green SG Series, or approved equal.

E. In-Line Pressure Seal

1. Where specified provide a pressure isolating ring that uses a elastomer membrane to isolate a pressure measurement from the process fluid in the pipeline. The membrane/diaphragm shall be provide direct contact with the process fluid but shall isolate the pressure measurement from the effects of solids, abrasives and slurries in the pipe line that would clog standard pressure sensing lines.
2. The pressure sensed by the membrane shall be transmitted to the associated pressure sensor, gauges, and/or transmitter via use of a suitable fill fluid – defaulting to silicone oil. Any air between the membrane and the associated pressure devices shall be fully evacuated during the filling process.
3. Inside diameter of the measuring membrane shall match the inside diameter of the associated pipeline.
4. Manufacturers: The in-line pressure seal shall be manufactured by Onxy Valve, Red Valve, or approved equal.

2.2 CABLES

A. Fiber Optic Cable

1. Fiber optic cable shall be optic multimode, loose tube, all-dielectric cable, Siemens, Nordx/CDT, Belden, or approved equal, and meet the following specifications:

Cladding Diameter	125.0 Microns
Core Diameter	62.5 Microns
Attenuation Range	≤0.8 dB/KM at 1300 NM ≤3.1 dB/KM at 850 NM
Bandwidth Range	≥600 Mhz-KM at 1300 NM ≥200 Mhz at 850 NM
Cable Construction	Splitable outdoor cable
Core Type	Hollow core, filled
Materials	
– basic element	PVC, gray
– strain relief	Kevlar fibers and impregnated glass

– outer sheath/cable color	PVC black

Mechanical Characteristics

– dimensions of basic element	(3.5 ± 0.2) mm dia
– cable dimensions	(6.3 X 9.8) ± 0.4 mm
– cable weight	approx. 65 kg/km
– permissible tensile load	≤ 500 N (short time)
– bending radii	≥ 100 mm Over flat side only

Permissible Ambient Conditions

– laying and installation temp.	-5°C to +50°C
– operating temperature	-25°C to +60°C
– storage temperature	-25°C to +70°C

Cable shall be compliant with EIA, ANSI Standards, graded index. All fibers must be color coded for easy identification with all-dielectric construction. All cables shall be of an insulation type rated for the purpose of installation. Where shown on Contract Drawings all fiber optic conduit run shall contain redundant 24 strand fiber optic cables as specified in this section.

2. Connector Type BFOC
3. Coordinate the exact fiber cable requirement with the SCADA system integrator.

B. Industrial Twisted Pair (ITP) 100 Mb Fast Ethernet Cables

1. ITP cable shall have two cores stranded with two dummy elements to form a pair.
2. Each pair shall be sheathed in plastic film and shielded with two plastic-clad aluminum foils.
3. The outer shield braid shall be made of tinned copper wires around all pairs.
4. The plastic sheath shall be PVC.
5. The ITP cable shall be a standard 9 pin cable with RJ45 type connectors.
6. ITP Cables shall be Siemens Industrial Twisted Pair standard cable or equal by AT&T or Belden.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Instrument Tagging

1. Provide stainless steel identification tags attached with stainless steel wire or screws for all field instruments.

3.2 FIELD QUALITY CONTROL

A. Tests And Calibration

1. Perform continuity and insulation resistance tests on instrumentation conductors.

2. Calibrate each instrument to its published accuracy. Submit calibration sheets including the instrument tag number or name, the date, name of individual performing calibration, procedures and equipment used, and results obtained.

END OF SECTION 40 70 00

SECTION 40 71 13 – MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnetic flow meters.
2. Transmitters.
3. Indicators.
4. Recorders.
5. Integrators.

B. Related Requirements:

1. Division 26 - Electrical
2. Division 27 – Communications
3. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
2. AWWA M33 - Flowmeters in Water Supply.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Coordinate Work of this Section with piping work.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports.

C. Product Data:

1. Submit manufacturer information for system materials and component equipment, including connection requirements.
2. Measurement accuracy.
3. Flow range ability.
4. Enclosure rating.
5. Classification rating.
6. Electrical characteristics.
7. Output options.

1.5 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work according to applicable standards.

D. Manufacturer instruments in facilities certified to the quality standards of ISO Standard 9001.

E. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as cCSAus, FM, or UL for the specified electrical area classification.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store equipment according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one (1) year manufacturer's warranty for magnetic flow meters and appurtenant devices. If the meter is commissioned by a factory certified technician, the warranty shall be extended to three (3) years.

1.9 PROJECT AND SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Furnish sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, interconnecting cables, and unit conversions and algorithms as required for application.

2.2 MAGNETIC FLOW METERS

A. Manufacturers:

1. Endress+Hauser – Promag 400
2. McCrometer
3. Rosemount
4. Approved Equal

B. Description: Low-frequency, electromagnetic induction-type flow meter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.

C. Schedule:

1. FE/FIT1040
2. FE/FIT2201
3. FE/FIT3210
4. FE/FIT3220
5. FE/FIT4340
6. FE/FIT4350
7. FE/FIT6032
8. FE/FIT7220
9. FE/FIT8030

D. Performance and Design Criteria:

1. Design: According to AWWA M33.

E. Flow Rate Range: See instrument schedule

F. Size: As indicated on Drawings.

G. Flow Tubes:

1. Material: Type 304 stainless steel with PTFE liner.
2. Length: As indicated on Drawings.
3. End Connections: Flanged, ASME B16.1, carbon steel.

H. Electrodes:

1. Type 316L stainless steel.
2. Self-cleaning.

I. Accuracy: Plus or minus 1 percent of actual flow rate over a 10:1 range.

J. Provide adjustment for zero and span.

K. Accessories:

1. Furnish cable between transmitter and receiver.
2. Provide automatic, non-mechanical electrode cleaning system without taking meter out of service.

2.3 TRANSMITTERS

A. Transmitter Output:

1. 4- to 20-mA dc analog signal and pulse frequency output for totalization.
2. Accuracy: Plus or minus 0.25 percent of full scale.
3. External third-party signal converter is unacceptable.

B. Housing Material: Cast aluminum.

C. HMI:

1. Touch-screen programming, functioning through enclosure window without opening enclosure.
2. Display:

a. Size: Four lines by 16 characters.
b. Type: Backlit digital display.
c. User-selectable engineering units.
d. Readout of diagnostic error messages.
e. Indicate simultaneous flow rate and total flow with three totalizers (forward, reverse, and net total).

D. Indicators

1. Integrally mounted in transmitter housing

2. Scale: graduated
3. Units: gpm
4. Mounting: Panel

E. Mounting:

1. Integral or remote mounting up to 50 ft from flow meter.
2. Mounting locations less than 4 ft above grade: Provide stainless-steel mounting posts.

F. Transmitter Communication Interface: Modbus RTU, Modbus TCP, or Ethernet/IP.

G. Communication Firmware and Software: Obtain from the manufacturer as designated for the piece of equipment installed.

H. Accessories:

1. Current signal output simulation.
2. Empty pipe detection.
3. Self-diagnostics.
4. Automatic zero adjustment.
5. Stainless-steel sunshield.
6. Signal Cable: Provided by flow meter manufacturer.
7. Internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.
8. Protected against voltage spikes from the power source with internal transient protection.

2.4 OPERATION

A. Control Power:

1. 120-V ac, single phase, 60 Hz.
2. Furnish local transformers as required.

B. Enclosures: NEMA 4X

2.5 ACCESSORIES

A. Stainless steel tag – labeled to match the contract documents

B. Provide grounding rings, as per manufacturer's recommendations, if required.

C. Provide sun shield for outdoor installations.

2.6 SOURCE QUALITY CONTROL

A. Electromagnetic flow meters shall be factory calibrated on an ISO 17025 accredited test stand with certified accuracy traceable to NIST per "General Requirements for the Competence of Testing and Calibration Laboratories."

B. Evidence of accreditation must originate from a national verification agency such as A2LA.

C. Each meter shall ship with a certificate of a 2-point calibration report exceeding stated standard accuracy of 0.5% or 0.2% of rate as specified.

D. A real-time computer generated printout of the actual calibration data points shall indicate apparent and actual flows. The flow calibration data shall be confirmed by the manufacturer and shipped with the meters to the project site.

E. The manufacturer shall provide complete documentation covering the traceability of all calibration instruments.

2.7 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be certified for use in hazardous areas, independent of the output protocol selected.

C. All devices shall be suitable for use as non-incendive devices when used with appropriate non-incendive associated equipment.

D. Electrical equipment housing shall conform to NEMA 4X classification.

E. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as cCSAus, FM, or UL for the specified electrical area classification.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. As shown on installation details and mechanical Drawings.

B. As recommended by the manufacturer’s installation and operation manual.

C. Specific attention should be given to the following technical requirements:

1. Verify ground rings (if required) have been installed according to the manufacturer's recommendations.
2. Reduced inlet installations must be accompanied by manufacturer's documented evidence of third party testing and data collection in comparison to a traceable standard.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the Engineer shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC.
2. Each instrument shall provide direct control of totalizer reset functions through the PLC
3. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

B. The Engineer shall witness all instrument verifications in the field.

C. Manufacturers Field Services are available for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP) – the warranty against manufacturing defects is three years.

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
2. Manufacturer representative shall notify the Engineer in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
4. Manufacturer representative shall generate a configuration report for each meter.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 71 13

SECTION 40 71 69 – PARSHALL FLUME

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered by this section shall include materials and installation for the fiberglass reinforced plastic (FRP) parshall flume to measure the influent and effluent flow, as shown on the drawings and described in the specifications.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related work specified elsewhere includes:

1. Division 3 – Concrete
2. Division 5 – Metals
3. Division 26 – Electrical
4. Division 27 – Communications

1.3 REFERENCES

A. ASTM D256 - Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.

B. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

C. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

D. ASTM D2583 - Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.4 COORDINATION

A. Coordinate installation of anchorages for weirs, baffles, frames and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: For glass-fiber-reinforced-plastic parshall flume. Test results of fiberglass reinforced plastic.

C. Shop Drawings:

1. Include plans, sections, details, and attachments to other work.
2. Critical dimensions, jointing and connections, fasteners and anchors
3. Materials of construction.
4. Sizes, spacing, and locations of structural members, connections, attachments, openings, fasteners, and loads.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging, including application instructions.

C. Inspection: Accept Parshall flume and accessories on-site in original packaging. Inspect for damage.

D. Store equipment and accessories according to manufacturer's instructions.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with parshall flume by field measurements before fabrication.

1.8 QUALIFICATIONS

A. Manufacturer of baffle wall system shall have full responsibility for products and design. Split responsibility of materials or design is not acceptable.

B. Manufacturer of baffle wall system shall have completed within the last five (5) years a minimum of five (5) projects of similar type as those required in this scope.

C. Manufacturer must be ISO9001 certified, and manufacturer all of the FRP components in its own facility.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment, parshall flume, shall be manufactured by:

1. Warminster Fiberglass Company; Southampton, PA
2. Tracom Fiberglass Products; Alpharetta, GA
3. Enduro Composities, Inc.
4. Strongwell; Bristol, VA
5. Virtual Polymer Compounds; Getzville, NY
6. Or Approved Equal.

2.2 PRODUCTS

A. All components of the weir, baffle, frame and support system shall be design and fabricated by a single manufacturer to insure uniform and finished appearance as a well as component compatibility.

B. Baffle planks shall be installed without the need of drilling or fastening, and the panels shall be removable without the need of loosening fasteners or any other mechanical device.

C. The baffle planks shall be supports in a channel-shaped frame on each end. Such frame shall fold the baffle blanks for a maximum strength and load bearing capability. The channel frames shall be manufacturer of T-304 stainless steel.

D. The baffle panels, when mounted in their structural support system, shall be square and accurately size to minimize gaps between the frame members and panels.

2.3 PARSHALL FLUME

A. Material: Fiberglass reinforced plastic:

1. Tensile strength (ASTM D 638): 14,000 psi.
2. Flexural strength (ASTM D 790): 27,000 psi.
3. Flexural modulus (ASTM D 790): 1,000,000 psi.
4. Impact, notched, Izod (ASTM D 256): 10 ft-lb/in.
5. Barcol hardness (resin-rich surface) (ASTM D 2583): 50, minimum, average.
6. Temperature limit: 150 °F.
7. Chemical resistance: Comply with ANSI/AWWA F101, Type II classification.
8. Wall thickness: Minimum 3/16 inch

B. Construction: One-piece, fiberglass reinforced plastic, with integral stiffening ribs to make unit self-supporting and eliminate external bracing.

1. For flumes to be embedded in concrete, provide temporary internal bracing.
2. Parshall flume shall have 18” throat, and shall be able to accurately measure flow up to 15.87 MGD.

C. Level Transducer

1. Level transducers shall comply with Section 40 72 13 – Ultrasonic Level Meters.

D. Accessories:

1. Ultrasonic Transponder mounting bracket.
2. Staff gauge graduated in MGD.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fiberglass reinforced plastic (FRP) parshall flume per the manufacturer's recommendations.

3.2 MATERIAL HANDLING

A. The Contractor shall protect FRP materials from cuts, scratches, gouges, abrasions, and impacts. When lifting crated FRP materials, spreader bars shall be used (not wire slings unless materials are fully protected). FRP components shall not be dragged across one another unless separated by a non-scratching spacer.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the contract documents.

C. Set flume at proper elevation in accordance with drawings.

D. Set floor of flume at inlet end level with flow and across flow. Set side walls plumb. Set top flanges level, each side.

E. Fasten flume securely to prevent flotation or twisting during placement of concrete.

F. Place concrete along sides and bottom of flume to ensure complete filling without voids and displacement of flume. Stage placement in alternating lifts, 1/3 height on each side of flume.

3.4 ADJUST AND CLEAN

A. Clean surfaces in accordance with manufacturer's instructions.

B. Remove trash and debris, and leave the site in a clean condition.

END OF SECTION 40 71 69

SECTION 40 72 13 - ULTRASONIC LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ultrasonic-level measurement devices.
2. Transmitters.

B. Related Requirements:

1. Division 26 – Electrical
2. Section 40 70 23 – Process Control Narratives

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with tank Work.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work according to applicable standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish three-year manufacturer's warranty for ultrasonic-level measurement devices.

PART 2 - PRODUCTS

2.1 ULTRASONIC-LEVEL MEASUREMENT DEVICES

A. Manufacturers:

1. Siemens
2. Or approved equal

B. Description:

1. Measuring Range: Up to 35 feet
2. Operating Temperature Range: Minus 40 to plus 170 ˚F
3. Operating Pressure: 10 to 36 psig

C. Operation: Menu guided.

D. Transmitters:

1. Selected by sensor manufacturer to match sensor.
2. Visual Display: Four digit.
3. Output Signal: 4- to 20-mA dc.
4. Location: As indicated on Drawings.
5. Control Power:

    a. 120-V ac, single phase, 60 Hz.
    b. Furnish local transformers as required.

6. Enclosures: NEMA 250 Type 4.
7. Mounting:

    a. Integral with sensor
    b. Wall

8. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

2.3 SCHEDULE

A. LE/LIT1230

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) days on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 72 13

SECTION 40 72 43 - PRESSURE AND DIFFERENTIAL PRESSURE TYPE LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydrostatic-level measurement devices.
2. Transmitters.

1.2 SUBMITTALS

A. Product Data: Manufacturer information for system materials and component equipment, including connection requirements.

B. Shop Drawings:

1. System materials and component equipment.
2. Installation requirements and other details.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

E. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

F. Qualifications Statement:

1. Qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.4 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work in accordance with Federal, State and Local codes, regulations and laws.

D. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.6 WARRANTY

A. Furnish five-year manufacturer's warranty for hydrostatic level measurement devices.

PART 2 - PRODUCTS

2.1 HYDROSTATIC-LEVEL MEASUREMENT DEVICES

A. Manufacturers:

1. Cerlic Model NV52d (0-16.5’) or NV152d (0-35’) or Endress-Hauser.
2. Substitutions: Permitted.

B. Sensor:

1. Description: Pressure sensor, condensate proofed and long-term stable, and incorporating continuous temperature and pressure compensation.
2. Turndown: 100:1.
3. Certified according to IEC 61508 and IEC 61511.
4. Measuring Cell:

a. Hermetically sealed.
b. Material: Ceramic.
c. Accuracy: Plus or minus 0.2 percent.
d. Furnish pressure range 0 – 16ft.

