SECTION 40 05 15

PIPING AND CABLE TRAY SUPPORT SYSTEMS

PART 1 GENERAL

1.1 WORK OF THIS SECTION

A. Work of this Section includes design, furnishing, and installation of pipe support systems and cable tray supports. Comply with support concepts where shown on the Drawings and complete with additional design as necessary to provide complete support systems.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
      b. B31.3, Process Piping.
      c. B31.9, Building Services Piping.
   2. American Society for Testing and Materials (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
      c. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   3. Canadian General Standards Board (CGSB):
      a. 1-GP-181, Ready-Mixed Organic Zinc-Rich Coating.
   4. Canadian Standards Association (CSA):
      a. B51, Boiler, Pressure Vessel, and Pressure Piping Code.
      b. C22.2 No. 126.1, Metal Cable Tray Systems.
      c. C22.2 No. 126.2, Nonmetallic Cable Tray Systems.
   5. Manufacturers' Standardization Society (MSS):
      a. SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   6. National Electrical Manufacturers Association (NEMA):
      a. VE 1, Metal Cable Tray Systems.
      b. VE 2, Cable Tray Installation Guidelines.
   7. 2010 National Building Code of Canada, with 2011 Manitoba Amendments (NBC).

1.3 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 300 mm above liquid surface, below top of channel wall, under cover or slab of channel or tank, or other damp locations.

B. Design Differential Temperature: Temperature differential between piping design temperature and outdoor winter one percent design temperature as defined by governing building code.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Drawings of piping and cable tray support systems, locating each support, brace, hanger, guide, component, expansion joint, and anchor on piping or cable tray. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number. Indicate point load reactions from pipe and cable tray supports on supporting structure in vertical, lateral, and longitudinal directions.
   2. If computer piping stress analyses are used, submit piping isometric drawings with nodal numbers consistent with analyses.
   3. Catalog information on piping and cable tray supports.
   4. Details of piping and cable tray supports for custom designed items.
   5. Revisions to support systems resulting from changes in related piping and cable tray system layout or addition of flexible joints.
   6. Submit computer piping stress analyses in accordance with CSA B51 and ASME B31.1, B31.3, or B31.9, as applicable, for all piping support systems for piping subject to any of the following design conditions:
      a. Pipe sizes 100 mm and larger and design differential temperature exceeding 205 degrees C.
      b. Pipe sizes 200 mm and larger and design differential temperature exceeding 150 degrees C.
      c. Pipe sizes 300 mm and larger and design differential temperature exceeding 90 degrees C.
      d. Pipe sizes 500 mm and larger and any design differential temperature.
      e. Pipe sizes 75 mm and larger and design pressure exceeding 3450 kPag.

B. Information Submittals:
   1. Submit written certification from Professional Engineer licensed in province of Manitoba stating that support systems, anchorage, and equipment have been designed in accordance with requirements of NBC for post-disaster structures, at time of Shop Drawing submittals.
   2. Maintenance information on piping and cable tray support systems.

1.5 QUALIFICATIONS

A. Piping and cable tray support systems shall be designed, and Shop Drawings prepared and sealed, by Professional Engineer licensed in province of Manitoba.

1.6 DESIGN REQUIREMENTS

A. General:
   1. Review requirements of Section 40 27 00, Process Piping – General; Section 22 10 01, Plumbing Piping and Accessories; Section 23 21 13, Hydronic Piping; Section 40 42 13, Piping Insulation; Section 40 27 02, Process Valves and Operators; Section 40 27 01, Process Piping Specialties; and Contract Drawings.
   2. Piping and cable tray supports shall be designed and constructed to meet requirements of NBC. Specifically, design shall meet requirements of NBC for post-disaster structures, where the piping shall be installed.

3. Design, size, and locate piping and cable tray support systems throughout facility, whether or not shown on Drawings. Shop Drawings will not be reviewed for structural adequacy. Full responsibility for design and installation of piping and cable tray support systems rests with Contractor.
4. Cable Tray Design Loads: Use working load adequate for actual cable installed plus 20 percent additional weight allowance for future cables, plus 100 kg concentrated static load applied between side rails and mid-span. Use safety factor of 2 in accordance with NEMA VE 1, Table 3-1.
5. Locate piping and cable tray support systems such that they will not interfere with any doors, windows, or other openings. Locate to clear headroom requirements.
6. Locate and select material of pipe and cable tray support systems such that all valves and flow meters can be removed in future for maintenance.
7. Select piping and cable tray support systems such that they incorporate existing and new expansion joints in pipes and structures.
8. Locate piping and cable tray supports such that they will not interfere with any existing, proposed, or future equipment and its clearance requirement around them.
9. Support Arrangement from Floor, Roof, or Wall: Locations of piping and cable tray supports shall be either from floor, wall, or roof based on best option and to suit field condition unless otherwise noted in Contract Documents.
10. Supports may be shown on Drawings only where specific types and locations are required; additional supports are required in addition to those shown.
11. Meet requirements of MSS SP-58 or as modified by this section.
12. Design anchorage and support piping and cable tray systems for vertical and lateral loading in accordance with NBC.
13. All supports shall be laterally restrained.

B. Piping Support Systems:
1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.
2. Prevent contact of two dissimilar metals per manufacturer’s recommendations.
3. Maximum Support Spacing and Minimum Rod Size:
   a. Steel and Ductile Iron Piping (note that following spacing may require use of higher load pipe clamps and more than single anchor point in concrete):

Nominal Pipe Size (mm)	**Maximum Support/Hanger Spacing (m)**	**Minimum Rod Size Single Rod Hangers (mm)**
25 & smaller	1.8	6.25
32 through 65	2.4	6.25
75 & 100	3.0	9.5
150	3.6	9.5
200	3.6	12.5
250 & 300	4.3	15.9
350	4.8	19.1

Nominal Pipe Size (mm)	**Maximum Support/Hanger Spacing (m)**	**Minimum Rod Size Single Rod Hangers (mm)**
400 & 450	4.8	22.2
500	5.4	25.4
600	5.4	31.7
750 & larger	As shown on Drawings	45

b. Copper Piping:
   1) Maximum Support/Hanger Spacing: 0.61 m less than specified above for steel piping, with 25 mm and smaller piping supported every 1.5 m.
   2) Minimum Hanger Rod Size: Same as specified above for steel piping.

c. Plastic and Fiberglass Piping:
   1) Maximum Support/Hanger Spacing: As recommended by manufacturer for flow temperature in pipe.
   2) Minimum Hanger Rod Size: Same as specified above for steel pipe.

d. Stainless Steel Piping:

Nominal Pipe Size (mm)	**Maximum Support/Hanger Spacing (m)**	**Minimum Rod Size Single Rod Hangers (mm)**
25 & smaller	1.8	6.25
32 through 100	2.4	6.25
150	2.4	9.5
200 & 250	3.0	12.5
300	3.0	12.5
350 & 400	3.6	15.9
450 & 500	4.3	19.1
600	4.3	22.2
750 & larger	As shown on Drawings	45

C. Cable Tray Support Systems:
   1. Prevent contact of two dissimilar metals per manufacturer’s recommendations.
   2. Maximum Support/Hanger Spacing: In accordance with manufacturer’s recommendations and applicable code requirements.

D. Framing Support Systems:
   1. Beams: Size such that beam stress does not exceed 172,000 kPa and maximum deflection does not exceed 1/240 of span.
   2. Column Members: Size in accordance with manufacturer's recommended method.
   3. Support Loads: Calculate using weight of pipes filled with water.
   4. Maximum Spans:
      a. Steel and Ductile Iron Pipe 75 mm Diameter and Larger: 3 m centers, unless otherwise shown.
      b. Other Pipelines and Special Situations: May require supplementary hangers and supports.
   5. Electrical Conduit Support: Include in design of framing support system.

E. 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.

F. Vertical Sway Bracing: 3 m maximum centers, or as shown.

PART 2 PRODUCTS

2.1 GENERAL

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

B. Materials: In accordance with Tables 1 and 2, attached as supplements to this section.

C. Customized pipe supports shall be supplied by the manufacturers listed in this specification section or by Taylor Pipe Supports.

2.2 PIPE HANGERS

A. Clevis Type:
   1. MSS SP-58 Type 1.
   2. Manufacturers and Products:
      a. Anvil; Figure 260.
      b. Cooper B-Line; Figure B3100.

B. J-Hanger:
   1. MSS SP-58 Type 5.
   2. Manufacturers and Products:
      a. Anvil; Figure 67.
      b. Cooper B-Line; Figure B3690.

C. Adjustable Split-Ring Type:
   1. MSS SP-58 Type 6.
   2. Manufacturers and Products:
      a. Anvil; Figure 104.

D. Adjustable Split-Ring Type with Turnbuckle:
   1. MSS SP-58 Type 11.
   2. Manufacturers and Products:
      a. Anvil; Figure 108 with Figure 230.

E. Extension Split Pipe Clamp:
   1. MSS SP-58 Type 12.
   2. Manufacturers and Products:
      a. Anvil; Figure 138R.
      b. Cooper B-Line; Figure B3198R or B3198H.

F. Adjustable Yoke Pipe Roll:
   1. MSS SP-58 Type 43.
   2. Manufacturers and Products:
      a. Anvil; Figure 181.
      b. Cooper B-Line; Figure B3110.

2.3 SADDLE SUPPORTS

A. Pedestal Type – Non-Adjustable:
   1. MSS SP-58 Type 37.
   2. Schedule 40 pipe stanchion, non-adjustable saddle with U-bolt, and anchoring flange.
   3. Manufacturers and Products:
      a. Anvil; Figure 259.
      b. Cooper B-Line; Figure B3090.

B. Pedestal Type – Adjustable:
   1. MSS SP-58 Type 38, with U-bolt.
   2. Schedule 40 pipe stanchion, adjustable saddle with U-bolt, and anchoring flange.
   3. Manufacturers and Products:
      a. Anvil; Figure 265.
      b. Cooper B-Line; Figure B3092.

2.4 ROLLER SUPPORTS

A. Roller Chair:
   1. Manufacturers and Products:
      a. Anvil; Figure 175.
      b. Cooper B-Line; Figure B3120.

B. Adjustable Roller Support:
   1. MSS SP-58 Type 41.
   2. Manufacturers and Products:
      a. Anvil; Figure 177.
      b. Cooper B-Line; Figure B3122.

C. Pipe Roll:
   1. MSS SP-58 Type 44.
   2. Manufacturers and Products:
      a. Anvil; Figure 271.
      b. Cooper B-Line; Figure B3117SL.

D. Adjustable Pipe Roll:
   1. MSS SP-58 Type 46.
   2. Manufacturers and Products:
      a. Anvil; Figure 274, 274P, or 275.
      b. Cooper B-Line; Figure B3118SL.

2.5 BOLTED SUPPORTS

A. Flange Type:
   1. Bolts directly to pipe flange.
   2. Adjustable pipe stanchion, single or double pipe supports.
   3. Manufacturers and Products:
      a. Cooper B-Line; Figure B3094.
      b. Standon; Model S89.

2.6 WALL BRACKETS

A. Welded Steel Bracket (medium duty):
   1. MSS SP-58 Type 32.
   2. Manufacturers and Products:
      a. Anvil; Figure 195.
      b. Cooper B-Line; Figure B3066.

B. Welded Steel Bracket (heavy duty):
   1. MSS SP 58 Type 33.
   2. Manufacturers and Products:
      a. Anvil; Figure 199.
      b. Cooper B-Line; Figure B3067.

2.7 PIPE CLAMPS

A. Riser Clamp:
   1. MSS SP-58 Type 8.
   2. Manufacturers and Products:
      a. Anvil; Figure 261.
      b. Cooper B-Line; Figure B3373.

B. Offset Pipe Clamp:
   1. Manufacturers and Products:
      a. Anvil; Figure 103.
      b. Cooper B-Line: Figure B3148.

C. Pipe Strap:
   1. MSS SP-58 Type 26.
   2. Manufacturers and Products:
      a. Anvil; Figure 262.
      b. Cooper B-Line: Figure B2400.

2.8 CHANNEL TYPE SUPPORT SYSTEMS

A. Pre-Engineered Support System:
   1. Channel Size:
      a. Steel: 12-gauge, 41.3 mm wide minimum.
      b. FRP: 38.1 mm wide minimum.
   2. Members and Connections: Design for all loads with safety factor of 5.
   3. Pipe Clamps: Two-piece clamps for all pipes unless otherwise noted.
   4. Manufacturers and Products:
      a. Anvil; Power-Strut.
      b. Cooper B-Line; Strut System.
      c. UBS Industries; Unistrut.
      d. Tyco; Aickinstrut (FRP system).

2.9 FLOOR-MOUNTED PIPE AND CABLE TRAY SUPPORT SYSTEMS

A. W, H, or HSS shapes steel sections conforming to Section 05 50 00, Metal Fabrication (Basic). Hot-dip galvanize after fabrication.

B. MI Industrial Modular Support System supplied by Hilti may be used as alternative support system.

C. Support system shall be placed at locations not to interfere with equipment maintenance and walkways.

2.10 ACCESSORIES

A. Hanger Rods, Clevises, Nuts, U-bolts, Sockets, and Turnbuckles: In accordance with MSS SP-58.

B. Concrete Inserts:
   1. MSS SP-58 Type 18.
   2. Continuous channel insert with load rating not less than that of hanger rod it supports.
   3. Manufacturers and Products:
      a. Cooper B-Line; Figure B22I, B32I, or B52I.

C. Beam Clamps:
   1. MSS SP-58 Type 21, 28, 29, or 30.
   2. Concentric loading type which engage both sides of flange.
   3. Manufacturers and Products:
      a. Anvil; Figure 133 or 292.
      b. Cooper B-Line; Figure B3050 or B3054.

D. Insulation Protection Saddles:
   1. MSS SP-58 Type 39.
   2. Manufacturers and Products:
      a. Anvil; Figure 160 through 166A.
      b. Cooper B-Line; Figure B3160 through B3165.

E. Insulation Protection Shields:
   1. MSS SP-58 Type 40.
   2. Galvanized steel or stainless steel.
   3. Manufacturers and Products:
      a. Anvil; Figure 167.
      b. Cooper B-Line; Figure B3151.

F. Vibration Isolation Pads:
   1. Type: Neoprene waffle.
   2. Manufacturers and Products:
      a. Mason Industries; Type W.
      b. Korfund; Korpad 40.

G. Flush Type Insert Channels: As specified in Section 05 50 00, Metal Fabrications (Basic).

2.11 PIPE GUIDES

A. Intermediate Guides:
   1. Piping 150 mm and Smaller:
      a. Type: Pipe clamp with oversized pipe sleeve to provide minimum 3.2 mm clearance.
      b. Manufacturers and Products:
         1) Cooper B-Line; B3148 or B3180.
         2) Anvil; Figure 103.
   2. Piping 200 mm and Larger:
      a. Type: Specially formed U-bolts with double nuts to provide 6.4 mm minimum clearance around pipe.
      b. U-Bolt Stock Size:
         1) 200 mm Pipe: 15.9 mm.
         2) 250 mm Pipe: 19.1 mm.
         3) 300 mm Through 400 mm Pipe: 22.2 mm.
         4) 450 mm Through 762 mm Pipe: 25.4 mm.

B. Alignment Guides:
   1. Piping 200 mm and Smaller:
      a. Spider or sleeve type.
      b. Manufacturers and Products:
         1) Anvil; Figure 255 or 256.
         2) Cooper B-Line; Figure B3281 through B3287.
         3) Flexonics; Series PGT.
   2. Piping 250 mm and Larger:
      a. Adjustable double roller type.

b. Manufacturers and Products:
   1) Anvil; Figure 177 with Figure 171.
   2) Cooper B-Line; Figure B3122A.

2.12 PIPE ANCHORS

A. Anchor Chairs:
   1. Type: Anchor chair with U-bolt strap.
   2. Manufacturers and Products:
      a. Cooper B-Line; Figure B3147A or B3147B.

2.13 ANCHORING SYSTEMS

A. Size: Sized by equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications (Basic).

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Install support systems in accordance with MSS SP-58 unless shown otherwise.
   2. Support piping connections to equipment by pipe support and not by equipment.
   3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
   4. Support no pipe from pipe above it.
   5. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
   6. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
   7. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
   8. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
   9. Repair mounting surfaces to original condition after attachments are made.

B. Standard Pipe Supports:
   1. Horizontal Suspended Piping:
      a. Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.
      b. Grouped Pipes: Trapeze hanger systems.
      c. Furnish galvanized steel insulation protection shield and oversized hangers for insulated pipe.
      d. Furnish precut sections of rigid insulation with vapor barrier at hangers for insulated pipe.
   2. Horizontal Piping Supported From Walls:
      a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

b. Stacked Piping:
   1) Wall mounted framing system and clips acceptable for piping smaller than 75 mm minimal diameter.
   2) Piping clamps that resist axial movement of pipe through support not acceptable.
c. Wall mounted piping clips not acceptable for insulated piping.

3. Horizontal Piping Supported From Floors:
   a. Stanchion Type:
      1) Pedestal type, adjustable with stanchion, saddle, and anchoring flange.
      2) Use yoked saddles for piping whose centerline elevation is 450 mm or greater above floor and for exterior installations.
      3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
   b. Floor Mounted Channel Supports:
      1) Use for piping smaller than 75 mm nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.
   c. Concrete Cradles: Use for piping larger than 75 mm along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
5. Standard Attachments:
   a. To Concrete Ceilings: Concrete inserts.
   b. To Steel Beams: I-beam clamp or welded attachments.
   c. To Wooden Beams: Lag screws and angle clips to members not less than 62.5 mm thick.
   d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

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

D. Accessories:
   1. Insulation Protection Shield: Install on insulated non-steel piping. Oversize rollers and supports.
   2. Insulation Protection Saddle: Install on insulated steel pipe. Oversize rollers and supports.
   3. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
   4. Dielectric Barrier:
      a. Install between carbon steel members and copper or stainless steel pipe.

b. Install between stainless steel supports and non stainless steel ferrous metal piping.

5. Electrical Isolation: Install 6.4 mm by 75 mm neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.2 FIELD FINISHING

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

3.3 SUPPLEMENTS

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

END OF SECTION

Table 1 **Nonchemical Areas**	
Exposure Conditions	**Hanger Material**
Office areas	Galvanized steel or precoated steel
Shops and warehouse areas	Galvanized steel or precoated steel
Pipe Galleries	Galvanized steel or precoated steel
Headworks	Stainless steel or FRP
Primary Clarifiers	Stainless steel or FRP
Fermenter	FRP
Biofilter	FRP
Process areas: high humidity or hydrogen sulfide	Stainless steel or FRP
Process areas: wetted or submerged	Stainless steel or FRP
Outside	Galvanized steel

Notes:
1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M. Repair galvanized coatings damaged by welding, cutting, or rough handling during shipping, installation or otherwise, in accordance with ASTM A780/A780M using organic zinc-rich primer, CGSB 1-GP-181M, Sealtight Galvafroid Zinc-Rich Coating by W.R. Meadows Ltd., or approved equal in accordance with B8. Dry film thickness on repairs to exceed original coating thickness by minimum 25 percent.

Table 2 Chemical Areas		
Exposure Conditions	**Hanger for Direct Exposure**	**Hanger for Remote Exposure**
Ferric Chloride	FRP	Precoated steel
Polymers	FRP	Precoated steel
Sodium Hydroxide	FRP	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel
Sodium Bisulphite	FRP	Precoated steel

Notes:
1. Direct exposure includes entire area within the chemical room including both basement and ground floors.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.

SECTION 40 05 53

IDENTIFICATION LABELS FOR EQUIPMENT, FABRICATED TANKS, VALVES, AND PIPING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standards Institute (ANSI):
      a. Z535.1, Safety Colors.
      b. Z535.2, Environmental and Facility Safety Signs.
   2. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.
   3. Manitoba Health and Safety Act (OHSA).

1.2 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer’s catalog information and descriptive literature for identification label materials and products.
   2. Schedule of equipment identification labels.
   3. Schedule of piping and ducting identification labels
   4. Schedule of tank identification labels.
   5. Schedule of valve tags.

B. Samples:
   1. Submit samples of labels, tags, markers, and fastening devices for review.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide identification labels for all piping, ducting, equipment, fabricated tanks, and valves shown on Drawings.

B. Provide high quality, industrial grade labels and signs, suitable for long-term indoor and outdoor use, and resistant to weathering, fading, and UV degradation.

C. Unless specified otherwise, identification labels and signs shall comply with the following:
   1. Identification Labels for Piping: ASME A13.1.
   2. Safety Colours: ANSI Z535.1.
   3. Signs: ANSI Z535.2.

D. Painting:
   1. In accordance with Section 09 90 00, Painting and Coating.
   2. Carbon Steel, Ductile Iron, Cast Iron, and Galvanized Piping Systems: Paint full surface of pipe.
   3. Stainless Steel, Copper, Aluminum, and Plastic Piping Systems: Paint 75 mm wide band around full circumference of pipe at each location where pipe identification label and flow directional arrow is applied.

E. Size of Characters and Symbols:

Item	Character Height (mm)	Character Line Width (mm)	Arrow Line Width (mm)
Piping 32 mm OD[1] and smaller	13	2	6
Piping larger than 32 mm OD[1] and up to 50 mm OD[1]	19	2.5	10
Piping larger than 50 mm OD[1] and up to 150 mm OD[1]	32	5	16
Piping larger than 150 mm OD[1] and up to 250 mm OD[1]	64	10	32
Piping larger than 250 mm OD[1]	89	13	45
Ducting	64	10	32
Valves	20	2	-
Equipment	20	2	-
Fabricated tanks	64	10	-
[1] Outside diameter including any insulation and jacketing.			

F. Refer to Drawings for equipment and tank names, identification numbers, and fluid commodity descriptions. Do not abbreviate identification.

2.2 PAINT COLOURS

A. Piping:

Fluid Commodity Code	Fluid Description	Colour Name[1]	Sherwin Williams Colour Code[1]	Colour Type[1]
ALP	Air, Low Pressure	Grandview (bluer green)	SW 6466	Interior

Fluid Commodity Code	Fluid Description	Colour Name[1]	Sherwin Williams Colour Code[1]	Colour Type[1]
BLS	Ballasted Sludge	TLS	TLS	TLS
CON	Condensate Drain	TLS	TLS	TLS
D	Drain (Non-Process)	TLS	TLS	TLS
DFR	Diesel Fuel Return	TLS	TLS	TLS
DFS	Diesel Fuel Supply	TLS	TLS	TLS
DHR	Domestic Hot Water Return	TLS	TLS	TLS
DHW	Domestic Hot Water	TLS	TLS	TLS
FC	Ferric Chloride	Solar Yellow	SW 4075	I&M
FOA	Foul Air	TLS	TLS	TLS
FPW	Fire Protection Water	Safety Red	SW 4081	I&M
FSF	Fermented Sludge Filtrate	TLS	TLS	TLS
FSL	Fermented Sludge	Bengal Grass	SW 6411	Interior
FSW	Flushing Water	Safety Blue	SW 4086	I&M
GE	Grit Effluent	TLS	TLS	TLS
GR	Glycol Return	Hibiscus	SW 6851	Interior
GRS	Grit Slurry	TLS	TLS	TLS
GS	Glycol Supply	Gala Pink	SW 6579	Interior
HFW	Hot Flushing Water	TLS	TLS	TLS
HRS	High Rate Clarifier Sludge	TLS	TLS	TLS
HWR	Hot Water Return	Greenland	MC-29	Industrial
HWS	Hot Water Supply	Lucky Green	SW 6926	Interior
IAS	Instrument Air Supply	Shamrock (dark green)	SW 6454	Interior
ML	Mixed Liquor	Extra White	SW 7006	Interior
MP	Mixed Polymer	TLS	TLS	TLS
NG	Natural Gas	Safety Yellow	SW 4084	I&M
NPH	Non-Potable Hot Water	TLS	TLS	TLS
NPT	Non-Potable Tempered Water	TLS	TLS	TLS

Fluid Commodity Code	Fluid Description	Colour Name[1]	Sherwin Williams Colour Code[1]	Colour Type[1]
NPW	Non-Potable Water	TLS	TLS	TLS
PD	Process Drain	Extra White	SW 7006	Interior
PE	Primary Effluent	Emerald Ice	SW 4069	I&M
PO	Process Overflow	TLS	TLS	TLS
PS	Primary Sludge	Iron Ore	SW 7069	Interior
PW	Potable Water	Vapor (light blue)	MC-85	Industrial
PV	Process Vent	TLS	TLS	TLS
R	Refrigerant	TLS	TLS	TLS
RAS	Return Activated Sludge	Invigorate (orange)	SW 6886	Interior
RS	Raw Sewage	TLS	TLS	TLS
RW	Rain/Roof Water	Web Gray	SW 7075	Interior
SAM	Sample	TLS	TLS	TLS
SBS	Sodium Bisulphite	TLS	TLS	TLS
SC	Scum	Grays Harbour	SW 6236	Interior
SHC	Sodium Hypochlorite	TLS	TLS	TLS
SHD	Sodium Hydroxide	TLS	TLS	TLS
SNS	Sand Slurry	TLS	TLS	TLS
SPD	Sump Pump Discharge	TLS	TLS	TLS
STS	Southend Thickened Sludge	TLS	TLS	TLS
TDW	Tempered Domestic Water	TLS	TLS	TLS
TFS	Thickened Fermented Sludge	TLS	TLS	TLS
TP	Trap Primer	TLS	TLS	TLS
TWAS	Thickened Waste Activated Sludge	Crispy Gold	SW 6699	Interior
VTA	Vent to Atmosphere	TLS	TLS	TLS
WAS	Waste Activated Sludge	Midday (sunny yellow)	SW 6695	Interior

Fluid Commodity Code	Fluid Description	Colour Name[1]	Sherwin Williams Colour Code[1]	Colour Type[1]
WSF	Waste Activated Sludge Filtrate	TLS	TLS	TLS
[1] TLS = To later selection.				

B. Equipment:

Equipment Description	Colour Name	Sherwin Williams Colour Code	Colour Type
Boilers	Heat Resistant Aluminum	B 59S3	Industrial
Ductwork	Unusual Gray	SW 7059	Interior
Exterior Pedestals/Panels	Safety Yellow	SW 4084	I&M
Motors	Safety Red	SW 4081	I&M
Motor Bases	Poppy Flower	SW 2904	Interior
Polymer Mix/Age Tanks	Outgoing Orange	SW 6641	Interior
Polymer Feed Tanks	Techno Teal	SW 4065	I&M
Steel Pipe Supports	Grey	ANSI 61 Grey	
Valve Handwheels/Chainwheels	Safety Red	SW 4081	I&M

2.3 IDENTIFICATION LABELS

A. Equipment:
1. Plastic lamacoid, 3 mm thick, mechanically fastened with self-tapping stainless steel screws.
2. Include equipment identification number on first line and description on second line.
3. Background and Text Colours:
   a. General: White background with black lettering.
   b. Fire Safety Equipment: Red background with white lettering.

B. Piping, Ducting, and Fabricated Tanks:
   1. Piping and Ducting: Include fluid description and direction of flow arrow. Do not abbreviate fluid description.
   2. Fabricated Tanks: Include tank identification number on first line and description on second line.
   3. Indoor Locations:
      a. Printed self-adhesive vinyl film, minimum 0.1 mm thick, with permanent industrial grade pressure-sensitive acrylic adhesive and peel-to-release coated paper backing.
      b. Manufacturer and Product: Brady, Style B-946.
   4. Outdoor Locations:
      a. Printed vinyl sheet, minimum 0.5 mm thick, cylindrically-coiled snap-on style or flat style fastened with nylon straps.
      b. Manufacturer and Product: Brady, Style B-915.
   5. Chemical Areas:
      a. Printed PVF over-laminated polyester sheet, minimum 0.15 mm thick, with sealed colour graphics, cylindrically-coiled and secured with adhesive strip.
      b. Manufacturer and Product: Brady, Style B-689.
   6. Background and Text Colours:

Fluid Category	**Background Colour**	**Text Colour**
Fire protection fluids	Safety red	White
Toxic and corrosive fluids (e.g., chemicals)	Safety orange	Black
Flammable fluids (e.g., diesel fuel)	Safety yellow	Black
Compressed air	Safety blue	White
All others	Safety green	White

C. Valves:
   1. Polished rectangular Type 304 stainless steel tags, 1.5 mm thick, with black stamped alphanumeric characters, 40 mm high and long enough to provide 12 mm clear of characters at each end of tag.
   2. Securely fasten to valve with stainless steel chains or bands.
   3. Include valve identification number.
   4. Provide tag for every valve shown with identification number on Drawings.

2.4 SIGNS

A. Industrial grade with protected graphics, round cornered and hole-punched for application to rigid surfaces.

B. Fasten with stainless steel hardware at locations to be confirmed by Contract Administrator.

C. Material:
   1. Indoor Locations:
      a. Coated aluminum, minimum 0.9 mm thick.
      b. Manufacturer and Product: Brady, Style B-555.
   2. Chemical Areas and Outdoor Locations:
      a. Fiberglass reinforced polyester, minimum 2.5 mm thick, with permanently embedded graphics.
      b. Manufacturer and Product: Brady, Style B-120.

D. Equipment Signs:

Legend	Width x Height (mm)	Brady Catalog No.	Location
WARNING THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME	250 x 175	Custom	All motor-driven equipment including pumps, blowers, fans, etc.
CAUTION HEARING PROTECTION REQUIRED	350 x 250	40972/ 47018	Each entrance to blower rooms
WARNING WEAR GOGGLES AND RUBBER GLOVES WHEN HANDLING CHEMICALS	350 x 250	69615	All chemical storage and handling areas
SAFETY FIRST IF YOU GET CHEMICALS ON YOUR BODY OR EYES WASH THOROUGHLY WITH PLENTY OF WATER	500 x 350	74616	All chemical storage and handling areas
DANGER DIESEL FUEL NO SMOKING NO OPEN FLAMES	350 x 250	123632	Diesel fuel storage areas
CAUTION NON-POTABLE WATER DO NOT DRINK	350 x 250	40846/ 69408	All non-potable water hose stations
DANGER PERMIT REQUIRED CONFINED SPACE DO NOT ENTER WITHOUT PERMIT AND ATTENDANT CS#_____	350 x 250	Custom	All confined spaces
SAFETY FIRST EYE WASH FOUNTAIN	350 x 250	41207	All eyewash stations

Legend	Width x Height (mm)	Brady Catalog No.	Location
SAFETY FIRST SAFETY SHOWER AND EYEWASH STATION	500 x 350	41219/ 73493	All combination safety shower/eyewash stations

PART 3 EXECUTION

3.1 APPLICATION OF LABELS

A. Clean sufficient area of equipment, tanks, pipes, pipe jackets, and ducts and apply labels as recommended by label manufacturer.

B. Apply labels in positions that allow them to be easily read from normal operating positions.

C. If labels will not suitably adhere to particular surface, use plastic plates or band with nylon string.

D. Apply identification labels and flow directional arrows to piping and ducting at or near the following locations:
   1. Both sides of valves.
   2. All branch fittings.
   3. Changes in direction or elevation.
   4. Both sides of penetrations through walls, floors, and ceilings.
   5. Straight runs at maximum 6 m spacing, center to center.
   6. Where circumstances make contents or direction of flow doubtful.

3.2 VISIBILITY

A. Apply labels, tags, and signs in locations that allow them to be easily read from normal operating positions at walkways or near valve stations.

B. On straight runs of multiple parallel pipes, align labels such that they are all readily visible from one viewing location.

END OF SECTION

SECTION 40 27 00

PROCESS PIPING – GENERAL

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:
   1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
   2. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
   3. American Society of Mechanical Engineers (ASME):
      a. Boiler and Pressure Vessel Code (BPVC):
         1) Section II, Part C, Specifications for Welding Rods, Electrodes, and Filler Metals.
         2) Section V, Nondestructive Examination.
         3) Section VIII, Rules for Construction of Pressure Vessels.
         4) Section IX, Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, and Brazing, and Fusing Operators.
      b. A13.1, Scheme for the Identification of Piping Systems.
      c. B1.20.1, Pipe Threads, General Purpose (Inch).
      d. B16.1, Grey Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
      e. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
      f. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
      g. B16.9, Factory-Made Wrought Buttwelding Fittings.
      h. B16.11, Forged Fittings, Socket-Welding and Threaded.
      i. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
      j. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
      k. B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
      l. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
      m. B16.25, Buttwelding Ends.
      n. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
      o. B16.47, Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard.
      p. B31.1, Power Piping.
      q. B31.3, Process Piping.
      r. B31.9, Building Services Piping.
      s. B36.10M, Welded and Seamless Wrought Steel Pipe.
   4. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
   5. American Society for Testing and Materials (ASTM):
      a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.

b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
f. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
g. A135/A135M, Standard Specification for Electric-Resistance-Welded Steel Pipe.
h. A139/A139M, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
i. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
j. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
k. A182/A182M, Standard Specification for Forged or Rolled Alloy- and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
l. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
m. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High-Temperature or High-Pressure Service and Other Special Purpose Applications.
n. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both.
o. A197/A197M, Standard Specification for Cupola Malleable Iron.
p. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
q. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
r. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
s. A276, Standard Specification for Stainless Steel Bars and Shapes.
t. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
u. A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength.
v. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
w. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
x. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
y. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
z. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

aa. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
bb. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
cc. A536, Standard Specification for Ductile Iron Castings.
dd. A563, Standard Specification for Carbon and Alloy Steel Nuts.
ee. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
hh. B32, Standard Specification for Solder Metal.
ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
jj. B61, Standard Specification for Steam or Valve Bronze Castings.
kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
ll. B75/B75M, Standard Specification for Seamless Copper Tube.
mm. B88, Standard Specification for Seamless Copper Water Tube.
nn. B98/B98M, Standard Specification for Copper-Silicone Alloy Rod, Bar and Shapes.
oo. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
pp. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
qq. D413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
rr. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ss. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
tt. D1330, Standard Specification for Rubber Sheet Gaskets.
uu. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
vv. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ww. D2000, Standard Classification System for Rubber Products in Automotive Applications.
xx. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
yy. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
zz. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
aaa. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
bbb. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
ccc. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

ddd. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
eee. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
fff. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
ggg. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
hhh. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
iii. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
jjj. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
kkk. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
lll. F593, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
mmm. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
nnn. F1476, Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   c. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
   f. C153/A21.53, Ductile-Iron Compact Fittings.
   g. C200, Steel Water Pipe, 6 In. (150 mm) and Larger.
   h. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied.
   i. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
   j. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   k. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   l. C606, Grooved and Shouldered Joints.
   m. C651, Disinfecting Water Mains.
   n. M11, Steel Pipe - A Guide for Design and Installation.
7. American Welding Society (AWS):
   a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   b. QC1, Standard for AWS Certification of Welding Inspectors.
8. Canadian Standards Association (CSA):
   a. B51, Boiler, Pressure Vessel, and Pressure Piping Code.
   b. B139, Installation Code for Oil-Burning Equipment.
   c. B149.1, Natural Gas and Propane Installation Code.
   d. B149.2, Propane Storage and Handling Code.
   e. B149.6, Code for Digester Gas and Landfill Gas Installations.

f. W47.1, Certification of Companies for Fusion Welding of Steel.
g. W47.2, Certification of Companies for Fusion Welding of Aluminum.
h. W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-6, Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings.
   b. SP-43, Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications.
10. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
11. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
12. NSF International (NSF): 61, Drinking Water System Components – Health Effects.

1.2 DEFINITIONS

A. Submerged or Wetted:
   1. Zone below elevation of:
      a. Top face of channel walls and cover slabs.
      b. Top face of aeration basin walkways.
      c. Top face of clarifier walkways.
      d. Roof of digester, including structure piping penetrations.
      e. Liquid surface or within 1 m above top of liquid surface.
      f. Top of tank wall or under tank cover.

1.3 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:
   1. ASME B31.1, B31.3, and B31.9, as applicable.
   2. CSA B51, as applicable.
   3. Ductile Iron Piping: AWWA C104/A21.4, C110/A21.10, C111/A21.11, C115/A21.15, C151/A21.51, and C153/A21.53, as applicable.
   4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO Standard Specifications for Highway Bridges, as applicable.
   5. Thrust Restraints:
      a. Design for test pressure shown in Process Piping Schedule.
      b. Allowable Soil Pressure: 50 kPa.
      c. Low Pressure Pipelines:
         1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
         2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Shop Fabricated Piping:
      a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
      b. Layout drawings showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
   2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
   3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
   4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
   5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
   6. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths and live lengths (as applicable).
   7. Design calculations and details on fabricated branches and non manufactured tees and elbows. Calculations sealed by a Professional Engineer registered in the province of Manitoba.

B. Quality Control Submittals:
   1. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
   2. Certified welding inspection and test results.
   3. Qualifications:
      a. Piping Contractor and Fabricator: Certification and qualifications.
      b. Weld Inspection and Testing Agency: Certification and qualifications.
      c. Welding Inspector: Certification and qualifications.
      d. Welders:
         1) List of qualified welders and welding operators.
         2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
   4. Weld Procedures: Records in accordance with ASME BPVC, Section IX, and Section II, Part C, for weld type(s) and base metal(s).
   5. Nondestructive Inspection and Testing Procedures: Requirements according to ASME B31.3, ASME BPVC, Section V, and as indicated in the specification.
   6. Manufacturer's Certification of Compliance:
      a. Pipe and fittings.
      b. Welding electrodes and filler materials.
      c. Factory applied resins and coatings.
   7. Certified weld inspection and test reports.

1.5 QUALIFICATIONS

A. Piping Contractor and Fabricators: Minimum 10 years of experience in design, fabrication, and installation of industrial pressure piping.

B. Independent Inspection and Testing Agency:
   1. Minimum 10 years of experience in field of inspection of industrial pressure piping.
   2. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
   3. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   4. Testing Personnel: Qualified for nondestructive test methods to be performed.
   5. Certified by Canadian Welding Bureau (CWB) to CSA W47.1, W47.2, and W186.
   6. Inspection Services: Qualified piping fabrication and welding inspector.

C. Welding Inspector:
   1. CWB-certified and employee of CWB-certified company to CSA W47.1, W47.2, and W186.
   2. AWS-certified to AWS QC1.
   3. Prior inspection experience with pipe fabrication and welds specified.

D. Welders and Welding Operators:
   1. Qualified by accepted inspection and testing agency before starting Work in accordance with ASME BPVC, Section IX, Article III.
   2. Qualified to perform groove welds in Positions 2G and 5G for each welding process and pipe material specified.
   3. Inspection Technical Services Manitoba certified and employee of CWB-certified company.
   4. Qualification tests may be waived by Contract Administrator based on evidence of prior qualification.
   5. Retesting: Upon Contract Administrator's written request, retest qualified welder(s).

1.6 QUALITY CONTROL

A. Provide services of independent inspection and testing agency for welding operations.

B. Obtain registration of pressure piping systems and fittings where required by Inspection Technical Services Manitoba.

C. Fittings shall bear a Canadian Registration Number (CRN) where required by the Inspection Technical Services Manitoba.

1.7 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:
   1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
   2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
   3. Linings and Coatings: Prevent excessive drying.
   4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
   5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.
   6. Avoid ferrous materials in contact with stainless steel products.

PART 2 PRODUCTS

2.1 PIPING

A. As specified on Piping Data Sheet(s) and Process Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:
1. Standardized Products: Nominal size.
2. Fabricated Steel Piping Except Cement-Lined: Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

C. PVDF Tubing with Clear PVC Sleeve for Chemical Systems:
1. Tubing (or hose): Clear heavy wall PVDF tubing.
2. Sleeve (or jacket): Clear rigid PVC Schedule 40 pipe.
3. Tubing Working Pressure: Minimum 450 kPag (65 psig) at 20 degrees Celcius. Product: Kynar Flex 2750 Heavy Wall Tubing.
4. PVDF tubing with clear PVC sleeve shall be used for some chemical feed piping where indicated in Contract Documents.
5. Long radius PVC elbows or extremely flexible clear PVC hose with stainless steel clamps to be used in short sections on all changes in direction or elevation of the straight run sleeves.
6. Use flare fittings for connecting PVDF tubing to valves and PVC piping.

2.2 JOINTS

A. Grooved End System:
1. Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.
2. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.
3. Manufacturer: Victaulic.

B. Flanged Joints:
1. Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.
3. Manufacturer: Same as pipe manufacturer.

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

D. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

E. Restrained Mechanical Follower Gland:
1. Ductile iron anchor type, wedge action, with breakoff tightening bolts.
2. Manufacturer and Product: EBAA Iron Inc.; Series 1100 Megalug.

F. Flexible Mechanical Compression Joint Coupling:
   1. Flexible PVC sleeve.
   2. ASTM A276, Type 305 stainless steel bands.
   3. Manufacturers:
      a. Pipeline Products Corp.
      b. Fernco Joint Sealer Co.

G. Mechanical connections of high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:
   1. A polyethylene stub end thermally butt-fused to end of pipe.
   2. ASTM A240, Type 304 stainless steel backing flange, 863 kPag, ANSI B16.1 standard. Insulating flanges shall be used where shown.
   3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
   4. Gaskets as specified on Pipe Data Sheet(s).

2.3 GASKET LUBRICANT

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

2.4 PIPE CORROSION PROTECTION

A. Heat Shrink Wrap:
   1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
   2. Manufacturer and Product: Raychem; WPC or TPS.

B. Polyethylene Encasement (Bagging):
   1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, Class C, Free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
   2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 25 mm wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

C. Insulating Flanges, Couplings, and Unions:
   1. Materials:
      a. In accordance with applicable piping material specified in Pipe Data Sheet(s). Complete assembly shall have ASME B31.9 rating equal to or higher than that of joint and pipeline.
      b. Galvanically compatible with piping.
      c. Resistant for intended exposure, operating temperatures, and products in pipeline.
   2. Union Type, 50 mm and Smaller:
      a. Screwed or solder-joint.
      b. O-ring sealed with molded and bonded insulation to body.

3. Flange Type, 64mm and Larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
4. Flange Insulating Kits:
   a. Gaskets:
      1) Full-face, Type E with O-ring seal.
      2) Supplemented with neoprene facing on each side to accomplish seal.
   b. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA LI 1, G-10 grade).
   c. Insulating Washers: High strength phenolic. (NEMA LI 1, G-10 grade).
   d. Steel Washers: Plated, hot-rolled steel, 3.2mm thick.
5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) Pipeline Seal and Insulator, Inc., Houston, TX.
      2) Central Plastics Co., Shawnee, OK.
   b. Insulating Couplings:
      1) Dresser; STAB-30.
      2) Baker Coupling Company, Inc.; Series 216.

D. Dielectric Pipe Nipples
1. Materials:
   a. Galvanized steel pipe nipple lined with plastic dielectric liner.
   b. Size for 50 mm and smaller.
   c. NPT male connections or grooved.
2. Applications as indicated.
3. Manufacturers and Products:
   a. ClearFlow; dielectric waterway fittings.

E. Concrete Encased Pipes:
1. Ensure the pipe and utility material are compatible with concrete.
2. Paint galvanized metal surfaces encased in concrete with rust inhibitive epoxy.
   a. Manufacturer and Product: AkzoNobel/Devoe; Devran 201H.
3. Coat aluminum surfaces encased in concrete with bituminous coating.

F. Buried Pipes:
1. Stainless steel pipes shall be protected with protective tape applied over the entire pipe surface in accordance with the manufacturer’s written instructions.
   a. Manufacturer: Denso North America Inc.

2.5 THRUST BLOCKS

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

2.6 VENT AND DRAIN VALVES

A. Pipelines 50 mm Diameter and Smaller: 13 mm vent, 25 mm drain, unless shown otherwise.

B. Pipelines 65 mm Diameter and Larger: 19 mm vent, 25 mm drain, unless shown otherwise.

2.7 FABRICATION

A. Mark each pipe length on outside with:
   1. Size or diameter and class.
   2. Manufacturer's identification and pipe serial number.
   3. Location number on laying drawing.
   4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.

2.8 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Piping Data Sheet(s) and Process Piping Schedule.

B. Galvanizing:
   1. Hot-dip applied, meeting requirements of ASTM A153.
   2. Electroplated zinc or cadmium plating is unacceptable.
   3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Some piping embeds were installed in a previous contract. They may not have been installed exactly at the location shown on the Drawings. Field measure all piping embeds to which connection to new piping under this contract are required prior to preparation of piping spool Shop Drawings. Modify new piping to fit as necessary.

C. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

D. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

E. Upon delivery immediately remove rust spots and stains on stainless steel piping by means as specified.

F. Provide the following minimum non-destructive inspection and testing procedures as indicated on the Process Piping Schedule:
   1. 100 percent visual inspection on all welds

2. 5 percent of butt welds shall be examined fully by random radiography.
3. 5 percent of the non butt welds shall be examined fully by random ultrasonic examination.
4. Use liquid penetrant examination if radiography and ultrasonic examination cannot be used and for checking surface cracks only.
5. Spot radiography for longitudinal groove welds of at least 300 mm in each 30 m of weld for each welder or welding operator.
6. Spot radiography for circumferential groove welds and other welds of at least one shot in each 20 welds for each welder or welding operator.

3.2 PREPARATION

A. Notify Contract Administrator at least 2 weeks prior to field fabrication of pipe or fittings.

B. Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside, and ensure that no dirt or other foreign matter enters the pipe during assembly.

C. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.3 WELDING

A. Perform in accordance with ASME BPVC, Section IX, and ASME B31.1, B31.3, and B31.9 for Pressure Piping, as applicable and as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Mark each weld with symbol identifying welder.

C. Pipe End Preparation:
1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ASME B16.25.

D. Surfaces:
1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:
1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 25 mm, whichever is greater.

F. Climatic Conditions:
   1. Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 0 degrees C.
   2. Stainless Steel and Alloy Piping: If the ambient is less than 0 degrees C, local preheating to a temperature warm to the hand is required.

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

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

I. Weld Passes: As required in welding procedure.

J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.4 INSTALLATION - GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. All pipe joints shall be restrained.

D. All submerged bolts and nuts shall be of Type 316 stainless steel unless otherwise specified or indicated.

E. Underground bolted joint assemblies shall be protected with protective mastic and tape applied over the entire fastener assembly in accordance with the manufacturer’s printed instructions.
   1. Manufacturer: Denso North America Inc.

F. Apply protective paste to all bolt threads at field joints.
   1. Manufacturer: Denso North America Inc.

G. Flanged Joints:
   1. Install perpendicular to pipe centerline.
   2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
   3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
   4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
   5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
   6. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

7. Threaded flanged joints must be shop fabricated and delivered to jobsite with flanges in-place and properly faced.

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

I. Grooved-End Joints:
1. Type: Rigid, except where joints are used to correct misalignment, to provide flexibility, and where shown otherwise, in which case provide flexible type.

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

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

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

M. Ductile Iron, and Cement-Lined Ductile Iron Piping:
1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

3.5 INSTALLATION - EXPOSED PIPING

A. Piping Runs:
1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

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

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

D. Provide flanges or unions as specified for the particular piping system on both sides of sleeved or cast-in-place pipe sections through interior walls, ceilings and floors.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:
   1. Over Walkway and Stairs: Minimum of 2200 mm, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 1000 mm, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   3. From Adjacent Work: Minimum 25 mm from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
   5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
   6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
   7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

G. Installation of Primary Measuring Elements:
   1. Install primary elements and accessories supplied under Division 40, including but not limited to the following:
      a. Orifice, venturi and magnetic flow meters.
      b. Bubbler, ultrasonic, and radar level meters.
      c. Pressure/vacuum indicators, switches, and transmitters.
      d. Flow and level switches.
      e. Temperature sensors, indicators, switches, and transmitters.
      f. Valve positioners, pneumatic booster relays, and I to P and P to I converters.
   2. Install units in locations shown. Attention is directed to suggest mounting details, flow schematics and circuit diagrams on the Electrical and Instrumentation Drawings.
   3. Provide all reducers, weldolets, tapped saddles, flanges, shut-off valves, pneumatic tubing, flushing connections, drains, bolts, nuts, washers, gaskets, and other items necessary to complete the installation.

4. Install bubbler tubes centrally guided in stilling wells of 200 mm diameter Schedule 80 PVC pipe. Fasten stilling well to wall as shown with Type 304 stainless steel clamps and anchor bolts.
5. Install bubbler tube stilling wells a minimum of 150 mm below the bubbler tubes supplied and mitre the bottom end at 45 degrees.
6. Provide and install pipe couplings for pressure sensors and pressure switch sensors on piping systems where indicated. Use tapped saddles when connecting to piping systems with wall thickness less than that required for tapping size. Back weld pipe couplings installed on steel or stainless steel pipes.
7. Provide suitable flexible connectors from the pipe couplings to instruments such as pressure switches and pressure gauges to eliminate vibrations and provide a stainless steel lever operated ball valve. Mount pressure switches on separate supports.
8. Provide necessary reducers and fittings and install level and flow switches where indicated.
9. Provide pipe couplings and install wells for temperature sensors on piping system where indicated.
10. Pipe couplings, tapped saddles, valves, flexible connectors and fittings must be of material similar to that of the piping system and have pressure-temperature ratings equivalent to that of the piping to which they are connected.
11. Couplings, valves, wells, weldolets, tapped saddles, flexible connectors and fittings, and other similar items must be suitable for installing primary elements supplied under Division 40.
12. Provide and install 13 mm diameter pipe couplings complete with bronze or brass ball valves on potable and plant water pipes at branches from mains and submains to enable pressure measurements using portable pressure gauge.

3.6 INSTALLATION - BURIED PIPE

A. Joints:
   1. Dissimilar Buried Pipes:
      a. Provide flexible mechanical compression joints for pressure pipe.
      b. Provide concrete closure collar for gravity and low pressure (maximum 70 kPa) piping or as shown.
   2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete unless specifically shown.

B. Placement:
   1. Keep trench dry until pipe laying and joining are completed.
   2. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
   3. Measure for grade at pipe invert, not at top of pipe.
   4. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
   5. Prevent foreign material from entering pipe during placement.
   6. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
   7. Lay pipe upgrade with bell ends pointing in direction of laying.
   8. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.

9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
   a. Shorter pipe lengths.
   b. Special mitered joints.
   c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, or HDPE Pipe Placement:
   1. Lay pipe snaking from one side of trench to other.
   2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
   3. Do not lay pipe when temperature is below 5 degrees C, or above 32 degrees C when exposed to direct sunlight.
   4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:
   1. Deflection from Horizontal Line: Maximum 50 mm.
   2. Deflection from Vertical Grade: Maximum 6 mm.
   3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
   4. Horizontal position of pipe centerline on alignment around curves maximum variation of 500 mm from position shown.
   5. Pipe Cover: Minimum 1000 mm, unless otherwise shown.

3.7 INSTALLATION - CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.8 THRUST RESTRAINT

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

B. Thrust Ties:
   1. Steel Pipe: Attach with fabricated lugs.

2. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through the coupling sleeve.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or thrust tie-rods and socket clamps.

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

3.9 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.10 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 13 mm nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:
1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.11 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown on Drawings. Install vents on high points and drains on low points of pipelines at all low and high point locations whether or not shown on Drawings.

3.12 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 0.8 m/s minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris plant process air, natural gas, and instrument air-lines with compressed air at 138 kPa (20 psi); do not flush with water.

C. Immediately after cleaning pipes, dry to minus 5 C dew point with dry compressed instrument air or compressed commercial grade nitrogen.

D. If impractical to flush large diameter pipe at 0.8 m/s or blow at 1200 m/min velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

F. Remove accumulated debris through drains 50 mm and larger or by removing spools and valves from piping.

3.13 DISINFECTION

A. Required only on potable water systems and associated piping:
   1. AWWA C651-99, Standard for Disinfecting Water Mains.
   2. AWWA C652-02, Disinfection of Water Storage Facilities.

3.14 FIELD FINISHING

A. Notify Contract Administrator at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.15 PIPE IDENTIFICATION AND COLOUR PAINTING

A. As specified in Section 09 90 00, Painting and Coating and Section 40 05 53, Identification Labels for Equipment, Fabricated Tanks, Valves and Piping Systems.

3.16 PIPE CORROSION PROTECTION

A. Preparation:
   1. Repair abraded areas of coatings on pipe to be buried, submerged, or embedded by cleaning to bare metal and repainting to provide protective covering equal to original and acceptable to Contract Administrator.

B. Ductile Iron and Cast Iron Soil Pipe:
   1. Exposed: As shown in Process Piping Schedule.
   2. Buried: Wrap with polyethylene bagging.
   3. Submerged or Embedded: As specified on the Drawings.

C. Carbon Steel/Stainless Steel Pipes and Ducts:
   1. Carbon Steel and Stainless Steel Buried:
      a. Pipe: Wrap with tape wrap.
      b. Joints: Wrap with tape wrap or heat shrink wrap.
   2. Carbon Steel Submerged or Embedded: As shown on the Drawings.

D. Copper Pipe:
   1. Buried:
      a. Pipe: Wrap with tape wrap
      b. Joints: Wrap with tape wrap or heat shrink wrap

E. Piping Accessories:
   1. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
   2. Buried:
      a. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
      b. Flexible Couplings Grooved Couplings and Similar Items: Wrap with heat shrink wrap or coat with cement.
      c. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
      d. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.

F. Polyethylene Encasement: Install in accordance with AWWA C105 and manufacturer's instructions.

G. Tape Wrap: Apply in accordance with manufacturer's instructions and as specified herein.

H. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

I. Insulating Flanges, Couplings, and Unions:
   1. Applications:
      a. Dissimilar metal piping connections.
      b. Cathodically protected piping penetration to buildings and watertight structures.
      c. Submerged to unsubmerged metallic piping connections.
      d. Where required for electrically insulated connection.
   2. Pipe Installation:
      a. Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation.
      b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
      c. Align and install insulating joints according to manufacturer's recommendations to avoid damaging insulating materials.

J. Dielectric Pipe Nipples:
   1. Applications:
      a. Dissimilar metal piping connections.
   2. Pipe Installation:
      a. Install as indicated or where insulating flanges, couplings and unions can not be used.