C. Communications Protocol: HART, PROFIBUS PA, FOUNDATION Fieldbus.

D. Operation: Menu guided.

2.2 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Install as shown on the Drawings or as directed by Engineer.

3.3 FIELD QUALITY CONTROL

A. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 72 43

SECTION 40 72 76 – LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. A point level switch for use in hazardous areas with all international certificates. It is useable in all industries and has functional SIL2/SIL3 safety. It offers reliable measurement value that is not affected by flow, turbulence, bubbles, foam, vibration, bulk solids content or build-up.

1.2 SUBMITTALS

A. Furnish complete Product Manufacturer's Technical Information, Operating and Maintenance

B. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

B. Any instruments that are not stored in strict conformance with the Manufacturer's recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 WARRANTY

A. The meter shall have standard one year warranty from date of shipment and if the meter is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

1.7 MAINTENANCE

A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 LEVEL SWITCHES

A. MANUFACTURER:

1. Anchor Scientific
2. Or approved Equal.

B. MERCURY-FLOAT TYPE:

1. Switch Description: Two normally open (NO) mercury switches.
2. Relays: Intrinsically safe.
3. Float Casing: Polypropylene.
4. Housing: NEMA 250 Type 4X.
5. Cable: Oil-resistant thermoplastic.
6. Rated Voltage: 600 V.

C. REQUIRED INSTRUMENTS:

1. LSH2100
2. LSL2100
3. LS6025
4. LS6026
5. LS6027

2.2 SOURCE QUALITY CONTROL AND CALIBRATION

A. A Certificate of Compliance shall be available from the manufacturer if required.

B. An application data sheet should be filled out, with all known data, and submitted to the manufacturer to ensure proper instrument choice

2.3 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be certified for use in the following hazardous areas:

1. Explosion proof: Class I, Div. 1, Groups ABCD, Temperature rating T6 (Ta= 70ºC)
2. Intrinsically safe: Class I, II, III, Div. 1, Groups ABCDEF, Temperature rating T5 (Ta=70ºC)
3. Non- Incendive- Class I, Div. 2, Groups ABCD, Temperature rating T5 (Ta= 70ºC)

C. All devices shall be suitable for use as non-incentive devices when used with appropriate non-incentive associated equipment. Devices with intrinsically safe ratings will normally be acceptable with vendor's approval.

D. Electrical housing shall conform to NEMA 4x classification.

E. Non- intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, ETL, CSA, etc. for the specified electrical area classification.

F. Electrical equipment specified as intrinsically safe shall qualify as "simple apparatus" or NRTL approved intrinsically safe equipment per ANSI/ISA-RP12.6 "Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations," latest edition.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. As shown on installation details and mechanical drawings.

B. As recommended by the manufacturer's installation and operation manual.

3.3 FIELD QUALITY CONTROL

A. Demonstrate the performance of all instruments to the Engineer before commissioning.

B. ENGINEER to witness all instrument calibration verification in the field.

C. Each instrument shall be tested before commissioning and the Engineer shall witness the response in the PLC control system and associated displays.

D. Manufacturer's Field Services:

1. Manufacturer's representative shall verify installation of all installed transmitters.
2. Notify the Engineer in writing of any problems or discrepancies and proposed solutions.

3.4 ADJUSTING

A. Verify set-up and configuration of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

    a. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 72 76

SECTION 40 73 13 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Pressure gauges.

B. Related Requirements:

1. Section 40 73 64 – Annular Pressure Seals: Isolation of gauges from process fluid.

1.2 REFERENCE STANDARDS

A. ASME International:

1. ASME B40.100 - Pressure Gauges and Gauge Attachments.

B. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of equipment and accessories.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:

1. Gauges: Furnish 20 percent spare gauges, with a minimum of one gauge for each range used.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for pressure gauges.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:

1. Ashcroft; Model Series T5500
2. Ametek; Model Series 1550
3. Wika; Model Series 716

B. Type: Differential - Compound.

C. Dials:

1. Nominal Diameter: 4 inches.
2. Face: White, laminated plastic dials with black graduations.
3. Scale: Extend over arc not less than 270 degrees.
4. Ranges and Graduation Units: As indicated on Instrument Schedule.

D. Cases:

1. Liquid filled.
2. Stainless Steel case and wetted parts.
3. Windows:
    a. Material: Clear, shatterproof glass.
    b. Thickness: 1/8 inch.
    c. Provide gasket.

E. Connection:

1. Location: Bottom.
2. Socket:
    a. 1/4-inch NPT male thread.
    b. Extend minimum 1-1/4 inches below gauge cases.
    c. Provide wrench flats.

3. Mounting: Stem.

F. Measuring Element:

1. Bourdon Tubes:

    a. Material: Stainless steel to brass socket.
    b. Provide welded, stress-relieved joints.

2. Movement:

    a. Rotary.
    b. Material: Stainless steel.

3. Accuracy:

    a. Comply with ASME B40.100.
    b. ±0.5 percent of full-scale range.

G. Adjustment:

1. Provide for zero-reading adjustment.
2. Adjusting Screws: Accessible from rear of case without need for disassembly.

H. Accessories:

1. Shutoff Cocks: Furnished by gauge manufacturer.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Coordinate location and orientation of gauges and seal assemblies with final piping and equipment installations.

C. Ensure that gauges are located to be easily read during operation and easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 73 13

SECTION 40 73 64 – ANNULAR PRESSURE SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure Seals, Annular Type

B. Related Requirements:

1. Section 40 73 13 - Pressure and Differential Pressure Gauges: Pressure gages requiring isolation from process fluid.

1.2 REFERENCE STANDARDS

A. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of equipment and accessories.

1.5 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for annular pressure seals.

PART 2 - PRODUCTS

2.1 ANNULAR PRESSURE SEALS

A. Manufacturers:

1. Ashcroft Model 80 Wafer Seal
2. Red Valve Series 48 Pressure Sensor
3. Onyx Isolator Ring
4. Approved Equal

B. Description:

1. Mounting: Wafer Style.
2. Wetted Parts and Bolt Materials: Corrosion resistant to process fluid.
3. Instrument Connection: NPT, 1/4 inch.
4. Working Pressure Rating: Pipeline working pressure + 50 psig.
5. Fill fluid: 50/50 solution of ethylene glycol and water, unless otherwise noted

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Annular Seals:

1. Factory-assemble, fill, and calibrate entire assembly, including gage or switch, prior to shipment.
2. Field filling is not acceptable.

C. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Mount only one pressure element per annular seal.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 73 64

SECTION 40 75 00 – REFRIGERATED AUTO SAMPLER

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements for a refrigerated sampler for the representative collection and storage of liquid water samples. Samplers may take inputs from other process liquid analytical or flow devices and may be used to collect samples and/or monitor influent and effluent waters from municipal and industrial NPDES facilities. These requirements define samplers suitable for indoor and/or outdoor use:

1. Field, laboratory, and portable pH/ORP analyzers.
2. Testers.

B. Related Sections:

1. Control and Information Systems Scope and General Requirements Connections: Wiring connections to equipment.
2. Power Instruments, General.

1.2 SUBMITTALS

A. Furnish complete product data, shop drawings, test reports, operating manuals, record drawings, manufacturer's certifications, manufacturer's Field Reports.

B. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement Accuracy.
4. Range and Range Ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacturing facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.

B. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced:

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. The sampler shall have standard one year warranty from date of shipment and if the sampler is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

1.7 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. Scheduled maintenance:

1. On a monthly basis the sampler shall require no more than a visual inspection, if necessary, cleaning.

C. Unscheduled maintenance:

1. Pump tube replacement (peristaltic pump only).
2. Dosing chamber cleaning (vacuum only).
3. Rotor removal and cleaning.
4. Clean distributor arm.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 SYSTEMS/ASSEMBLIES

A. Manufacturers:

1. Endress+Hauser Model Liquistation CSF48 with options as outlined below.

B. Performance criteria:

1. Sample cooling: Maintain sample liquid at 4°C (39°F) in ambient temperature -15 (5°F) to 40°C (104°F) maximum.
2. Sampling methods:

    a. Vacuum pump/peristaltic pump include event, single and multiple samples and use of the sampling table.
    b. Vacuum pump additionally includes time proportion and volume proportion sampling.
    c. Peristaltic pump additionally includes time, volume and flow proportion sampling.

3. Sample volume shall be variable based on sample pumping technology:

    a. When peristaltic pumping is employed it shall be programmable in 10 mL
    b. Increments from 10 to 10,000 mL.
    c. When vacuum pumping is employed is shall be programmable in 10 mL increments from 20 to 350 mL.

4. Sample volume repeatability (peristaltic or vacuum): + 5ml (0.17 oz) or 5% of the set volume.
5. Peristaltic pump vertical lift: maximum transport velocity 0.6 m/s (>1.9 ft/s), 8.0 m (26 ft.) suction head using 30 ft. of 3/8" PVC or EPDM intake tubing.
6. Vacuum pump sample transport velocity: 0.6 m/s (1.9 ft/s) at 30m (98 ft. of 3/8"PVC or EPDM intake tubing).

C. Certifications:

1. AC power supply: CSA ("C" and "USA"), UL (UL 60950-1) ("C: and "US"), and UL (UL508).

D. Environment:

1. Medium temperature range: 2 to 50 °C (36 to 122 °F).
2. Storage temperature: -20 to 60 °C (0 to 140 °F).
3. Relative humidity: 10 to 95%, non-condensing.
4. Ambient temperature range: -30 to 50 °C (-20 to 120 °F).
5. Ingress protection: NEMA 4X.
6. Electromagnetic compatibility: Interference emission and interference immunity as per EN 61326-1:2006, Class A for industry.

2.2 MANUFACTURED UNITS

A. The sampler shall be an all in one unit with controller and sampling in separate compartments:

1. The sampler housing shall be all-weather ASA-PC high-impact plastic with the option for a stainless steel shell and shall have the option for refrigeration components and copper plumbing corrosion protected with conformal polyurethane coating. The refrigerated cabinet shall be insulated with 2-inch rigid foam insulation on the walls and bottom and 5 inches on top. The refrigeration system shall be located in a separate, upper compartment from the sample compartment and cool the sample compartment through forced air convection. For areas with sub-zero temperatures, the standard refrigeration unit shall also contain a compartment heater.
2. An air sensing thermostat is capable of maintaining the sample enclosure within specified limits that will be set through the HMI. Samplers whose temperature control is not set via HMI to measure the sampling chamber are not acceptable.
3. Samplers that cannot measure the sample temperature are not acceptable.

B. The controller shall be rated NEMA 4X and enclosed in a housing that is watertight, dust-tight, corrosion and ice resistant with the sampler doors in the closed position.

1. The sampler will be designed for indoor and outdoor use.
2. The sampler shall have a 9 line high contrast backlit HMI display making the measurements visible in direct sunlight. The user interface is self-prompting/menu driven program using four function keys, and navigator dial. Samplers that are not configured with the HMI are not acceptable.
3. The sampler memory shall store up to 8 data logbooks with each 150,000 measured values and dates/times, the stored data can the visualized on the sampler display as a graph or table. All other sampling activities including events and sampling statistics shall be stored in program and event logbooks.

C. The sampler shall store up to 100 sampling program entries while the main program shall run up to 24 sub-programs simultaneously.

D. Sample pacing modes shall include composite and discrete with multiple bottle time, multiple bottle flow, single bottle time, single bottle flow, flow with time over ride, variable interval, user start/stop, and external set point.

1. Manual grab sample can be made to deliver a grab sample to a specific bottle location.
2. The intake air purge shall be performed automatically before and after each sample, allowing for complete drainage of the intake line to prevent cross-contamination between samples. The duration shall automatically compensate for varying intake line lengths.
3. The sample collection cycle shall be repeated from one to three times if a sample is not obtained on the initial attempt.

E. The sampler shall have a choice of 17 bottle configurations.

F. The refrigerated sampler shall be available in one of two sample collection options.

1. High-speed peristaltic pump for collection of the liquid sample.
2. High-speed vacuum pump for collection of the liquid sample.

3. Samplers that cannot be interchanged between high speed vacuum and high-speed peristaltic pumps are not acceptable.

G. The method of sample detection shall be conductive or capacitive (vacuum pump) or pressure (peristaltic pump).

H. Power supply: 100-120/200-240 VAC +/- 10%, 50/60 Hz, or 24 VDC +15/-9%.

I. An internal real time clock will be maintained for a minimum of five years.

J. The basic unit shall include two galvanically isolated analog and two galvanically isolated binary inputs, with options to include up to 4 Memosens® sensors.

1. Samplers that cannot be upgraded to incorporate Memosens® protocol sensors will not be accepted.

K. The basic unit shall include two galvanically isolated binary outputs with additional optional outputs:

1. Up to six current outputs shall be available as an option.
2. Up to two change-over contact relays.

L. Digital communications protocols available shall include the following without using an external converter. Digital communication shall be available as a native output from the sampler. Use of an external third-party signal converter is not acceptable.

1. 4-20mA, HART.
2. Profibus RS485 with webserver.
3. Modbus RS485 with webserver.
4. Modbus TCP with webserver.
5. EtherNet/IP with webserver.

a. EtherNet/IP communication shall be supported with the Electronic Data Sheet (EDS) file available for download directly from the sampler. The Add-On Profile (AOP) for integration shall be a Level 3 profile to simplify control system integration.
b. The EtherNet/IP communications shall also be supported with Add-on Instructions (AOI) files and pre-configured faceplates for ease of control system integration.

M. Suction lines; choice of internal diameter (3/8", 1/2", 5/8" or ¾") and material (PVC or EPDM) in 33 ft. lengths with stainless steel strainers.

N. Device configuration and logbooks can be saved or restored.

1. An SD card slot shall be provided for configuration downloads, logbook downloads and for embedded software upgrades in the field.
2. Data management shall be available via a CDI link directly to PC using a serial port and communications interface. (Such as Endress+Hauser FieldCare® Data Management software and Commubox FXA291).

2.3 ACCESSORIES

A. An accessory system shall be available for sampling from a pressurized line.

B. The sampler shall have a choice of 3 configurations of sampler stands.

C. The sampler shall have the option for additional inputs including up to 4 Memosens® protocol industrial sensors that can be added in the field.

D. The sampler shall be available with key locks for both the upper and lower compartments.

E. Outside and direct sample temperature measurement shall be available as an option.

F. Optional batter backup system ensures uninterrupted operation in the event of power failure.

2.4 SOURCE QUALITY CONTROL AND CALIBRATION

A. Any standards and cleaning solutions will be supplied with MSDS data sheets.

2.5 SAFETY

A. All devices shall be suitable for operation in a non-hazardous area.

B. Device failure modes, self-monitoring characteristics and diagnosis shall follow NAMUR standard NE 43.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and ensure instruments are compatible with installed process and environmental conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. Contractor will install the sampler in strict accordance with the manufacturer’s instructions and recommendation.

B. The sampler must be installed in a suitable manner so that the sampler is not directly installed over the sampling area.

C. The standard one-year warranty against manufacturing defects shall be extendable to three-years on covered equipment if paid start-up service is accomplished on that covered equipment by an authorized service provider.

D. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the Engineer shall witness the interface capability in the PLC control system and associated registers.

B. The Engineer shall witness all instrument verifications in the field.

C. Manufacturers Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer field service representative shall verify installation of all installed samplers.
2. Manufacturer representative shall notify the Engineer in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall generate a configuration report for each sampler installation following commissioning.

3.4 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

    a. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 00

SECTION 40 75 13 – PH/ORP SENSORS

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements for a pH/ORP sensor for in-process measurement. The sensor will incorporate Memosens® digital technology for maximum process and data integrity with simple operation. The sensor-to-cable connection will use a moisture-resistant inductive connection that resists corrosion, enabling lab calibration while facilitating predictive maintenance. The sensor must have galvanic isolation from the transmitter and cable. The sensor shall be calibrated prior to leaving the producing factory with calibration data including the date and time of the calibration stored within the sensor, for immediate installation without the need for post-installation field calibration.

B. Related Sections:

1. Control and Information Systems Scope and General Requirements.
2. Power Instruments, General.

1.2 SUBMITTALS

A. Furnish complete product data, shop drawings, test reports, operating manuals, record drawings, Manufacturer's certifications, Manufacturer's Field Reports.

B. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement accuracy.
4. Measurement Range.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacture facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.

B. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. Sensors shall arrive pre-calibrated and ready for installation. Calibration information is to be stored in the sensor for automatic download to the transmitter, once connected.

B. The manufacturer's warranty does not cover normal wear and tear, damage to the sensor due to improper storage or handling, or any other mode of failure or reduced sensor life that is not a direct consequence of a manufacturing defect.

C. The sensor and transmitter system shall have standard one year warranty from date of shipment and if the meter is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

1.7 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 SYSTEMS/ASSEMBLIES

A. Manufacturer:

1. Endress+Hauser, Digital pH/ORP Sensors.

B. Performance criteria (Sensor):

1. Measurement Range:

a. pH: 0-14 pH.
b. ORP -1500 mV to 1500 mV.
c. Temperature range: Sensor dependent; 5 to 275 °F.
d. Lengths: Available in 120, 225, 360 or 425 mm lengths (sensor dependent).

C. Certifications:

1. CE marked.
2. Available FM/CSA Class I, Div. 1 IS, when used with an approved controller and cable. Proper installation requirements and specific sensor, cable and transmitter part numbers approved for uses in specific hazardous areas are listed on the control drawing for the transmitter/controller.
3. Specific sensors 3A approved for use in hygienic applications.

D. Environment:

1. Acceptable sensor temperature range options:

a. 5 to 176 °F (-15 to 80 °C)
b. 32 to 176 °F (0 to 80 °C)
c. 32 to 275 °F (0 to 135 °C)

2. Pressure: Sensor dependent; up to 232 psi maximum.
3. Cable length (between sensor and transmitter): 330 feet (100 m) maximum.

2.2 MANUFACTURED UNITS

A. Sensor:

1. The Endress+Hauser Memosens® pH or ORP Sensor system consists of the following sensors and a Liquiline CM 44x or CM44xR transmitter.

a. pH sensors: Orbisint CPS11D, Ceragel CPS71D, Orbipore CPS91D, Ceraliquid CPS41D, Tophit CPS441D, Tophit CPS471D, Tophit CPS491D, Orbipac CPF81D or Ceramax CPS341D.
b. ORP sensors: Orbisint CPS12D ORP, Ceragel CPS72D ORP, or Ceraliquid CPS42D.
c. Combination pH/ORP sensors: CPS16D, CPS76D, or CPS96D.

2. Completely encapsulated sensor having no fixed cable and no metallic contacts. Sensor must be galvanically isolated from the transmitter and cable, use a non-proprietary inductive coupling system, pH glass or ORP noble metal measurement electrode and reference system with fouling resistant diaphragm.
3. Sensor does not require replacement parts or electrolyte solutions.
4. Standard cables are available for connection of the sensor to a suitable transmitter in lengths of 3, 5, 10, 15, and 25 meters with special lengths and extensions available up to 100 meters.
5. Wetted materials:

a. Glass sensor with PTFE, ceramic or open junction.

b. PEEK sensor with EPDM and ceramic or open junction.

6. Standard available holder materials for industry-standard 120 mm x 12 mm sensors with PG13.5 connection to holder:

   a. PVDF (Kynar® or equivalent)
   b. Stainless steel (316L)
   c. Polyoxymethylene (POM)
   d. Polypropylene (PP)
   e. PVC

7. Sensors shall work with digital transmitter designed to operate with Memosens® pH or ORP sensors.
8. pH and ORP sensors shall have a built in temperature compensator.
9. Various mounting configurations shall be possible using a range of holders, including:

   a. Pipe nipple for mounting in a pipe or tank.
   b. Immersion holders for installation in open channels, basins or tanks.

      1) Endress+Hauser CYA112/CYH112 submersion mounting and suspension system (all versions)

   c. Immersion assemblies for installation in tanks or pipes with the requirement for manual or automated retraction of the sensor from the process without disrupting the process. These shall be made of Stainless Steel with matching hardware and mounting accessories, and installed as shown on the plans.

2.3 ACCESSORIES

A. Liquid cleaning

1. Optional cleaning assemblies shall be installed for in-process sensor cleaning using liquid from the in-plant reuse water system.

B. Calibration solutions shall be available for both pH sensors (buffer solutions, pH 4 and pH 7 recommended) and ORP sensors.

2.4 REQUIRED INSTRUMENTS

A. AIT-3106A/3106B

B. AIT-3206A/3206B

C. AIT-3306A/3306B

2.5 SOURCE QUALITY CONTROL AND CALIBRATION

A. Any standards and cleaning solutions will be supplied with MSDS data sheets.

2.6 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be suitable for operation in a non-hazardous area.

C. Device failure modes, self-monitoring characteristics and diagnosis shall follow NAMUR standard NE 43.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. Contractor will install the transmitter and sensor in strict accordance with the manufacturer's instructions and recommendation.

B. The sensor must be mounted using a suitable mounting assembly so that the sensor is always submersed in the solution to be measured.

C. Mount sensor vertically with electrode pointing down. The sensing tip of the sensor must be pointing slightly down with a minimum angle of 15 degrees.

D. The standard one-year warranty against manufacturing defects shall be extendable to three-years on covered equipment if paid start-up service is accomplished on that covered equipment by an authorized service provider.

E. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the Engineer shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC.
2. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

B. The Engineer shall witness all instrument verifications in the field.

C. Manufacturers Field Services Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer field service representative shall verify installation of all installed sensors, cables and transmitters.
2. Manufacturer representative shall notify the Engineer in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall generate a configuration report for each senor installation following commissioning.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

    a. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 13

SECTION 40 75 43 – FLUORESCENT DISSOLVED OXYGEN MEASURING

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements for a high-performance, digital fluorescence sensor for measurement of dissolved oxygen in liquid. The sensor will offer fast, accurate and drift-free measurement. The sensor will support low maintenance, with high availability and easy handling. The sensor's long-term stable fluorescence layer will be exclusively oxygen-selective (interference-free), ensuring consistently reliable measurement. The sensor will use Memosens® digital technology to provide maximum process and data integrity, and facilitate simple lab calibration.

B. Related Sections:

1. Control and Information Systems Scope and General Requirements.
2. Power Instruments, General.

1.2 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports.

B. Product Data:

1. Dimensional drawings.
2. Materials of construction.
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacturing facilities shall be certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

B. Any instruments that are not stored in strict conformance with the Manufacturer's recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. The sensor shall have standard one year warranty from date of shipment and if the measuring system is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

B. The manufacturer's warranty does not cover normal wear and tear, damage to the sensor due to improper storage or handling, or any other mode of failure or reduced sensor life that is not a direct consequence of a manufacturing defect.

1.7 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 SYSTEMS/ASSEMBLIES

A. Manufacturer:

1. Endress+Hauser Oxymax COS61D digital oxygen sensor with Liquiline CM44x or CM44xR transmitter.

B. Performance Criteria:

1. Measurement Range: 0-20 mg/l, 0-200 %SAT, 0-400 hPa

2. Repeatability: ±0.5% of measuring range end

3. Max Measured Error: 0.01 mg/l or ±1 % of measured value (< 12 mg/l) ±2 % of measured value (from 12 to 20 mg/l)

4. Response time (t_{90}): 60 sec.

5. Sensor cap lifetime: >2 years (under reference operating conditions, protected against direct sunlight)

6. Temperature Sensor: NTC temperature sensor, 0-50°C (32-122°F)

C. Certifications:

1. CE marked.
2. Interference emission and interference immunity with EN 61326; 2005, Namur NE 21:2007.

D. Environment:

1. Process temperature: -5 to 55 °C (23 to 131°F).
2. Process pressure: max 10 bar (145 psi).
3. Ambient Temperature: -20 to 60°C (0 to 140°C)
4. Ingress Protection: IP68

2.2 MANUFACTURED UNITS

A. Sensor:

1. Optical fluorescence technology with minimum maintenance and maximum availability.
2. Shall incorporate digital Memosens technology with calibration saved in sensor and a high degree of EMC protection.
3. Simple single-point calibration in air, air-saturated water or in medium shall be possible.
4. Extended maintenance intervals and a high degree of long-term stability; intelligent self-monitoring shall guarantee reliable measure values.
5. Fixed, waterproof cable connection at the sensor with up to 330 feet (100 meters) length between the sensor and transmitter.

2.3 ACCESSORIES

A. Assemblies

1. Sensor mounting hardware shall be available in a modular assembly system to secure sensors in open basins, channels and tanks. Versions in stainless steel shall be available for immersion in open basins. The mounting hardware shall be applicable for nearly any type of fixing - fixing on the floor, wall or directly on a rail.
2. A retractable assemby shall be available, constructed in stainless steel and ball valve, to allow for retraction of the sensor from the process without shutting down the process.

B. Interconnecting Cable

1. The sensor cable shall be available in length up to 330 feet (100 m) with a choice of direct wire to the transmitter or connection using M12 quick connections.

2.4 REQUIRED INSTRUMENTS

A. AE/AIT-7101

B. AE/AIT-7102

2.5 SOURCE QUALITY CONTROL AND CALIBRATION

A. Reagents, standards and cleaning solutions for the analyzer will be supplied with MSDS data sheets.

2.6 SAFETY

A. All devices shall be suitable for operation in a non-hazardous area.

B. Device failure modes, self-monitoring characteristics and diagnosis shall follow NAMUR standard NE 43.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. As shown on installation details and mechanical Drawings.

B. Installation will occur in strict accordance with the manufacturer's instructions and recommendation.

C. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

1. General contractor.
2. Electrical or Instrumentation contractor.
3. Endress+Hauser factory trained authorized service provider or representative.
4. Site (owner/operator) personnel.
5. Engineer.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC.
2. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

B. The ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
4. Manufacturer representative shall generate a configuration report for each meter.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

a. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 75 43

SECTION 40 90 00 - INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements

Requirements specified in Division 01 of these Specifications form a part of Division 26. This Section covers the general requirements for furnishing and installation of the instrumentation, control and monitoring (ICM) system complete in every detail for the purposes specified and shall form a part of the other Sections of Division 26 unless otherwise specified. The other Sections of this Division shall supplement this Section as necessary.

1. Work Included
   a. The intent of Division 40 is to require that the complete Instrumentation, Control and Monitoring System, including other Sections of Division 40 shall be furnished by a single Control Systems Integrator (CSI) to assure system uniformity, subsystem compatibility and coordination of system interfaces.
   b. The new SCADA system shall deliver a complete and functional system as described herein, as per the Contract Documents, and as shown on the Contract Drawings. The SCADA system shall be capable of monitoring and performing controls (as indicated on the drawings) of Homesteads Pollution Control Facility equipment. And shall be capable of communication with the existing Piedmont Water master SCADA workstation to depict the new facility I/O points and new HMI graphics. All equipment, materials, incidentals, software, supervision, and labor shall be provided under this Contract.
   c. Furnish the tools, equipment, materials, and supplies and perform the labor required to complete the furnishing and installation of, including instrumentation signal and power conduit and wiring not specifically shown on the electrical drawings, validation, start-up and operational testing of a complete and operable ICM system as indicated on the Contract Drawings and as specified herein.
   d. Provide the equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to ensure that the Owner receives an integrated and operational ICM system as herein specified.
   e. Coordinate with the requirements of Division 26 – Electrical, and provide for operator restart of all equipment on restoration of loss-of-power condition. Sequence automatically equipment restart and provide for time delays as necessary to prevent breaker trips on inrush from multiple equipment concurrent starting.
2. As a minimum, the CSI shall perform the following work:
   a. Implementation of the ICM system:
      i. Prepare shop drawing submittals.
      ii. Design, develop, and electronically draft loop drawings and control panel designs.

iii. Prepare the test plan, the training plan, and the spare parts submittals.
iv. Procure hardware.
v. Fabricate panels.
vi. Program the ICM system as shown on the Contract Drawings.
vii. Perform factory tests on panels.
viii. Perform bench calibration and verify calibration after installation.
ix. Oversee and certify installation.
x. Oversee, document, and certify loop testing.
xi. Oversee, document, and certify system commissioning.
xii. Conduct the performance test.
xiii. Prepare operations and maintenance manuals.
xiv. Conduct training classes.
xv. Prepare record drawings.
xvi. Prepare calibration sheets.
xvii. Certify the installation of the ICM system.

b. Integration of the ICM system with instrumentation and control devices being provided under other Sections:
   i. Develop all requisite loop drawings and record loop drawings associated with equipment provided under other Divisions and Owner equipment.
   ii. Resolve signal, power, or functional incompatibilities between the ICM system and interfacing devices.

3. Work Not Included
   a. Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, air compressors, main air supply headers, and mechanical work as specified in other Divisions.
   b. Electrical power distribution specifically included under Division 26, circuit protection devices, power conduit and wiring indicated, local equipment control stations, and miscellaneous electrical requirements as specified in Division 26.

B. System Responsibility
1. The ICM system as specified in Division 40 is an integrated system and therefore shall be provided by a competent, qualified CSI who shall have total responsibility for the Work of Division 40. Entire system installation including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar installations. The System shall be integrated using the CSI's latest, most modern proven design and shall, as far as practical, be by one manufacturer.
2. The Contractor shall perform the Work under this Division 40, through the use of a qualified CSI who shall perform said Work but it shall be understood that this shall not relieve the Contractor from any responsibility under the Contract.
3. The Contractor shall be responsible for the correct installation of all hardware and systems specified in Division 40.

4. The Contractor shall be responsible to see that all instrumentation components of other Divisions, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices and appurtenances are compatible and shall function as outlined, and he shall furnish and install such additional equipment, accessories and appurtenances as are necessary to meet these objectives at no additional cost to the Owner.
5. The Contractor shall use the instrument tag and equipment numbering scheme as shown in Contract Documents, for identifying components which are part of this system.
6. Due to the complexities associated with the interfacing of numerous control system devices, the CSI or vendor shall be responsible to the Contractor for the integration of the ICM system with existing devices and devices provided under other Divisions and provide a completely–integrated control system free of signal incompatibilities; this includes providing review and comment to other vendor equipment submittals and overall coordination of the system.

C. Certification of Intent:
1. Fifteen days after notice to proceed, the Contractor shall submit a certification from the selected CSI. The certification shall be typed on letterhead paper of the CSI. The certification shall be signed by an authorized representative of the CSI. The certification shall include the following statements:
a. (Company name) "hereby certifies intent to assume and execute full responsibility to the Contractor to perform all tasks defined under Paragraph 1.01 Scope, in full compliance with the requirements of the Contract Documents."
b. “It is certified that the quotation to the Contractor includes full and complete compliance with the requirements of the Contract Documents without exception."

D. Documentation of Instrumentation Subcontractor Qualifications:
1. General
a. The entire control system installation including panel building, calibration, validation, start-up, operational testing, and training shall be performed by a control systems integrator (CSI) staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.
b. The system shall be integrated using the latest, most modern proven design and shall, as far as practical, be of one manufacturer.
c. The equipment, level of detail, and overall quality of the control system shall be consistent a typical industrial type control system.
d. Overall system performance shall be guaranteed.
e. Software packages shall be latest versions available.
2. System Integrator qualifications:
a. The following system integrator is pre-qualified to perform the control system work described in Division 40:
i. **Southern Flow Inc., Alpharetta, GA**
3. Training and Certification:

a. Completion of the following training courses (or appropriate portions thereof) or possession of the following certifications may be substituted for portions of the System Integrator's personnel experience requirements described above.
b. Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
c. Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
d. Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Technical Skills Training program.
e. Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
f. Training program curriculums as offered by ISA.
g. Training or certification does not satisfy the related project experience requirements described above.
h. Submit training and registration evidence with the above experience evidence.