3.17 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

B. Minimum Duties of Welding Inspector:
   1. Job material verification and storage.
   2. Qualification of welders.
   3. Certify conformance with approved welding procedures.
   4. Maintenance of records and preparation of reports in a timely manner.
   5. Notification to Contract Administrator of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:
   1. Perform examinations as indicated under article Examination as a minimum.
   2. Provide following additional examinations:
      a. As required by Piping Code, ASME B31.1, ASME B31.3 for Category M fluids, as applicable.
      b. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
      c. Examine at least one of each type and position of weld made by each welder or welding operator.
      d. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

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

3.18 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:
   1. Process Piping Schedule.
   2. Piping Data Sheets:

Number	Title
40 27 00.01	Cement-Mortar Lined Ductile Iron Pipe and Fittings
40 27 00.02	Carbon Steel Pipe and Fittings - Special Service
40 27 00.03	Carbon Steel Pipe and Fittings - General Service
40 27 00.08	Stainless Steel Pipe and Fittings - General Service
40 27 00.08A	Stainless Steel Pipe and Fittings - Process Air Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe, Tubing, and Fittings
40 27 00.15	Double Wall Containment Piping

END OF SECTION

PROCESS PIPING SCHEDULE

Service Abbrev. [Note 1]	Service Description	Size(s) (mm) [Note 2]	Exposure [Note 3]	Piping Material [Note 4]	Pipe Specification Code	Piping Data Sheet Specification Section	Thickness, Class, or Schedule [Note 5]	Joints [Note 6]	Design Maximum Operating Pressure (kPag)	Design Temp. Range (deg C)	Test Pressure (kPag) and Type [Note 7]	ASME Code and Fluid Service Category	Lining / Coating [Note 8]	Remarks [Note 9]
ALP	Air, Low Pressure	ALL	ALL	SS	SS03	40 27 00.08A	See Data Sheet	BW	80	Minus 35 - 120	100, P	B31.3, Normal	-- / --	(1),(2),(3)
BLS	Ballasted Sludge	ALL	EXP	CS	CS01	40 27 00.03	See Data Sheet	GR	200	5 - 25	300, H	B31.3, Normal	-- / Paint	(1),(2),(7),(8)
		ALL	ENC	CS	CS01	40 27 00.03	Sch. 80	BW	200	5 - 25	300, H	B31.3, Normal	-- / --	(1)
DFR	Diesel Fuel Return	ALL	ALL	CS		40 27 00.02	Sch. 80	SW	50	Minus 35 - 50	CSA-B139	B31.3, Normal	-- / Paint	(1), insulate and heat trace all outdoor piping
DFS	Diesel Fuel Supply	ALL	ALL	CS		40 27 00.02	Sch. 80	SW	50	Minus 35 - 50	CSA-B139	B31.3, Normal	-- / Paint	(1), insulate and heat trace all outdoor piping
FC	Ferric Chloride	ALL	ALL	PVDF	PV04	40 27 00	See Specification	PRJ	350	5 - 25	525, H	B31.3, Normal	-- / --	(1), pipe material per Drawings
FC		ALL	ALL	PVC	PV01	40 27 00.10	Sch. 80	SV	350	5 - 25	525, H	B31.3, Normal	-- / --	(1), pipe material per Drawings
FC		ALL	ALL	CPVC	PV03	40 27 00.11	Sch. 80	SV	350	5 - 25	525, H	B31.3, Normal	-- / --	(1), pipe material per Drawings
FOA	Foul Air	ALL	ALL	SS	SS01	40 27 00.08A	See Data Sheet	BW	80	Minus 35 - 45	100, P	B31.3, Normal	-- / --	(1),(2),(3)
FSF	Fermented Sludge Filtrate	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	400	5 - 25	600, H	B31.3, Normal	-- / --	(1),(2)
FSL	Fermented Sludge	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	700	5 - 25	1050, H	B31.3, Normal	-- / --	(1),(2)
FSW	Flushing Water	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	1035	5 - 25	1550, H	B31.3, Normal	-- / --	(1),(2)
GE	Grit Effluent	ALL	ALL	CS	CS02	40 27 00.03	See Data Sheet	BW		5 - 25		B31.3, Normal	-- / Paint	(1),(2)
GRS	Grit Slurry	ALL	EXP	CS	CS01	40 27 00.03	See Data Sheet	GR	700	5 - 25	1050, H	B31.3, Normal	-- / Paint	(1),(2),(7),(8), long radius elbows
		100	EXP	SS	SS01	40 27 00.08	See Data Sheet	BW		5 - 25		B31.3, Normal	-- / --	Only where shown on Drawings for pump P-G102 GRS piping
		ALL	ENC	CS	CS01	40 27 00.03	Sch. 80	BW	700	5 - 25	1050, H	B31.3, Normal	-- / --	(1)
HFW	Hot Flushing Water	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	1035	5 - 60	1050, H	B31.3, Normal	-- / --	(1),(2)
HRS	High Rate Clarifier Sludge	ALL	EXP	CS	CS01	40 27 00.03	See Data Sheet	GR	100	5 - 25	150, H	B31.3, Normal	-- / Paint	(1),(2),(7),(8)
		ALL	ENC	CS	CS01	40 27 00.03	Sch. 80	BW	100	5 - 25	150, H	B31.3, Normal	-- / --	(1)
		ALL	ENC	SS	SS01	40 27 00.08	See Data Sheet	BW	100	5 - 25	150, H	B31.3, Normal	-- / --	(1),(2), concrete encased inside fermenters
IAS	Instrument Air Supply	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW/SW	1035	5 - 25	1550, P	B31.3, Normal	-- / --	(1),(2)
ML	Mixed Liquor	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	200	5 - 25	300, H	B31.3, Normal	-- / --	(1),(2)
MP	Mixed Polymer	ALL	ALL	PVC	PV01	40 27 00.10	Sch. 80	SV	350	5 - 25	525, H	B31.3, Normal	-- / --	(1),(2)
NPW	Non-Potable Water	ALL	ALL	CU	CU01	40 27 00.13	See Data Sheet	SD	1035	5 - 25	1550, H	B31.3, Normal	-- / --	(1),(2)
PD	Process Drain	ALL	EXP	SS	SS01	40 27 00.08	See Data Sheet	BW, FL	150	5 - 25	225, H	B31.3, Normal	-- / --	(1),(2)
		ALL	ENC	SS	SS01	40 27 00.08	See Data Sheet	BW, FL	150	5 - 25	225, H	B31.3, Normal	-- / --	(1),(2)
PE	Primary Effluent	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	200	5 - 25	300, H	B31.3, Normal	-- / --	(1),(2)
PO	Process Overflow	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW		5 - 25		B31.3, Normal	-- / --	(1),(2)
PS	Primary Sludge	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	200	5 - 25	300,H	B31.3, Normal	-- / --	(1),(2)
		ALL	EXP	CS	CS02	40 27 00.03	See Data Sheet	BW, GR	200	5 - 25	300,H	B31.3, Normal	-- / Paint	(1),(2)
PV	Process Vent	ALL	EXP	SS	SS01	40 27 00.08	See Data Sheet	BW		5 - 25		B31.3, Normal	-- / --	(1),(2)
RAS	Return Activated Sludge	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	200	5 - 25	300, H	B31.3, Normal	-- / --	(1),(2)
RS	Raw Sewage	ALL	EXP	CS	CS01	40 27 00.03	See Data Sheet	BW	200	5 - 25	300, H	B31.3, Normal	-- / Paint	(1),(2),(7),(8)
		ALL	ENC	CS	CS01	40 27 00.03	Sch. 80	BW	200	5 - 25	300, H	B31.3, Normal	-- / --	(1)
SAM	Sample	ALL	ALL	PVC	PV01	40 27 00.10	See Data Sheet	SV	350	5 - 25	525, H	B31.3, Normal	-- / --	(1)
SBS	Sodium Bisulphite	ALL	ALL	CPVC	PV03	40 27 00.11	Sch. 80	SV	350	10-25	525, H	B31.3, Normal	-- / --	(1),(2),(3),(5), insulate
SC	Scum	ALL	EXP	SS	SS01	40 27 00.08	See Data Sheet	GR	200	5 - 25	300, H	B31.3, Normal	-- / --	(1),(2)
		ALL	ENC	SS	SS01	40 27 00.08	See Data Sheet	BW	200	5 - 25	300, H	B31.3, Normal	-- / --	(1),(2)
SHC	Sodium Hypochlorite	ALL	ALL	PVC	PV01	40 27 00.10	See Data Sheet	SV	350	5 - 25	525, H	B31.3, Normal	-- / --	(1)
SHD	Sodium Hydroxide	ALL	ALL	CPVC	PV03	40 27 00.11	Sch. 80	SV	350	15 - 25	525, H	B31.3, Normal	-- / --	(1),(2),(3),(5), insulate and heat trace
SNS	Sand Slurry	ALL	EXP	CS	CS01	40 27 00.03	See Data Sheet	GR	--	5 - 25	G	B31.3, Normal	-- / Paint	(1),(2),(7),(8)
		ALL	ENC	CS	CS01	40 27 00.03	Sch. 80	BW	--	5 - 25	G	B31.3, Normal	-- / --	(1)

PROCESS PIPING SCHEDULE

Service Abbrev. [Note 1]	Service Description	Size(s) (mm) [Note 2]	Exposure [Note 3]	Piping Material [Note 4]	Pipe Specification Code	Piping Data Sheet Specification Section	Thickness, Class, or Schedule [Note 5]	Joints [Note 6]	Design Maximum Operating Pressure (kPag)	Design Temp. Range (deg C)	Test Pressure (kPag) and Type [Note 7]	ASME Code and Fluid Service Category	Lining / Coating [Note 8]	Remarks [Note 9]
TFS	Thickened Fermented Sludge	ALL	ALL	SS	SS01	40 27 00.08	Sch. 40	BW	700	5 - 25	1050, H	B31.3, Normal	-- / --	(1),(2)
TWAS	Thickened Waste Activated Sludge	ALL	ALL	SS	SS01	40 27 00.08	Sch. 40	BW	700	5 - 25	1050, H	B31.3, Normal	-- / --	(1),(2)
VTA	Vent to Atmosphere	ALL	EXP	SS	SS01	40 27 00.08	See Data Sheet	BW		5 - 25		B31.3, Normal	-- / --	(1),(2)
WAS	Waste Activated Sludge	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	700	5 - 25	1050, H	B31.3, Normal	-- / --	(1),(2)
WSF	Waste Activated Sludge Filtrate	ALL	ALL	SS	SS01	40 27 00.08	See Data Sheet	BW	400	5 - 25	600, H	B31.3, Normal	-- / --	(1),(2)

Notes:

1. Where piping carries more than one service designation, the piping material shall conform to the requirement of the first service listed. (e.g., CGW/OF would require the material used for CGW piping).

2. Size Designations:
   < = Less than — ≤ = Less than or equal to — ALL = All sizes
   > = Greater than — ≥ = Greater than or equal to

3. Exposure:
   EXP = Exposed (indoors or outdoors) — ENC = Concrete-encased — ALL = All exposures
   BUR = Buried — SUB = Submerged

4. Material Abbreviations:
   CLDI = Cement mortar-lined ductile iron — CU = Copper — HDPE = High density polyethylene
   CPP = Concrete pressure pipe — DI = Ductile iron — PVC = Polyvinyl chloride
   CPVC = Chlorinated polyvinyl chloride — FRPx = Fiberglass reinforced plastic (x = 1 to 6) — PVDF = Polyvinylidene fluoride
   CS = Carbon steel — GS = Galvanized steel — SS = Stainless steel

5. Thickness, Class, or Schedule:
   Pipe thickness, class, or schedule shown in the Process Piping Schedule supercedes that shown in the Piping Data Sheets.

6. Joint Types (as specified in Section 40 27 00, Process Piping - General, and in the Piping Data Sheets):
   BS = Bell and spigot — MJ = Mechanical joint — SD = Soldered
   BW = Butt welded — PO = Push-on — SV = Solvent welded
   FL = Flanged — PRJ = Proprietary restrained (push-on type) — SW = Socket welded
   GR = Grooved — SC = Screwed (threaded) — TBF = Thermal butt fusion

7. Pressure Tests (as specified in Section 40 80 01, Process Piping Leakage Testing):
   H = Hydrostatic
   P = Pneumatic
   G = Gravity (if test pressure is not shown, test under the highest static head that the pipe can be subjected to)
   CSA-B139 = Test in accordance with the requirements of CSA-B139

8. Lining:
   AS = Asphaltic
   CM = Cement mortar
   GL = Glass

   Coating:
   AS = Asphaltic
   Paint = Prepare surface, prime and finish coat per Section 09 90 00, Painting and Coating

9. Remarks:
   (1) All joints shall be restrained.
   (2) Provide flanged joints where required to connect to valves and equipment.

PROCESS PIPING SCHEDULE

Service Abbrev. [Note 1]	Service Description	Size(s) (mm) [Note 2]	Exposure [Note 3]	Piping Material [Note 4]	Pipe Specification Code	Piping Data Sheet Specification Section	Thickness, Class, or Schedule [Note 5]	Joints [Note 6]	Design Maximum Operating Pressure (kPag)	Design Temp. Range (deg C)	Test Pressure (kPag) and Type [Note 7]	ASME Code and Fluid Service Category	Lining / Coating [Note 8]	Remarks [Note 9]

(3) Provide insulation as specified in Section 40 42 13, Process Piping Insulation.
(4) Not used.
(5) Provide electric heat tracing as specified in Section 40 41 13, Pipe Heat Tracing, and as shown on Drawings.
(6) Provide cathodic protection as specified.
(7) Provide Schedule 80 fittings (elbows, tees, laterals, wyes, reducers).
(8) Provide Schedule 80 pipe for concrete-encased wall and floor penetrations.

SECTION 40 27 00.01

CEMENT-MORTAR LINED DUCTILE IRON PIPE AND FITTINGS

Item	Description
Pipe	Buried Service Using Push-On, Mechanical, or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Tables 5 and 7 for Type 4 trench, 1725 kPa minimum working pressure. Follower glands shall be ductile iron. Exposed Pipe Using Grooved End and Flanged Joints: AWWA C115/A21.15, thickness Class 53 minimum, 1725 kPa minimum working pressure.
Lining	Cement-Mortar: AWWA C104/A21.4.
Fittings	Lined and coated same as pipe. Push-On: AWWA C110/A21.10 and C111/A21.11, gray or ductile iron, 1725 kPa minimum working pressure. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: AWWA C110/A21.10, C111/A21.11, and C153/A21.53 gray or ductile iron, 1725 kPa minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C111/A21.11 and C153/A21.53, ductile iron, 1725 kPa minimum working pressure. Clow Corp., Super-Lock Joint; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring Joint; U.S. Pipe, TR Flex. Grooved End: AWWA C606 and C110/A21.10, ductile iron, 1725 kPa minimum working pressure. Victaulic. Flanged: AWWA C110/A21.10, ductile iron, faced and drilled to ASME B16.1 and MSS SP-6, Class 125 flat face. Gray cast iron will not be allowed.
Joints	Push-On: 1725 kPa minimum working pressure, AWWA C110/A21.10 and C111/A21.11. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: 1725 kPa minimum working pressure. Proprietary Restrained: 1050 kPa minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Grooved End: Rigid type radius cut conforming to AWWA C606, 1700 kPa minimum working pressure. Victaulic. Flanged: Class 125 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 80 mm and smaller shall be made with service saddles as specified in Section 15205, Process Piping Specialties.

SECTION 40 27 00.01

CEMENT-MORTAR LINED DUCTILE IRON PIPE AND FITTINGS

Item	Description
Couplings	Grooved End: 1725 kPa minimum working pressure, malleable iron per ASTM A47 or ductile iron per ASTM A536. Victaulic. Grooved End Adapter Flanges: 1725 kPa minimum working pressure, malleable iron per ASTM A47 or ductile iron per ASTM A536. Victaulic.
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Class 125 Flat-Faced Flanged Joints: ASTM A307, Grade A carbon steel hex head bolts and ASTM A563, Grade A carbon steel hex head nuts.
Gaskets	Push-On, Mechanical, and Proprietary Restrained Joints: Rubber conforming to AWWA C111/A21.11. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606. Flanged, Water and Sewage Service: 3 mm, red rubber (SBR), hardness 80 (Shore A), rated to 930 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Full face for Class 125 flat-faced flanges. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange. Gasket pressure rating to equal or exceed system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.02 CARBON STEEL PIPE AND FITTINGS-SPECIAL SERVICE		
Item	Size	Description
Pipe		Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints:
	40 mm & smaller	Schedule 80.
	50 mm thru 250 mm	Schedule 40, except 100 mm and smaller in chlorine service; Schedule 80.
	300 mm thru 400 mm	Schedule 30.
	450 mm thru 600 mm	Schedule 20.
Joints	50 mm & smaller	Threaded or socket-welded; flanged at equipment as required or shown.
	60 mm & larger	Butt-welded or flanged at valves and equipment.
Fittings	50 mm & smaller	Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, 900 kg or 1365 kg WOG (1365 kg chlorine service), conforming to ANSI B16.11; bore to match pipe inside diameter.
	60 mm & larger	Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	50 mm & smaller	Threadolet or socket in conformance with Fittings above.
	60 mm & larger	Butt-welding tee in accordance with Fittings above.
Flanges	50 mm& smaller	Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, 1.50 mm raised face..
	60 mm & larger	Forged carbon steel, ASTM A105/A105M, ASME B16.5 or B16.47 Class 150 or Class 300 slip-on or welding neck, 1.50mm raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Use flat face Class 150 for connection to ductile/cast iron Class 125 flanges.

SECTION 40 27 00.02 CARBON STEEL PIPE AND FITTINGS-SPECIAL SERVICE		
Item	Size	Description
Unions	50 mm & smaller	Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, 13800 or 20700 kPag WOG, integral ground steel-to-steel seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe. Chlorine Service: Threaded or socket-weld end ammonia type tongue-and-groove flange union, ASTM A105/A105M forged carbon steel, 10350 kPag two-bolt oval type.
Bolting	All	Carbon steel ASTM A193/A193M, Grade B7 studs and ASTM A194/A194M, Grade 2H hex head nuts. Quench and temper for chlorine service. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts and ASTM A563, Grade A heavy hex nuts.
Gaskets	All flanges	General Service and Oil/Gas: 1.5 mm thick compressed nonasbestos composition flat ring type. Garlock, Style 3000; Manville, Style 978. Steam Service: Spiral wound, Type 304 stainless steel with nonasbestos filler, integral 3 mm thick carbon steel centering ring. Garlock, Guardian Style 555; Flexitalic, Style CGP. Chlorine Unions: Chemical lead, 2 to 4 percent antimony, 3 mm thick.
Thread Lubricant		General Service: Teflon tape. Chlorine Service: White lead paste or litharge and glycerine.

END OF SECTION

SECTION 40 27 00.03

CARBON STEEL PIPE AND FITTINGS – GENERAL SERVICE

Item	Size	Description
Pipe	600 mm & smaller	Black carbon steel, ASTM A106/A106M Grade B seamless, or ASTM A53/A53M Grade B seamless or ERW, conforming to ASME B36.10M.
	750 mm & larger	Carbon steel, ASTM A283/A283M Grade C, or ASTM A285/A285M Grade C, sheet or coil, fabricated in accordance with AWWA C200 and ASTM A134, straight or spiral seam, conforming to ASME B36.10M.
	Screwed:	
	50 mm & smaller	Schedule 80.
	Welded:	
	65 mm to 250 mm	Schedule 40.
	300 mm to 400 mm	Schedule 30.
	450 mm to 600 mm	Schedule 20.
	650 mm & larger	Schedule 20, min. 12.7 mm (1/2 in) wall thickness.
	Grooved:	
	60 mm to 150 mm	Schedule 40.
	200 mm to 300 mm	Schedule 30.
	350 mm	Standard weight, min. 9.5 mm (3/8 in) wall thickness.
Joints	50 mm & smaller	Threaded, or grooved end meeting the requirements of AWWA C606; flanged at valves and equipment where required.
	60 mm & larger	Butt-welded, or grooved end meeting the requirements of AWWA C606; flanged at valves and equipment where required.
Fittings	50 mm & smaller	Threaded: Malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ANSI B16.3 Class 150 or Class 300. Fire sprinkler fittings to be UL listed.
	350 mm & smaller	Grooved End: Malleable iron, ASTM A47/A47M, or ductile iron, ASTM A536, grooved ends to accept couplings without field preparation. Victaulic; Grinnell.

SECTION 40 27 00.03

CARBON STEEL PIPE AND FITTINGS – GENERAL SERVICE

Item	Size	Description
	65 mm to 600 mm	Butt-welded: Wrought carbon steel butt-welding, ASTM A234/A234M Grade WPB, meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
	650 mm & larger	Butt-welded: Shop-fabricated from carbon steel pipe as specified above in accordance with AWWA C208; fitting wall thickness to match adjoining pipe; elbows to have 22.5-degree maximum miter deflection angle, minimum of three sections for 45-degree elbows, minimum of five sections for 90-degree elbows; wyes, tees, crosses, and outlets to be reinforced in accordance with AWWA M-11.
Branch Connections	50 mm & smaller	Threaded or grooved end straight or reducing tees in conformance with Fittings specified above.
	65 mm & larger	Butt-welding or grooved end straight or reducing tees in conformance with Fittings specified above.
Flanges	50 mm & smaller	Threaded Systems: Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 or Class 300, socket-weld or threaded, 1.5 mm raised face.
	350 mm & smaller	Grooved End Systems: Grooved end adapter flange, malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic; Grinnell.
	65 mm to 600 mm	Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300, slip-on or welding neck, 1.5 mm raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Flat face Class 150 for connection to ductile/cast iron Class 125 flanges.
	650 mm & larger	Butt-Welded Systems: Carbon steel, AWWA C207 Class D or Class E, hub or ring type, flat face, drilling to ASME B16.1 Class 125; Class F, hub or ring type, flat face, drilling to ASME B16.1 Class 250.
Unions	50 mm & smaller	Threaded malleable iron, ASTM A197/A197M or A47/A47M, meeting the requirements of ANSI B16.3 Class 150 or Class 300.

SECTION 40 27 00.03

CARBON STEEL PIPE AND FITTINGS – GENERAL SERVICE

Item	Size	Description
Couplings	50 mm & smaller	Screwed End: Malleable iron, ASTM A197/A197M or A47/A47M.
	60 mm thru 350 mm	Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536. Victaulic; Grinnell.
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts. Use 3 mm undersize bolting material for insulating flanges. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 758,620 kPa minimum tensile strength.
Gaskets	All	Water and Sewage Service: 3 mm thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 93 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330 Grades 1 and 2. Steam and Air Services: 1.5 mm thick, compressed inorganic fiber with nitrile binder, rated to 371 degrees C and 6900 kPa. Fuel Gas Service: 3 mm thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 150 degrees C, conforming to ANSI B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. Grooved Couplings: EPDM per ASTM D2000 for water and air to 110 degrees C, nitrile for oil service to 82 degrees C.
Thread Lubricant	50 mm & smaller	General Service: Teflon tape.

END OF SECTION

SECTION 40 27 00.08

STAINLESS STEEL PIPE AND FITTINGS – GENERAL SERVICE

Item	Size	Description
Pipe	50 mm & smaller	Schedule 40S, ASTM A312/A312M, Type 316L, seamless, conforming to ASME B36.19M; annealed, pickled and passivated per ASTM A380.
	65 mm to 750 mm	Schedule 10S, ASTM A778, “as-welded” grade, Type 316L, straight-seam welded, conforming to ASME B36.19M; pickled and passivated per ASTM A380.
	900 mm & larger	9.5 mm (3/8 in) wall thickness, ASTM A778, “as-welded” grade, Type 316L, straight-seam welded, conforming to ASME B36.19M; pickled and passivated per ASTM A380.
		For pipe sizes 750 mm and larger, provide external stiffening rings around the pipe - 6 mm thick 50 mm wide - spaced every 2 m.
Joints	50 mm & smaller	Threaded; flanged at valves and equipment as required and where shown.
	65 mm & larger	Butt-welded; flanged at valves and equipment and where shown.
Fittings	50 mm & smaller	Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L.
	65 mm to 750 mm	Butt-welded, ASTM A774/A774M, Grade 316L, conforming to MSS SP-43, “as-welded” grade, pickled and passivated per ASTM A380; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Provide custom fabricated fittings where indicated and where required to suit piping layout shown on Drawings.
	900 mm & larger	Butt-welded, shop-fabricated from stainless steel pipe as specified above in accordance with AWWA C208; fitting wall thickness to match adjoining pipe; elbows to have maximum 22.5-degree miter deflection angle, minimum of three sections for 45-degree elbows, minimum of five sections for 90-degree elbows; wyes, tees, crosses, and outlets to be reinforced in accordance with AWWA M-11. Provide custom fabricated fittings where indicated and where required to suit piping layout shown on Drawings.

SECTION 40 27 00.08

STAINLESS STEEL PIPE AND FITTINGS – GENERAL SERVICE

Item	Size	Description
Branch Connections	50 mm & smaller	Tee or reducing tee in conformance with Fittings above.
	65 mm & larger	Butt-welding tee or reducing tee in accordance with Fittings above.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 or B16.47 Class 150 or Class 300, slip-on or weld neck. Raised face for Class 150 and Class 300. Flat face for flange connecting to ductile/cast iron Class 125 and Class 250 flanges.
	All	Carbon Steel (acceptable in dry locations only): ASTM A234, drilled to ASME B16.5/B16.47 Series A, Class 150, minimum flange thickness to AWWA C207 Class D, non-code Van Stone type backing flanges and blind flanges, hot-dip galvanized per ASTM A123, Type 316L stainless steel butt-weld angle collars. Shop Finish for Carbon Steel Flanges: Omit last step in galvanizing process (no chromate treatment). Solvent clean surface to SSPC SP-1. Scuff-sand to impart profile. Apply two coats of Sherwin Williams Macropoxy 646 or approved equal in accordance with B8, colour blue, 3-4 mils DFT per coat. Apply touch-up paint in field after installation. Provide carbon steel blind flanges with Type 316 stainless steel liner.
Unions	50 mm & smaller	Threaded, forged, ASTM A182/A182M, Grade F316, 13800 or 20700 kPag WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Couplings (where indicated)	All	Flexible Sleeve Type: As specified in Section 15205, Process Piping Specialties.
	350 mm & smaller	Grooved End Type: Rigid or flexible joint as indicated, malleable iron ASTM A47 or ductile iron ASTM A536, EPDM gasket, 1725 kPa working pressure. Victaulic; Style 77 (flexible), Style 07 (rigid).

SECTION 40 27 00.08

STAINLESS STEEL PIPE AND FITTINGS – GENERAL SERVICE

Item	Size	Description
Bolting	All	Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex nuts. Type 316 stainless steel flat washer under all bolt heads and nuts. Apply anti-galling compound to bolt threads.
Gaskets	All Flanges	Sewage Service: 3 mm thick unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 93 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Water Service: 3 mm thick unless otherwise specified, Santoprene thermoplastic or approved equal in accordance with B8, NSF 61, hardness 59 (Shore A), rated to 93 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	50 mm & smaller	Teflon tape.

END OF SECTION

SECTION 40 27 00.08A STAINLESS STEEL PIPE AND FITTINGS – PROCESS AIR SERVICE		
Item	**Size**	**Description**
Pipe	50 mm & smaller	Schedule 40S, ASTM A312/A312M, Type 316L, seamless, conforming to ASME B36.19M; annealed, pickled, and passivated per ASTM A380.
	65 mm & larger	Exposed/Submerged: Schedule 10S, ASTM A778, “as-welded” grade, Type 316L, straight-seam welded, conforming to ASME B36.19M; pickled and passivated per ASTM A380; minimum 7.92 mm (0.312 in) wall thickness for pipe sizes larger than 750 mm. For pipe sizes 600 mm and larger, provide external stiffening rings around the pipe - 6 mm thick 50 mm wide - spaced every 2 m. Buried: Schedule 40S, ASTM A312/A312M, Type 316L, seamless or straight-seam welded, conforming to ASME B36.19M; annealed, pickled, and passivated per ASTM A380; minimum 9.53 mm (0.375 in) wall thickness for pipe sizes larger than 600 mm.
Joints	All	Butt-welded; flanged at valves and equipment as required and where shown. Where indicated on Drawings and where required for thermal expansion and contraction of piping, provide flexible sleeve type couplings as specified in Section 40 27 01, Process Piping Specialties.
Fittings	50 mm & smaller	Butt-welded, ASTM A403/A403M, Grade WP316L, seamless, wall thickness to match adjoining pipe, conforming to ASME B16.9; annealed, pickled, and passivated per ASTM A380. Smooth flow elbows and tees, bell type reducers. Long radius elbows unless shown otherwise on Drawings.

SECTION 40 27 00.08A STAINLESS STEEL PIPE AND FITTINGS – PROCESS AIR SERVICE		
Item	**Size**	**Description**
	65 mm & larger	Exposed/Submerged: Butt-welded, ASTM A774/A774M, "as-welded" grade, Type 316L, wall thickness to match adjoining pipe, conforming to MSS SP-43; pickled and passivated per ASTM A380. Buried: Butt-welded, ASTM A403/A403M, Grade WP316L, wall thickness to match adjoining pipe, conforming to ASME B16.9; annealed, pickled, and passivated per ASTM A380. Smooth flow elbows, fabricated tees, bell type reducers. Long radius elbows unless shown otherwise on Drawings.
Branch Connections	All sizes	Butt-welded tee or reducing tee in accordance with Fittings above; weld-o-let where shown on Drawings.
Flanges	50 mm & smaller	Forged, ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150, slip-on or weld neck, raised face.
	65 mm & larger	Dry areas only - Van Stone, ASTM A234 hot-dip galvanized steel backing flanges and blind flanges, galvanized to ASTM A123, drilled to ASME B16.5/B16.47 Series A, Class 150, Type 316L stainless steel butt-weld angle collars. Minimum flange thickness to AWWA C207 Class D. Provide blind flanges with Type 304L stainless steel liner. Submerged areas or outdoor - Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150, slip on or weld neck. Raised face for Class 150.
Unions	50 mm & smaller	Threaded, forged, ASTM A182/A182M, Grade F316, 13,800 or 20,700 kPag WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex nuts. Type 316 stainless steel flat washer under all bolt heads and nuts. Apply anti-galling compound to bolt threads.

SECTION 40 27 00.08A STAINLESS STEEL PIPE AND FITTINGS – PROCESS AIR SERVICE		
Item	**Size**	**Description**
Gaskets	All	3 mm thick unless specified otherwise, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 150 degrees C, conforming to ASME B16.21 and ASTM D1330 steam grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 80 PVC, Type I, Grade I, or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to match pipe above, ASTM D2467 for socket weld type and ASTM D2464 for threaded type.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, ANSI B16.1 Class 125 drilling.
Bolting	All	With Flat Face Mating Flange and In Corrosive Areas: Type 316 stainless steel, ASTM A193/A193M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex nuts. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 3 mm thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 3 mm thick ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441. Threaded nipples shall be Schedule 80.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; 862 kPag ANSI B16.1 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 3 mm thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 3 mm ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM F493.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	Description
Pipe	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	Seamless, conforming to ASTM B88 as follows: Oxygen service — Type K, hard drawn No. 1 water (buried) — Type K, soft or hard temper No. 1 water (exposed) — Type L, hard drawn Domestic hot water — Type L, hard drawn Compressed air service — Type L, hard drawn Laboratory air service — Type L, hard drawn Laboratory vacuum service — Type L, hard drawn Refrigerant service — Type L, hard drawn P-Trap priming service — Type L, soft temper Sample line service — Type L, hard drawn Laboratory gas service — Type L, hard drawn
Fittings	Oxygen Service: Bronze, screwed, 1725 kPag conforming to ASTM B62, dimensions conforming to ANSI B16.15 or wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22. Other Services: Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22.
Flanges	Oxygen Service: Bronze, screwed, conforming to ASTM B61, faced and drilled Class 150 ANSI B16.24 standard. Other Services: Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled Class 150 ANSI B16.24 standard.
Bolting	Oxygen Service: ASTM A320/A320M, stainless steel Type 304, Grade B8 bolts with copper silicon hex nuts conforming to ASTM B98 Grade A hard. Other Services: ASTM A307, carbon steel, Grade A hex head bolts and ASTM A563 Grade A hex head nuts.
Gaskets	1.5 mm thick nonasbestos compression type, full face, Cranite, John Manville.
Solder	Oxygen Service: Silver brazing alloy, 15 percent silver content, 640 degrees C to 705 degrees C melting range, conforming to AWS A5.8. Other Services: 95-5 wire solder (95 percent tin, 5 percent antimony), conforming to ASTM B32 Grade 95TA. Do not use cored solder.

END OF SECTION

SECTION 40 27 00.15 DOUBLE WALL CONTAINMENT PIPING	
Item	Description
Carrier Pipe	Carbon Steel: Schedule 80 carbon steel, ASTM A53, Grade B ERW or seamless, except piping 40 mm and smaller, which shall be ASTM A106, Grade B. All joints shall be butt-welded for sizes 60 mm and greater, and socket-welded for 50 mm and below. Where possible, supply straight sections in 12 metres random lengths with 150 mm of piping exposed at each end for field joint fabrication.
Containment Pipe	Reference Section 40 27 00.02 Carbon Steel Piping and Fittings – Special Service.
Leak Detection System	ULC certified and suitable for diesel fuel No. 2.

END OF SECTION

SECTION 40 27 01

PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.1 REFERENCES

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

1.2 SUBMITTALS

A. Action Submittals:
   1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
   2. Chemical Injectors:
      a. Type, size, quantity, materials, and model number of each.
      b. Sketch of each showing major parts, main pipe, and dimensions.
      c. Details and model number of each support system and component.
      d. Details and model of connects; e.g. service saddle, weld-o-let.

B. Informational Submittals:
   1. Coupling Harness:
      a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
      b. Weld procedure qualifications.
      c. Load proof-testing report of prototype restraint for any size coupling.
   2. Basket Strainer:
      a. Manufacturer’s written/printed installation instructions.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

2.2 CONNECTORS

A. Teflon Bellows Connector:
   1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
   2. Flanges: Ductile iron, drilled to ASME B16.5 Class 150 standard.
   3. Working Pressure Rating: 965 kPa minimum at 49 degrees C.
   4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
   5. Manufacturers and Products:
      a. Garlock; Style 214.
      b. Resistoflex; No. R6904.
      c. Unisource Manufacturing, Inc.; Style 112.
      d. Proco Products, Inc.; Series 442.

B. Elastomer Bellows Connector:
   1. Type: Fabricated spool with single filled arch.
   2. Materials: Nitrile tube and wrap-applied neoprene cover.
   3. End Connections: Flanged, drilled to ASME B16.1 Class 125 standard, with full elastomer face and steel retaining rings.
   4. Working Pressure Rating: 965 kPa minimum at 82 degrees C for sizes 300 mm and smaller.
   5. Thrust Restraint: Control rods to limit travel of elongation and compression.
   6. Manufacturers and Products:
      a. Goodall Rubber Co.; Specification E-1462.
      b. Garlock; Style 204.
      c. Unisource Manufacturing, Inc.; Style 1501.
      d. Proco Products, Inc.; Series 230/220.
      e. Senior Flexonics Pathway; Style 200.

C. Elastomer Bellows Connector for Foul Air Service:
   1. Type: Fabricated spool with single filled arch.
   2. Materials: Neoprene, fabric-reinforced.
   3. End Connections: Flanged, drilled to ASME B16.1 Class 125 standard, with full elastomer face and steel retaining rings.
   4. Working Pressure Rating: 170 kPa minimum at 82 degrees C.
   5. 228 mm (9”) face to face.
   6. Suitable for full vacuum.

7. Manufacturers and Products:
   a. Proco Products, Inc.; Series 530.
   b. Garlock; Style 204EVS.

D. Metal Bellows Connector:
1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ANSI B16.5 Class 150 carbon steel flanges.
4. Minimum Design Working Pressure: 1035 kPa at 398 degrees C.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
   a. Hyspan Precision Products, Inc.; Series 1500.
   b. Senior Flexonics Pathway.

E. Flexible Metal Hose Connector:
1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Bronze.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 3450 kPa at 20 degrees C.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
   a. Senior Flexonics.
   b. Anamet Industrial, Inc.
   c. Unisource Manufacturing, Inc.
   d. Proco Products, Inc.

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

2.3 COUPLINGS

A. General:
1. Coupling linings for use in potable water systems shall be in conformance with NSF 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 1035 kPa.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA M11, and restrained with retainer bar or ring welded to pipe end, or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:
1. Steel Pipe:
   a. Fusion-bonded epoxy-coated middle ring and followers, Type 304 stainless steel bolts and nuts, Buna N gaskets.

b. Manufacturers and Products:
1) Dresser Piping Specialties; Style 38.
2) Smith-Blair, Inc.; Style 411.

2. Stainless Steel Pipe:
a. Type 304 or 316 stainless steel casing, bolts, and bars, EPDM gasket.
b. On process air service provide Type 316 stainless steel strip insert. Couplings to be suitable for minus 40 to 100 degrees C.
c. Manufacturers and Products:
1) Straub; Straub-Flex.

3. Ductile Iron Pipe:
a. Fusion-bonded epoxy-coated middle ring and followers, Type 304 stainless steel bolts and nuts, Buna N gaskets.
b. Manufacturers and Products:
1) Dresser Piping Specialties; Style 38 or 253.
2) Smith-Blair, Inc.; Style 411 or 441.
Robar; Style 1508 or 1506

C. Grooved End Coupling:
1. Malleable iron ASTM A47 or ductile iron ASTM A536 housing, 1725 kPa working pressure, enamel coated. Couplings located outside shall be in stainless steel including bolts and nuts.
2. EPDM gaskets for all services except for Air Low Pressure (ALP) which shall be silicone rated for 125 deg C minimum.
3. Acceptable on pipes 350 mm diameter and smaller only.
4. Flexible type unless indicated as rigid type.
5. Manufacturers and Products:
a. Steel and Stainless Steel Pipe:
1) Victaulic; Style 77 (flexible).
2) Victaulic; Style 07 (rigid).
b. Ductile Iron Pipe:
1) Victaulic; Style 31.

D. Transition Coupling for Steel Pipe:
1. Manufacturers and Products:
a. Dresser Piping Specialties; Style 162.
b. Smith-Blair, Inc.; Style 413.

E. Flanged Coupling Adapter:
1. Manufacturers and Products:
a. Steel Pipe:
1) Dresser Piping Specialties; Style 128.
2) Smith-Blair, Inc.; Style 913.
b. Ductile Iron Pipe:
1) Dresser Piping Specialties; Style 128.
2) Smith-Blair, Inc.; Style 912.

F. Restrained Flange Adapter:
   1. Pressure Rating:
      a. Minimum Working Pressure Rating: Not less than 1035 kPa.
      b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
   2. Thrust Restraint:
      a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
      b. Products employing set screws that bear directly on pipe will not be acceptable.
   3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

G. Dismantling Joints:
   1. Pressure Rating:
      a. Minimum working pressure rating shall not be less than rating of the connecting flange.
      b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
   2. Manufacturers and Products:
      a. Dresser Piping Specialties; Style 131.
      b. Viking Johnson.

H. Exposed Metallic Piping Plain End Couplings:
   1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
   2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
   3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or approved equal in accordance with B8.

2.4 EXPANSION JOINTS

A. Elastomer Bellows:
   1. Type: Reinforced molded wide arch.
   2. End Connections: Flanged, drilled to ASME B16.1 Class 125 standard, with split galvanized steel retaining rings.
   3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
   4. Thrust Protection: Control rods to protect the bellows from overextension.
   5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
   6. Rated Temperature: 120 degrees C.
   7. Rated Deflection and Pressure:
      a. Lateral Deflection: 19 mm, minimum.
      b. Burst Pressure: Four times the working pressure.

c. Compression deflection and minimum working pressure as follows:

Size (mm)	Deflection (mm)	Pressure (kPa)
65 to 300	27	1035
350	42	837
400 to 500	42	759

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E-711.
   d. Unisource Manufacturing, Inc.; Series 1500.
   e. Proco Products, Inc.; Series 251.

B. Teflon Bellows:
1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled to ASME B16.5 Class 150 standard.
3. Working Pressure Rating: 690 kPa, minimum, at 49 degrees C.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 215.
   b. Resistoflex; No. R6905.
   c. Unisource Manufacturing, Inc.; Style 113,
   d. Proco Products, Inc.; Series 443.

C. Metal Bellows (All pipes except Air Low Pressure and Foul Air):
1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ASME Class 150 carbon steel flanges.
4. Minimum Design Working Pressure: 1035 kPa at 398 degrees C.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
   a. Hyspan Precision Products, Inc.; Series 2500.
   b. Senior Flexonics Pathway.

D. Metal Bellows for Air Low Pressure Piping and Foul Air:
1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 304 or 316 stainless steel.
3. Limit rods material: Type 304 or 316 stainless steel.
4. Stainless steel 304 or 316 flow liner. Flow liner to be full bore to allow condensation in piping to pass through (install in the proper direction of pipe slope).
5. End Connections: Carbon steel flanges drilled per ASME B16.5, Class 150.
6. Minimum Design Working Pressure: 103.5 kPa (15 psi) at 398 degrees C.
7. For pipe diameters 150 mm to 450 mm. Axial Compression: 75 mm min., Axial Extension: 38 mm min.

8. For pipe diameters 500 mm and larger. Axial Compression: 88 mm min., Axial Extension: 45 mm min.
9. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
10. Installation temperature should be at ambient temperature not exceeding 5 degrees C. Installation at ambient temperature between 5 and 25 degrees C is allowed but shall require the addition of a cut grooved flexible Victaulic coupling in stainless steel with silicone gaskets rated for 125 degrees C next to the metal bellows coupling. Installation at ambient temperature higher than 25 degrees C is not allowed.
11. Manufacturers and Products:
    a. Hyspan Precision Products, Inc.; Series 1500.
    b. Senior Flexonics Pathway.

E. Galvanized and Black Steel Pipe Expansion Compensator:
1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 1200 kPa, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
    a. Senior Flexonics; Model H.
    b. Hyspan; Model 8503.
    c. Unisource Manufacturing, Inc.; Style EC-MMT.

F. Flexible Metal Hose:
1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
    a. NPS 80 mm Diameter and Larger: Shop fabricated flanged ends to match mating flanges.
    b. NPS 65 mm Diameter and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 4140 kPa at 21 degrees C for 300 mm and smaller.
5. Length: Provide hose live-length equal to lengths shown on Drawings.
6. Manufacturer:
    a. Senior Flexonics; Series 401M.
    b. Hyspan Anamet Industrial, Inc.; 800.

2.5 SEAL WATER HOSE

A. EPDM tube with EPDM black cover, reinforced with two textile braids, 12 mm diameter by 300 mm long, with brass male NPT ends.

B. Rated Minimum Working Pressure: 1380 kPa.

C. Manufacturers:
1. Goodyear.
2. Boston.

2.6 SERVICE SADDLES

A. Double-Strap Iron:
   1. Pressure Rating: Capable of withstanding 1035 kPa internal pressure without leakage or over stressing.
   2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
   3. Taps: Iron pipe threads.
   4. Materials:
      a. Body: Malleable or ductile iron.
      b. Straps: Galvanized steel.
      c. Hex Nuts and Washers: Steel.
      d. Seal: Rubber.
   5. Manufacturers and Products:
      a. Smith-Blair; Series 313 or 366.
      b. Dresser; Style 91.

B. Nylon-Coated Iron:
   1. Pressure Rating: Capable of withstanding 1035 kPa internal pressure without leakage or over stressing.
   2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
   3. Materials:
      a. Body: Nylon-coated iron.
      b. Seal: Buna-N.
      c. Clamps and Nuts: Stainless steel.
   4. Manufacturer: Smith-Blair; Style 315 or 317.

2.7 PIPE SLEEVES

A. Steel Pipe Sleeve:
   1. Minimum Thickness: 4.7 mm.
   2. Seep Ring:
      a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 4.7 mm minimum thickness.
      b. Outside Diameter: Unless otherwise shown, 80 mm greater than pipe sleeve outside diameter.
      c. Continuously fillet weld on each side all around.
   3. Factory Finish:
      a. Galvanizing:
         1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
         2) Electroplated zinc or cadmium plating is unacceptable.
      b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:
   1. Molded HDPE with integral water stop ring not less than 80 mm larger than sleeve.
   2. Provided with end caps for support during concrete placement.
   3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

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

D. Modular Mechanical Seal:
   1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
   2. Fabrication:
      a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
      b. Pressure plates shall be reinforced nylon polymer.
   3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 12 metres of water.
   4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.8 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:
   1. Diameter and Ends: Same as connecting ductile iron pipe.
   2. Thickness: Equal to or greater than remainder of pipe in line.
   3. Fittings: In accordance with applicable Pipe Data Sheet.
   4. Thrust Collars:
      a. Rated for thrust load developed at 1725 kPa.
      b. Safety Factor: 2, minimum.
      c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
   5. Manufacturers:
      a. American Cast Iron Pipe Co.
      b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:
   1. Same material and thickness as connecting pipe, except 6.3 mm minimum thickness.
   2. Lining: Same as connecting pipe.
   3. Thrust Collar:
      a. Outside Diameter: Unless otherwise shown, 80 mm greater than outside diameter of wall pipe.
      b. Continuously fillet welded on each side all around.

2.9 CHEMICAL INJECTOR SYSTEMS

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

B. Support System:
   1. Stainless steel Unistrut or FRP Aickenstrut.

2. Materials compatible with chemical service and subject to Contract Administrator approval.

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

2.10 MISCELLANEOUS SPECIALTIES

A. Blower Intake Filter Silencer:
1. Quantity: 12
2. Top-Outlet Intake Filter Silencer, 450 mm (18") flange (drillings to match pipe)
3. Rated at 18,000 SCFM
4. Headloss at 9500 SCFM, 19 mm (3/4”) WG max initial.
5. Filter: Enduralast, Hi-Flow Synthetic Medium, 98% efficient @ 10-micron nominal, Powder coated.
6. Supply 12 additional replacement filters (total of 24 filters)
7. Manufacturers and Products:
   a. Endustra Filter Manufacturers; Tri-Vent Series TM09, Model TM09RS, Element Number E047937

B. Hoar Frost Control Air Nozzles (located in blower intake plenum):
1. Quantity: 96 installed and 5 loose as spares
2. Multi-channel flat jet nozzle, extremely silent (rated at 78 dbA at 200 kPa)
3. Stainless Steel 316
4. Manufacturers and Products:
   a. Lechler Series 600.493.1Y

C. Sampling Pump P-S540:
1. Magnetic Drive, polypropylene material
2. Flow 2 L/sec at 3 m TDH
3. 115 Volts, 1 Phase, 0.25 kW
4. 25 mm inlet, 25 mm outlet
5. Cole-Parmer, Item EW-72010-80

D. Foam/Scum Control Nozzles (located in IFAS basins):
1. Quantity: 51 installed and 3 loose as spares
2. Flat fan spray, Buna N deflector insert for quick removal upon wear,
3. Flow 3.5 gpm and 10 psi
4. 90 degrees spray angle,
5. Manufacturers and Products:
   a. Lechler Series 564 Model 564.946.32.BC

E. Foam/Scum Control Nozzles (located in fermenters):
1. Quantity: 258 installed and 10 loose as spares
2. Solid Cone-shaped spray system, extra large free passage design (0.188”), 3/8” connection, 316 stainless steel
3. Flow 6 gpm and 40 psi and 9.5 gpm, at 100 psi
4. 90 degrees spray angle,

5. Manufacturers and Products:
    a. Spraying Systems Co. Model SPIRALJET 3/8-HHSJX-SS-90-30

F. Non Freeze Hydrant (located in bioreactors and secondary clarifiers 4 and 5):
1. Quantity: 6 (4 in bioreactors and 2 in secondary clarifiers)
2. Wall Hydrant Exposed Non Freeze, 25 mm diameter
3. Bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer. Complete with operating key.
4. Supply a hose beside each Non freeze hydrant complete with rack. The hose to be supplied per spec section 22 10 01 Plumbing and Piping Accessories. The rack to be supplied per the rack detail provided on the relevant Drawing.
5. Manufacturers and Products:
    a. ZURN Z1315

G. Infrared Radiant Heaters (located in bioreactors):
1. Quantity: 27 (9 in each bioreactor)
2. For use in outdoor installations and areas subject to periodic washdown
3. Anodized and chemically brightened extruded aluminum reflector
4. 3.6 kW, 600 V,
5. Overall length 1149 mm, heated length 1041 mm
6. Wire guard
7. Provide a factory designed and supplied mounting frame compatible with installation detail shown on Drawing
8. Manufacturers and Products:
    a. CCI Thermal Technologies, OKA Series, Model OKA413H6R with wire guard

H. Movable Platform Ladders:
1. General:
    a. Suitable for use in outdoor locations and areas subject to periodic washdown.
    b. Material: FRP, non-conductive.
    c. Wide, fully serrated, slip-resistant insulated platform.
    d. Top platform railing for safe working.
    e. Heavy duty steel base frame, epoxy coated.
    f. Safety paddle lock feature for wheel engagement.
    g. Minimum 900 mm wide steps.
2. Item 1:
    a. Location: Beside slide gate FV-R1306 at Bioreactors.
    b. Quantity: One.
    c. Platform to Floor Height: 1.5 m.
    d. Manufacturer and Product: Arham Model AM 15 08, or approved equal in accordance with B8.
3. Item 2:
    a. Location: Grit and Screenings Platform.
    b. Quantity: One.
    c. Platform to Floor Height: 1.5 m.
    d. Manufacturer and Product: Arham Model AM 15 08, or approved equal in accordance with B8.

4. Item 3:
    a. Location: Grit and Screenings Loading Bay.
    b. Quantity: One.
    c. Platform to Floor Height: 1.5 m.
    d. Manufacturer and Product: Arham Model AM 15 08, or approved equal in accordance with B8.

I. Chemical Injector Systems
1. Chemical Injectors:
    a. Sodium Hypochlorite, 25 mm diameter, in 750 mm RAS pipe
    b. Sodium Hypochlorite, 12 mm diameter, in 350 mm FSW pipe
2. Materials compatible with chemical service and subject to the Contract Administrator approval.
3. Connectors: Stainless steel service saddle or weld-o-let.
4. Manufacturer: SAF-T-FLO.

J. Strainers, Water Service, 50 mm and Smaller:
1. Type: Bronze body, Y-pattern, 1380 kPa non-shock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or Monel, 20-mesh.
3. Manufacturers and Products:
    a. Armstrong International; Inc.; Model F.
    b. Mueller Steam Specialty; Model 351M.

K. Strainers, Water Service, 65 mm and Larger:
1. Type: Cast iron or ductile iron body, Y-pattern, 1200 kPa non-shock rated, with flanged gasketed iron cap.
2. Screen: Heavy-gauge Type 316 stainless steel, 1.1 mm perforations.
3. Manufacturers and Products:
    a. Armstrong International, Inc.; Model A1FL 125.
    b. Mueller Steam Specialty; Model 751/752.

L. Strainers, Plastic Piping Systems, 100 mm and Smaller:
1. Type: Y-pattern PVC body, 1035 kPa non-shock rated, with screwed PVC cap and Viton seals
2. End Connections: Screwed or solvent weld, 50 mm and smaller. Class 150 ANSI flanged, 65 mm and larger.
3. Screen: Heavy-gauge PVC, 0.8 mm mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

M. Water Hose:
1. Furnish 15 m lengths of 25 mm and 15 m lengths of 40 mm rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 1380 kPa.
3. Manufacturers:
    a. Goodyear.
    b. Boston.

N. Hose Nozzles:
   1. Furnish 25 mm and 40 mm cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.
   2. Manufacturers:
      a. Croker.
      b. Elkhart.

PART 3 EXECUTION

3.1 GENERAL

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

3.2 PIPING FLEXIBILITY PROVISIONS

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

B. Flexible Joints at Concrete Backfill or Encasement: Install within 450 mm or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:
   1. Install 450 mm or less from face of structures; joint may be flush with face.
   2. Install a second flexible joint, whether or not shown.
      a. Pipe Diameter 450 mm and Smaller: Within 450 mm of first joint.
      b. Pipe Diameter Larger than 450 mm: Within one pipe diameter of first joint.

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

3.3 PIPING TRANSITION

A. Applications:
   1. Provide complete closure assembly where pipes meet other pipes or structures.
   2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
   3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
   4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
   5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
   6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:
   1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
   2. Concrete Closures:
      a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
      b. Clean pipe surface before placing closure collars.
      c. Wet nonmetallic pipe thoroughly prior to pouring collars.
      d. Prevent concrete from entering pipe.
      e. Extend collar a minimum of 300 mm on each side of joint with minimum thickness of 150 mm around outside diameter of pipe.
      f. Make entire collar in one placement.
      g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.4 PIPING EXPANSION

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

B. Expansion Joints:
   1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
   2. Nonmetallic Pipe: Teflon bellows expansion joint.
   3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
   4. Air and Water Service above 49 degrees C: Metal bellows expansion joint.
   5. Pipe Run Offset: Flexible metal hose.

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

3.5 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.6 COUPLINGS

A. General:
   1. Install in accordance with manufacturer's written instructions.
   2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
   3. Do not remove pipe coating. If damaged, repair before joint is made.
   4. Application:
      a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
      b. Concrete Encased Couplings: Flexible coupling.

3.7 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:
   1. Nonmetallic Piping: Teflon bellows connector.
   2. Copper Piping: Flexible metal hose connector.
   3. Compressor and Blower Discharge: Metal bellows connector.
   4. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.8 PIPE SLEEVES

A. Application:
   1. As specified in Section 40 27 00, Process Piping—General.
   2. Above Grade in Non-submerged Areas: Hot-dip galvanized after fabrication.
   3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
   4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation:
   1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
   2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.9 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:
   1. Watertight and Below Ground Penetrations:
      a. Wall pipes with thrust collars.
      b. Provide taps for stud bolts in flanges to be set flush with wall face.
   2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
   3. Existing Walls: Rotary drilled holes.
   4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:
   1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations.
   2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

END OF SECTION

SECTION 40 27 02

PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Petroleum Institute (API):
      a. 598, Valve Inspection and Testing.
      b. 600, Steel Gate Valves – Flanged and Butt-welding Ends, Bolted Bonnets.
      c. 607, Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats.
   2. American Society of Mechanical Engineers (ASME):
      a. B16.1, Grey Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
      b. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
      c. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   3. American Society of Sanitary Engineers (ASSE):
      a. 1011, Performance Requirements for Hose Connection Vacuum Breakers.
   4. American Society for Testing and Materials (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
      e. A536, Standard Specification for Ductile Iron Castings.
      f. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
      g. B61, Standard Specification for Steam or Valve Bronze Castings.
      h. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
      i. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
      j. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
      k. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
      l. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
      m. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
      n. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
      o. D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
      p. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   5. American Water Works Association (AWWA):
      a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

b. C500, Metal-Seated Gate Valves for Water Supply Service.
c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
d. C508, Swing-Check Valves for Waterworks Service, 2-in. Through 24-in. (50-mm Through 600-mm) NPS.
e. C509, Resilient-Seated Gate Valves for Water Supply Service.
f. C510, Double Check Valve Backflow Prevention Assembly.
g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
k. C542, Electric Motor Actuators for Valves and Slide Gates.
l. C550, Protective Interior Coatings for Valves and Hydrants.
m. C606, Grooved and Shouldered Joints.
n. C800, Underground Service Line Valves and Fittings.

6. International Standards Organization (ISO):
   a. 5210, Industrial Valves – Multi-Turn Actuator Attachment.
   b. 5211, Industrial Valves – Part-Turn Actuator Attachment.
7. Manufacturers Standardization Society (MSS):
   a. SP-81A, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
   b. SP-88, Diaphragm Valves.
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
9. NSF International (NSF):
   a. 61, Drinking Water System Components – Health Effects.
10. Underwriters Laboraties (UL):
   a. 1709, UL Standard for Safety, Rapid Rise Fire Tests of Protection Materials for Structural Steel.

1.2 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
      b. Complete catalog information, descriptive literature, specifications, identification of materials of construction, and cross-sectional details.
      c. Submit the following data complete, grouped together, and separated by divider, for each set of valves with the same combination of features and accessories:
         1) Dimensional outline drawing showing valve body, trim, actuator, and accessories.
         2) Identification of materials of construction, cross-sectional views and details; for valves, components, and accessories.
         3) Power and control wiring diagrams, including terminals and numbers.
         4) Complete motor nameplate data.
         5) Sizing calculations for open-close, throttling and modulating valves.
         6) Valve pressure and temperature ratings.

7) List of Configuration Parameters: Include the following for each piece of equipment and/or component which contains adjustable or programmable settings:
   a) List of switchable settings, or programmable settings complete with:
      (1) Switch/parameter tag No. or I.D. or address.
      (2) Range of possible settings.
      (3) Factory default setting.
      (4) Blank column for recording final field setting.
   b) Description of each adjustable parameter c/w description of each allowable value.

B. Information Submittals:
   1. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Contractor Field Services for:
      a. Electric motor actuators; full compliance with AWWA C542.
      b. Butterfly valves; full compliance with AWWA C504.
   2. Tests and inspection data.
   3. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Contractor Field Services.
   4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 GENERAL

A. All valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories, as required, for complete operation from the intended operating level.

B. Valves to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjoining piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for the full range of pressures and velocities.

G. Size actuators for drip-tight shutoff and breakaway at full valve pressure rating, unless otherwise specified.

H. Valve to open by turning counterclockwise, unless otherwise specified.

I. Factory mount operator, actuator, and accessories.

2.2 SCHEDULES

A. Additional requirements relative to this section are shown on Manual Valve Schedule (Smaller than 75 mm) - General Schedule, Manual Valve Schedule (75 mm and Larger), Electric Motor Actuated Valve Schedule, Solenoid Valve Schedule, and Self-Contained Valve Schedule located at end of this section.

2.3 MATERIALS

A. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
   1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
   2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.4 FACTORY FINISHING

A. Epoxy Lining and Coating:
   1. Use where specified for individual valves described herein.
   2. In accordance with AWWA C550 unless otherwise specified.
   3. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
   4. Minimum 0.18 mm dry film thickness except where limited by valve operating tolerances.
   5. Coatings in contact with potable water shall conform to NSF 61.

B. Exposed Valves:
   1. In accordance with Section 09 90 00, Painting and Coatings.
   2. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

2.5 VALVES

A. Gate Valves:
   1. General:
      a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
         1) Provide 50 mm operating nut and handwheel for AWWA gate valves 300 mm and smaller.
         2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 350 mm and larger.
         3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
         4) Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
         5) Repaired AWWA gate valves shall not be submitted or supplied.

6) Supply AWWA gate valves with stainless steel bolting.
7) AWWA C509 and AWWA C515 valves may be substituted for each other.