E. Contract Drawings
1. Information on the Drawings
a. The following information relative to the Work of Division 40 is indicated on the Division 26 Contract Drawings.
i. Location of primary elements, control panels, and final control elements.
ii. Instrumentation signal and power conduit runs between control panels and field instruments and devices.
iii. Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.
iv. Location of all equipment having alarm and equipment status contacts.
v. Major instrument conduit runs.
2. Information Not on the Drawings
a. The following information relative to the Work of Division 40 may not be shown on the Drawings, but shall be the responsibility of the Contractor to determine, furnish, coordinate with other Trades, and submit for acceptance, based upon the systems specified.
i. Tubing for pneumatic signals, and/or power between main headers and control panels, field mounted primary elements, field instruments and final control elements.
ii. Number or sizes of tubing required for pneumatic and hydraulic signals.
iii. Point of connection to any hydraulic or pneumatic supply lines.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. Instrument Society of American (ISA).
      a. ISA S5.4 – Instrument Loop Diagrams.
   2. National Electrical Manufacturers Associations (NEMA).
      a. NEMA – Electrical Code.
   3. American Standard Code for Information Interchange (ASCII).
   4. Institute of Electrical and Electronic Engineers (IEEE).
      a. IEEE C62.41 – Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits.

1.03 SUBMITTALS

A. General.

Refer to the General Conditions of the Contract Documents for required method of preparation and transmittal and conform to requirements herein.

1. Pre-submittal Conference
   a. Arrange a conference with CSI, the Engineer, and the Owner within thirty (30) days after award of the Contract for the purpose of informally discussing in detail and verifying the correctness of the CSI's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by CSI, and duly authorized representatives of the Contractor, Engineer, and Owner.
   b. Submit 4 copies of the following items for discussion at the Pre-submittal Conference:
      i. A list of equipment and materials required for the ICM system and the manufacturer's name and model number for each proposed item. Identify items by tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing of the published specifications for the item specified and for the item proposed. Equivalent items shall only be accepted by the Engineer if the specified item is no longer manufactured.
      ii. A list of proposed clarifications to the Contract Documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the Engineer.
      iii. A sample of each type of submittal specified herein.
      iv. A flow chart showing the steps to be taken in preparing and coordinating each submittal.
      v. A bar-chart type schedule for all system related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided

to show activities relative to each major item or group of items when everything in a given group is on the same schedule.

vi. An overview of the proposed training plan. The Engineer will review the overview and may request changes. All changes to the proposed training shall be resolved at the Pre-submittal Conference. The overview shall include the following for each proposed course:

a) Course title and objectives.

b) Prerequisite training and experience of attendees.

c) Course content – a topical outline.

d) Course duration.

e) Course format – lecture, laboratory demonstration, etc.

vii. A preliminary copy of the ICSI Qualification submittal.

c. Take minutes of the Pre-submittal Conference, including all events, questions, and resolutions. Before adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

B. Shop Drawings

Before proceeding with any manufacturing, submit Shop Drawings for acceptance in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Schematics shall be complete with tag and terminal numbers. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing equipment and tag numbers on panels. Submit panel graphic drawings where applicable. Include material specifications lists where applicable. Include a draft of the theory of operation for relay logic circuits including those implemented via programmable controllers. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

1. In accordance with the requirements of Section 01 - Submittals, provide the following submittals:

a. Catalog Cuts

i. Catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under Division 40. This includes, but is not limited to, primary elements, transmitters, analytical equipment, gauges, valves, controllers, indicators, power supplies, switches, lights, relays, timers, etc.

2. Component Data Sheets

a. Data sheets, specification sheets, and an instrument list shall be provided for components provided under this Section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., part numbers, scales, ranges, service, materials of

construction, component location, options, and the individual tag number as noted in the Contract Drawings and in Contract Documents.

b. Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item may be included on a sheet.

3. Sizing Calculations
   a. Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all computing modules and function generating modules and shall include the actual scaling factors and units used.
4. Panel Construction Drawings
   a. Shop Drawings and Catalog Cuts
      i. Provide detailed shop drawings and catalog cuts for panels, instrument racks, and enclosures. Drawings shall show the location of front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show major dimensions as well as elevations, in inches from the base up, of the rows of components.
      ii. Shop drawings shall indicate location and size of available spare mounting space for rear-of-panel devices.
      iii. The panel legend shall list and identify front of panel devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
      iv. The bill of materials shall include devices mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.
   b. Color Schedule
      i. Provide a color schedule with color samples for control panels for the Owner's selection/approval.
5. Power Requirement and Heat Dissipation
   a. Provide a summary of the power requirements and heat dissipation for control panels. Power requirements shall state required voltages, currents, and phase(s) Heat dissipations shall be maximums and shall be given in BTU/Hr. Summary shall be supplemented with calculations.
6. Panel Wiring Diagrams
   a. Wiring diagrams shall be similar to those diagrams shown in the Contract Drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, hand switches and interlocks.
   b. Provide complete terminal identification of external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.
   c. External wiring that the electrical contractor must provide and wire shall be shown as a dotted line. Special cables that are provided with the instrument shall be clearly identified.

d. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show each circuit individually. Common or typical diagrams shall not be allowed.

e. Provide panel power wiring diagrams for panels. The diagrams shall include grounding requirements.

7. Interconnecting Wiring Diagrams

   a. Diagrams shall show component and terminal board identification numbers, external wire and cable numbers. The drawings shall show intermediate terminations between field elements and panels (e.g., terminal junction boxes) This diagram shall be coordinated with the Contractor and shall bear his mark showing that this has been done.

8. Loop Diagrams

   a. Provide an individual wiring diagram for each analog loop showing terminal numbers, the location of the DC power supply, the location of any dropping resistors, the location and connection of the surge protection devices. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:

   b. Each loop diagram shall be divided into three areas for identification of device locations: panel face, back-of-panel, and field respectively. Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11-inch by 17-inch Drawings.

9. Instrument Installation Details

   a. The CSI shall review the Contract Documents and develop and submit for review, complete installation details for each field mounted device and panel prior to shipment and installation. Common details, not requiring any modification, may be referenced by an index showing the complete instrument tag number, service, location, and device description. Installation details shall be provided as required to adequately define the installation of the ICM system components.

10. Operator Interface Submittal

    a. This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays.

    b. The submittal shall contain the semi-final details of all logs, reports, and process graphic displays. The specifics of what shall appear on each display and what calculations are required to support them shall be developed and submitted.

    c. Submitted process graphic displays shall be no smaller than 8.5-inches by 11-inches and in full color.

    d. A complete listing of all signals to be collected for long term historical information shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

    e. A complete listing of all signals to be collected for trend display shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

11. Process Control Strategy Submittal:

a. The process control schemes shall be developed in a ladder logic diagram or functional block (logic) diagram presentation based on information from the Contract Documents. Included with each diagram shall be:
   i. Brief Scope of the Control Function.
   ii. Listing of all scanned inputs to the control function.
   iii. A short narrative of the control strategy.
   iv. Any assumptions made in developing the program.
   v. Listing of all inputs and outputs (i.e., AI, DI, AO. DO) from the control function.
   vi. Cross reference list of all I/O showing to which I/O modules or software modules they are linked.
   vii. Listing of all operator inputs/outputs to and from the control function. Any special CRT displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.
   viii. Failure contingencies shall be described in detail.
   ix. A flowchart representing the control strategy.

b. This submittal shall cover all of the associated logic developed under the CSI required to implement the control functions specified.

c. The System Integrator shall submit annotated logic on 8-1/2-inch x 11-inch format and as an ASCII file on compact diskettes for all logic developed. Annotation shall be 3 lines of 6 characters each for every logic contact. In addition, each network or rung shall be annotated so that a non-technical person can read and easily comprehend what control function the rung or network is performing.

d. This submittal shall also include copies of the PLC I/O configuration tables, I/O reference usage table, complete cross reference to specific rung used of all inputs, outputs, internal coils, data registers, and special purpose coils. In addition, any special switch settings or hardware configuration requirements such as com port configurations shall be described in detail and submitted.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Operational Field Acceptance Test (OAT) Documentation.

   The CSI shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

   After acceptance of the examples, the CSI shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active ICM system element (except simple hand switches, lights, etc.) These sheets shall be submitted after the tests are completed.

   a. Instrument Calibration Sheets.
      i. Provide a written report to the Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include all applicable data as listed below plus any defects noted, correction

action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items:

a) Facility identification (Name, location, etc.)
b) Loop identification (Name or function)
c) Equipment tag and serial numbers.
d) Scale Ranges and units.
e) Test mode or type of test.
f) Input values or settings.
g) Expected outputs and tolerances
h) Actual readings at 10%, 50%, and 90% of span.
i) Explanations or special notes as applicable.
j) Date, time, and weather.
k) Tester's certification with name and signature.

2. Functional Acceptance Test Documentation.

The CSI shall prepare two types of test procedures and forms as follows.

a. Loop Test Documentation

For functions that can be demonstrated on a loop-by-loop basis, the form shall include:

i. Project Name.
ii. Loop number.
iii. Loop description.
iv. Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.
v. For each component: tag number, description, manufacturer, and data sheet number.
vi. Space for sign off and date by the CSI, the Contractor, and the Engineer.

b. Functional Test Documentation

For those functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

i. Specification page and paragraph of function demonstrated.
ii. Description of Function.
iii. Test procedure description.
iv. Space after each specific test to facilitate signoff on completion of each test.

E. Testing

1. Factory Testing, field Testing, and Final Acceptance Testing shall be provided.
2. System Commissioning Assistance.

a. Provide the services of a factory trained and field experienced instrumentation engineer to assist Owner's personnel during each startup of the various systems. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

F. Operation & Maintenance Manuals.

Furnish Instruction Manuals and Parts Lists for instrumentation equipment in accordance with the requirements of Division 1 and as noted herein.

1. Schedule.
   a. Deliver manuals not later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to Engineer.
2. Material Content. Include in the manuals not less than the following applicable information for each instrument, equipment, subsystem and/or control loop. The O&M Manuals shall consist of, at least, the following material:
   a. Bill of Materials.
      i. A listing of all the panels, racks, instruments, components, and devices supplied. Components shall be grouped by component type, with the component types identified in a similar manner to the component identification code used in these specifications. The list shall contain, as a minimum:
         a) Instrument, panel, rack or device tag number.
         b) Description.
         c) Quantity supplied.
         d) Reference to component data sheet and/or catalog cut.
         e) Component type.
   b. Component Data Sheets.
      i. See Paragraph 1.03 C.2 specified herein before.
   c. Catalog Cuts.
      i. See Paragraph 1.03 C specified herein before.
   d. Component O&M Manuals.
      i. An O&M manual shall be submitted for instruments and devices supplied. The O&M manuals shall contain, as a minimum:
         a) Operating procedures.
         b) Installation procedures.
         c) Maintenance procedures.
         d) Troubleshooting procedures.
         e) Calibration procedures.
         f) Internal device schematics and wiring diagrams.
         g) Shut-down procedures.
         h) Component parts list.
         i) Detailed circuit operational description including annotated programmable controller ladder diagrams.
   e. Spare Parts and Expendables List

i. The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.

f. "As-Shipped" Drawings

i. Drawings shall be a record of work "As-Shipped" from the factory and shall be labeled as "As-Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As-Shipped" drawings as a minimum:

a) Panel Fabrication Drawings.

b) Panel Wiring and Interconnection Drawings.

G. Final Record Documentation's

1. Reproducible Drawings. Contractor shall submit reproducible's of finished schematics, wiring diagrams and installation drawings to include installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "RECORD DOCUMENTS", in accordance with the requirements of Section 01 – Contract Closeout. One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.

a. Loop Diagrams.

1) See Paragraph 1.03 C.8 specified herein before.

b. Panel Fabrication and Wiring diagrams.

1) See Paragraph 1.03 C.4 and 1.03 C.6 specified herein before.

c. Interconnecting Wiring Diagrams.

1) See Paragraph 1.03 C.7 specified herein before.

d. Instrument Installation Details.

1) See Paragraph 1.03 C.9 herein before.

2. Process and Instrumentation Diagrams (P&ID's).

a. The Engineer will supply the Contractor with P&ID's on magnetic media for revisions to reflect the final installed system.

b. The P&ID's shall be updated by the Contractor who may use these drawings for producing the final documentation.

3. Software Documentation. In addition to the reproducible hard copy of drawings and literature generated specifically for the project, Contractor shall submit electronic copy to the Engineer with all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc. Drawing format shall be compatible with AutoCad ver. 2018 or newer.

H. Training Requirements.

1. General:

a. Contractor shall provide the services of a CSI factory trained and field experienced instrumentation engineer to conduct group training of Owner's designated personnel in the operation of each instrument system. Obtain Owner's written consent that the training has been adequate. Include instruction covering basic system theory, operating principles and adjustments, routine

maintenance and repair, and "hands on" operation. The text for this training shall be the P & ID's, graphic operation interface, PLC and SCADA software, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.

2. Duration:
    a. Training specific to the system control panel hardware and software. This training shall be for a minimum time period of 30-8-hour days and 6 trips. This training shall be separate from start-up and testing.
3. Operator Training:
    a. Operator training shall include instruction in the use of Control Panels and Field Panels furnished.
4. Maintenance Training:
    a. Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments.

I. Post-Contract System Support.
1. Maintenance Contract:
    a. Duration.
        i. Provide a 1 year maintenance contract for components furnished starting from the date of acceptance.
    b. Schedule.
        i. Develop a program of preventive maintenance visits that includes verification of instrument performance on a monthly basis and complete calibration of instruments on a semi-annual basis. After every visit, submit to the Owner records of instrument verification and calibration on appropriate forms.

J. Guarantee and Warranties
1. The equipment manufacturers shall warrant and guarantee against defective equipment, workmanship, and materials under normal use, operation and services, unless otherwise noted in other Division 40 Sections shall be for a period of 2 years after acceptance from the final date or final resolution of the Owner acceptance of Work as substantially complete. For equipment bearing a manufacturer's warranty in excess of two years, furnish a copy of the warranty to Engineer with Owner named as beneficiary.

PART 2 - PRODUCTS

2.01 HARDWARE REQUIREMENTS

A. Job Conditions.
1. Contract Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Contract Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to accommodate structural features. Verify dimensions and

conditions at the project site, and install materials and equipment in the available spaces.

B. Materials and Standard Specifications.

1. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities, instruments supplied by the Contractor, of the same type shall be by the same manufacturer. All panel mounted instruments shall have matching style and general appearance. All meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise required to match existing equipment. This allows the stocking of the minimum number of spare parts.

C. Product Delivery, Storage, and Handling.

1. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

D. Mountings.

1. Mount and install equipment as indicated. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with suppliers recommendation. Unless specified otherwise all mounting hardware shall be stainless steel. Where mounted in control panels, mount according to manufacturer recommendations.
2. Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor higher than five (5) feet above walkways, platforms, and catwalks. Such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in Type 316 stainless steel NEMA 4X cases unless otherwise noted.

E. Instrument Identification.

1. Components provided under this Section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.
2. Nameplates for panels and panel mounted equipment shall be as specified on the design documents.
3. Field mounted tags shall be 16-gauge, Type 304 stainless steel with 3/16-inch high characters.
4. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with

standard stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gage stainless steel wire.

5. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In each case, the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

F. Electronic Equipment.

1. If the equipment is electronic in nature, provide solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppresser directly to the instrument, the arrestor shall be so mounted. Field equipment shall have a Joslyn (or accepted equal) surge suppresser mounted on the instrument housing, if such mounting is provided on the instrument, otherwise a threaded surge suppresser connection shall be provided on the conduit as close as practical to the instrument.

G. Equipment Operating Conditions.

1. Equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
2. Power:
   a. Electrical. 115 VAC +/- 10%, 60 Hz +/-1 Hz except where specifically stated otherwise on the drawings or in the specifications.
3. Field Instruments:
   a. Atmospheric contaminants (All Areas):
      i. Hydrogen Sulfide: 0.1 mg/l.
      ii. Chlorine: 0.01 mg/l.
      iii. Ammonia: 0.5 mg/l.
      iv. Dust: 50.0 µg/m3.
   b. Outdoor Areas:
      i. Ambient Temperature: -20^{O}F to +120^{O}F.
      ii. Ambient Relative Humidity: 10% to 100%.
      iii. Weather: Rain, wind, sun and blowing sand.
4. Indoor Environmentally Uncontrolled Areas:
   a. Ambient Temperature: 40^{O}F to +105^{O}F.
   b. Ambient Relative Humidity: 20% to 80%.
5. Indoor Environmentally Controlled Areas:
   a. Ambient Temperature: 55^{O}F to +85^{O}F.
   b. Ambient Relative Humidity: 20% to 80%.

c. Short term excursions to temperature limits for non-environmental controlled areas.

6. Provide, as necessary, enclosures, heat tracing, heaters and sunshields, etc. to assure normal operations under these conditions.
7. Corrosive Areas: Provide instrument enclosures and hardware suitable for the corrosive location.
8. Hazardous Areas: All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Contract Drawings for the locations. All Work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all Owner costs arising there from.

H. Power Supplies.

1. Provide electrical instruments and control devices for operation on 120 VAC, 60 Hz current. Protect each device power supply with properly sized fuses.
2. Unless otherwise indicated provide battery backed up Uninterruptable Power Supply (UPS) with AC inversion for each control panel and PLC. UPS shall be sized to run the peak tributary load for a period of not less than 30 minutes. UPS shall be mounted in the respective panel. Minimum UPS size shall be 990 watt-hour. Provide bypass switch for panels to run directly from power source or through UPS with front of panel mounted indicator light showing current models.
3. Output overvoltage and overcurrent protective devices shall be provided for DC power supplies to protect instruments from damage due to power supply failure and to power supply from damage due to external failure. Power supplies shall be provided with NEMA 1 enclosures. Power supplies shall be mounted such that dissipated heat does not adversely affect other components. Source of operating power shall be 120 VAC, 60 Hz commercial power. Units shall be mounted within the control panels. Power supply fusing shall be provided with blown fuse indicators.

I. Signal Isolators, Converters and Conditioners.

1. Insure that input-output signals of all instruments and control devices (new and existing) are compatible. Analog signals between field and panels shall be 4-20 mA unless specifically accepted otherwise. Granting such acceptance does not relieve the Contractor from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

J. Auxiliary Contacts by Others.

1. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

K. Painting.

1. Provide factory paint for instruments and equipment except where in pipelines.

L. Electrical.

1. Work shall include the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Division 26.
2. Wiring installations shall include cables, conductors, terminals, connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the Work of other Divisions.
3. Provide the materials and complete the required installations for equipment grounding as specified in Division 26 of these Specifications and indicated on the Contract Drawings.
4. Incidental items not specifically included in the Contract Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Contractor at no additional cost to the Owner.
5. Field Wiring. For wiring materials, refer to Division 26 and Details on the Contract Drawings. Test signal wiring for continuity prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type heat shrink label or equal for each termination.

M. Process Connections.

1. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be Type 316 stainless steel. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other Divisions of these Specifications but coordinated by Division 40.

N. Electrical Transient Protection.

1. Instrument and control equipment mounted outside of protective structures (field mounted equipment) shall be equipped with surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Both power and signal circuits shall be protected with surge and transient protectors installed at the source and destination ends of the circuits. Protective devices used on 120 VAC inputs to field mounted equipment shall be secondary surge protectors conforming to the requirements of IEEE C62.41 8/20μs wave form.
2. Surge and transient protectors shall be normally connected to the electrical system ground. When an electrical system ground is not available near the device, the protectors shall be connected to a ground rod located within 10 feet of the device. The ground rod shall meet all the requirements of Section 26 05 26 - Grounding and Bonding, in Division 26, Electrical.

3. Protectors for analog signal circuits on or near field instrument housings shall be Innovative Technology Model OEM D22TX, Phoenix Contact Surge Trab Series, or accepted equal.
4. Protectors shall be provided for conductors penetrating panel enclosures for power circuits protectors shall be Innovative Technology Model HS-P-5P secondary arrestor, Phoenix Contact PT Series, or accepted equal. For analog and data circuits protectors shall be rail mounted Innovative Technology Model HS, or accepted equal. Protectors for data utilizing coaxial connections shall be Innovative Technology, or accepted equal. Provide multi-stage gas tube and solid state Innovative Technology, or accepted equal, protectors for digital circuits.

O. Spares and Maintenance Materials.
1. Furnish the following items as specified herein. Deliver to Engineer, as directed, with itemized list in a letter of transmittal accompanying each shipment.
2. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.
3. One Fuse of each size and type for every five used but no less than five of each type.
4. One Relay of each type for every five used but no less than two of each type.
5. One Panel Indicating Light Bulb for every five used but no less than four of each type.
6. One Transient Protector for every five used but no less than four of each type.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING

A. Shipping Precautions: After completion of shop assembly, factory test, and acceptance, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment before packaging and shipment.

C. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the ICM system. Identification shall be prominently displayed on the outside of the package.

D. Storage: Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected

against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at no additional cost to the Owner. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. Such tests shall be at no additional cost to the Owner, and if the equipment fails the tests, it shall be replaced at no additional cost to the Owner.

E. Protection during Construction: Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters.

F. Paint Finish: Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer.

3.02 MANUFACTURER'S SERVICES

A. Furnish the following Manufacturer's services for all instrumentation provided:
   1. Perform bench calibration.
   2. Oversee installation.
   3. Verify installation of installed instrument.
   4. Certify installation and reconfirm Manufacturer's accuracy statement.
   5. Oversee loop testing, prepare loop validation sheets, and certify loop testing.
   6. Oversee pre-commissioning, prepare pre-commissioning validation sheets, and certify pre-commissioning.
   7. Train the Owner's personnel.

3.03 INSTALLATION

A. General:
   1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed per the manufacturers' instructions and Division 40.
   2. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment that do not impact material quantities or cause material rework, make such changes without additional cost to the Owner.

B. Conduit, Cables, and Field Wiring
   1. All conduit shall be provided, in accordance with Section 26 05 33.

2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, remote I/O, PLC I/O, and other non-specialty field wiring and cables shall be provided and installed, in accordance with Division 26.
3. All ICM system specialty cables, data highway fiber optic cable and specialty cable termination devices shall be provided under Division 40 and installed, in accordance with Division 26.
4. All field cables and wiring terminations and wire identification at ICM system equipment furnished under this or any other Division shall be provided in accordance with the requirements of Division 26. All terminations shall be checked by the equipment supplier and the electrical contractor.

C. Instrumentation Tie-Downs: All instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements that apply to the site.

D. Existing Instrumentation: Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned and recalibrated by an authorized service facility of the instrument Manufacturer. Provide certification of this Work before reinstallation of each instrument. Provide replacement for interim period as required.

E. Ancillary Devices: The Contract Documents show all necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the Owner. All such additions and all such changes, including the proposed method of installation, shall be submitted to the Engineer for acceptance before commencing the Work. Such changes shall not be a basis of claims for extra work or delay.

F. Installation Criteria and Validation: All field-mounted components and assemblies shall be installed and connected according to the requirements below:
1. Installation personnel have been instructed on installation requirements of the Contract Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the accepted and approved shop drawings and data.
4. Instrument process sensing lines shall be installed similar to conduit. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3-feet of rigid tubing.
5. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.
6. All differential pressure elements shall have three valve manifolds.
7. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
8. All power and signal wires shall be terminated with crimped type lugs.
9. All connectors shall be, as a minimum, water tight.

10. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
11. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically accepted by the Engineer. All wiring shall be protected from sharp edges and corners.
12. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.
13. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. Certify in writing that for each loop or system checked out, all discrepancies have been corrected.
14. The Owner will not be responsible for any additional cost of rework attributable to actions of the Contractor or the CSI.

3.04 CALIBRATION

A. General: All devices provided under the instrumentation Sections shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Calibration Points: Each instrument shall be calibrated at 20, 40, 60, 80 and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.

C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Field Calibration: Instruments that were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. All samples and sample gases shall be furnished by the manufacturers.

F. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. Have the Instrumentation Supplier sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.05 LOOP TESTING

A. General: Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the Engineer for review before the loop tests. The Contractor shall notify the Engineer of scheduled tests a minimum of 30 days before the estimated completion date of installation and wiring of the ICM. After the

Engineer's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the Engineer.

B. Control Valve Tests: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to ensure that no changes have occurred since the bench calibration.

C. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.

D. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its Manufacturer's specifications and instructions. Any instrument that fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the direction of the Engineer at no additional cost to the Owner.

E. Loop Validation: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA and PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks that incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test that include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

F. Loop Validation Sheets: Prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop provided by the CSI:

1. Project name.
2. Loop number.
3. Tag number, description, manufacturer and model number for each element.
4. Installation bulletin number.
5. Specification sheet number.
6. Loop description number
7. Adjustment check.
8. Space for comments.
9. Space for loop sign-off by Instrumentation Supplier and date.
10. Space for Engineer witness signature and date.

G. Loop Certifications: When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Engineer as a witness, with test data entered, shall be submitted to the Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.06 PRE-COMMISSIONING

A. General: Pre-commissioning shall start after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

B. Pre-commissioning Procedures and Documentation: All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer as submitted by the CSI. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, that include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.

C. Operational Validation: Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic

analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

D. Loop Tuning: All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.

E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on one of two types of test forms as follows:
   1. For functions that can be demonstrated on a loop-by-loop basis, the form shall include:
      a. Project name.
      b. Loop number.
      c. Loop description.
      d. Tag number, description, manufacturer and data sheet number for each component.
      e. Space for sign-off and date by both the CSI and the Engineer.
   2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description, the following information shall be included:
      a. Specification page and paragraph of function demonstrated.
      b. Description of function.
      c. Space for sign-off and date by both the CSI and the Engineer.

F. Pre-commissioning Certification: Submit an ICM system pre-commissioning completion report that shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

3.07 ONSITE SUPERVISION

A. Furnish the services of an on-site service engineer to supervise and coordinate installation, adjustment, testing, and start-up of the ICM system. The Engineer will be present during the total period required to affect a complete operating system. A qualified team of the Instrumentation Subcontractor personnel shall be on site as required to check all equipment, perform the tests indicated in this Section, and furnish startup services.

3.08 PERFORMANCE TEST

A. The entire ICM system shall operate for 30 days without failure.

B. Furnish all necessary support staff as required to maintain the system and to satisfy the repair or replacement requirements.

C. If any component fails during the performance test, it shall be repaired or replaced within 4 hours and the ICM system shall be restarted. If the system is not repaired and running within four (4) hours or more than six component failures within the four (4) hour repair period, the system shall be restarted and operate for an additional 30 days without failure.

3.09 TRAINING

A. Test entire ECM system.

B. General: Train the Owner's personnel on the maintenance, calibration and repair of all instruments provided under this Contract.

C. Instructions: The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Duration: Each training class shall be a minimum of 8 hours in duration and shall cover, as a minimum, operational theory, maintenance, troubleshooting/repair, and calibration of instruments. Include a minimum of 4 hours training per instrument or control device; for PLC, and software include 8 hours for each type supplied.

E. Schedule: Training shall be performed during the pre-commissioning phase of the project and 30 days after acceptance. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The Owner and Engineer will review the course outline and the training manual as submitted by the CSI for suitability and provide comments that shall be incorporated.

F. Agenda: The training shall include operation and maintenance procedures, trouble shooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment.

G. Documentation: Within 10 days after the completion of each session the Contractor shall submit the following:
   1. List of all Owner personnel who attended the session.
   2. Evaluation of Owner personnel via written testing or equivalent evaluation.
   3. Copy of the training materials used including all notes, diagrams, and comments.

3.10 ACCEPTANCE

A. For the purpose of this Section, the following conditions shall be fulfilled before the Work is considered substantially complete:
   1. All submittals have been completed and accepted.
   2. The ICM system has been calibrated, loop tested and pre-commissioned.

3. The Owner training has been performed.
4. All required spare parts and expendable supplies and test equipment have been delivered to the Owner.
5. The performance test has been successfully completed.
6. All punch-list items have been corrected.
7. All record drawings in both hard copy and electronic format have been submitted.
8. Revisions to the operations and maintenance manuals information that may have resulted from the field tests have been made and reviewed.
9. All debris associated with installation of instrumentation has been removed.
10. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

3.11 WARRANTY

A. Supplier shall warrant design, materials, and workmanship for customary period applicable for the equipment involved, but in no case for less than 24 months from date of acceptance, in accordance with the requirements of Paragraph 1.03, J, 1.

B. During warranty period, if mechanical defects occur, or equipment fails to perform in accordance with specified performance requirements under conditions of normal use within the design limitations of the equipment, supplier shall, upon request of the company, repair or replace equipment or parts as required and shall place equipment in proper working condition, assuming all expenses involved.

C. A written prepaid maintenance contract executed by the CSI shall be provided to the Owner for on-site warranty and travel maintenance services, in accordance with the requirements of Paragraph 1.03, H, and Paragraph I, 1. This maintenance contract shall include all travel and living expenses, labor, parts, and emergency calls providing on-site response within 4 hours, to provide complete system maintenance for a period of one year after the date of final acceptance of the system.

D. The maintenance contract shall include a minimum of 4 (quarterly) preventive maintenance visits by a qualified serviceman of the Supplier who is familiar with the type of equipment and software provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and written verification of calibration and correct software operation.

E. An annual fee shall be quoted 90 days before completion of the first year maintenance contract for annual maintenance subsequent to the first year of operation. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from day of issue.

END OF SECTION 40 90 00

SECTION 40 94 03 - PROGRAMMABLE LOGIC CONTROLLER SUBSYSTEM (PLCS)

PART 1 - GENERAL

1.01 SCOPE

A. General - This section describes the Programmable Logic Controller (PLC), Input/Output (I/O) equipment, Operator Interface Terminal (OIT), fiber optic industrial Gigabit Ethernet and associated network communication equipment, and associated hardware and equipment, PLC programming software, Human Machine Interface (HMI) SCADA application software including all engineering and programming and development required for monitoring and control. All devices, accessories, programming, and appurtenances required for proper operation of a complete and functional Instrumentation Control and Monitoring (ICM) system shall be provided.

1. The SCADA system shall be designed, coordinated, and supplied by a Control System Integrator (CSI) consisting of PLC based data acquisition and operator interface graphic display systems, who shall guarantee satisfactory operation of the installed ICM system.
2. Develop and provide the PLC and SCADA HMI and OIT graphic display applications programs and hardware configuration needed to monitor and control the process equipment to perform the functional requirements as specified in Division 40 Sections or as required by the process equipment manufacturers and as required by and described in these Contract Documents.
3. SCADA PLCs shall be configured and provided with hardware necessary to communicate with Ethernet enabled process instrumentation and equipment as required in these specifications.
4. In general, communication network from structure to structure shall be via industrial redundant, self-healing Ethernet optical fiber network. Each PLC and Operator Workstation shall be provided with a UPS with a 30-minutes full load minimum. In the event of local power failure, the PLC shall automatically stop fault sequencing, PID windup, and continue accumulation of data and process calculations while notifying the operator via the HMI screens. Communication shall continue with PLC and workstations.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. National Electrical Manufacturers Association (NEMA).
2. Instrument Society of America (ISA).

1.03 SUBMITTALS

A. The Contractor shall make submittals in accordance with Divisions 01 and 40.

B. The following information shall be provided:

1. Electronic copy of each of the following shall be submitted:
   a. Manufacturers complete data.
   b. Shop drawings, which include the following:

i. Outline drawings of all components and a composite drawing.
ii. Schematic drawings of auxiliary piping and wiring.

2. Electronic copy of each of the following shall be submitted:
   a. Operation and maintenance manual.
   b. Training documentation.

1.04 TESTING

A. Factory testing, field testing, and final acceptance testing of computers and programmable logic controllers shall conform to the requirements of Section 40 90 00.