2. Type V100 Gate Valve, 75 mm and Smaller:
   a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, non-rising stem, Class 125, rated 862 kPa SWP, 1380 kPa WOG/CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) NPT Threaded Ends:
         a) Watts; Series GV
         b) Crane; Fig. 438
         c) Nibco; Fig. T-113
      2) Soldered Ends:
         a) Watts; Series GVS
         b) Crane; Fig. 1324
         c) Nibco; Fig. S-113
3. Type V104 Gate Valve, 75 mm and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, non-rising stem, stainless steel seat rings, Class 200, rated 1380 kPa SWP, 2760 kPa WOG/CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Fig. 426
      2) Or approved equal in accordance with B8.
4. Type V110 Gate Valve, 50 mm and Larger:
   a. Iron body, bronze mounted, ASME B16.1 Class 125 flanged ends, solid wedge gate, outside screw and yoke, rated 862 kPa SWP, 1380 kPa WOG/CWP for 50 mm through 300 mm and 690 kPa WOG/CWP for 350 mm through 600 mm.
   b. Manufacturers and Products:
      1) Newco; Fig. 12F-IB7
      2) Crane; Fig. 465 1/2
5. Type V136 Resilient Seated Gate Valve, Flanged Ends, 100 mm to 300 mm:
   a. ULC Listed and FM Approved, iron body, resilient seat, bronze mounted, ASME B16.1 Class 125 flanged ends, outside screw and yoke, handwheel operator, in accordance with AWWA C509, design working water pressure 1375 kPa, full port, fusion-bonded epoxy coated inside and outside per AWWA C550, NSF Standard 61 certified, Supervisory switch, as specified in Section 21 05 23, General-Duty Valves for Water-Based Fire-Suppression Piping. Valve supervised in OPEN position so closing results in actuation of alarm.
   b. Manufacturers and Products:
      1) American AVK; Style 25/46X
      2) Mueller; Fig. R-2360-6
      3) Clow; Fig. F-6136
6. Type V137 Resilient Seated Gate Valve, 100 mm to 300 mm:
   a. ULC Listed and FM Approved for fire protection, iron body, resilient seat, bronze mounted, ASME B16.1 Class 125 flanged ends [mechanical joint ends], non-rising stem, 50 mm square operating nut, in accordance with AWWA C509, design working water pressure 1375 kPa, full port, fusion-bonded epoxy coated inside and outside per AWWA C550, NSF 61 certified, indicator post flange and indicator post assembly with lockable handle.

b. Manufacturers and Products:
   1) American AVK; Style 25/4X, 25/0X
   2) Mueller; Fig. P-2360-6, P-2360-20

7. Type V138 Resilient Seated Gate Valve, 350 mm to 400 mm:
   a. ULC Listed and FM Approved, ductile iron body, bonnet, and wedge, bronze mounted, resilient seated, ASME B16.42 Class 150 flanged ends, outside screw and yoke, in accordance with AWWA C509, minimum 1375 kPa working pressure, fusion-bonded epoxy coating inside and outside per AWWA C550.
      1) American AVK; 45/FFO FLxFL
      2) Clow; Model 2638
      3) Nibco; Model F-609-RWS
8. Type V140 Gate Valve, 19 mm to 50 mm:
   a. ULC Listed and FM Approved, all bronze, solid wedge disc, outside screw and yoke, screwed ends rated 1207 kPa WOG/CWP minimum.
   b. Supervisory switch, as specified in Section 21 05 23, General-Duty Valves for Water-Based Fire-Suppression Piping. Valve supervised in OPEN position so closing results in actuation of alarm.
   c. Manufacturers and Products:
      1) Kennedy; Fig. 66
      2) Nibco; T-104-O.
9. Type V150 Knife Gate Valve, 600 mm and Smaller:
   a. Bonnetless, full lug body, non-rising stem, working pressure rating of 1000 kPa minimum, bi-directional drip-tight differential pressure rating of 1000 kPa minimum up to 350 mm size and 600 kPa minimum for 400 mm and larger size, drilled and tapped to ASME B16.5 Class 150 dimensions, round port, resilient seat/seals of EPDM or PTFE, drip-tight shutoff with downstream flange removed (dead-end service).
   b. Type 316 stainless steel body, gate and stem; aluminum bronze or brass stem nut; braided graphite- or Teflon-impregnated packing with resilient core; stainless steel packing gland; low friction gate with rounded or chamfered edges.
   c. Packing system to provide leak-tight seal around the gate; valve superstructure and yoke designed for full peripheral access to gland bolts when valve is equipped with manual bevel gear handwheel or power actuator.
   d. For valves larger than 350 mm with stem oriented horizontally, provide adjustable gate side load mechanism to carry gate load throughout full travel to protect valve packing.
   e. Provide bevel gear operator for manually operated valves 350 mm and larger.
   f. In compliance with MSS SP-81.
   g. Manufacturers and Products:
      1) Trueline; Model F8112
      2) DeZurik; Series KGC-BD
      3) Stafsjo; Series XV
      4) Orbinox; BT Series 22
10. Type V155 Knife Gate Valve, 750 mm and Larger:
   a. Bonnetless, full lug body, rising stem, working pressure rating of 600 kPa minimum, bi-directional drip-tight differential pressure rating of 345 kPa minimum, drilled and tapped to ASME B16.5 Class 150 dimensions, round port, resilient seat/seals of

EPDM or PTFE, drip-tight shutoff with downstream flange removed (dead-end service).

b. Type 316 stainless steel body, gate and stem; aluminum bronze or brass stem nut; braided graphite- or Teflon-impregnated packing with resilient core; stainless steel packing gland; low friction gate with rounded or chamfered edges.

c. Packing system to provide leak-tight seal around the gate; valve superstructure and yoke designed for full peripheral access to gland bolts when valve is equipped with manual bevel gear handwheel or power actuator.

d. For valves with stem oriented horizontally, provide adjustable gate side load mechanism to carry gate load throughout full travel to protect valve packing.

e. Provide bevel gear operator for manually operated valves.

f. In compliance with MSS SP-81.

g. Manufacturers and Products:

1) Trueline; Model F8112

2) Dezurik; Series KGC-BD

3) Stafsjo; Series XV

4) Orbinox; BT Series 20

11. Type V160 Shear Gate Valve:

a. Heavy duty design. Cast iron body, disc, and removable wedge.

b. The seat rings, disc ring, hinge bolt, and hinge nut shall be bronze.

c. The valve shall be single hinged for a tight closing configuration.

d. The gate shall be bronze to bronze in order to shear off any remaining sludge on the seat.

e. All iron parts shall be coated in TNEMEC 2 part epoxy with 3-4 mils dry film thickness to prevent rusting or corrosion.

f. Lift Rods approximately 5.7 m (exact length adjusted to suit) long in stainless steel 316. Lift handle guide and hook catch in stainless steel 316.

g. Manufacturers and Products:

1) Troy Valve Model A2520 or approved equal in accordance with B8

B. Globe Valves:

1. Type V200 Globe Valve, 75 mm and Smaller:

a. All-bronze, union bonnet, packed gland, inside screw, rising stem, PTFE disc, Class 150, rated 1035 kPa SWP, 2070 kPa WOG/CWP, complies with MSS SP-80 Type 2.

b. Manufacturers and Products:

1) NPT Threaded Ends:

a) Crane; Fig. 7TF

b) Nibco; Fig. T-235-Y

2) Soldered Ends:

a) Nibco; Fig. S-235-Y.

2. Type V208 Needle Disc Type Globe Valve, 3 mm to 19 mm:

a. Screwed or union bonnet, NPT threaded ends, packed gland, rising stem, bronze body and stem, Class 200, rated 1380 kPa SWP, 2760 kPa WOG/CWP, complies with MSS SP-80.

b. Manufacturers and Products:

1) Crane; Fig. 88

2) United Brass Works; Model 79

3. Type V230 PVC Globe Valve, 13 mm to 50 mm:
   a. Rated minimum 1035 kPa at 20 degrees C, ASTM D1784, Type I, Grade 1 polyvinyl chloride body, bonnet, and stem, threaded ends, EPDM bonnet and stem seals.
   b. Manufacturers and Products:
      1) Chemline; Series GV
4. Type V234 Angle Type Hose Valve, 13 mm to 19 mm:
   a. Bronze or brass, angle sillcock type body, threaded or solder inlet as applicable, pressure rating 863 kPa cold water.
   b. Manufacturer and Product:
      1) NPT Threaded Inlet: Nibco; QT63X
      2) Soldered Inlet: Nibco; QT763X
5. Type V240 Hydronic Heating Globe Type Control Valve, 150 mm and Smaller:
   a. Globe type control valve complete with matching actuator for hydronic heating control purpose
   b. Actuator with modulating control signal 4-20mA
   c. Valve sizes 15m to 50mm:
      1) Body - Globe style, UNS CA 844 bronze ANSI Class 250, NPT threaded type fittings.
      2) Trim – Brass
      3) Stem – Stainless steel ASTM A582 Type 303, 20mm stroke
      4) Seat – Single seat, metal-to-metal
      5) Packing EPDM O-ring
   d. Valve sizes 65mm to 150mm
      1) Body - Flanged style, cast iron ASTM A126 Class B, ANSI Class 125
      2) Trim – Bronze
      3) Stem – Stainless steel ASTM A582 Type 303, 20mm stroke for up to 75mm valve, and 40mm stroke for larger valve size
      4) Packing – Double EPDM O-rings
   e. Manufacturers and Products:
      1) Siemens, Flowrite 599 Series.

C. Ball Valves:
   1. Type V300 Ball Valve, 50 mm and Smaller, for General Water and Air Service:
      a. Two-piece end entry type, standard port, bronze body and end piece, hard chrome-plated bronze or brass ball, PTFE seats and stem packing, blowout-proof stem, zinc-coated steel hand lever operator with vinyl grip, rated 4140 kPa WOG/CWP, 1035 kPa SWP.
      b. Manufacturers and Products:
         1) NPT Threaded Ends:
            a) Crane; Series 9211
            b) Watts; Series B6080
            c) Conbraco Apollo; 70-100
            d) Nibco; T-580-70
         2) Soldered Ends:
            a) Crane; Series 9212
            b) Watts; Series B6081
            c) Conbraco Apollo; 70-200

d) Nibco; S-580-70

2. Type V303 Ball Valve, 50 mm and Smaller, for Equipment Air System Shutoff:
   a. Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, PTFE packing, reinforced PTFE seats, blowout-proof stem, adjustable packing gland, rated 4140 kPag WOG/CWP, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel latch-locking handle with vinyl grip, pad-lockable in closed position.
   b. Manufacturers and Products:
      1) Watts; Series B6000-LH-SE
      2) Conbraco Apollo; 75-100-41
      3) Nibco; T-580-70-SV/T-585-70-SV
3. Type V304 Ball Valve, 50 mm and Smaller, for General Water and Air Service:
   a. Three-piece, full port, bronze body and end pieces, hard-chrome plated solid bronze or brass ball, reinforced PTFE seats, PTFE packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 4140 kPa WOG/CWP, 1035 kPa SWP.
   b. Manufacturers and Products:
      1) NPT Threaded Ends:
         a) Crane; Series 9311
         b) Conbraco Apollo; Series 82-100
         c) Nibco; T-595-Y
      2) Soldered Ends:
         a) Crane; Series 9312
         b) Conbraco Apollo; Series 82-200
         c) Nibco; S-595-Y
4. Type V305 Ball Valve, 50 mm and Smaller, for Fuel Oil Service:
   a. Two-piece bronze or forged brass body and end piece, NPT threaded ends, hard chrome plated solid brass ball, reinforced PTFE seats, PTFE seal, blowout-proof stem, zinc-plated hand lever operator with vinyl grip, UL Listed Guide MHKZ for Fuel Oil, 4140 kPa WOG.
   b. Manufacturers and Products:
      1) Crane; Series 9201-UL
      2) Conbraco Apollo; Series 80-100
      3) Nibco; T-585-70-UL/T-580-70-UL
5. Type V306 Stainless Steel Ball Valve, 50 mm and Smaller:
   a. Two piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body, ball, and end piece, NPT threaded ends, reinforced PTFE seats, PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 6900 kPa WOG/CWP, 1035 kPa SWP.
   b. Manufacturers and Products:
      1) Conbraco Apollo; Series 76F-100-A
      2) Nibco; T-585-S6-R-66-LL
      3) Watts; S-FBV-1
      4) Crane; CSC-9502-2
6. Type V307 Stainless Steel Ball Valve, 100 mm and Smaller:
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, PTFE packing, blowout proof stainless steel stem,

stainless steel lever operator with vinyl grip, rated 6900 kPa WOG/CWP, 1035 kPa SWP.

b. Manufacturers and Products:
   1) Trueline; Model N650(T)
   2) Conbraco Apollo; Series 86-500
   3) Nibco; T-595-S6-R-66-LL
   4) Velan; V3P-1000
   5) Bray/Flow-Tek; Series 7000

7. Type V308 Stainless Steel Ball Valve, 50 mm and Smaller:
   a. Three-piece, full port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball and stem, actuator-ready ISO 5211 mounting pad, reinforced PTFE seats, PTFE packing, adjustable packing gland, blowout proof stem, rated 6900 kPa WOG/CWP.
   b. Manufacturers and Products:
      1) Nibco; TM-595-S6-R-66
      2) Crane; CSC-9503-T
      3) Bray/Flow-Tek; Series DM7000
8. Type V311 Stainless Steel Ball Valve, 12 mm to 50 mm, for Digester Gas Service:
   a. Top entry, regular port, floating ball, NPT threaded ends, ASME Class 600, rated 8275 kPa at 38 degrees C, Type 316 stainless steel, body, ball and stem, reinforced PTFE seats with both seats in tension or spring loaded to provide leak tight seal at both low and high pressures, blowout-proof stem with reinforced PTFE stem seal, lever operator, CGA/CSA and ULC or cUL approved and conforming to the requirements of CSA B149.6 and CGA-3.16.
   b. Manufacturers and Products:
      1) Velan; TE-600 Memoryseal.
      2) Or approved equal in accordance with B8.
9. Type V315 Ductile Iron Ball Valve, 50 mm to 250 mm, for General Water Service:
   a. Face to face flange ball valve mounted. The valves shall be class 300 with a rated working pressure of at least 2070 kPa WOG, 1035 kPa SWP.
   b. The valve shall consist of a solid stainless steel ball. The valve shall be a bi-directional tight shutoff designed for tight shut off in accordance with MSS-SP-72.
   c. The valve body shall be ductile iron with exterior and interior epoxy coating.
   d. Seat and seat body shall be PTFE. The stem seal shall be PTFE.
   e. Valves shall be equipped with locking handles. Lockable in full open and closed positions. Adjustable length/removal handles.
   f. Manufacturers and Products:
      1) American Valve; Model 4000D.
      2) Trueline
      3) Kitz
10. Type V321, Three-Way Stainless Steel Ball Valve, 50 mm and Smaller:
   a. Three-way, 90-degree L-port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball and stem, actuator-ready ISO 5211 mounting pad, reinforced PTFE seats, PTFE packing, adjustable packing gland, blowout proof stem, rated 5500 kPa WOG.
   b. Manufacturers and Products:
      1) Bray/Flow-Tek; MPT130
      2) Burkert; 2651

3) Marwin Valve; 3-L/T-2100

11. Type V330 PVC Ball Valve, 50 mm and Smaller:
    a. Rated minimum 1035 kPa at 22.8 degrees C, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, PTFE seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
    b. On sodium hypochlorite service, provide pressure relief hole drilled on low pressure side of ball.
    c. Manufacturers and Products:
        1) Chemline; Type 21
        2) Hayward; TB Series, TBZ Series
        3) Nibco-Chemtrol; Model D

D. Plug Valves:
1. Type V400 Eccentric Plug Valve, 65 mm and Smaller:
    a. Non-lubricated type rated 1208 kPa CWP, drip-tight shutoff with pressure from either direction, cast or ductile iron body, NPT threaded ends, lever operator, cast or ductile iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber. Fusion-bonded epoxy coated internal and external.
    b. Manufacturers and Products:
        1) Val-Matic; Cam-Centric 5800RTL
        2) DeZurik; Style PEC
        3) Homestead; Series 120
        4) GA Industries; Figure 517
2. Type V405 Eccentric Plug Valve, 75 mm to 350 mm:
    a. Non-lubricated type rated 1208 kPa CWP, drip-tight shutoff with pressure from either direction, cast or ductile iron body, exposed service flanged ends per ANSI B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
    b. Plug cast or ductile iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N , seats welded nickel, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on stem.
    c. Provide external and internal fusion-bonded epoxy coating.
    d. Operators:
        1) 75 mm Valves: Wrench lever manual.
        2) 100 mm to 300 mm Valves: Totally enclosed, geared, manual operator with handwheel, 50 mm nut, or chain wheel. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
    e. Manufacturers and Products:
        1) Val-Matic; Cam-Centric 5800R
        2) DeZurik; Style PEC
        3) Homestead; Series 120
        4) Milliken; Millcentric Series 600

3. Type V420 Lubricated Plug Valve 50 mm and Smaller:
   a. Ductile iron or carbon steel body, 316 stainless steel plug with straight-way rectangular ports, Teflon sleeves, screwed ends, wrench operator. Conforming to ASTM A-126, UL Listed and C.G.A. Approved for Natural Gas Service.
   b. Class: 150.
   c. Rating: 1897 kPa WOG.
   d. Manufacturers and Products:
      1) Resun; Model R-1430
      2) Nordstrom; Model 142
4. Type V422 Lubricated Plug Valve 65 mm to 350 mm:
   a. Ductile iron or carbon steel body, 316 stainless steel plug with straight-way rectangular ports, Teflon sleeves, flanged ends. Conforming to ASTM A-126, UL Listed and C.G.A. Approved for Natural Gas Service.
   b. Class: 150.
   c. Rating: 1897 kPa WOG.
   d. Operator:
      1) 100 mm and Smaller Valve: Wrench type.
      2) 150 mm and Larger Valve: Enclosed gear type.
   e. Manufacturers and Products:
      1) Resun; Model R-1431
      2) Nordstrom; Model 143
5. Type V470 Combination Balancing and Shutoff Valve, 65 mm and Smaller, for Heating, Chilled, and Cooling Water Service:
   a. Non-lubricated plug valve, cast iron or semi-steel body, wrench lever manual operator, cast iron plug with EPT resilient plug facing, adjustable memory stop, rated 1207 kPa WOG/CWP, NPT threaded ends, two 3 mm flow taps.
   b. Manufacturer and Product:
      1) ITT/Bell & Gossett; Type CB
      2) DeZurik; Series 100, Figure 118
      3) S.A. Armstrong; Type CBV.
6. Type V472 Combination Balancing and Shutoff Valve, 75 mm and Larger, for Heating, Chilled, and Cooling Water Service:
   a. Non-lubricated plug valve, cast iron or semi-steel body, cast iron plug with EPT resilient plug facing, adjustable memory stop, rated 1035 kPa WOG/CWP minimum, ASME B16.1 Class 125 flanged ends, wrench lever manual operator for 75 mm valves, totally enclosed and sealed heavy-duty gear operator for 100 mm and larger valves, two 3 mm flow taps, suitable for service intended.
   b. Manufacturer and Product:
      1) ITT/Bell & Gossett; Type CB
      2) DeZurik; Series 100, Figure 118
      3) S.A. Armstrong; Type CBV
7. Type V473 Three Way Electrical Actuated Mixing Valve, 50 mm to 400 mm, for Heating Water Service:
   a. Cast-iron body, ASME B16.1 Class 125 flanged ends, stainless steel rotor and shaft Nitrile seats, 862 kPa CWP and 121 degrees C minimum
   b. Electric Actuator: Refer to article Electric Motor Actuators.
   c. Manufacturer and Product:
      1) DeZurik; Style PTW.

2) Amot GE.
3) Bell & Gossett.

8. Type V475 Triple Duty Valve, 50 mm to 350 mm, for Heating Water Service:
   a. Straight or angle pattern to match the Drawings.
   b. Non-slam check, throttling, balance and shut off valve.
   c. Cast-iron body, ASME B16.1 Class 125 flanged ends, bronze seats, brass disc, stainless steel shaft EPDM insert, 1206 kPa CWP and 121 degrees C minimum.
   d. Manufacturer and Product:
      1) ITT/Bell & Gossett; Model 3 D or 3DS
      2) S.A. Armstrong; Model FTV

E. Butterfly Valves:
1. General:
   a. Valves specified as AWWA C504 to be in full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) For valves 600 mm and larger, seats shall be field-adjustable and replaceable. Provide one seat adjustment kit per valve model where applicable.
      3) Bubble-tight with rated pressure applied from either side in accordance with AWWA C504.
      4) All material coatings and lubricants to be suitable for potable water applications and conform to requirements of NSF 61. Provide NSF certification approval number.
      5) Valve shafts to be solid stainless steel, corresponding to design requirements of AWWA C504. The shafts to be fastened to the discs by a means designed to provide vibration proof connection.
      6) No travel stops for disc on interior of body.
      7) Self-adjusting Buna-N V-type seat and shaft seals.
      8) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      9) Provide traveling nut or worm gear actuator with handwheel and an externally adjustable closed position stop. Valve actuators to meet the requirements of AWWA C504.
      10) The interior and exterior of valves to be coated with a fusion bonded epoxy suitable for contact with potable water conforming to the requirements of NSF 61. Coatings to be applied at the valve manufacturing facility.
      11) Two different butterfly valve manufacturers are permitted provided that valves smaller than 600 mm diameter are from the same manufacturer and valves 600 mm and larger are from the same manufacturer.
2. Type V500 Butterfly Valve, 75 mm to 1800 mm:
   a. Flanged end, short body type.
   b. AWWA C504, Class 150B.
   c. Cast or ductile iron body, ductile iron disc with Type 304 stainless steel shaft, Buna N rubber seat, and stainless steel seating surface. NSF 61 fusion-bonded epoxy coating internal/external.
   d. Manufacturers and Products:
      1) Pratt; Model 2FII or Triton XR-70
      2) DeZurik; BAW

3) Val-Matic; Series 2000
4) GA Industries; Series 800 or EKN

3. Type V510 Lug Style Butterfly Valve, Resilient Seated, 50 mm to 500 mm, for Low Pressure Process Air Service:
   a. Lug style cast iron body, Type 316 stainless steel disc, Type 316 stainless steel one-piece stem, self-lubricating sleeve type bearing, EPDM replaceable resilient seat suitable for operating temperatures up to 121 degree C, 1035 kPa working pressure rating, bubble-tight at 345 kPa differential pressure, valve body to fit between ASME Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Tyco/Keystone; Model AR2
      2) Bray Controls; Series 31
      3) Watts/Contromatics; Series BF-03-M2
      4) Sure Seal; Series 522/622
4. Type V513 Butterfly Valve, 50 mm to 500 mm:
   a. Lug style, cast iron Type 316 stainless steel disc, Type 316 or 18-8 stainless steel one-piece stem, EPDM replaceable resilient seat, heavy-duty self-lubricating sleeve type bushings, NBR stem seal, minimum 1035 kPa working pressure rating, valve body to fit between ASME Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 30 31
      2) Tyco/Keystone; Fig. AR1 AR2
      3) Watts/Contromatics; Series BF 03-M2 BF 04-M2
      4) Sure Seal; Series 500 522
      5) Flow Plus; Series BFW & BFL
5. Type V514 High Performance Butterfly Valve, 50 mm to 900 mm:
   a. ASME B16.5 Class 150 lug style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, reinforced PTFE seat, PTFE stem packing, stainless steel with RTFE thrust washer.
   b. Manufacturers and Products:
      1) Tyco/Keystone; K-LOK Fig. 362
      2) DeZurik; BHP
      3) Watts/Contromatics; Series QF
      4) Sure Seal; GTD Series
      5) Bray/McCannalok; Series 41
6. Type V515 Rectangular Butterfly Valve:
   a. Rectangular butterfly valve shall be rubber seated and shall be 711 mm (28”) in width and 2372 mm (93.5”) in height. Valve design shall be suitable for an operating differential pressure of 69 kPa(g) maximum. Valve discs shall rotate 90 degrees from the full open position to the tight shut position. When subjected to the maximum design head, a stress safety factor of 3.0 on the yield point or 5.0 on ultimate strength, whichever is the lower, shall not be exceeded. Maximum deflection of the valve structural design limit shall be 1.58 mm (1/16").
   b. Carbon steel ASTM A36 rectangular body. Valve body shall be designed for jack bolt mounting.

c. Carbon steel valve disc with a stainless steel 304 seating edge. Exposed disc rib stiffeners are not acceptable. Valve disc shall be 559 mm (22”) in width and 1651 mm (65”) in height. Valve to be three sided.
d. Valve seat shall be contained in the body of the valve. Retaining segment and retaining screws shall be of ASTM A276 Type 304 stainless steel. The seat shall be a 50 durometer synthetic rubber compound. Seat adjustment possible and inherent in the design shall not be less than 3.1 mm (1/8 inch). Valve seats shall be fully field adjustable and replaceable without dismantling the actuator, disc or shaft. The valve manufacturer shall certify that the rubber seat is fully field adjustable and replaceable without the use of special tools or processes, as well as adjustable from both sides of the disc.
e. Valve to be provided with a torque tube.
f. Shafts shall be the stub type with shafts extending into the disc for a minimum distance of at least 1.5 shaft diameters. Shafts shall be securely locked to the disc by stainless steel taper pins. Shaft material shall be ASTM A276, Type 304 stainless steel.
g. Main shaft bearings shall be Teflon lined, fiberglass backed sleeve type fitted into each valve body trunnion bore. Unit bearing stress shall not exceed 27600 kPa (4000 psi). Each valve assembly shall be furnished with a 2-way thrust bearing assembly designed to hold the disc centered in the valve seat at all times. Thrust bearing shall be secured by a locking device, located in the top trunnion of the valve body and easily accessible for field adjustment from the actuator end of the valve.
h. Valve shall be installed to provide a means of removing the complete valve assembly without dismantling the valve or actuator. Installation methods that employ permanent, multiple bolting shall not be acceptable.
i. Two coats of paint shall be applied to the inside and outside surfaces of the valve body and the outside surfaces of the disc, except finished surfaces, bearing surfaces and the stainless steel seat retainers and disc edge. The paint shall be asphalt varnish per Federal Specifications TT-C494A for sewage service.
j. Manufacturers and Products:
    1) Henry Pratt
    2) DeZURIK
    3) Waterman
    4) Golden Anderson

F. Check and Flap Valves:
1. Type V600 Check Valve, 50 mm and Smaller:
    a. All bronze, threaded cap, threaded or soldered ends, swing type replacebable bronze disc, rated 862 kPa SWP, 1380 kPa WOG/CWP.
    b. Manufacturers and Products:
        1) NPT Threaded Ends:
            a) Watts; Series CVY
            b) Crane; Fig. 37
            c) Nibco; T-413
        2) Soldered Ends:
            a) Watts; Series CVYS
            b) Nibco; S-413

2. Type V602 Check Valve, 50 mm and Smaller:
   a. All bronze, threaded cap, NPT threaded ends, swing type replaceable Teflon disc and bronze disc holder, rated 1035 kPa SWP, 2070 kPa WOG/CWP.
   b. Manufacturers and Products:
      1) Crane; Fig. 141TF
      2) Nibco; T-433-Y
3. Type V603 Check Valve, 150 mm and Smaller:
   a. All stainless steel, ASTM A351/A351M Grade CF8M body, cap, and disc, PTFE plug and body seals, threaded cap with NPT threaded ends for 50 mm and smaller, flanged for 65 mm and larger, swing type, rated 1380 WOG/CWP.
   b. Manufacturers and Products:
      1) Crane/Aloyco; Fig. 49 / 377
      2) Trueline; Fig. N-690/ N-296
      3) Kitz
4. Type V604 Check Valve, 63 mm to 300 mm:
   a. Flanged ends, cast iron body, bronze mounted swing type, solid bronze or bronze-faced cast iron disc, bronze seat ring, replaceable brass hinge pin, rated 862 kPa SWG, 1380 kPa WOG/CWP.
   b. Manufacturers and Products:
      1) Newco; Fig. 32F-IB7
      2) Crane; Fig. 373
5. Type V605 Check Valve, 50 mm and Smaller, for Fuel Oil Service:
   a. Forged steel, lift-check type integral seat, stainless steel disc, screwed ends, rated 5520 kPa at 454 degrees C.
   b. Manufacturers and Products:
      1) Smith; Class 800 C80
      2) R-P&C; Class 800 C90D
      3) Trueline; LC800R
6. Type V609 Rubber Flapper Check Valve, 50 mm to 900 mm:
   a. AWWA C508, cast or ductile iron body and cover, ASME B16.1 Class 125 flanged ends, reinforced Buna-N flapper with raised seating ring, stainless steel bolting, fusion-bonded epoxy coating internal/external, with external backflow device and disc position indicator.
   b. Valves 50 mm through 300 mm rated minimum 1207 kPa CWP and 350 mm through 900 mm rated minimum 1035 kPa CWP.
   c. Manufacturers and Products:
      1) Val-Matic; Series 500 Swing-Flex
      2) APCO; Series 100
      3) Clow/Kennedy; Style 506
      4) Mueller; Flexible Disc Check Valve
      5) Milliken; Flex Check
      6) GA Industries; Figure 200
7. Type V618 Wafer Style Check Valve, 150 mm to 1350 mm, for Process Air Service:
   a. Extended body wafer style with dual metal-hinged plates, ASTM A351 Grade CF8M Type 316 stainless steel body and valve plates, Type 316 stainless steel spring and trim, Viton seal, ASME B16.5 Class 150, suitable for process air service up to 210 degrees C.

b. Manufacturers and Products:
   1) Crane; Duo-Chek Style X

8. Type V630 PVC Ball Check Valve, 100 mm and Smaller:
   a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 1035 kPa at 22 degrees C, and Viton seat and seal.
   b. Manufacturers and Products:
      1) Nibco-Chemtrol; Tru Union U45BC
      2) Chemline; Series BT-A-OXX-V-S
      3) Spears; True Union 2000 Standard Ball Valve
9. Type V640 Double Check Valve Backflow Prevention Assembly, 19 mm to 250 mm:
   a. Two resilient seated check valves, two [non-rising stem] [outside screw and yoke] resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated 1208 kPa maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
   b. Manufacturers and Products:
      1) FEBCO; Series 850
      2) Cla-Val; Model D-4
      3) Watts; Series 719
10. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly, 19 mm to 250 mm:
   a. Two resilient seated check valves with an independent relief valve between the valves, two [non-rising stem] [outside screw and yoke] resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 1208 kPa maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
   b. Manufacturers and Products:
      1) FEBCO; Series 860
      2) Cla-Val; Model RP-4
      3) Watts; Series 909
11. Type V692 Flap Valve, 100 mm to 400 mm:
   a. Flanged frame, iron body, fully bronze mounted with bronze hinge pin and seat.
   b. Manufacturers and Products:
      1) Troy; A-2540-6
      2) Clow; T3012

G. Self-Contained Automatic Valves:
   1. Type V710 Pressure Reducing Valve, 63 mm and Smaller:
      a. Direct diaphragm operated, spring controlled, bronze body.
      b. Maximum inlet pressure 1380 kPa, downstream pressure to be field adjusted.
      c. Size/Rating: As shown in Self-Contained Valve Schedule.
      d. Manufacturers and Products:
         1) Fisher; Type 75A
         2) Watts; Series 223
   2. Type V711 Pressure Reducing Valve, 50 mm and Smaller:
      a. Direct diaphragm operated, spring controlled, cast iron body, spring case, seat and diaphragm, stainless steel valve stem.
      b. Maximum upstream pressure 1035 kPa, downstream pressure to be field adjusted.
      c. Size/Rating: As shown in Self-Contained Valve Schedule.

d. Manufacturers and Products:
   1) Fisher; Series MR95

3. Type V722 PVC Pressure Regulating Valve, 12 mm to 38 mm:
   a. Diaphragm operated assembly, spring controlled, in-line pattern, NPT threaded inlet and outlet, 1035 kPa design pressure.
   b. PVC body, Viton seals and diaphragm, coated stainless steel spring, stainless steel adjusting bolt, locknut, and fasteners.
   c. Designed to regulate downstream pressure, closing when pressure reaches set point; outlet set pressure adjustable from 35 kPa to 345 kPa. Factory set outlet pressure as indicated in Valve Schedule.
   d. Manufacturers and Products:
      1) Chemline; SR 50
      2) Hayward; PR Series

4. Type V716 Pressure-Reducing/Back-Pressure Sustaining Valve75 mm and Larger:
   a. Hydraulically operated, diaphragm actuated, pilot controlled globe valve, ductile iron, or steel body, rated 1208 kPa, ANSI B16.1 flanged ends, stainless steel trim, stainless steel stem, externally mounted strainers with cocks, and maintain a constant downstream pressure while maintaining a minimum upstream pressure.
   b. Size/Rating: As shown in the Valve Schedule.
   c. Manufacturers and Products:
      1) Cla-Val; Series 92-01
      2) Singer; Model 106-PR-R.