1.05 WARRANTY

A. Conform to warranty requirements of Division 40.

B. The equipment manufacturers shall warrant and guarantee against defective equipment, workmanship, and materials under normal use, operation and service, for a period of 2 years after acceptance from the final date or resolution of the Owner accepting Work as substantially complete.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as required. In addition, the following specific spare parts items shall be provided:
   1. One of each type of CPU and co-processor module for PLC equipment furnished under this Contract.
   2. One of each type of input/output module for PLC equipment furnished under this Contract.
   3. One of each type and size of PLC and equipment power supply furnished under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Provide Programmable Logic Controller including necessary equipment and appurtenances as manufactured by the following acceptable manufacturer:
   1. Allen Bradley – CompactLogix.

2.02 PROGRAMMABLE LOGIC CONTROLLER AND I/O HARDWARE

A. General
   1. Provide PLC hardware including processors, power supplies, rack assemblies, interconnecting cables, grounding system, communication modules, hot standby modules, and accessories required to perform the control and monitoring functions.

B. Programmable Logic Controller (PLC)
   1. The PLC shall be provided with the following minimum features:

a. The processor shall be the slot mount type, include at least 2MB available user memory. Minimum CPU shall be CompactLogix series.

b. The PLC system shall be able to accommodate the quantity and type of I/O points shown and described including future I/O points. In addition, provide 20% spare I/O points for each type, where a certain type of I/O is not required such as analog output, provide at least one such I/O module.

c. The PLC system shall include one Ethernet communication module. Ethernet communication module shall be used for permanent system-type communications from PLC to PLC and to HMI operator workstations throughout the plant. Data transfer rate shall be up to 100Mbit/s.

d. The PLC system shall operate over 0-to-60-degree Celsius temperature range, and a 0 to 95% (non-condensing) humidity range.

e. The processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.

f. The PLC system shall allow on-line and off-line programming.

g. The CPU's shall have executive firmware which may be upgraded in the field using an upgrade/download procedure which does not require the removal and/or insertion of IC chip.

h. The PLC system shall be capable of communicating with third party devices such as Motor Control Centers, including Variable Frequency Drives (VFD), and packaged vendor equipment systems via Ethernet IP.

2. The PLC system in each control panel shall include a single or redundant processor (when shown on the drawings), power supply, and hot standby module. If the primary PLC system fails the standby PLC system shall assume primary control functions within 48 milliseconds of the failure. A failed component shall be able to be removed, replaced, and reloaded (with software) without shutting the on-line PLC system down. No special application programming shall be required to implement the hot standby PLC systems.

3. A power supply (quantity and size as required) shall be provided to supply power to the processor and I/O modules. The supply voltage to the power supply shall originate within the control panel and shall be 120 VAC. A separate 24 VDC power supply shall be provided to power the analog loops.

4. I/O modules shall be provided as required to accommodate the types and quantities of I/O points identified. Sample I/O point types include; dry contact outputs, 4-20 mAdc analog inputs, 4-20 mAdc analog outputs, and 120 VAC discrete inputs. Discrete inputs shall use 120 VAC as the voltage signal, and analog loop signals that leave the control panel shall use a 4-20 mAdc current signal. I/O module point density shall not exceed 16 points per module. Each I/O module shall include front panel mounted diagnostic indicators for point status, fault conditions, and active conditions. The I/O modules shall be able to be replaced while under power and shall be keyed to prevent the wrong type of module from being inserted in the wrong slot. All I/O modules shall have removable terminal blocks for termination of field wiring. All terminal blocks shall be 'keyed' to prevent application of terminal block to wrong I/O module. All I/O modules shall report to the CPU should a terminal block fail or be removed.

5. The PLC and I/O modules rack assemblies shall be housed in the control panels as specified.

6. The control panels shall be provided with sufficient I/O modules to allow 20% spare installed and wired I/O points. Spares shall be provided for each different type of I/O.

7. The PLC and I/O equipment shall be a standard industrial grade product mechanically and electrically suitable for use in an industrial environment with a satisfactory product history of at least five years.

2.03 PROGRAMMABLE CONTROLLER APPLICATION & DEVELOPMENT SOFTWARE

A. The PLC programming and configuration software shall be the manufacturer's latest version, and compatible with the Windows 10 operating system. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. Programming shall be accomplished through the use of ladder logic and other IEC 1131.3 languages. PLC programming software shall include electronic documentation.

B. Third-party programming software shall be acceptable if recommended by the manufacturer and if that software exceeds the capabilities of the PLC manufacturer's standard software package.

C. All configuration and programming software necessary shall be provided on each operator workstation computer specified, including the Portable Laptop Programming Terminal, for connection to any PLC processor on the Ethernet network or via direct connection to the processor communications port. All necessary hardware drivers required to perform PLC configuration and programming shall be provided.

D. If available, the configuration and programming software shall support communication over the network to implement its functions remotely from an operator workstation. All configuration and programming software necessary to implement this functionality shall be provided on the SCADA System Operator Workstations. All necessary hardware and software drivers required to allow the operator workstation to perform PLC configuration and programming shall be provided.

E. The ladder logic instruction set for the PLC shall include the following, as a minimum:
   1. Relay type instructions.
   2. Counter and timer instructions.
   3. Comparison instructions (equal, greater than, limit tests, etc.).
   4. Integer and floating-point mathematical instructions.
   5. Advanced math and trigonometric functions.
   6. Statistical instructions.
   7. Matrix and array instructions.
   8. Logical instructions (and, not, or, etc.).
   9. BCD conversion instructions.
   10. Bit modification, moving, and shift instructions.
   11. File instructions (search, copy, fill, etc.).
   12. Diagnostic instructions.
   13. Sequencer instructions.
   14. Program control instructions (jump, goto, subroutine, etc.).
   15. PID control loops.
   16. Block read and write capability.

17. Send/receive messages.
18. Immediate I/O and communications update instructions.

F. The PLC programming & configuration software shall be the latest version of RSLogix as required.

2.04 SCADA HMI APPLICATION SOFTWARE

A. Provide an operator interface software package that, when combined with the operator station computer hardware, will gather, display, and store real-time operating information. The operator interface software package shall be sized according to the appropriate I/O point count and shall be able to accommodate 20% additional I/O in the future, but as a minimum shall accommodate 10,000 I/O.

B. HMI Application Software

1. The operator interface software package shall provide the following minimum functions:
   a. Compatible with Windows 10 Pro operating system.
   b. The software package shall be provided with the appropriate Ethernet driver software, Ethernet hardware interfaces, and required Ethernet communication/configuration interface software as required.
   c. The SCADA software shall utilize existing HMI software package.
   d. Database management shall be performed using Microsoft SQL Server Database. The ability to store historical data (analog or digital) to daily, weekly, or monthly files and the ability to archive historical data to tape.
   e. Report writing software shall be the latest version of XLReporter by SyTech, Inc., or accepted equal. The system integrator shall coordinate directly with the owner on types of required report as well as the reports format, etc.
   f. Analog data shall be configured to be stored as average, minimum, maximum, or instantaneous values, in the proper engineering units.
   g. A complete alarm handling package shall be provided that shall annunciate alarms in an alarm queue and allow them to be displayed on the process graphic displays with messages or by changing colors or otherwise massaging graphic display symbols. An alarm summary screen shall be provided. Alarms shall be able to be acknowledged by an operator at the operator station CRT on an individual or screen basis and nuisance alarms shall be able to be disabled. Alarms shall be logged to the alarm printer.
   h. Password protection for the various levels of access (day-to-day functions versus configuration changes), Log in and Log out at all times and Auto log off with set time.
   i. The data base points shall be identifiable by tag numbers.
   j. The entire system configuration, including database, shall be able to be backed up on Cloud Storage (cloud services shall be prepaid by the system integrator for at least 3 years) as well as a local External Drive.
2. Real Variables Processing.
   a. Real Variables shall represent process data for which there are analog signal inputs to the system. The system shall sample each of these input signals at their selected scan frequency, and perform the proper conversions and scaling to obtain the instantaneous

engineering values. These values then shall be used to update real-time data on CRT displays, check for alarm conditions, and store for use in the historical files.

3. Calculated Variables Processing:
   a. Calculated variables shall represent process parameters for which there are no direct analog inputs to the system. These variables shall utilize Real Variables, and manually entered constants or laboratory data to compute their value.
   b. There shall be two types of calculated variables defined:
      i. Calculated Variables that utilize one or more Real Variables and/or manually entered constants. These variables shall be treated in the same manner as Real Variables and shall have the same attributes as Real Variables (including alarming and control), with the exception that the calculation shall be performed automatically every 5 seconds.
      ii. Calculated Variables which are used only for the Daily, Monthly, and Annual Operation Summary reports, and which utilize laboratory input data shall be computed once a day for inclusion in the Daily report and stored for use in the Monthly and Annual reports. The capability to display these variables shall be provided.
   c. The System shall provide for a minimum of 4096 calculated variables.
4. Manual Input Data Handling.
   a. The application software shall provide the capability to enter data manually from any operator's keyboard. This data shall consist of additional values for the current data file (e.g., laboratory analyses), inserting alarm limits, set point changes, adjustments to process constants, control system set point changes and system tuning parameter adjustments.
   b. All manually entered data shall be entered and stored in the appropriate engineering units. All data entered shall be displayed for confirmation on the data entry device prior to incorporation to the data base.

2.05 MANAGED ETHERNET SWITCHES

A. The managed Ethernet switch will be IEEE 802.3 compliant.

B. The switch shall be powered by a nominal 24VDC supply.

C. The switch will have a permissible voltage range of 18.5 VDC to 30.2 VDC

D. Switch will support redundant power inputs that allow immediate switchover without switch operation interruption.

E. The switch shall have an operating temperature range of 0°C to +55°C.

F. The permissible storage temperature range for the switch will be -20°C to +70°C.

G. The switch will withstand a maximum continuous operating humidity of 95% without condensation.

H. Units should be of fan-less design to increase reliability

I. Switching Capabilities:
   1. Auto-negotiation.
      a. All Copper TX ports will support auto negotiation.
      b. Each TX port will be able to interface to 10/100/1000 Mbps or full/half duplex devices.
      c. Fiber optic ports will support continuous 10/100/1000 Mbps full duplex communications.
   2. Auto Cross.
      a. All TX ports will support MDIX providing cable autocross capability.
   3. Auto Polarity.
      a. The switch will support automatic port polarity change in the event a pair of twisted pair receive cables (RD+/RD-) are connected incorrectly.
   4. Serial Interface.
      a. The device will have a V.24 RS232 communications interface.
   5. Accuracy & Capacity of switching table.
      a. The switch will only forward valid Ethernet frames using the store and forward, or equivalent method.
      b. The MAC address table will have a storage capacity of 8000 addresses.
   6. Configurations.
      a. The switch will support a removable memory device for the storing of switch settings, and the ability to share settings among like switches.

J. Diagnostics:
   1. Port Status LED's.
      a. Link: Each port will have an LED indication that there is a proper electrical connection to the attached device as well as providing indication that there is port activity.
      b. Communication: Each port will have an LED indication for detection of packet collisions, and showing communication duplex mode.
      c. To simplify the process of troubleshooting, the status indication of heavy communications traffic vs. the status of an active link with no communications traffic will be unambiguous.
   2. LED Display.
      a. The switch will employ a multi-position diagnostic display for reporting various startup and operational states, or error conditions that may occur.
   3. Alarm Contact.
      a. Switch to be equipped with an alarm contact to enable automatic audible or visual alarm in the event of loss of port communication, or either (or both) power supply inputs.
      b. Switch to be equipped with an LED to indicate the status of the alarm contact.
   4. Power Supply LED.
      a. Switch will have a separate power indication LED for each power supply connection.

K. Internal Switch Functions:
   1. Simple Network Management Protocol (SNMP).
      a. The switch will support SNMP v1, v2 for network monitoring and configuration.

b. The switch will operate with any industry MIB browser.
c. Switch will have a system of fully configurable SNMP Trap messages.

2. Device Addressing.
   a. The switch will, by default, support dynamic device addressing via BootP.
   b. The switch will be capable of operation with a static IP address assignment.
   c. Support for switch IP address assignment via DHCP will be available.
   d. Switch address can be set via serial port connection.
3. Redundancy.
   a. Rapid Spanning Tree Protocol (RSTP).
      i. The switch will conform to the IEEE standard 802.1w for redundancy.
      ii. The switch will support redundant port connections and loops without causing network operation failure
      iii. The system of redundancy will be applicable for any network topology
      iv. Entire redundancy method will be integral to the individual switch and not dependent upon a separate management device.
   b. Fast Ring Detection (FRD).
      i. The Switch shall support the RSTP extension Fast Ring Detection to enable data channel recovery times faster than standard RSTP.
   c. Media Redundancy Protocol (MRP).
      i. Switch will support MRP in accordance with the IEC protocol 62439.
4. Web-Based Management.
   a. The switch will be programmed with an embedded web server.
   b. The web server will provide a comprehensive configuration, and diagnostic mechanism for the switch.
5. Security.
   a. The switch will provide the user the ability to entirely disable the Web-based management interface.
   b. Switch will support an IP address-based method for restriction of Web server access.
   c. Modifications to switch settings will be protected by a user selectable/changeable password.
   d. The switch will support an optional MAC address-based mechanism for controlling port access.
6. Port Mirroring.
   a. The switch will have the capability to send a copy of all network packets seen on one switch port to a network monitoring connection on another switch port.
   b. The switch will support mirroring of both ingress and egress traffic.
7. Firmware Administration.
   a. The switch will be structured so that future functionalities can be added through firmware upgrades.
   b. The switch will have the capability to receive firmware upgrades as a field serviceable process.

c. Firmware upgrades will be performed via the integrated web server in conjunction with any TFTP server software, or via the serial connection.

8. IGMP Snooping and Query.
   a. The switch will be capable of passively monitoring IGMP (multicast) messages and dynamically creating appropriate groups for proper message forwarding.
   b. The query interval and snoop aging times will be user configurable to up to 60 minutes.
   c. The switch will support up to 128 multicast groups.
9. Large Ring Networks.
   a. The switch will support a configurable "Large Tree" extension to the Rapid Spanning Tree option, making a ring topology suitable for 28 switches along the relevant path from the Root.
   b. This support option will provide the capability of constructing an RSTP ring topology of up to 57 switches, when all switches are configured with same function.
10. Traffic Prioritization.
   a. The switch will support multiple priority queues for adjusting the internal packet processing sequence.
   b. The switch will employ "Strict Priority" for transmitting data telegrams to ensure all high-priority data packets are transmitted.
   c. Switch will have a user settable internal prioritization for individual ports, so that the processing of Ethernet data for a particular port can be optimized.
11. Power over Ethernet (PoE).
   a. Switch shall provide support of Power over Ethernet in compliance with IEEE standard 802.3af.
12. Virtual LAN (VLAN).
   a. The switch is able to maintain up to 32 concurrent VLANs.
   b. The switch will support GARP VLAN Registration Protocol (GVRP) for dynamic VLAN implementation.
13. Link Layer Discovery Protocol (LLDP).
   a. The switch will support LLDP according to IEEE 802.1ab, for topology detection of devices that also have LLDP activated.

L. Managed Ethernet switches shall be Allen Bradley, N-Tron, Cisco, Phoenix Contact, Hirschman, or accepted equal.

2.06 UNMANAGED ETHERNET SWITCH SPECIFICATION

A. Ethernet Interfacing & Switching Capabilities
   1. The Unmanaged Ethernet switch will be IEEE 802.3 compliant.
   2. The switches must be capable of reading and processing high priority Ethernet packets before low priority during times of heavy network traffic in accordance with the priority levels of IEEE 802.1P/Q.
   3. Auto-negotiation:
      a. All Copper TX ports will support auto negotiation. Each TX port will be able to interface to 10/100 meg or full/half duplex devices.

4. Auto Cross:
    a. All TX ports will provide cable autocross capability.
5. Accuracy & Capacity of switching table.
    a. The switch will only forward valid Ethernet frames using the store and forward or equivalent method.
    b. The address table will have a minimum capacity of 4000 addresses.

B. Diagnostics.
1. Port Status LED's.
    a. Link Active: Each port will have a LED indication that there is a proper electrical connection to the attached device.
    b. Communications Status: Each port will have an LED indication of communications activity.
    c. To simplify the process of troubleshooting, the status indication of heavy communications traffic vs. the status of an active link with no communications traffic will be unambiguous.