5. Type V724 PVC Back Pressure Valve, 12 mm to 38 mm:
   a. PVC body.
   b. Valves shall be suitable for aggressive clean non-scaling chemicals.
   c. All exposed external metal parts including spring tensioning bolt and body bolts shall be 304 stainless steel covered with polyethylene caps.
   d. All valves shall have a large Teflon coated control diaphragm to fully open at no more than 10-15% over pressure.
   e. Static seals shall be FPM (Viton).
   f. Designed to regulate upstream pressure, opening when pressure reaches set point; set pressure adjustable from 35 kPa to 345 kPa. Factory set outlet pressure as indicated in Valve Schedule.
   g. Manufacturers and Products:
      1) Chemline
      2) Hayward

6. Type V730 Pressure-Relief Valve, 50 mm and Smaller:
   a. Direct diaphragm, spring controlled, cast iron body, spring case, nitrile seat, neoprene diaphragm, stainless steel valve stem.
   b. Capable of opening when upstream pressure reaches a maximum set point.
   c. Size/Rating: As shown in the Self-Contained Valve Schedule.
   d. Manufacturers and Products:
      1) Fisher; Series 98
      2) Watts; Series 74

7. Type V735 Pressure-Relief Valve, Sludge Service, 100 mm and Larger:
   a. Angle style, ASTM A126 Class B cast iron body and cover or ductile iron body, stainless steel seat and seat ring, Buna-N seals, ASME B16.1 Class 125 or 150 flanged ends, full port, direct acting with hydraulic self-contained oil cylinder or

diaphragm isolator with speed control to dampen closing speed, fully enclosed spring, fusion-bonded epoxy coating internal and external.

b. Size/Rating: As shown in the Self-Contained Valve Schedule.
c. Manufacturers and Products:
   1) Ross Valve; Model 70SWR
   2) Singer; Model A106-DL

8. Type V738 Vacuum-Relief Valve:
   a. All Type 316 stainless steel with Teflon seat insert.
   b. Top mounted.
   c. All-weather type for freezing climates.
   d. Factory set at 5000 Pascals vacuum.
   e. Size/Rating: 300 mm.
   f. Manufacturers and Products:
      1) Varec; Model 3500B
      2) Shand and Jurs
9. Type V752 Sewage Air Release Valve, 50 mm to 100 mm:
   a. Suitable for sewage service; automatically exhausts entrained air that accumulates in a system.
   b. Rated Working Pressure: 1035 kPa, operating pressure of 100 kPa, built and tested to AWWA C512.
   c. Materials: Cast iron, ductile iron body and cover with NPT threaded inlet and 25 mm NPT threaded outlet, concave or skirted stainless steel float and trim; Buna-N resilient seat.
   d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 1.6 meters of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
   e. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 400 SARV
      2) Val-Matic Valve; Series 48A & 49A
      3) GA Industries Figures 925, 927 and 929
10. Type V754 Natural Gas Pressure Reducing Valve, 50 mm:
   a. Direct-operated, cast iron body, aluminum diaphragm nitrile diaphragm and O-ring, suitable for minus 28.8 degrees C temperature, ANSI Class 125 flanges, rated 862 kPag.
   b. Inlet Operating Pressure: 34.5 kPag.
   c. Outlet Operating Pressure: 1.75 to 3.5 kPag.
   d. Manufacturers and Products:
      1) Fisher; Series CS400 or Series R622
11. Type V755 Natural Gas Pressure Relief Valve, 50 mm:
   a. Direct-operated, cast iron body, aluminum diaphragm nitrile diaphragm and O-ring, suitable for minus 28.8 degrees C temperature, ANSI Class 125 flanges, rated 862 kPag.
   b. Capable of opening when outlet pressure reaches a maximum setpoint.
   c. Manufacturers and Products:
      1) Fisher; Model 1808A and 289P

H. Miscellaneous Valves:
   1. Type V905 Pinch Valve, 50 mm to 300 mm:
      a. Ductile iron, fully enclosed body, epoxy lined and coated, with ANSI B16.1 Class 125 flanged ends, one-piece molded reinforced Buna-N elastomer sleeve, 345 kPa minimum working pressure, double-acting upper and lower pinch bars that close on centerline, non-rising handwheel operator.
      b. Manufacturers and Products:
         1) Red Valve Co.; Series 75
   2. Type V915 Mud Valve:
      a. Cast iron body tapered seat, bronze disc and seat ring, frame flanged, non-rising type stem, bronze extension stem, 50 mm square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 1.6 meters. Epoxy coated.
      b. Manufacturers and Products:
         1) Troy; A-25612 RB
         2) Clow; Fig. F-3085-T
   3. Type V940 Solenoid Valve, 6 mm to 50 mm:
      a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (open or closed when de-energized) as indicated.
      b. Minimum operating pressure differential not greater than 35 kPag, unless otherwise noted.
      c. Maximum operating pressure differential not less than 863 kPag.
      d. Slow closing where indicated.
      e. Provide integral manual override switch where indicated.
      f. Manufacturers and Products:
         1) ASCO; Series 8210

I. Dampers:
   1. Type V960 Volume Control Damper:
      a. Type 316 stainless steel, flanged to pipe flanges drilling, 1250 Pa (5 inches w.c.) maximum differential pressure for 75 mm to 250 mm diameter, 7450 Pa (30 inches w.c.) maximum differential pressure for 300 mm diameter and larger, metal bar seal, manual quadrant, manual lever arm.
      b. Manufacturers and Products:
         1) AWV; Series VC-561/565
   2. Type V965 Isolation Damper, 300 mm and Larger:
      a. Type 316 stainless steel, flanged to pipe flanges drilling, 3700 Pa (15 inches w.c.) maximum differential pressure, neoprene seal, manual quadrant, manual lever arm.
      b. Manufacturers and Products:
         1) AWV; Series VC-56-ISO

2.6 OPERATORS AND ACTUATORS

A. Manual Operator:
   1. General:
      a. Operator force not to exceed 178 N under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 178 N.
      b. Operator self-locking type or equipped with self-locking device.
      c. Position indicator on quarter-turn valves.
      d. Worm and gear operators of one-piece design, gears of gear bronze material. Worm of hardened alloy steel with threads ground and polished. Traveling nut type operators, threaded steel reach rods with internally threaded bronze or ductile iron nut.
   2. Exposed Operator:
      a. Galvanized or painted handwheel.
      b. Lever operator allowed on quarter-turn valves 100 mm and smaller.
      c. Crank on gear type operators.
      d. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.
      e. Valve handles to take a padlock, and wheels a chain and padlock.
   3. Buried Operator:
      a. Buried service operators on valves 65 mm and larger shall have a 50 mm AWWA operating nut. Buried operators on valves 50 mm and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
      b. Design buried service operators for quarter-turn valves to withstand 610 N-m of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 69 kPa.
      c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Motor Actuators - Valves 50 mm and Smaller, Single Phase:
   1. General:
      a. Use only when specifically permitted in the Electric Motor Actuated Valve Schedule.
      b. Full 90-degree rotation of quarter-turn valves.
      c. Suitable for the area classification.
      d. Valve shall remain in last position on loss of operator power unless indicated otherwise.
   2. Sizing: Actuator shall be sized to provide torque required to operate valve at 90 percent of nominal voltage.
   3. The required fuse protection size is not to exceed 5A Time Delay.
   4. Actuator Power Supply: 120V ac, single-phase, 60 Hz unless indicated otherwise.
   5. Enclosure:
      a. CSA/NEMA 250, Type 4 except where indicated otherwise or where area classification requires higher rating such as Class I, Zone 1 or Zone 2.
      b. Entire unit enclosure shall be double O-ring sealed and watertight.
   6. Gearing:
      a. Actuator gearing shall be totally enclosed in grease-filled cast iron gear case.

b. Provide single stage worm gearing designed to operate in any vertical or horizontal position, except inverted, and to allow gear disassembly without releasing valve stem thrust or taking valve out of service.

7. Drive Unit:
   a. Motors and controls shall conform in all respects to applicable NEMA and CSA standards.
   b. Integral reversible motor.
   c. Size for 1.5 times required operating torque.
   d. Duty Cycle: 100 percent.
   e. Suitable for full 90-degree rotation of quarter-turn valves.
   f. Manual Override Handwheel: Include an automatic clutch to positively disengage handwheel any time drive motor control is energized.
   g. Complete with visual position indicator visible from normal walkway.
   h. Operation:
      1) Drive valve to fully OPEN or CLOSED position while OPEN or CLOSED external contact is made.
      2) Motor shall stop in mid-travel when no input is received.
   i. Limit switches wired internally to stop motor at fully OPEN and fully CLOSED positions.
   j. Optional 120 VAC heater sized to prevent condensation and frost inside enclosure, where required.
   k. Motor thermal protection to sense motor temperature and de-energize motor in case of overheating.
8. Control Features: Electric actuators with features noted above, and as modified or supplemented in Electric Motor Actuated Valve Schedule.
9. Actuators Without Integral LOCAL/REMOTE Selector Switch:
   a. Provide terminals for individual field adjustable 5 A, 120 VAC rated SPDT dry contact closed and open limit switch outputs for remote indication. Contacts shall maintain correct status while actuator is powered or not, without use of batteries.
   b. Provide terminals to accept remote OPEN (maintained) and CLOSE (maintained) 120 VAC control signals. Signal power shall be used to drive actuator motor.
   c. Acceptable Manufacturers:
      1) Unclassified Areas – Open-Close Service:
         a) Rotork; ROM Series.
         b) Limitorque; LY or L75 Series.
         c) Valvcon Corporation; V Series.
      2) Unclassified Areas – Modulating Service:
         a) Valvcon Corporation; V Series with 4-20 mA option card.
         b) Rotork CMA Series
      3) Class I, Zone 2 Hazardous Areas:
         a) Rotork; RCEL Series.
         b) Valvcon Corporation; V Series.
10. Actuators With Integral LOCAL/REMOTE Selector Switch:
   a. Provide LOCAL/REMOTE and OPEN/CLOSE selector switches integral to actuator. Provide means to locally stop actuator in both local and remote modes.
   b. Provide terminals for individual field adjustable 5 A, 120 VAC rated SPDT dry contact closed and open limit switch outputs for remote indication. Contacts shall maintain correct status while actuator is powered or not, without use of batteries.

c. Provide terminals to accept remote OPEN (maintained) and CLOSE (maintained) 24 VDC control signals when in REMOTE mode. Signal power source to be external to actuator.
d. Provide terminals for 120 VAC external power source for actuator and all internal controls.
e. Acceptable Manufacturers:
   1) Rotork; ROMpak Series.

C. Electric Motor Actuators - Valves 65 mm and Larger, Three Phase:
1. General:
   a. Comply with AWWA C542.
   b. Controls integral with the actuator and fully equipped as specified in AWWA 542.
   c. Stem protection for rising stem valves.
   d. Lubricant shall be NSF 61 certified for potable water application.
   e. Capable of functioning properly in ambient temperature range of minus 33 degrees C to 70 degrees C and up to 100 percent relative humidity.
   f. Provide intermediate gear box if required to meet valve torque requirements. Gear box shall be of same manufacturer as actuator.
   g. Design that allows gear case to be opened for inspection or disassembly without releasing stem thrust or taking valve out of service.
   h. Equipped with side-mounted handwheel for manual operation. Include automatic clutch to positively disengage handwheel when drive motor control is energized. Design handwheel operator such that failure of motorized gearing will not prevent hand operation of valve.
   i. Circuitry which ensures motor turns in correct direction irrespective of supply polarity connected to power terminal; valve and operator to suffer no damage due to incorrect power connection.
   j. Instantaneous reversal protection whereby automatic time delay circuit limits current surges when actuator is signaled to instantaneously reverse direction.
   k. Anti-hammer protection whereby electronic torque limitation switches off actuator when preset load is reached due to obstruction or end of travel.
   l. Bi-metal thermostat embodied in motor control transformer windings to prevent overheating due to extensive use.
   m. Jammed valve motor protection whereby logic circuit protects motor from overheating by de-energizing motor if valve does not move after developing maximum torque.
   n. Opto-isolators incorporated to interface with remote control inputs to protect logic circuits from high voltage transients appearing at actuator terminals.
   o. Actuator shall include diagnostic module which will store and enable download of historical actuator data to permit analysis of changes in actuator or valve performance. Retrieval of this information must be demonstrated in the field.
2. Actuator Operation - General:
   a. Suitable for full 90-degree rotation on quarter-turn valves or for use on multi-turn valves.
   b. Manual override handwheel.
   c. Valve position indication.
   d. Operate from fully CLOSED to fully OPEN positions or reverse in minimum of 60 seconds, unless indicated otherwise.

e. Non-Intrusive Electronics: Local controls, diagnostics, and calibration, including limit and torque switch settings, shall be accomplished non-intrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.

3. Open-Close/Throttling Service:
   a. Capable of 60 starts per hour.
   b. Size with a minimum of 1.5 safety factor based on the maximum unseating and seating torque of the valve at its AWWA pressure classification. Safety factor shall be demonstrated and documented in Shop Drawings submittals and at time of commissioning under real service conditions using actuator software and torque display on actuator. Motor stall torque not to exceed capacity of valve.
   c. Actuator suitable for throttling operation of valve at intermediate positions.
   d. Controls and Indicators:
      1) PROFIBUS DP interface, unless otherwise noted.
      2) LOCAL-OFF-REMOTE selector switch, padlockable in each position.
      3) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
      4) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
      5) Auxiliary contact that closes in REMOTE position.
      6) OPEN and CLOSED indicating lights.
   e. Integral reversing motor starter with built-in overload protection. Control transformer for 120-volt or 24-volt control voltage.
   f. Valve shall remain in last position on loss of operator power.
4. Modulating Service:
   a. Size motors for continuous duty.
   b. Actuators to be sized with minimum 2.0 safety factor based on maximum unseating and seating torque of valve at its AWWA pressure classification. Safety factor shall be demonstrated and documented at time of commissioning under real service conditions using actuator software. Motor stall torque not to exceed torque capacity of valve.
   c. Feedback potentiometer and integral electronic positioner/comparator circuit to maintain valve position.
   d. Controls and Indicators:
      1) PROFIBUS DP interface, unless otherwise noted.
      2) LOCAL-OFF-REMOTE selector switch, padlockable in each position.
      3) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
      4) Auxiliary contact that closes in REMOTE position.
      5) OPEN and CLOSED indicating lights.
   e. Valve shall close upon loss of signal unless indicated otherwise.
   f. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Non-solid state compliant equipment will not be acceptable. Controller capable of 1200 starts per hour.
   g. Duty cycle limit timer and adjustable band width, to prevent actuator hunting.

h. Valve position output converter controlled by a modulating analog signal with feedback signal in proportion to valve position, either through a PROFIBUS DP interface or 4-20 mA signals.

5. Actuator Power Supply:
   a. 600V ac, three-phase, 60 Hz unless indicated otherwise.
   b. Control power transformer, 24-volt or 120-volt secondary.
   c. Externally operable power disconnect switch.
6. Enclosure:
   a. Unless indicated otherwise, provide enclosure as defined in NEMA 250, Type 6P.
   b. Contain 120-volt space heaters, or electrical compartment shall be non-breathing to prevent condensation.
7. Fire Protection:
   a. Where indicated in Electric Motor Actuated Valve Schedule, provide actuator with intumescent coating system for fire protection.
   b. Coating shall provide minimum 30 minutes protection at 1093 degrees C and meet or exceed requirements of API 607 and UL 1709.
   c. Coating shall provide complete access to all actuator components and permit dismantling and re-assembly of actuator without disturbing coating.
8. Limit Switches:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have minimum of two transfer contacts at end position, one for valve fully OPEN and one for valve fully CLOSED.
   c. Housed in actuator control enclosure.
9. Control Features: Electric actuators with features noted above, and as modified or supplemented in the Electric Motor Actuated Valve Schedule.
10. Product Standardization:
    a. This product was standardized by the City via RP 331-2014.
    b. No alternates or substitutes will be accepted.
    c. All requests for purchase or quotation shall reference RP 331-2014 to receive standardized pricing that the City has negotiated with the vendor.
    d. Manufacturer and Series:
       1) Rotork; IQ3.
11. Remote Control Stations:
    a. Provide remote control stations where indicated in Electric Motor Actuated Valve Schedule, and for electric motor actuators where local controls on actuator are inaccessible and/or more than 2100 mm above ground or operating platform.
    b. Enclosure:
       1) CSA approved.
       2) Non-hazardous Locations: NEMA 250 Type 4X, Type 316 stainless steel.
       3) Hazardous Locations: NEMA 250 Type 7, cast ferrous metal with electro-galvanized finish, or copper-free aluminum, with drilled and tapped conduit entrances, hinged cover.
    c. Provide stanchion for floor-mounting control station where wall-mounting is not practical.
    d. Control station shall be supplied with terminal strip that corresponds with actuator terminals. Control will be wired from plant PLC to control station, then to actuator.

e. All control stations shall contain LOCAL-REMOTE selector switch and “Remote Selected” contact to be wired in series with remote-selected contact in actuator.
f. For open-close/throttling actuators, control station shall include OPEN and CLOSE momentary pushbuttons, red indicating light for OPEN, yellow indicating light for mid-position, green indicating light for CLOSED, and emergency STOP pushbutton.
g. For modulating actuators, control station shall include OPEN and CLOSE hold-to-run pushbuttons, red indicating light for OPEN, yellow indicating light for mid-position, green indicating light for CLOSED, and two digital displays, one for input commanded position and one for output valve position indication.
h. All pushbuttons, lights and digital displays shall be properly labeled with lamacoids.

2.7 ACCESSORIES

A. Tagging: 38 mm diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve 75 mm and larger, bearing the valve tag number shown on the Valve Schedules.

B. Limit Switch:
1. Factory installed limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

C. T-Handled Operating Wrench:
1. Galvanized operating wrenches, 1.2 meter long.
2. Manufacturers and Products:
a. Mueller; No. A-24610.
b. Clow No.; F-2520.
c. Valmatic
d. GA Industries.

D. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.
1. Manufacturers and Products:
a. Valmatic.
b. DeZurik.
c. GA Industries.

E. Floor Stand and Extension Stem:
1. Non-rising, indicating type.
2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 SST.
5. Manufacturers and Products:
a. Clow; Figure F-5515.
b. Mueller; Figure A-26426.
c. Valmatic.
d. GA Industries.
e. Troy.

F. Floor Box and Extension Stem:
   1. Plain type, for support of non-rising type stem.
   2. Complete with solid extension stem, operating nut, and stem guide brackets.
   3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
   4. Anchor Bolts: Type 304 SST.
   5. Manufacturers and Products:
      a. Neenah Foundry; R 7506.
      b. Clow; No. F5690.

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

PART 3 EXECUTION

3.1 INSTALLATION

A. Confirmation of Dimensions:
   1. Confirm with the valve manufacturers, the face to face dimensions of all valves as well as the dimensions of the various valve operators.
   2. In the event that the face to face dimensions or other details vary from that shown on Drawings or listed above, the Contractor shall be responsible to modify the connecting pipe lines to suit the valves supplied.
   3. Essentially, center-lines of shafts shall remain as shown on the Drawings provided operators have suitable clearance from all other equipment.
   4. Orient butterfly valves in the piping to allow access to seat adjustment screws (where applicable) from the removable pipe section of the piping.

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

C. Screwed Ends:
   1. Clean threads by wire brushing or swabbing.
   2. Apply joint compound.

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

E. Valve Orientation:
   1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 1500 mm or less above finished floor, unless otherwise shown.

2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 1500 mm and 2000 mm above finish floor, unless otherwise shown.
3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
4. If no plug valve seat position is shown, locate as follows:
   a. Horizontal Flow: The flow shall produce an “unseating” pressure, and the plug shall open into the top half of valve.
   b. Vertical Flow: Install seat in the highest portion of the valve.

F. Orientation of valve position Indication: Install valve operators whether manual, pneumatic or electric, to clearly indicate whether the valve is open, closed or partially open from a point no less than 3 m away and visible from a position compatible with normal plant operation.

G. Orientation of Electric Actuators: Orient electric actuators to satisfy the following:
1. Direct viewing and access of actuator controls and monitoring devices such as handwheels, pilot lights, and pushbuttons, when:
   a. Valve is installed in horizontal runs of pipe having centerline elevations 1500 mm or less above the finished floor, or
   b. When valve is installed in vertical runs of pipe with centre of valve body at elevations 1500 mm or less above the finished floor,
   c. Unless otherwise shown.
2. Limit interference with structures and with any other equipment or piping.
3. Show valve position indicator from operating position.
4. With drive shaft of manual override handwheel oriented perpendicular to piping axis.

H. Limit Switches:
1. Set limit switches to indicate valve positions or equipment status as required and indicated on Drawings.
2. Provide stem-mounted stainless steel devices and hardware to actuate limit switches.
3. Arrange limit switch contacts to close when valve is fully open, unless otherwise noted.

I. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

J. Install safety isolation valves on compressed air.

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

L. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 1000 mm below grade, furnish an operating extension stem with 50 mm operating nut to bring the operating nut to a point 150 mm below the surface of the ground and/or box cover.

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

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

O. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 2057 mm above finished floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors.

3.2 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer’s data.

E. Set, verify, and record set pressures for all relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set all opening and closing speeds, limit switches, as required or recommended by the Contract Administrator.

3.3 CITY TRAINING

A. General:
1. Provide an integrated training program for City's personnel.
2. Perform training to meet specific needs of the City's personnel.
3. Provide a detailed training manual covering all aspects of the training provided.
4. Include training sessions, classroom and field, for maintenance personnel.
5. Provide instruction on all working shift(s) as needed to accommodate the City's personnel schedule.
6. The City reserves the right to make and reuse recordings of all training sessions.

B. Training Requirements:
1. Provide a minimum of 1 day of training at the site indicated by the City for personnel in the operation and maintenance of the 600 V, 3 phase valve actuators
2. Provide a minimum of 1 day of training at the site indicated by the City for personnel in the operation and maintenance of the 120 V, single phase valve actuators
3. Topics to include, but not be limited to:
   a. Operation and maintenance of the actuator
   b. Setup and configuration of actuator
   c. Troubleshooting

3.4 MANUFACTURER’S SERVICES

A. The valve type(s) as listed below require manufacturer’s field services:
1. All electric motor actuated valves.

B. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:
   1. 10 person-days for installation assistance and inspection.
   2. 15 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

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

3.5 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this Specification:
   1. Manual Valve Schedule (Smaller than 75 mm) – General Schedule.
   2. Manual Valve Schedule (75 mm and Larger).
   3. Electric Motor Actuated Valve Schedule.
   4. Solenoid Valve Schedule.
   5. Self-Contained Valve Schedule.

B. The valves schedules in supplements may not include all valves on the project. Contractor to supply all other valves shown on the Drawings.

END OF SECTION

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (Smaller than 75 mm) - General Schedule

Service / Description	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Piping Material	Remarks
PROCESS MECHANICAL							
Ball valves on flushing water	Ball	V306	≤ 50	FSW	Flushing Water	SS	
Butterfly valves on flushing water	Butterfly	V513	65	FSW	Flushing Water	SS	
Check valves on flushing water	Swing check	V603	≤ 50	FSW	Flushing Water	SS	
Check valves on flushing water	Rubber flapper check	V609	65	FSW	Flushing Water	SS	
Ball valves on potable water	Ball	V307	≤ 65	PW	Potable Water	SS	
Ball valves on non-potable water	Ball	V300	≤ 50	NPW	Non-Potable Water	CU	
Butterfly valves on non-potable water	Butterfly	V513	65	NPW	Non-Potable Water	SS	
Check valves on non-potable water	Swing check	V600	≤ 50	NPW	Non-Potable Water	CU	
Check valves on non-potable water	Rubber flapper check	V609	65	NPW	Non-Potable Water	SS	
Check valves on secondary effluent	Rubber flapper check	V609	65	SE	Secondary Effluent	SS	
Ball valves on sampling service	Ball	V330	≤ 50	SAM	Sample	PVC	
Globe valves on sampling service	Globe	V230	≤ 50	SAM	Sample	PVC	
Ball valves on sodium hypochlorite service	Ball	V330	≤ 50	SHC	Sodium Hypochlorite	PVC	
Ball valves on sodium hydroxide service	Ball	V330	≤ 50	SHD	Sodium Hydroxide	CPVC	
Ball valves on ferric chloride service	Ball	V330	≤ 50	FC	Ferric Chloride	PVC	
Ball valves on sodium bisulphite service	Ball	V330	≤ 50	SBS	Sodium Bisulphite	PVC/CPVC	
Ball valves on mixed polymer service	Ball	V330	≤ 50	MP	Mixed Polymer	PVC	
Globe valves on mixed polymer service	Globe	V230	≤ 50	MP	Mixed Polymer	PVC	
Ball valves on low pressure air service	Ball	V300	≤ 50	ALP	Air, Low Pressure	SS	
Plug valves on sand slurry service	Plug	V400	65	SNS	Sand Slurry	CS	
Ball valves on ballasted sludge service	Ball	V306	12	BLS	Ballasted Sludge	CS	Sampling bin inlet valves
Ball valves on high-rate clarifier sludge service	Ball	V306	25	HRS	High Rate Clarifier Sludge	CS	Sample valves on cyclone overflow
Pressure gauge isolation valves	Ball	V306	12	Various	Various	SS	
Pressure switch isolation valves	Ball	V306	12	Various	Various	SS	
Pressure transmitter isolation valves	Ball	V306	12	Various	Various	SS	
Ball valves on drains and flushing connections	Ball	V306	≤ 50	Various	Various	SS	
Ball valves for various services	Ball	V306	≤ 50	Various	Various	SS	
Ball valves for portable air flow meter connections	Ball	V307	32	ALP	Air, Low Pressure	SS	
Ball valves on instrument air service	Ball	V303	≤ 65	IAS	Instrument Air Supply	SS	
Air release on return activated sludge service	Air Release	V752	≤ 65	RAS	Return Activated Sludge	SS	
Backflow preventer on various services	Backflow Preventer	V642	≤ 65	Various	Various	SS	Includes replacing four existing backflow preventers in the RDT Pump Room as shown on P&ID 1-0102-PPID-S504
Ball valves on diesel fuel service	Ball	V305	≤ 50	DFS	Diesel Fuel Supply	CS	
Check valves on diesel fuel service	Check	V605	≤ 50	DFS	Diesel Fuel Supply	CS	
BUILDING MECHANICAL							
Ball valves on sump discharge service	Ball	V306	≤ 50	SPD	Sump Pump Discharge	SS	
Check valves on sump discharge service	Check	V603	≤ 50	SPD	Sump Pump Discharge	SS	
Ball valves on domestic hot water	Ball	V300	≤ 50	DHW	Domestic Hot Water	CU	
Ball valves on domestic hot water return	Ball	V300	≤ 50	DHR	Domestic Hot Water Return	CU	
Ball valves on potable water	Ball	V300	≤ 50	PW	Potable Water	CU	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (Smaller than 75 mm) - General Schedule

Service / Description	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Piping Material	Remarks
Check valves on domestic hot water return	Check	V600	25	DHR	Domestic Hot Water Return	CU	
Check valves on potable water	Check	V600	40	PW	Potable Water	CU	
Ball valves on non potable water	Ball	V300	≤ 65	NPW	Non-Potable Water	CU	
Plug valves on natural gas	Plug	V420	≤ 65	NG	Natural Gas	CS	
Ball valves on natural gas	Ball	V311	≤ 65	NG	Natural Gas	CS	
Ball valves on glycol service	Ball	V300	≤ 65	GS	Glycol Supply	CS	
Plug valves on hot water supply	Plug	V400	≤ 50	HWS	Hot Water Supply	CU	
Plug valves on hot water return	Plug	V400	≤ 50	HWR	Hot Water Return	CU	

General Notes:

1. This schedule is provided for the Contractor's convenience and shall not be taken as complete.
2. Valves to be supplied and installed under this contract unless otherwise indicated.
3. n/a = not applicable; valve supplied by others, installed under this contract.
4. Refer to the scope of pre-purchased equipment for valves that are supplied by others to be installed under this contract.