C. Installation Requirements.
1. Mounting.
    a. The Switch will be din rail mountable out of the box and without the need to add/assemble adaptor or similar mounting plates.
    b. All power connections will be wired using removable connectors.
2. Port Security.
    a. The switch will be configured to accept optional security frames. When installed, these frames will lock inserted cables or plugs into place, then requiring the use of a small mechanical key for cable or plug removal.

D. Environmental Specifications & Agency Approvals.
1. Temperature & Humidity.
    a. The Switch will have an operating temperature range of 0 to 60c or greater. For extended application life, the maximum temperature will be a minimum of 10 degrees C lower than the specified operating temperature of the internal switch chips.
    b. The switch will withstand a maximum continuous operating humidity of 95% without condensation.
2. Electrical Noise Immunity.
    a. The switch will conform to the IEC61000-4-2 to 4-8 series of noise specifications as specified below:
        i. IEC 61000-4-2 Electrostatic Discharge: Criterion B.
        ii. IEC 61000-4-3 Radiated Noise Immunity: Criterion A.
        iii. IEC 61000-4-4 Fast Transient (Burst) Withstand: Criterion B.
        iv. IEC 61000-4-5 Surge Voltage: Criterion B.
        v. IEC 61000-4-6 Conducted Noise Interference: Criterion A.
        vi. IEC 61000-4-8 Electromagnetic Field withstand: Criterion A.

3. Shock & Vibration.
    a. The operating shock rating will conform to IEC60068-2-27 and withstand a shock pulse of 25G or more for 11ms.
    b. The operating vibration spec will conform to IEC60068-2-6 (Criterion 3) at 5G 150Hz, in all 3 axes.
4. Agency Certifications.
    a. The switch will be certified for UL/Cul 508.

E. Unmanaged Ethernet switches shall be Allen-Bradley, N-Tron, Hirschman, Phoenix Contact, Weidmuller, or accepted equal.

2.07 ETHERNET COMMUNICATION NETWORKS

A. General
1. Ethernet links shall be provided to connect all PLCs to Network Interface Panels (NIP), Motor Starters (MCC), and Control Panels as shown on the Contract Drawings. The Ethernet communication system shall use modular rack or back of panel mounted components for interfacing with required field connections. Provide necessary racks, interface modules, gateways, segment couplers, power supplies, Fiber-to-Ethernet converters, fiber patch panels and all other components as necessary for a complete and operable Ethernet communications system.

PART 3 - **EXECUTION**

3.01 PROGRAMMABLE LOGIC CONTROLLER APPLICATION SOFTWARE & DEVELOPMENT

A. Provide programming to produce completely annotated application programs. Application programs shall be produced on equipment supplied by the Contractor as part of the Work. The application programming shall be developed as follows:
1. The application programs shall be developed in a neat, professional, logical, and efficient manner such that the available PLC memory is not wasted. The application programming shall be completely documented with detailed rung comments and address comments that correspond to tag numbers provided on the Contract Drawings or in the description of operation. Application programming that manipulates analog signals shall utilize values that are scaled in the proper engineering units and are of the correct magnitude. Formulas utilized shall be described in detail.
2. Use the system descriptions from Contract Drawings, process equipment manufacturer supplied information, and other application-oriented documents to develop the application programs.
3. The application programming shall account for the fact that an HMI operator interface will be communicating with the PLC. The programming and addressing schemes shall allow efficient and logical block mapping of points between the various pieces of equipment.
4. Provide programming package software and hardware tools at the conclusion of the Project, including USB Memory drives and reference manuals.

B. The manufacturer's license agreements for software packages shall be made out to the Owner.

3.02 SCADA HMI APPLICATION SOFTWARE DEVELOPMENT

A. Data Management.

1. The workstations shall scan the PLCs on demand and as necessary to retrieve and send analog, discrete and virtual input information for displays, control and related operator workstation functions. The current database shall be resident in the distributed network devices as appropriate.
2. Elapsed running time values shall be maintained in the database for all process drives. This data shall be expressed in hours and tenths of hours and shall be updated every sixty seconds using the last scanned value for each associated discrete input. Accumulated runtime data shall be periodically updated (once per hour) in disk memory. The exact time and date of initiation shall be maintained for each runtime accumulation. The operator may, at any time, from any operator workstation, access historical or current accumulated runtime values and either display or print reports containing accumulated runtime for certain specified equipment (i.e., sorted by accumulated hours, equipment ID, etc. within a user specified range) or all equipment. The operator shall be able to selectively reset any or all runtime accumulations to zero (or other legal values). The specified spreadsheet and database software shall be furnished with all required macros/applications to perform the reporting functions.
3. For reporting purposes, the database shall perform averaging and integration on a point basis over the following time periods:
    a. Five second – derived from readings accumulated at scan rates, stored for 3 days.
    b. Five minutes – derived from above 5-second valves, stored for 3 days.
    c. Hourly – derived from above five-minute values, stored for 1 year.
    d. Daily – derived from above one-hour values, stored for 1 year.
    e. Monthly – derived from above shift values, stored for 1 year.
    f. Annually – derived from above monthly values, stored for 1 year.

B. Graphic Display Organization - General

1. The display system described in the following paragraphs only defines those types of displays commonly used during normal operations and overall display organization. Displays shall be based upon information contained on the process flow diagrams, mechanical sheets, electrical drawings, other related drawings, and written narrative descriptions contained in the Specifications. The Contractor shall provide sufficient displays to satisfy all specified plant instrumentation and control system requirements
2. The description of the workstation operation in the remainder of this Section is based on the use of a mouse with screen icons. Should an alternate device be provided, operation shall be functionally equivalent to the procedures outlined below.
3. Alternative, but equivalent, graphic display formats and organization may be submitted for acceptance by the Engineer. However, any such substitutions shall conform to all functional requirements specified herein.
4. Each display format may consist of more than one page. If so, the display shall contain the message MORE (or other suitable descriptive text) as an icon on the bottom line and the next page shall be obtained by a strike on the "page forward" (PF) or the MORE icon. Backpaging shall be accomplished by a strike in the "page back" (PB) icon.

5. The Page Forward (FRWD) and Page Back (BACK) icons shall permit the user to page forward and backpage on a multipage listing. If a listing is larger than the capacity of a single CRT page, a MORE icon shall appear on the display. MORE means that there is more data for this display which can be accessed a page at a time with the MORE or FRWD icon. The BACK icon shall be used to reverse the forward display sequence, a page at a time. FRWD or BACK icons shall not be used on a single page display.
6. For map based and/or site plan displays, system pan/zoom features as well as system vertical horizontal and vertical scroll bars may be used for this purpose.
7. Vector targets shall be employed to move vertically and laterally between related displays or, alternatively, the vertical and horizontal window can be used, where appropriate.
8. The formats for all schematic diagrams (e.g., unit process, process partition and control strategy diagrams) shall be based on the site plan, mechanical and electrical power distribution drawings and shall be submitted to the Engineer for review. Process displays shall generally be site plan oriented, unless otherwise accepted by the Engineer.
9. The operator screens shall be made of any number of the following components, as appropriate:
    a. Static and dynamic alphanumeric information.
    b. Static and dynamic graphic objects.
    c. Dynamic bar graph displays.
    d. Dynamic analog trending displays.
    e. Password protected operator actions.
    f. Screen navigation commands.
10. Dynamic analog information shall be capable of at least eight value related color changes with or without flashing in response to a change in value, state, or alarm condition for linked tags. Dynamic displays linked to digital tags shall be capable of displaying at least three states with corresponding color/flash indications.
11. All data displayed in operator screens on each workstation shall be valid and current. Current values displayed in operator screens shall be instantly replaced with an error indication for "bad" data, loss of data or loss of communications for each individual tag. These conditions shall be treated as alarms, with specified reporting and routing.
12. When communications are restored and/or errors are cleared, data displays shall automatically display actual values, and "change in status" messages shall be routed to all alarm reports and files.
13. While viewing screens, and through password access, operator interaction with individual, modifiable data points shall include: value changes; placing points on/off scan; manual/automatic mode changes; alarm acknowledge; alarm enable/disable; etc.
14. A "pick" point in an operator screen indicates possible operator interaction for data entry, screen navigation or task switching. When the mouse pointer is "dragged" across operator "pick" points, a highlight box shall appear around each. In addition to pointing and clicking, the operator may press the "down" arrow key, to select a "pick" point and then press enter.
15. Point-click procedures shall be available for all operator/screen interface for navigation, data entry, etc. Operator data entry procedures shall be configured as keyboard entry; point-click calculator; multiple choice point-click, up/down ramping or data value slide.

16. Provide user changeable lower, upper and rate-of-change limits on all screen setpoint entry points. Initial limits shall be set at: lower = 10%, upper = 85% and rate-of-change = 10% of value. The user shall not be able to enter setpoint changes beyond these valid limits.
17. Configure the software at each workstation to check, verify and require appropriate password login prior to each start/stop action, setpoint change, tuning parameter change or any other equipment control or functional change.
18. The system shall respond to each operator request to perform any of these actions in the following manner:
    a. Present a "pop up" start/stop faceplate screen with start and stop push buttons for each individually or grouped equipment start/stop system requirement.
    b. Present a "pop up" setpoint entry faceplate screen for each system setpoint change requirement.
    c. Present a "pop up" control parameter tuning faceplate screen for each system control parameter tuning requirement.
    d. English language operator prompting prior to any system response to operator request. Prompting shall inform the operator of the action about to be taken and provide a confirming "proceed" or "quit" choice.
    e. Each action and system response shall be clearly displayed in the appropriate "pop up" screen.
    f. System response indication shall be the most positive feedback required by this specification. At a minimum, the actual PLC register containing the data to be verified shall be displayed and shall be used for any sequential, interlocked or other related control scheme.
    g. At a minimum, each "pop up" screen shall provide for operator input/action and positive feedback indication. Each digital and feedback control display shall provide an English word rather than a digital number indicating conditions. These shall be: start, stop, enable, disable, etc.
    h. Each variable input shall allow operator keyboard or vertical slide bar data entry. Each variable, input, and feedback shall be displayed in number and bar graph formats, both individually and in color-coded multiple bar chart for system evaluation.
19. Objects in screens shall indicate field status, such as "stopped" or "running" by appropriate animation, positioning and color coding.
20. The software at all workstations shall be configured to allow password protected user screen configuration without the use of dedicated programmers, the need to change or reconfigure hardware or cabling, or the need to reboot.

C. Graphic Screen Navigation
1. Each operator screen display shall be configured with a multiple choice Menubar at the top of the screen. Each selection button shall display a related pull down menu of additional selections, screen navigation, system administration, diagnostics and task switching with appropriate password protection.
2. Each selection shall be made by a single point-click or by pressing the "down" arrow to the appropriate selection and then pressing [ENTER]. None of these selections shall cause screen updating, database updating, data collection, alarm monitoring or any other system function to pause or stop.

3. When a Menubar selection is made, the Menubar button and text for that selection shall protrude and become bold to positively indicate user's selection, and the pull-down menu shall be displayed. When pull-down menus are closed or when a new operator screen is displayed, Menubar selections return to previous, normal states.
4. Menubar selections and related pushbutton menu selections and functions shall include:
    a. SYSTEM Menubar selection: shall display a pull-down menu with the following selections:
        i. SECURITY LOGIN selection: shall display a password login dialogue box, enabling the system user to login by entering an assigned login name and password.
        ii. SYSTEM ADMINISTRATION selection: shall provide a pull-down menu with the following selections:
            a) SECURITY CONFIGURATION selection: shall display workstation security configuration dialogue boxes enabling the user, through password protection, to modify or disable/enable workstation security functions.
            b) FILE MANAGEMENT selection: shall provide the user with password protected access to Windows file manager.
            c) TASK MANAGER selection: shall provide the user with password protected access to the Windows Task Manager through which any Windows program can be run.
            d) HISTORICAL CHART CONFIGURATION selection: shall provide password protected access to workstation historical chart, pen and time group configuration through which the user shall be able to view, add and modify historical data charts.
            e) SYSTEM BACKUP selection: shall provide password protected access to the workstation on-board CD-ROM or tape drive backup function, through which the user shall be able to partially or totally backup workstation software files.
        iii. MESSAGE CENTER selection: shall provide access to a personal message center, through which users shall be able to provide brief messages to other users at any workstation on the network.
        iv. DIAGNOSTICS selection: shall display a pull-down menu providing the following selections:
            a) NETWORK STATUS selection: shall provide workstation network diagnostics indicating status of all network sessions, activity and trouble.
            b) I/O COMMUNICATION STATUS selection (available on the field I/O server workstations): shall provide password protected interactive display indicating data request/transmit communications status and error conditions between the field I/O server workstation and the PLC data highway.
            c) COMPUTER DIAGNOSTICS selection: shall provide password protected total workstation review and diagnoses of computer hardware, memory, drives, ports, etc. This function shall also provide hard copy reporting of the entire diagnostics review or any portion thereof.
        v. FIELD I/O AND PLC CONFIGURATION selection: shall provide a set of screens for each PLC including:
            a) Manufacturer

b) Model Number
c) Rack I.D.
d) Model number, type and location for each rack module.
e) I/O device, associated database tag, and module position for all field I/O points.

vi. SYSTEM ACTIVITY selection: shall provide a password protected pop-up display of live system activity including alarms, alarm resets, operator entries, communication errors, system messages and database configuration activity. This display shall be used to provide real time feedback for operator requests, troubleshooting, alarm management assistance, etc. This pop-up display shall be sized, moved, closed and set to be always "on-top" during screen navigation by user request and at any time without pausing or stopping data updates, data collection or alarm monitoring.

b. ALARM Menubar selection; shall provide user interactive alarm summary screen as specified in the alarms section of this specification.

c. HELP Menubar selection: shall provide project-specific full-function Microsoft Windows help including: "contents", "search", "back", etc.

d. TREND Menubar selection: shall provide a pull-down menu selection listing for:

i. LIVE TREND choice: shall provide a multiple trend menu of predefined live trends.

ii. HISTORICAL TREND selection: shall provide a menu selection listing of predefined historical trends.

e. REPORTS Menubar selection: shall provide access to a menu listing for all configured reports with features as described herein.

f. DISPLAY MENU Menubar selection: shall display a menu of all plant area displays for screen navigation.

g. OVERVIEW Menubar selection: shall display the plant overview screen.

h. PRINT Menubar selection: shall print the current display.

i. CONTROL PANEL Menubar selection: shall provide date and time display and access to Microsoft Windows Control Panel. A single point-click action from a supervisor's security level or above shall display the Control Panel icon group through which modification can be made for:

i. System Date and Time.

ii. System Fonts.

iii. Printers Setup.

iv. Other Standard Windows Control Panel Functions.

D. Process Overview Display(s)

1. The process overview graphic display shall be obtained by selecting the OVERVIEW icon. One or more targets or icons shall be provided for each unit process and shall permit the operator to directly access an associated unit process display. The plant site plan layout shall be used as the basis for the process overview display, which shall provide display vectoring functions to subordinate unit process displays. A separate display containing a text-based listing of all system graphic displays shall also be provided, accessible from the Overview Display or a separate Menubar selection.

2. Intermediate process overviews shall be provided to summarize information from a number of similar or identical unit process equipment items (e.g., filter overview showing all filters, aeration system overview, etc.). These intermediate overview displays shall allow vectoring to/from the plant overview(s) and the individual equipment detail displays, and shall show appropriate summary process data.