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
PROCESS MECHANICAL								
AREA G - HEADWORKS								
Screening								
Process Drain to Screens Effluent Channel	HV-G214H	1-0102-PPID-G202	Knife gate	V150	350	PD	Process Drain	
Process Drain to Screens Influent Channel	HV-G214J	1-0102-PPID-G202	Knife gate	V150	350	PD	Process Drain	
Process Drain Cross-connection	HV-G214K	1-0102-PPID-G202	Knife gate	V150	350	PD	Process Drain	
Sluice Water to Screenings Sluice	HV-G230A	1-0102-PPID-G203	Pinch	V905	100	GE	Grit Effluent	
Sluice Water from Grit Tanks 1 & 2 Effluent Channel	HV-G220A	1-0102-PPID-G204	Knife gate	V150	150	GE	Grit Effluent	
Sluice Water from Grit Tanks 3 & 4 Effluent Channel	HV-G220B	1-0102-PPID-G204	Knife gate	V150	150	GE	Grit Effluent	
Sluice Water Pump P-G221 Inlet	HV-G221A	1-0102-PPID-G204	Knife gate	V150	150	GE	Grit Effluent	
Sluice Water Pump P-G221 Outlet	CV-G221	1-0102-PPID-G204	Check	V609	100	GE	Grit Effluent	
Sluice Water Pump P-G221 Outlet	HV-G221B	1-0102-PPID-G204	Knife gate	V150	100	GE	Grit Effluent	
Sluice Water Pump P-G222 Inlet	HV-G222A	1-0102-PPID-G204	Knife gate	V150	150	GE	Grit Effluent	
Sluice Water Pump P-G222 Outlet	CV-G222	1-0102-PPID-G204	Check	V609	100	GE	Grit Effluent	
Sluice Water Pump P-G222 Outlet	HV-G222B	1-0102-PPID-G204	Knife gate	V150	100	GE	Grit Effluent	
Grit Removal								
Grit Tank 1 Outlet	HV-G321F	1-0102-PPID-G301	Knife gate	V150	100	GRS	Grit Slurry	
Grit Tank 2 Outlet	HV-G322F	1-0102-PPID-G301	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G323 Inlet	HV-G323A	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G323 Outlet	CV-G323	1-0102-PPID-G302	Check	V609	100	GRS	Grit Slurry	
Grit Slurry Pump P-G323 Outlet	HV-G323B	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G324 Inlet	HV-G324A	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G324 Outlet	CV-G324	1-0102-PPID-G302	Check	V609	100	GRS	Grit Slurry	
Grit Slurry Pump P-G324 Outlet	HV-G324B	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G325 Inlet	HV-G325A	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G325 Outlet	CV-G325	1-0102-PPID-G302	Check	V609	100	GRS	Grit Slurry	
Grit Slurry Pump P-G325 Outlet	HV-G325B	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry from Pumps P-G323/P-G324	HV-G323C	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry from Pumps P-G325/P-G324	HV-G325C	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pumps Suction Cross-connection	HV-G323D	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pumps Suction Cross-connection	HV-G325D	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G335 Outlet	CV-G335A	1-0102-PPID-G304	Check	V609	100	GRS	Grit Slurry	
Grit Slurry Pump P-G335 Outlet	HV-G335B	1-0102-PPID-G304	Knife gate	V150	100	GRS	Grit Slurry	
Grit Slurry Pump P-G336 Outlet	CV-G336A	1-0102-PPID-G304	Check	V609	100	GRS	Grit Slurry	
Grit Slurry Pump P-G336 Outlet	HV-G336B	1-0102-PPID-G304	Knife gate	V150	100	GRS	Grit Slurry	
Grit Classifier GRP-G341 Drain	HV-G341D	1-0102-PPID-G305	Knife gate	V150	75	GRS	Grit Slurry	
Grit Classifier GRP-G342 Drain	HV-G342D	1-0102-PPID-G305	Knife gate	V150	75	GRS	Grit Slurry	
Grit Blower B-G353 Inlet	HV-G353A	1-0102-PPID-G306	Butterfly	V510	200	ALP	Air, Low Pressure	
Grit Blower B-G353 Outlet	CV-G353	1-0102-PPID-G306	Check	N/A	100	ALP	Air, Low Pressure	Supplied by blower vendor.
Grit Blower B-G353 Outlet	HV-G353B	1-0102-PPID-G306	Butterfly	V510	200	ALP	Air, Low Pressure	
Grit Blower B-G354 Inlet	HV-G354A	1-0102-PPID-G306	Butterfly	V510	200	ALP	Air, Low Pressure	
Grit Blower B-G354 Outlet	CV-G354	1-0102-PPID-G306	Check	N/A	100	ALP	Air, Low Pressure	Supplied by blower vendor.
Grit Blower B-G354 Outlet	HV-G354B	1-0102-PPID-G306	Butterfly	V510	200	ALP	Air, Low Pressure	
Wash Water								
Automatic Strainer STR-G502 Inlet	HV-G535A	1-0102-PPID-G508	Butterfly	V500	150	FSW	Flushing Water	
Automatic Strainer STR-G502 Outlet	HV-G535B	1-0102-PPID-G508	Butterfly	V500	150	FSW	Flushing Water	
Automatic Strainer STR-G503 Inlet	HV-G536A	1-0102-PPID-G508	Butterfly	V500	150	FSW	Flushing Water	
Automatic Strainer STR-G503 Outlet	HV-G536B	1-0102-PPID-G508	Butterfly	V500	150	FSW	Flushing Water	
Wash Water to Screens	HV-G534C	1-0102-PPID-G508	Butterfly	V500	75	FSW	Flushing Water	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Wash Water to Screens	CV-G534	1-0102-PPID-G508	Check	V609	75	FSW	Flushing Water	
Channel Aeration								
Air Low Pressure to Screen Channel 1	HV-G211E	1-0102-PPID-G201	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screen Channel 1	HV-G212F	1-0102-PPID-G201	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screen Channel 2	HV-G211J	1-0102-PPID-G201	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screen Channel 2	HV-G212G	1-0102-PPID-G201	Butterfly	V510	75	ALP	Air, Low Pressure	
Sump Pump Discharge	HV-G201A	1-0102-PPID-G201	Ball	V315	100	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-G201B	1-0102-PPID-G201	Ball	V315	100	SPD	Sump Pump Discharge	
Air Low Pressure to Screen Channel 3	HV-G213E	1-0102-PPID-G202	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screen Channel 3	HV-G214E	1-0102-PPID-G202	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screen Channel 4	HV-G213G	1-0102-PPID-G202	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screen Channel 4	HV-G214G	1-0102-PPID-G202	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screens Influent Channel	HV-G211F	1-0102-PPID-G201	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screens Influent Channel	HV-G213F	1-0102-PPID-G202	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screens Effluent Channel	HV-G212E	1-0102-PPID-G201	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Screens Effluent Channel	HV-G214F	1-0102-PPID-G202	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 1 & 2 Influent Channel	HV-G353G	1-0102-PPID-G307	Butterfly	V510	100	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 1 & 2 Effluent Channel	HV-G353F	1-0102-PPID-G307	Butterfly	V510	150	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Influent Channel	HV-G353D	1-0102-PPID-G307	Butterfly	V510	75	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Influent Channel	HV-G353H	1-0102-PPID-G307	Butterfly	V510	100	ALP	Air, Low Pressure	
Air Low Pressure to Primary Clarifiers Area	HV-G353P	1-0102-PPID-G307	Butterfly	V510	300	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Influent Channel	HV-G332J	1-0102-PPID-G303	Butterfly	V510	100	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Influent Channel	HV-G332K	1-0102-PPID-G303	Butterfly	V510	100	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Influent Channel	HV-G332L	1-0102-PPID-G303	Butterfly	V510	100	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Effluent Channel	HV-G212H	1-0102-PPID-G201	Butterfly	V510	150	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Effluent Channel	HV-G331J	1-0102-PPID-G303	Butterfly	V510	150	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Effluent Channel	HV-G331K	1-0102-PPID-G303	Butterfly	V510	150	ALP	Air, Low Pressure	
Air Low Pressure to Grit Tanks 3 & 4 Effluent Channel	HV-G331L	1-0102-PPID-G303	Butterfly	V510	150	ALP	Air, Low Pressure	
Channel Aeration Blower B-G351 Inlet	HV-G351A	1-0102-PPID-G307	Butterfly	V510	300	ALP	Air, Low Pressure	
Channel Aeration Blower B-G351 Outlet	CV-G351	1-0102-PPID-G307	Check	V618	300	ALP	Air, Low Pressure	
Channel Aeration Blower B-G351 Outlet	HV-G351B	1-0102-PPID-G307	Butterfly	V510	300	ALP	Air, Low Pressure	
Channel Aeration Blower B-G352 Inlet	HV-G352A	1-0102-PPID-G307	Butterfly	V510	300	ALP	Air, Low Pressure	
Channel Aeration Blower B-G352 Outlet	CV-G352	1-0102-PPID-G307	Check	V618	300	ALP	Air, Low Pressure	
Channel Aeration Blower B-G352 Outlet	HV-G352B	1-0102-PPID-G307	Butterfly	V510	300	ALP	Air, Low Pressure	
Miscellaneous								
HRCS to Primary Clarifiers Influent Channel	HV-G321G	1-0102-PPID-G301	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
Flushing Water to Glycol/Flushing Water Heat Exchanger	HV-G534D	1-0102-PPID-G508	Butterfly	V500	100	FSW	Flushing Water	
AREA P - PRIMARY CLARIFIERS								
Primary Sludge to Sludge Holding Tanks	HV-P1092	1-0102-PPID-P205	Eccentric plug	V405	150	PS	Primary Sludge	Provide operator with open and close position limit switches.
Primary Sludge to Primary Sludge Fermenters Cell 4	HV-P503E	1-0102-PPID-P205	Eccentric plug	V405	150	PS	Primary Sludge	
Primary Sludge to Primary Sludge Fermenters	HV-P503J	1-0102-PPID-P205	Eccentric plug	V405	150	PS	Primary Sludge	
FSW to Fermenters, HRC, and Chemical Building.	HV-P576A	1-0102-PPID-P503	Eccentric plug	V405	250	FSW	Flushing Water	
Process Drain from Primary Clarifiers Effluent Channel	HV-P405A	1-0102-PPID-P103	Eccentric plug	V405	100	PD	Process Drain	
AREA R - BIOREACTORS / BLOWER BUILDING								
Bioreactor 1								
Primary Effluent to Pre-anoxic Zone	HV-R101B	1-0102-PPID-R101	Knife gate	V150	350	PE	Primary Effluent	
Primary Effluent to Pre-anoxic Zone	HV-R101C	1-0102-PPID-R101	Knife gate	V150	350	PE	Primary Effluent	
RAS to Pre-anoxic Zone	HV-R101A	1-0102-PPID-R101	Knife gate	V150	600	RAS	Return Activated Sludge	
Fermented Sludge Filtrate to Anaerobic Zone	HV-R101D	1-0102-PPID-R101	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Fermented Sludge Filtrate to Anaerobic Zone	HV-R101E	1-0102-PPID-R101	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anoxic Zone	HV-R102D	1-0102-PPID-R101	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anoxic Zone	HV-R102E	1-0102-PPID-R101	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate	
Process Drain Header	HV-R101J	1-0102-PPID-R101	Eccentric plug	V405	250	PD	Process Drain	
Air Low Pressure to IFAS Distribution Channel	HV-R104A	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Distribution Channel	HV-R104B	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Distribution Channel	HV-R104H	1-0102-PPID-R102	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104C	1-0102-PPID-R102	Butterfly	V514	500	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104D	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104E	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104F	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104G	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104AD	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104AE	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104AF	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R104AG	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R104K	1-0102-PPID-R102	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R104L	1-0102-PPID-R102	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R104I	1-0102-PPID-R102	Butterfly	V514	75	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R105A	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R105B	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R105C	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R105D	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to PE Channel	HV-R220A	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to PE Channel	HV-R220C	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to RAS Channel	HV-R220B	1-0102-PPID-R102	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to RAS Channel	HV-R220D	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure	
Bioreactor 2								
Primary Effluent to Pre-anoxic Zone	HV-R111B	1-0102-PPID-R103	Knife gate	V150	350	PE	Primary Effluent	
Primary Effluent to Pre-anoxic Zone	HV-R111C	1-0102-PPID-R103	Knife gate	V150	350	PE	Primary Effluent	
RAS to Pre-anoxic Zone	HV-R111F	1-0102-PPID-R103	Knife gate	V150	600	RAS	Return Activated Sludge	
Fermented Sludge Filtrate to Anaerobic Zone	HV-R111D	1-0102-PPID-R103	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anaerobic Zone	HV-R111E	1-0102-PPID-R103	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anoxic Zone	HV-R112D	1-0102-PPID-R103	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anoxic Zone	HV-R112E	1-0102-PPID-R103	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate	
Process Drain Pump P-R140 Inlet	HV-R140A	1-0102-PPID-R103	Eccentric plug	V405	200	PD	Process Drain	
Process Drain Pump P-R140 Outlet	ARV-R140A	1-0102-PPID-R103	Air release	N/A	25	PD	Process Drain	To be supplied by the Process Drain Pump vendor
Process Drain Pump P-R140 Outlet	CV-R140	1-0102-PPID-R103	Check	V609	200	PD	Process Drain	
Process Drain Pump P-R140 Outlet	HV-R140B	1-0102-PPID-R103	Eccentric plug	V405	200	PD	Process Drain	
Air Low Pressure to IFAS Distribution Channel	HV-R114A	1-0102-PPID-R104	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Distribution Channel	HV-R114B	1-0102-PPID-R104	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Distribution Channel	HV-R114H	1-0102-PPID-R104	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114C	1-0102-PPID-R104	Butterfly	V514	500	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114D	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114E	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114F	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114G	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114AD	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114AE	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Air Low Pressure to IFAS Zone	HV-R114AF	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R114AG	1-0102-PPID-R104	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R114K	1-0102-PPID-R104	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R114L	1-0102-PPID-R104	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R114I	1-0102-PPID-R104	Butterfly	V514	75	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R115A	1-0102-PPID-R104	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R115B	1-0102-PPID-R104	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R115C	1-0102-PPID-R104	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R115D	1-0102-PPID-R104	Butterfly	V514	150	ALP	Air, Low Pressure	
Bioreactor 3								
Primary Effluent to Pre-anoxic Zone	HV-R121B	1-0102-PPID-R105	Knife gate	V150	350	PE	Primary Effluent	
Primary Effluent to Pre-anoxic Zone	HV-R121C	1-0102-PPID-R105	Knife gate	V150	350	PE	Primary Effluent	
RAS to Pre-anoxic Zone	HV-R121H	1-0102-PPID-R105	Knife gate	V150	600	RAS	Return Activated Sludge	
Fermented Sludge Filtrate to Anaerobic Zone	HV-R121D	1-0102-PPID-R105	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anaerobic Zone	HV-R121E	1-0102-PPID-R105	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anoxic Zone	HV-R122D	1-0102-PPID-R105	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate	
Fermented Sludge Filtrate to Anoxic Zone	HV-R122E	1-0102-PPID-R105	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate	
Air Low Pressure to IFAS Distribution Channel	HV-R124B	1-0102-PPID-R106	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Distribution Channel	HV-R124C	1-0102-PPID-R106	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Distribution Channel	HV-R124H	1-0102-PPID-R106	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124A	1-0102-PPID-R106	Butterfly	V514	500	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124D	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124E	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124F	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124G	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124AD	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124AE	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124AF	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Zone	HV-R124AG	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R124K	1-0102-PPID-R106	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R124L	1-0102-PPID-R106	Butterfly	V514	100	ALP	Air, Low Pressure	
Air Low Pressure to IFAS Media Screens	HV-R125I	1-0102-PPID-R104	Butterfly	V514	75	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R125A	1-0102-PPID-R106	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R125B	1-0102-PPID-R106	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R125C	1-0102-PPID-R106	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Post Aerobic Zone	HV-R125D	1-0102-PPID-R106	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to Mixed Liquor Channel	HV-R125M	1-0102-PPID-R106	Butterfly	V514	200	ALP	Air, Low Pressure	
Miscelleaneous								
Air Low Pressure to Mixed Liquor Channel	HV-R130C	1-0102-PPID-R107	Butterfly	V514	150	ALP	Air, Low Pressure	
Air Low Pressure to RAS Occasionally Aerated Section	HV-R111H	1-0102-PPID-R108	Butterfly	V514	150	ALP	Air, Low Pressure	With torque tube to gear box outside channel.
RAS to Pre-Anoxic Zone TK-R101	HV-R101H	1-0102-PPID-R108	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS to Pre-Anoxic Zone TK-R111	HV-R111A	1-0102-PPID-R108	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS to Pre-Anoxic Zone TK-R121	HV-R121A	1-0102-PPID-R108	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS to Process Drain	HV-R400B	1-0102-PPID-R108	Eccentric plug	V405	150	PD	Process Drain	
RAS to WAS Sump	HV-R400A	1-0102-PPID-R108	Eccentric plug	V405	250	WAS	Waste Activated Sludge	
RAS to WAS Sump	HV-R400D	1-0102-PPID-R108	Eccentric plug	V405	250	WAS	Waste Activated Sludge	
RAS to RAS channel	HV-R400G	1-0102-PPID-R108	Knife gate	V150	750	RAS	Return Activated Sludge	
RAS pipe upstream tie-in to 750 mm RAS	HV-R400D	1-0102-PPID-R108	Eccentric plug	V405	450	RAS	Return Activated Sludge	
RAS to WAS Sump	HV-R300A	1-0102-PPID-R301	Eccentric plug	V405	250	WAS	Waste Activated Sludge	

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Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
WAS Mixing Pump P-R304 Inlet	HV-R304A	1-0102-PPID-R301	Eccentric plug	V405	250	WAS	Waste Activated Sludge	
WAS Mixing Pump P-R304 Outlet	HV-R304B	1-0102-PPID-R301	Eccentric plug	V405	200	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R301 Inlet	HV-R301A	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R301 Outlet	CV-R301	1-0102-PPID-R301	Check	V609	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R301 Outlet	HV-R301B	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R302 Inlet	HV-R302A	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R302 Outlet	CV-R302	1-0102-PPID-R301	Check	V609	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R302 Outlet	HV-R302B	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R303 Inlet	HV-R303A	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R303 Outlet	CV-R303	1-0102-PPID-R301	Check	V609	150	WAS	Waste Activated Sludge	
WAS RDT Feed Pump P-R303 Outlet	HV-R303B	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
Flushing Water to WAS Pipe	HV-R300G	1-0102-PPID-R301	Eccentric plug	V405	100	FSW	Flushing Water	
Flushing Water Header to Bioreactors Screens	HV-R300J	1-0102-PPID-R301	Eccentric plug	V405	100	FSW	Flushing Water	
Process Drain on Pump P-R301 Outlet	HV-R301C	1-0102-PPID-R301	Eccentric plug	V405	150	PD	Process Drain	
PE Channel drain	HV-R123C	1-0102-PPID-R105	Ball	V315	75	PD	Process Drain	
Blower Building								
Blower B-R201 Outlet	CV-R201	1-0102-PPID-R201	Check	N/A	350	ALP	Air, Low Pressure	Supplied by blower vendor.
Blower B-R202 Outlet	CV-R202	1-0102-PPID-R201	Check	N/A	350	ALP	Air, Low Pressure	Supplied by blower vendor.
Blower B-R203 Outlet	CV-R203	1-0102-PPID-R202	Check	N/A	350	ALP	Air, Low Pressure	Supplied by blower vendor.
Blower B-R204 Outlet	CV-R204	1-0102-PPID-R202	Check	N/A	350	ALP	Air, Low Pressure	Supplied by blower vendor.
Blower B-R205 Outlet	CV-R205	1-0102-PPID-R203	Check	N/A	350	ALP	Air, Low Pressure	Supplied by blower vendor.
Blower B-R206 Outlet	CV-R206	1-0102-PPID-R203	Check	N/A	350	ALP	Air, Low Pressure	Supplied by blower vendor.
Blower B-R201 Outlet	HV-R201A	1-0102-PPID-R201	Butterfly	V514	400	ALP	Air, Low Pressure	
Blower B-R202 Outlet	HV-R202A	1-0102-PPID-R201	Butterfly	V514	400	ALP	Air, Low Pressure	
Blower B-R203 Outlet	HV-R203D	1-0102-PPID-R202	Butterfly	V514	400	ALP	Air, Low Pressure	
Blower B-R204 Outlet	HV-R204D	1-0102-PPID-R202	Butterfly	V514	400	ALP	Air, Low Pressure	
Blower B-R205 Outlet	HV-R205A	1-0102-PPID-R203	Butterfly	V514	400	ALP	Air, Low Pressure	
Blower B-R206 Outlet	HV-R206A	1-0102-PPID-R203	Butterfly	V514	400	ALP	Air, Low Pressure	
Air Low Pressure to Hoar Frost	HV-R200A	1-0102-PPID-R201	Butterfly	V514	200	ALP	Air, Low Pressure	
AREA S - SECONDARY CLARIFIERS								
RAS Pumps P-S108 & P-S109 Suction Cross-connection	HV-S130E	1-0102-PPID-S104	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS Pumps P-S216 & P-S109 Suction Cross-connection	HV-S130F	1-0102-PPID-S104	Knife gate	V150	600	RAS	Return Activated Sludge	
Clarifier 4 RAS Outlet	HV-S140A	1-0102-PPID-S105	Knife gate	V150	600	RAS	Return Activated Sludge	
Clarifier 4 RAS Drain	HV-S140B	1-0102-PPID-S105	Eccentric plug	V405	350	RAS	Return Activated Sludge	
Clarifier 5 RAS Outlet	HV-S150A	1-0102-PPID-S106	Knife gate	V150	600	RAS	Return Activated Sludge	
Clarifier 5 RAS Drain	HV-S150B	1-0102-PPID-S106	Eccentric plug	V405	350	RAS	Return Activated Sludge	
RAS Pump P-S216 Suction	HV-S216A	1-0102-PPID-S204	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS Pump P-S216 Outlet	CV-S216	1-0102-PPID-S204	Check	V609	450	RAS	Return Activated Sludge	
RAS Pump P-S216 Outlet	HV-S216B	1-0102-PPID-S204	Knife gate	V150	450	RAS	Return Activated Sludge	
RAS Pump P-S216 Flushing Water	HV-S216C	1-0102-PPID-S204	Eccentric plug	V405	100	FSW	Flushing Water	
RAS Pump P-S217 Suction	HV-S217A	1-0102-PPID-S205	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS Pump P-S217 Outlet	CV-S217	1-0102-PPID-S205	Check	V609	400	RAS	Return Activated Sludge	
RAS Pump P-S217 Outlet	HV-S217B	1-0102-PPID-S205	Eccentric plug	V405	450	RAS	Return Activated Sludge	
RAS Pump P-S217 Flushing Water	HV-S217C	1-0102-PPID-S205	Eccentric plug	V405	100	FSW	Flushing Water	
RAS Pump P-S218 Suction	HV-S218A	1-0102-PPID-S205	Knife gate	V150	600	RAS	Return Activated Sludge	
RAS Pump P-S218 Outlet	CV-S218	1-0102-PPID-S205	Check	V609	400	RAS	Return Activated Sludge	
RAS Pump P-S218 Outlet	HV-S218B	1-0102-PPID-S205	Eccentric plug	V405	450	RAS	Return Activated Sludge	
RAS Pump P-S218 Flushing Water	HV-S218C	1-0102-PPID-S205	Eccentric plug	V405	100	FSW	Flushing Water	
Sludge Holding Tank 3 Outlet	HV-S416A	1-0102-PPID-S207	Ball	V315	250	STS	Southend Thickened Sludge	