E. Functional Area Display (s)

1. Functional Area Display(s) Unit Process Graphic Displays shall be provided to show all plant process areas and equipment in detail. Except where specified otherwise, all operator control actions shall be performed at the Unit Process Display level. Any unit process display shall be selectable from the process overview display or from an adjacent process area or otherwise related process display. A unit process display shall be a schematic representation of a process and use standard symbols to represent process equipment such as pumps, tanks, motors, etc. Process status shall be indicated using both color and alphanumeric annotations. Symbol color coding for all displays shall be based on the following convention:
2. All text shall be shown in white except alarm condition statements that are illuminated in either yellow or magenta.
    a. Yellow blinking = device has a noncritical alarm not yet acknowledged.
    b. Yellow = device has a noncritical alarm that has been acknowledged.
    c. Magenta blinking = device has critical alarm not yet acknowledged.
    d. Magenta = device has a critical alarm that has been acknowledged.
    e. Cyan = device off or not available. This may represent future equipment or equipment that has been taken off line for maintenance purposes.
    f. Red = device is on, running, energized, open.
    g. Green = device is available, ready to run, de-energized, closed.
    h. White with a black target background = device is in automatic (or semi-automatic) control mode.
    i. White with a blue target background = device is in manual mode.
3. The displays shall show all ID number, current status values and setpoints associated with a given process display and shall be updated with current values every five seconds or less.
4. The control status of each controllable device shall be modifiable and shall be displayed in text adjacent to that device. Control status shall be AUTO, MANUAL, AVAILABLE, etc., and shall be updated continuously. When the operator wishes to take control of the device or modify setpoints, the procedure shall be as follows:
    a. The operator shall click on the device symbol with the mouse.
    b. A dialog box shall appear which provides the current state or setpoint and enables the operator to make the appropriate change.
    c. For two-state devices, the dialog box shall allow the operator to start or stop, open or close, or otherwise change the state of the device.
    d. For setpoints and modulating final control devices (analog outputs), the dialog box shall display the old value, and shall allow the operator to enter a new value using standard Windows editing techniques. It shall also be possible for the operator to ramp the current value up and down by clicking on ramp targets.

e. Prior to the execution of the operator-commanded action, a confirmation message and target shall be displayed stating the old and new values and asking the operator to confirm the modification.

f. Control strategies shall be changed from AUTO to MAN or OFF (or vice versa) in the same manner as two-state devices.

F. Alarm & Event configuration

1. The operator workstation software shall be configured to provide alarm handling, reporting and archiving. Alarm grouping, printing and display shall be coordinated with Engineer and Owner prior to configuration.
2. Alarm management shall be provided for each database field input and shall include:
   a. Alarm reporting enable or disable.
   b. Alarm suppression to avoid nuisance alarms such as start up spiking.
   c. Re-alarming.
   d. Alarm routing to specific workstations and printers as appropriate.
   e. Alarm grouping for specific visual and audible group notification.
   f. Analog alarm types to include at least: low low; low; high; high high; rate of change; deviation; deadband; bad input; and off scan.
   g. Discrete alarm types to include at least: change from normal; return to normal; change of state; bad input; and off scan.
   h. Alarm acknowledgement and condition clear format.
3. The operator workstation software shall provide date and time stamped alarm reporting to at least five destinations. These destinations shall be:
   a. Operator screen alarm summaries.
   b. Alarm printers.
   c. System alarm and history file.
   d. System alarm and history display.
   e. Workstation network.
4. All points or modules that have the capability of being alarmed for amplitude or rate of change limit violations, and all discrete alarm inputs shall be linked to an associated discrete point for alarm suppression under specified conditions. For example, when there is no flow through a flow meter, the "not running" signal from the associated prime mover shall be used to suppress all alarms associated with the flow signal. Time delays shall be provided as necessary to eliminate transient alarm annunciation under start-up/shutdown conditions.
5. All alarms shall be OLE and Windows Sound System enabled. Sound files shall be individually assigned to each alarm point.
6. The system shall provide an alarm summary display as a pre-defined dynamic link within the graphics package. This alarm summary display shall show a list of the pending alarms in the system. As new alarms are detected, entries shall be made to the display list. As the alarm conditions clear, the entries shall be removed from the list.
7. The alarm summary display shall be user-configurable to the extent that the user can select the placement of tag name, current value, descriptor, time of alarm, and alarm status on the line as well as the color codes to be used to indicate the various alarm conditions.

8. Only alarms, including the loss of network, data highway and individual field I/O point communications, shall be reported to operator screen alarm summaries, which shall allow the operator to sort alarms in descending or ascending time order. The operator shall also be allowed to apply various priority level filters and to reconfigure alarm summary columns for detailed analyses, while viewing.
9. Alarms shall be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgement field) or by a full page using a menu pull-down. The system shall support up to twenty (adjustable) alarm messages in the summary display.
10. Each graphic display shall be configured with the indication of the last three alarms at the bottom of the screen.
11. An unacknowledged alarm shall flash in configured foreground/background colors until it is acknowledged. When an alarm is acknowledged, it shall stop flashing but remain displayed until the alarm condition is cleared.
12. When an alarm condition has been both acknowledged and cleared, the alarm statement shall be removed from the alarm summary.
13. Alarm summaries shall use system colors and provide at least the following column information:
    a. Date and time.
    b. Workstation name.
    c. Tag number.
    d. Tag description.
    e. Alarm condition.
    f. Tag value.
14. Configure alarm summaries with a distinctive color format for:
    a. Background color.
    b. High value alarms.
    c. Low value alarms.
    d. Rate-of-change alarms.
    e. Digital status alarms such as change of state, change from normal, etc.
    f. Plant area/access alarms.
15. The following color codes shall be used in conjunction with alarm displays:
    a. Cyan = normal.
    b. Yellow, blinking = noncritical, not acknowledged alarm.
    c. Yellow = noncritical, acknowledged alarm.
    d. Magenta, blinking = critical, not acknowledged alarm.
    e. Magenta = critical, acknowledged alarm.
16. The following alarm condition statements shall be provided as a minimum:
    a. RTN NRML - Return to Normal.
    b. HIHI LMT - Second High Limit.
    c. HI LMT - High Limit.
    d. LO LMT - Low Limit.
    e. LOLO LMT - Second Low Limit.

f. ROC LMT - Rate of Change Limit.
g. STAT CHGE - Status Change.
h. OFF SCAN - Off Scan.
i. OPEN FAIL - Open Failure.
j. CLOSE FAIL - Close Failure.
k. START FAIL - Start Failure.
l. STOP FAIL - Stop Failure.
m. FAULT – Fault.
n. HI DEV - High Deviation.
o. LO DEV - Low Deviation.
p. DISCREP – Discrepancy.
q. UNAVAIL – Unavailable.

17. Date and time stamped alarm reporting shall be sent to alarm printers with similar formatting, configuration and routing procedures as specified for alarm summaries.
18. Configure alarm and history files for sequential date and time stamped activity reporting for the entire system, on each workstation. This file shall be a daily text file with a file name indicating the date that the file was created, and shall include all system wide activity including:
    a. Alarms.
    b. Alarm acknowledgement.
    c. Loss and recovery of network, data highway and individual field I/O point communications.
    d. Status changes.
    e. Alarm clear and return to normal messages.
    f. Operator keyboard entries.
    g. Other system related activity (system startup, save/reload database, etc.).
19. Information format shall include:
    a. Date and time.
    b. Description.
    c. Condition.
    d. Current value.
20. Alarm and history files shall be saved to computer backup media including CD’s or tapes if selected by the operator.
21. The alarm and history display shall provide live viewing of alarm and history file entries, giving the operator instantaneous activity review and operator action verification.
22. The system alarm and history display, with on-line height and width adjustment capabilities, shall be displayed as part of operator screens, upon demand. The operator shall be able to size and move the display, as desired. Further, the operator shall be able to close this display, upon demand, or cause it to be continually displayed as the operator navigates through operator screens.

23. The opening, closing, moving or resizing of this display shall not cause screen updating, database updating, historical data collection, alarm monitoring or any other system function to pause or stop.
24. Workstations shall be configured to report all alarm conditions, operator activity, etc. to all other workstations.
25. The system shall be configured to provide a periodic date stamp on the alarm printout at the alarm printer to provide clear date/time evaluation of printed alarms.
26. Each workstation shall be configured for alarm and history activity file backup and archiving to the on-board tape or CD drive. Provide alarm and history file backup, and disk space management procedures.

G. System Security
1. Observer.
   a. Graphic display viewing and navigation.
   b. Historical data display.
   c. Password login and logout.
   d. Observer shall be the system default security mode.
2. Operator.
   a. Observer privileges.
   b. Password protected start/stop, setpoint entries, system activity display, etc.
   c. Lead Operator/Supervisor.
   d. Operator privileges.
   e. Historical data chart configuration.
   f. Report viewing, modification and exporting/printing.
   g. Task switching to the Windows operating system.
   h. Software system shut down.
   i. Windows NT Task Manager access.
3. System Administrator/Engineer.
   a. All privileges.
4. The software at each workstation shall be configured to automatically log in the observer group upon system startup.
5. The security system at each workstation shall be configured to not allow SCADA software shut down or Windows NT security access unless requested through Supervisors' or System Administrator security privileges.
6. The security configuration shall be exportable to a text file, which shall not include passwords. This text file shall have a user defined acronymic, mnemonic file name and shall be capable of being imported into the system to modify or create workstation security configuration.
7. All workstation security activity, including violations, shall be reported in a date and time stamped format to a daily text file for review and evaluation at any time. This security text file shall have a file name indicating the date that the security file was created. It shall be possible for any text editor to edit these files.

8. Each workstation shall be configured for security activity file backup and archiving to the on-board tape drive.

H. Trend Configuration
1. The system shall provide multiple sets of live trends in operator screens. Each set of live trends shall be capable of the following:
   a. Displaying up to eight pens.
   b. Being temporarily modified, while viewing.
   c. Displaying straight line or varying data value "target" curves.
   d. Full screen trend curve displays when trend screen is opened.
2. Each live trend chart shall allow temporary, on-line pen, range and chart X-Y parameter changes by the user. Each trend display shall allow on-line user modifiable straight-line "target" curve for each trended data point and, as specified, a user selected varying data value "target" curve based on pre-defined modeling for trended data points.
3. Trends shall automatically shut down and release system resources when closed.

I. Historical Data Management Configuration
1. The operator workstation SCADA, database, spreadsheet and reporting software shall be configured to provide historical data gathering for system and operations validating, testing, maintenance and regulatory reporting.
2. The system shall provide multiple choice options for historical data file size and shall automatically assign file names indicating the date and duration for data contained in each file. The installed system shall be configured for sequential data files beginning at midnight.
3. For data and system resource management the system shall allow the assignment of any number and type of database tags and tag groups for historical data collection with the following attributes:
   a. Collection rate and phasing.
   b. Data collection start/stop condition.
   c. Data collection deadband.
4. For additional resource management, the operator workstation software shall be configured to automatically delete historical data files when they reach a certain age, which is user selectable from a multiple-choice options list. Set initial automatic file deletion at 20 days with backup and archiving procedures occurring prior to deletion.
5. Configure each workstation for historical data files backup and archiving to Cloud Storage and local external Drive.
6. Provide historical data files backup, and disk space management procedures.
7. All attributes of each historical display chart shall be able to be configured or modified at any time.
8. In addition, the user shall be able to make temporary, view only modifications, while viewing historical trend charts.
9. The system shall be configured for the following on-line historical data user functionality, without pausing or stopping any system function:
   a. Zoom to any specific area of a chart.
   b. Automatic real time update of historical data, upon demand.

c. Reset to original trend chart parameters, upon demand.

d. Request completely different start/stop time and duration parameters, upon demand.

e. Chart data display update forward or backward in time, by a single point-click for two sets of modifiable time increments in each direction.

f. Export displayed trend chart data into a text file with a user defined acronymic, mnemonic file name.

g. Print any displayed historical trend chart, upon demand.

h. Display multiple historical trend charts at the same time with time synchronizing for detailed analyses.

i. Data trend charts configured by combining any pen and time groups.

j. Trend chart display format changes including colors, titles, legends, etc.

10. When configuring tag pen groups, the system shall provide for user configuration of at least:
    a. Individual tag and related attributes.
    b. Default or specific data value range.
    c. Individual color for each tag pen.
    d. A specific letter to further document each pen related curve.
    e. Trend chart display format.
11. Time group configuration shall include at least the following:
    a. Start/stop dates and times.
    b. Duration.
    c. Sample, average value, high value and low value displays individually or together.
    d. Trend chart display format.
12. Historical data files shall be saved to computer backup media including diskettes, tapes or optical disks if the operator chooses this option. The system shall allow these files to be restored to the appropriate system file path and reviewed with all system functions at any time, as if they had continued to be hard disk resident.
13. The collection of historical data shall begin automatically upon software system start-up.
14. All analog and digital field inputs shall be historically collected. Provide collected data in the "sample" mode with collection rate, phasing, etc. attributes assigned to maximize data collection and system resources.
15. Provide the following time groups:
    a. The previous hour.
    b. The previous twenty-four (24) hours.
    c. The previous thirty (30) days.
16. Operator access for viewing or printing any individual project specific, pre-defined historical trend chart shall be through a single point-click action while viewing operator screens via the TREND Menubar selection.

J. Reports Configuration

1. The report generator shall employ the specified electronic spreadsheet, report writing and database programs to provide the user with an interactive method to define, change, and replace report formats. The specified database, spreadsheet, and reporting software shall be

furnished with all required applications and macros to perform the specified reporting functions.

2. The report generator shall permit arithmetic, relational, logical and statistical operations on individual or groups of data values contained in the distributed database and shall be employed to build shift, daily, equipment runtime and other specified reports utilizing network based dynamic data exchange access to the databases.
3. The reporting module shall provide the user with all standard Excel-type interactive spreadsheet formats, functions, linking, various kinds of charts, live spreadsheet/database interaction, fonts, math functions, macros, print options, and report saving.
4. All tags in the Control and Information System, including inputs, outputs, calculations and historical data shall be available for use in reports. Points shall be referenced in report formats by tag names or pen/time groups, and linking to reports shall be automatic and transparent to the user.
5. Each report shall be capable of linking and displaying the following:
    a. All attributes of database tags including:
        i. Current value.
        ii. Engineering units.
        iii. Descriptors.
        iv. Field I/O equipment addresses.
        v. Alarm parameters.
    b. Any combination of historian pen/time groups.
    c. Manually entered data.
    d. Text.
    e. Date and Time.
6. The report package shall allow on-line user selection of a value or groups of values, and instantaneously create charts in X-Y, bar graph, pie and other formats. Charts shall be modifiable upon viewer demand. Chart printouts, on demand, shall be provided.
7. Reports shall display entries indicating "no data" and "bad data" to distinguish error conditions from zero values for individual report data links.
8. Report generation or configuration shall not cause screen updates, database updates, historical collection, alarm monitoring nor any other system operation to pause or stop.
9. The report module shall open on top of operator screens, so that, upon exiting, the previous operator screen shall be automatically displayed, and shall be fully functioning and updating.
10. The reporting of system operating data shall occur once per day at user-specified times. Data recorded on these reports shall be extracted from the operator workstation data files as required. Report data shall consist of the arithmetic average and sums of variable readings taken by the control system on scans made during the previous 24-hour period and from manually entered data. Where applicable, total, average, maximum, and minimum values shall be provided for each column of data on each report.
11. User access to any individual report shall be provided by means of a single point-click from a menu of all project specific reports.
12. Password protected access to reports shall also enable the user to create and/or modify reports through standard Microsoft Excel configuration and system macro procedures.

13. No reports access, work, viewing or any other reports related activity shall require the suspension, modification or the stopping/starting of the report's scheduler. Nor shall this activity cause any pausing or stopping of data updating, data collection, alarm monitoring, or any other Control and Information System function.

3.03 SYSTEM CONFIGURATION AND EXPANSION

A. The system shall provide an on-line installation and configuration program for configuring the various computers on the network. This configuration software shall allow assigning unique node names to each computer as well as selecting the functions that the machine will perform.

B. The system shall allow additional computers to be added to the network while on-line, without disrupting the operations of the other machines.

3.04 DIAGNOSTICS

A. The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

B. An additional display shall show the current session status (established, pending, offline) of all stations on the network. A session monitor program that automatically monitors and recovers communications shall be supplied with the system.

3.05 LICENSE AGREEMENTS/SECURITY

A. The manufacturer's license agreements for software packages shall be made out to the Owner.

B. Contractor developed application programs shall become the property of the Owner at the conclusion of the Contract. There shall be no license agreements of any kind for these programs.

C. The Owner shall be provided with passwords required to access the PLC application programs and operator interface configuration data. There shall be no Contractor programmed security schemes that prevent access to the application programs or configuration data.

END OF SECTION 40 94 03