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Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Sludge Holding Tank 2 Outlet	HV-S417A	1-0102-PPID-S207	Ball	V315	250	STS	Southend Thickened Sludge	
Sludge Holding Tank 1 Outlet	HV-S418A	1-0102-PPID-S207	Ball	V315	250	STS	Southend Thickened Sludge	
TFS from Pumps P-D418, P-D419, P-D420	HV-P213E	1-0102-PPID-S207	Eccentric plug	V405	150	STS	Southend Thickened Sludge	
Sludge Transfer Pump P-S401 Inlet	HV-S401A	1-0102-PPID-S208	Ball	V315	250	STS	Southend Thickened Sludge	
Sludge Transfer Pump P-S402 Inlet	HV-S402A	1-0102-PPID-S208	Ball	V315	250	STS	Southend Thickened Sludge	
Scum Pump P-S316 Suction	HV-S316A	1-0102-PPID-S303	Ball	V315	150	SC	Scum	
Scum Pump P-S316 Outlet	HV-S316B	1-0102-PPID-S303	Ball	V315	100	SC	Scum	
Scum Pump P-S317 Suction	HV-S317A	1-0102-PPID-S303	Ball	V315	150	SC	Scum	
Scum Pump P-S317 Outlet	HV-S317B	1-0102-PPID-S303	Ball	V315	100	SC	Scum	
Scum Pump P-S316 and P-S317 Recirculation	HV-S316K	1-0102-PPID-S303	Ball	V315	100	SC	Scum	
Scum Pump P-S316 and P-S317 System Supply	HV-S317K	1-0102-PPID-S303	Ball	V315	100	SC	Scum	
Secondary Clarifier 4 Scum Trough Outlet	HV-S315E	1-0102-PPID-S303	Eccentric plug	V405	250	SC	Scum	
Secondary Clarifier 5 Scum Trough Outlet	HV-S315F	1-0102-PPID-S303	Eccentric plug	V405	250	SC	Scum	
Scum from Tank V-S307	HV-S300F	1-0102-PPID-S304	Ball	V315	100	SC	Scum	
Scum from Tank V-S307	HV-S300G	1-0102-PPID-S304	Ball	V315	100	SC	Scum	
Scum from Tank V-S308	HV-S300D	1-0102-PPID-S304	Ball	V315	100	SC	Scum	
Scum from Tank V-S308	HV-S300E	1-0102-PPID-S304	Ball	V315	100	SC	Scum	
Flushing Water Pump P-S550 Suction	HV-S550A	1-0102-PPID-S506	Knife gate	V150	250	FSW	Flushing Water	
Flood Pump P-S593 Outlet	CV-S593	1-0102-PPID-S508	Check	V609	350	PD	Process Drain	
Flood Pump P-S593 Outlet	HV-S593A	1-0102-PPID-S508	Butterfly	V500	350	PD	Process Drain	
Flood Pump P-S594 Outlet	CV-S594	1-0102-PPID-S508	Check	V609	350	PD	Process Drain	
Flood Pump P-S594 Outlet	HV-S594A	1-0102-PPID-S508	Butterfly	V500	350	PD	Process Drain	
Flushing Service Water to RAS Pumps and Scum Pumps	HV-S215A	1-0102-PPID-S509	Ball	V315	100	FSW	Flushing Water	
Flushing Service Water to Glycol/Flushing Water HE	HV-S663A	1-0102-PPID-S509	Ball	V315	100	FSW	Flushing Water	
Flushing Service Water to RDT	HV-S555BC	1-0102-PPID-S509	Butterfly	V500	100	FSW	Flushing Water	
Sodium Bisulphite Dispersion Pumps Suction	HV-U190A	1-0102-PPID-U101	Gate	N/A	200	FE	Final Effluent	Valve to be supplied by the hot tapping contractor to suit the application
Sodium Bisulphite Dispersion Pump P-S181 Suction	HV-S181A	1-0102-PPID-S108	Eccentric plug	V405	200	FE	Final Effluent	
Sodium Bisulphite Dispersion Pump P-S181 Outlet	CV-S181	1-0102-PPID-S108	Check	V609	150	FE	Final Effluent	
Sodium Bisulphite Dispersion Pump P-S181 Outlet	HV-S181B	1-0102-PPID-S108	Eccentric plug	V405	150	FE	Final Effluent	
Sodium Bisulphite Dispersion Pump P-S182 Suction	HV-S182A	1-0102-PPID-S108	Eccentric plug	V405	200	FE	Final Effluent	
Sodium Bisulphite Dispersion Pump P-S182 Outlet	CV-S182	1-0102-PPID-S108	Check	V609	150	FE	Final Effluent	
Sodium Bisulphite Dispersion Pump P-S182 Outlet	HV-S182B	1-0102-PPID-S108	Eccentric plug	V405	150	FE	Final Effluent	
Flushing Water to RDT Wash Water Booster Pumps	HV-S555B	1-0102-PPID-S509	Butterfly	V500	100	FSW	Flushing Water	
AREA K - HIGH RATE CLARIFIERS								
Waste Sludge Pump P-K251 Outlet	CV-K251	1-0102-PPID-K203	Check	V609	300	HRS	High Rate Clarifier Sludge	
Waste Sludge Pump P-K252 Outlet	CV-K252	1-0102-PPID-K203	Check	V609	300	HRS	High Rate Clarifier Sludge	
Drain Pump P-K253 Outlet	CV-K253	1-0102-PPID-K203	Check	V609	150	HRS	High Rate Clarifier Sludge	
Drain from HRC Train 1 Clarifier Suction	HV-K114F	1-0102-PPID-K103	Eccentric plug	V405	150	PD	Process Drain	
Drain from HRC Train 2 Clarifier Suction	HV-K124F	1-0102-PPID-K105	Eccentric plug	V405	150	PD	Process Drain	
HRC Lamella Air Scour Blower Outlet	HV-K160A	1-0102-PPID-K108	Butterfly	V513	75	ALP	Air, Low Pressure	Supplied by HRC Vendor
Recycle Pump P-K211 Inlet	HV-K211A	1-0102-PPID-K201	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K211 Outlet	HV-K211B	1-0102-PPID-K201	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K212 Inlet	HV-K212A	1-0102-PPID-K201	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K212 Outlet	HV-K212B	1-0102-PPID-K201	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K213 Inlet	HV-K213A	1-0102-PPID-K201	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K213 Outlet	HV-K213B	1-0102-PPID-K201	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K221 Inlet	HV-K221A	1-0102-PPID-K202	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K221 Outlet	HV-K221B	1-0102-PPID-K202	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor

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Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Recycle Pump P-K222 Inlet	HV-K222A	1-0102-PPID-K202	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K222 Outlet	HV-K222B	1-0102-PPID-K202	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K222 Outlet	HV-K223A	1-0102-PPID-K202	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Recycle Pump P-K223 Outlet	HV-K223B	1-0102-PPID-K202	Eccentric plug	V405	200	BLS	Ballasted Sludge	Supplied by HRC Vendor
Waste Sludge Pump P-K251 Inlet	HV-K251A	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
Waste Sludge Pump P-K251 Outlet	HV-K251B	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
Waste Sludge Pump P-K252 Inlet	HV-K252A	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
Waste Sludge Pump P-K252 Outlet	HV-K252B	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
Drain Pump P-K253 Inlet	HV-K253A	1-0102-PPID-K203	Eccentric plug	V405	150	PD	Process Drain	
Drain Pump P-K253 Outlet	HV-K253B	1-0102-PPID-K203	Eccentric plug	V405	150	PD	Process Drain	
Drain Pump P-K253 Recirculation	HV-K253G	1-0102-PPID-K203	Eccentric plug	V405	150	PD	Process Drain	
Flushing Water to Sludge Pump P-K251	HV-K251C	1-0102-PPID-K203	Butterfly	V500	100	FSW	Flushing Water	
Flushing Water to Sludge Pump P-K252	HV-K252C	1-0102-PPID-K203	Butterfly	V500	100	FSW	Flushing Water	
HRS to Primary Influent Channels	HV-K254A	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
HRS to Fermenters Cell No. 4	HV-K254B	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
HRS to Primary Clarifiers 1 & 2 Influent Channel	HV-K254C	1-0102-PPID-K203	Eccentric plug	V405	200	HRS	High Rate Clarifier Sludge	
HRS to Primary Clarifier 3 Influent Channel	HV-K254D	1-0102-PPID-K203	Eccentric plug	V405	200	HRS	High Rate Clarifier Sludge	
Drain from HRC Train 1 Coagulation Zone to Maturation Zone	FG-K113	1-0102-PPID-K103	Flap	V692	150	PD	Process Drain	
Drain from HRC Train 2 Coagulation Zone to Maturation Zone	FG-K123	1-0102-PPID-K105	Flap	V692	150	PD	Process Drain	
AREA D - FERMENTERS / THICKENERS								
Fermenters								
Primary Sludge to PS Fermenters Train 1 Cell 1	HV-D301A	1-0102-PPID-D301	Eccentric plug	V405	150	PS	Primary Sludge	
Ferm. Sludge Recirc. to PS Fermenters Train 1 Cell 1	HV-D301B	1-0102-PPID-D301	Eccentric plug	V405	100	FSL	Fermented Sludge	
Ferm. Sludge Recirc. from PS Fermenters Train 1 Cell 3	HV-D301G	1-0102-PPID-D301	Eccentric plug	V405	150	FSL	Fermented Sludge	
Ferm. Sludge to RDT Feed Pumps	HV-D301F	1-0102-PPID-D301	Eccentric plug	V405	200	FSL	Fermented Sludge	
Process Drain from PS Fermenters Train 1 Cell 4	HV-D301D	1-0102-PPID-D301	Eccentric plug	V405	300	PD	Process Drain	
HRC sludge to PS Fermenters Train 1 Cell 4	HV-D304B	1-0102-PPID-D301	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
PS Fermenters Train 1 Cell 2 to Cell 3 Drain	HV-D302A	1-0102-PPID-D301	Shear Gate	V160	200	PS	Primary Sludge	
PS Fermenters Train 1 Cell 3 to Cell 4 Drain	HV-D303A	1-0102-PPID-D301	Shear Gate	V160	200	PS	Primary Sludge	
FSW to PS	HV-D314B	1-0102-PPID-D302	Ball	V315	75	FSW	Flushing Water	
Primary Sludge to PS Fermenters Train 2 Cell 1	HV-D311A	1-0102-PPID-D302	Eccentric plug	V405	150	PS	Primary Sludge	
Ferm. Sludge Recirc. to PS Fermenters Train 2 Cell 1	HV-D311B	1-0102-PPID-D302	Eccentric plug	V405	100	FSL	Fermented Sludge	
Ferm. Sludge Recirc. from PS Fermenters Train 2 Cell 3	HV-D313B	1-0102-PPID-D302	Eccentric plug	V405	150	FSL	Fermented Sludge	
Ferm. Sludge to RDT Feed Pumps	HV-D311F	1-0102-PPID-D302	Eccentric plug	V405	200	FSL	Fermented Sludge	
Process Drain from PS Fermenters Train 2 Cell 4	HV-D311D	1-0102-PPID-D302	Eccentric plug	V405	300	PD	Process Drain	
HRC sludge to PS Fermenters Train 2 Cell 4	HV-D314A	1-0102-PPID-D302	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge	
PS Fermenters Train 2 Cell 2 to Cell 3 Drain	HV-D312A	1-0102-PPID-D302	Shear Gate	V160	200	PS	Primary Sludge	
PS Fermenters Train 2 Cell 3 to Cell 4 Drain	HV-D313A	1-0102-PPID-D302	Shear Gate	V160	200	PS	Primary Sludge	
Ferm. Recirc. Pump P-D321 Suction	HV-D321A	1-0102-PPID-D303	Ball	V315	150	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D321 Outlet	CV-D321	1-0102-PPID-D303	Check	V609	100	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D321 Outlet	HV-D321B	1-0102-PPID-D303	Eccentric plug	V405	100	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D321 Flushing Water	HV-D321D	1-0102-PPID-D303	Eccentric plug	V405	100	FSW	Flushing Water	
Ferm. Recirc. Pump P-D321 Flushing Water	HV-D321E	1-0102-PPID-D303	Eccentric plug	V405	100	FSW	Flushing Water	
Ferm. Recirc. Pump P-D322 Suction	HV-D322A	1-0102-PPID-D303	Ball	V315	150	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D322 Outlet	CV-D322	1-0102-PPID-D303	Check	V609	100	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D322 Outlet	HV-D322B	1-0102-PPID-D303	Eccentric plug	V405	100	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D322 Flushing Water	HV-D322D	1-0102-PPID-D303	Eccentric plug	V405	100	FSW	Flushing Water	
Ferm. Recirc. Pump P-D322 Flushing Water	HV-D322E	1-0102-PPID-D303	Eccentric plug	V405	100	FSW	Flushing Water	
Ferm. Recirc. Pump P-D323 Suction	HV-D323A	1-0102-PPID-D303	Ball	V315	150	FSL	Fermented Sludge	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Ferm. Recirc. Pump P-D323 Outlet	CV-D323	1-0102-PPID-D303	Check	V609	100	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D323 Outlet	HV-D323B	1-0102-PPID-D303	Eccentric plug	V405	100	FSL	Fermented Sludge	
Ferm. Recirc. Pump P-D323 Flushing Water	HV-D323D	1-0102-PPID-D303	Eccentric plug	V405	100	FSW	Flushing Water	
Ferm. Recirc. Pump P-D323 Flushing Water	HV-D323E	1-0102-PPID-D303	Eccentric plug	V405	100	FSW	Flushing Water	
Ferm. Recirc. P-D321 & P-D322 Suction Cross-connection	HV-D320A	1-0102-PPID-D303	Eccentric plug	V405	150	FSL	Fermented Sludge	
Ferm. Recirc. P-D322 & P-D323 Suction Cross-connection	HV-D320B	1-0102-PPID-D303	Eccentric plug	V405	150	FSL	Fermented Sludge	
Ferm. Recirc. P-D321 & P-D322 Outlet Cross-connection	HV-D320C	1-0102-PPID-D303	Eccentric plug	V405	100	FSL	Fermented Sludge	
Ferm. Recirc. P-D322 & P-D323 Outlet Cross-connection	HV-D320D	1-0102-PPID-D303	Eccentric plug	V405	100	FSL	Fermented Sludge	
Thickeners								
WAS RDT RDT-D403 Inlet	HV-D403A	1-0102-PPID-D402	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS to Primary Clarifiers Influent Channel	HV-D403B	1-0102-PPID-D402	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS RDT RDT-D404 Inlet	HV-D404A	1-0102-PPID-D402	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
WAS to Primary Clarifiers Influent Channel	HV-D404B	1-0102-PPID-D402	Eccentric plug	V405	150	WAS	Waste Activated Sludge	
TWAS Hopper TK-D403-2 Drain	HV-D403E	1-0102-PPID-D402	Eccentric plug	V405	150	TWAS	Thickened Waste Activated Sludge	
TWAS Hopper TK-D404-2 Drain	HV-D404E	1-0102-PPID-D402	Eccentric plug	V405	150	TWAS	Thickened Waste Activated Sludge	
WAS RDT RDT-D403 Foul Air	HV-D403C	1-0102-PPID-D402	Volume control damper	V960	75	FOA	Foul Air	
Flocculation Tank TK-D403-1 Foul Air	HV-D403D	1-0102-PPID-D402	Volume control damper	V960	75	FOA	Foul Air	
WAS RDT RDT-D404 Foul Air	HV-D404C	1-0102-PPID-D402	Volume control damper	V960	75	FOA	Foul Air	
Flocculation Tank TK-D404-1 Foul Air	HV-D404D	1-0102-PPID-D402	Volume control damper	V960	75	FOA	Foul Air	
TWAS Pump P-D405 Inlet	HV-D405A	1-0102-PPID-D403	Eccentric plug	V405	100	TWAS	Thickened Waste Activated Sludge	
TWAS Pump P-D405 Outlet	CV-D405	1-0102-PPID-D403	Check	V609	100	TWAS	Thickened Waste Activated Sludge	
TWAS Pump P-D405 Outlet	HV-D405B	1-0102-PPID-D403	Eccentric plug	V405	100	TWAS	Thickened Waste Activated Sludge	
TWAS Pump P-D406 Inlet	HV-D406A	1-0102-PPID-D403	Eccentric plug	V405	100	TWAS	Thickened Waste Activated Sludge	
TWAS Pump P-D406 Outlet	CV-D406	1-0102-PPID-D403	Check	V609	100	TWAS	Thickened Waste Activated Sludge	
TWAS Pump P-D406 Outlet	HV-D406B	1-0102-PPID-D403	Eccentric plug	V405	100	TWAS	Thickened Waste Activated Sludge	
FSL RDT Feed Pump P-D411 Inlet	HV-D411A	1-0102-PPID-D404	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D411 Outlet	CV-D411	1-0102-PPID-D404	Check	V609	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D411 Outlet	HV-D411B	1-0102-PPID-D404	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D412 Inlet	HV-D412A	1-0102-PPID-D404	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D412 Outlet	CV-D412	1-0102-PPID-D404	Check	V609	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D412 Outlet	HV-D412B	1-0102-PPID-D404	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D413 Inlet	HV-D413A	1-0102-PPID-D405	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D413 Outlet	CV-D413	1-0102-PPID-D405	Check	V609	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D413 Outlet	HV-D413B	1-0102-PPID-D405	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D414 Inlet	HV-D414A	1-0102-PPID-D405	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D414 Outlet	CV-D414	1-0102-PPID-D405	Check	V609	150	FSL	Fermented Sludge	
FSL RDT Feed Pump P-D414 Outlet	HV-D414B	1-0102-PPID-D405	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT RDT-D415 Inlet	HV-D415A	1-0102-PPID-D406	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT RDT-D416 Inlet	HV-D416A	1-0102-PPID-D406	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT RDT-D417 Inlet	HV-D417A	1-0102-PPID-D407	Eccentric plug	V405	150	FSL	Fermented Sludge	
TFS Hopper TK-D415-2 Drain	HV-D415E	1-0102-PPID-D406	Eccentric plug	V405	150	FSL	Fermented Sludge	
TFS Hopper TK-D416-2 Drain	HV-D416E	1-0102-PPID-D406	Eccentric plug	V405	150	FSL	Fermented Sludge	
TFS Hopper TK-D417-2 Drain	HV-D417E	1-0102-PPID-D407	Eccentric plug	V405	150	FSL	Fermented Sludge	
FSL RDT RDT-D415 Foul Air	HV-D415C	1-0102-PPID-D406	Volume control damper	V960	75	FOA	Foul Air	
Flocculation Tank TK-D415-1 Foul Air	HV-D415D	1-0102-PPID-D406	Volume control damper	V960	75	FOA	Foul Air	
FSL RDT RDT-D416 Foul Air	HV-D416C	1-0102-PPID-D406	Volume control damper	V960	75	FOA	Foul Air	
Flocculation Tank TK-D416-1 Foul Air	HV-D416D	1-0102-PPID-D406	Volume control damper	V960	75	FOA	Foul Air	
FSL RDT RDT-D417 Foul Air	HV-D417C	1-0102-PPID-D407	Volume control damper	V960	75	FOA	Foul Air	
Flocculation Tank TK-D417-1 Foul Air	HV-D417D	1-0102-PPID-D407	Volume control damper	V960	75	FOA	Foul Air	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Polymer Solution to WAS RDT RDT-D415	HV-D415G	1-0102-PPID-D406	Ball	V330	75	MP	Mixed Polymer	
Polymer Solution to WAS RDT RDT-D415	CV-D415	1-0102-PPID-D406	Check	V630	75	MP	Mixed Polymer	
Polymer Solution to WAS RDT RDT-D416	HV-D416G	1-0102-PPID-D406	Ball	V330	75	MP	Mixed Polymer	
Polymer Solution to WAS RDT RDT-D416	CV-D416	1-0102-PPID-D406	Check	V630	75	MP	Mixed Polymer	
Polymer Solution to WAS RDT RDT-D417	HV-D417G	1-0102-PPID-D407	Ball	V330	75	MP	Mixed Polymer	
Polymer Solution to WAS RDT RDT-D417	CV-D417	1-0102-PPID-D407	Check	V630	75	MP	Mixed Polymer	
TFS Pump P-D418 Inlet	HV-D418A	1-0102-PPID-D408	Eccentric plug	V405	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D418 Outlet	CV-D418	1-0102-PPID-D408	Check	V609	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D418 Outlet	HV-D418B	1-0102-PPID-D408	Eccentric plug	V405	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D419 Inlet	HV-D419A	1-0102-PPID-D408	Eccentric plug	V405	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D419 Outlet	CV-D419	1-0102-PPID-D408	Check	V609	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D419 Outlet	HV-D419B	1-0102-PPID-D408	Eccentric plug	V405	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D420 Inlet	HV-D420A	1-0102-PPID-D409	Eccentric plug	V405	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D420 Outlet	CV-D420	1-0102-PPID-D409	Check	V609	100	TFS	Thickened Fermented Sludge	
TFS Pump P-D420 Outlet	HV-D420B	1-0102-PPID-D409	Eccentric plug	V405	100	TFS	Thickened Fermented Sludge	
RDT Flushing Water Booster Pump P-D431 Inlet	HV-D431A	1-0102-PPID-D410	Butterfly	N/A	100	FSW	Flushing Water	Supplied by booster pump package vendor
RDT Flushing Water Booster Pump P-D431 Outlet	CV-D431	1-0102-PPID-D410	Check	N/A	75	FSW	Flushing Water	Supplied by booster pump package vendor
RDT Flushing Water Booster Pump P-D431 Outlet	HV-D431B	1-0102-PPID-D410	Ball	N/A	75	FSW	Flushing Water	Supplied by booster pump package vendor
RDT Flushing Water Booster Pump P-D432 Inlet	HV-D432A	1-0102-PPID-D410	Butterfly	N/A	100	FSW	Flushing Water	Supplied by booster pump package vendor
RDT Flushing Water Booster Pump P-D432 Outlet	CV-D432	1-0102-PPID-D410	Check	N/A	75	FSW	Flushing Water	Supplied by booster pump package vendor
RDT Flushing Water Booster Pump P-D432 Outlet	HV-D432B	1-0102-PPID-D410	Ball	N/A	75	FSW	Flushing Water	Supplied by booster pump package vendor
Automatic Strainer STR-D433 Inlet	HV-D433A	1-0102-PPID-D410	Butterfly	V500	100	FSW	Flushing Water	
Automatic Strainer STR-D433 Outlet	HV-D433B	1-0102-PPID-D410	Butterfly	V500	100	FSW	Flushing Water	
Automatic Strainer STR-D434 Inlet	HV-D434A	1-0102-PPID-D410	Butterfly	V500	100	FSW	Flushing Water	
Automatic Strainer STR-D434 Outlet	HV-D434B	1-0102-PPID-D410	Butterfly	V500	100	FSW	Flushing Water	
WAS Filtrate Tank TK-D450 Outlet	HV-D450A	1-0102-PPID-D411	Knife gate	V150	200	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate Tank TK-D450 Drain	HV-D450B	1-0102-PPID-D411	Knife gate	V150	200	PD	Process Drain	
Filtrate Pump Suction Header Isolation	HV-D450C	1-0102-PPID-D411	Knife gate	V150	200	FSF	Fermented Sludge Filtrate	
Filtrate Pump Discharge Header Isolation	HV-D450D	1-0102-PPID-D411	Knife gate	V150	150	FSF	Fermented Sludge Filtrate	
WAS Filtrate Pump P-D451 Inlet	HV-D451A	1-0102-PPID-D411	Knife gate	V150	200	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate Pump P-D451 Outlet	CV-D451	1-0102-PPID-D411	Check	V609	150	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate Pump P-D451 Outlet	HV-D451B	1-0102-PPID-D411	Knife gate	V150	150	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate to Primary Clarifiers 1 and 2 Influent Channel	HV-D451K	1-0102-PPID-D411	Knife gate	V150	100	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate to Primary Clarifier 3 Influent Channel	HV-D451L	1-0102-PPID-D411	Knife gate	V150	100	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate Pump P-D452 Inlet	HV-D452A	1-0102-PPID-D411	Knife gate	V150	200	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate Pump P-D452 Outlet	CV-D452	1-0102-PPID-D411	Check	V609	150	WSF	Waste Activated Sludge Filtrate	
WAS Filtrate Pump P-D452 Outlet	HV-D452B	1-0102-PPID-D411	Knife gate	V150	150	WSF	Waste Activated Sludge Filtrate	
FSL Filtrate Pump P-D461 Inlet	HV-D461A	1-0102-PPID-D412	Knife gate	V150	200	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D461 Outlet	CV-D461	1-0102-PPID-D412	Check	V609	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D461 Outlet	HV-D461B	1-0102-PPID-D412	Knife gate	V150	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D462 Inlet	HV-D462A	1-0102-PPID-D412	Knife gate	V150	200	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D462 Outlet	CV-D462	1-0102-PPID-D412	Check	V609	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D462 Outlet	HV-D462B	1-0102-PPID-D412	Knife gate	V150	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D463 Inlet	HV-D463A	1-0102-PPID-D413	Knife gate	V150	200	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D463 Outlet	CV-D463	1-0102-PPID-D413	Check	V609	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D463 Outlet	HV-D463B	1-0102-PPID-D413	Knife gate	V150	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D464 Inlet	HV-D464A	1-0102-PPID-D413	Knife gate	V150	200	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D464 Outlet	CV-D464	1-0102-PPID-D413	Check	V609	150	FSF	Fermented Sludge Filtrate	
FSL Filtrate Pump P-D464 Outlet	HV-D464B	1-0102-PPID-D413	Knife gate	V150	150	FSF	Fermented Sludge Filtrate	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
FSL Filtrate Tank TK-D460 Outlet	HV-D460A	1-0102-PPID-D413	Knife gate	V150	250	FSF	Fermented Sludge Filtrate	
FSL Filtrate Tank TK-D460 Drain	HV-D460B	1-0102-PPID-D413	Knife gate	V150	200	PD	Process Drain	
Flushing Service Water Piping in RDT Pump Room	HV-S199L	1-0102-PPID-G107	Ball	V315	75	FSW	Flushing Water	
Flushing Service Water Piping in RDT Pump Room	HV-S199M	1-0102-PPID-G107	Ball	V315	75	FSW	Flushing Water	
Flushing Service Water Piping in RDT Pump Room	HV-S199N	1-0102-PPID-G107	Ball	V315	75	FSW	Flushing Water	
AREA T - BIOFILTER / ODOUR CONTROL								
East IPS Wet Well Cover	HV-T101A	1-0102-PPID-T101	Vol. Control Damper	V960	300	FOA	Foul Air	
West IPS Wet Well Cover	HV-T101B	1-0102-PPID-T101	Vol. Control Damper	V960	300	FOA	Foul Air	
Screen 4 Channel	HV-T101C	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Screen 3 Channel	HV-T101D	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Screen 2 Channel	HV-T101E	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Screen 1 Channel	HV-T101F	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Influent Channel	HV-T101AB	1-0102-PPID-T101	Vol. Control Damper	V960	200	FOA	Foul Air	
Effluent Channel	HV-T101AC	1-0102-PPID-T101	Vol. Control Damper	V960	200	FOA	Foul Air	
Sluice	HV-T101AD	1-0102-PPID-T101	Vol. Control Damper	V960	100	FOA	Foul Air	
Headworks odour control duct	HV-T101AJ	1-0102-PPID-T101	Vol. Control Damper	V960	400	FOA	Foul Air	
Grit Tank TK-G331	HV-T101G	1-0102-PPID-T101	Vol. Control Damper	V960	250	FOA	Foul Air	
Grit Tank TK-G332	HV-T101H	1-0102-PPID-T101	Vol. Control Damper	V960	250	FOA	Foul Air	
Grit Tank 3 and 4 effluent channel	HV-T101AE	1-0102-PPID-T101	Vol. Control Damper	V960	250	FOA	Foul Air	
Grit Tank 1 and 2 effluent channel	HV-T101AF	1-0102-PPID-T101	Vol. Control Damper	V960	200	FOA	Foul Air	
Grit Tank TK-G321	HV-T101Y	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Grit Tank TK-G322	HV-T101J	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Grit Tank 1 and 2 inffluent channel	HV-T101AG	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Grit Tank 3 and 4 inffluent channel	HV-T101AH	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Effluent channel and sluice	HV-T101V	1-0102-PPID-T101	Vol. Control Damper	V960	300	FOA	Foul Air	
Grit Tanks odour control duct	HV-T101AK	1-0102-PPID-T101	Vol. Control Damper	V960	600	FOA	Foul Air	
Washer Compactor WCP-G231	HV-T101K	1-0102-PPID-T101	Vol. Control Damper	V960	75	FOA	Foul Air	
Washer Compactor WCP-G241	HV-T101L	1-0102-PPID-T101	Vol. Control Damper	V960	75	FOA	Foul Air	
Grit Classifier GRP-G341	HV-T101M	1-0102-PPID-T101	Vol. Control Damper	V960	75	FOA	Foul Air	
Grit Classifier GRP-G342	HV-T101N	1-0102-PPID-T101	Vol. Control Damper	V960	75	FOA	Foul Air	
Washer Compactors and Grit Classifiers Duct	HV-T101AL	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Clarifier 3 Scum Hopper	HV-T101O	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Clarifiers 1 & 2 Influent Channel	HV-T101AM	1-0102-PPID-T101	Vol. Control Damper	V960	200	FOA	Foul Air	
Primary Clarifiers 3 Influent Channel	HV-T101AN	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Clarifiers 1 Launders	HV-T101Q	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Clarifiers 2 Launders	HV-T101R	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Clarifiers 1 & 2 Scum Hopper	HV-T101S	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Clarifiers Duct	HV-T101AP	1-0102-PPID-T101	Vol. Control Damper	V960	250	FOA	Foul Air	
Primary Clarifiers 3 Launders	HV-T101P	1-0102-PPID-T101	Vol. Control Damper	V960	150	FOA	Foul Air	
Primary Sludge Fermenter Train 1	HV-T101T	1-0102-PPID-T101	Vol. Control Damper	V960	850	FOA	Foul Air	
Primary Sludge Fermenter Train 2	HV-T101U	1-0102-PPID-T101	Vol. Control Damper	V960	850	FOA	Foul Air	
RDTs Duct	HV-T101AQ	1-0102-PPID-T101	Vol. Control Damper	V960	200	FOA	Foul Air	
Heater Coil Inlet	HV-T104A	1-0102-PPID-T102	Isolation Damper	V965	1200	FOA	Foul Air	
Heater Coil Outlet	HV-T104B	1-0102-PPID-T102	Isolation Damper	V965	1200	FOA	Foul Air	
Heater Coil By-pass	HV-T104C	1-0102-PPID-T102	Isolation Damper	V965	1200	FOA	Foul Air	
Glycol Recirculation Pumps Loop	HV-T105I	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pump P-T107 Inlet	HV-T107A	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pump P-T107 Outlet	CV-T107	1-0102-PPID-T102	Check	V603	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pump P-T107 Outlet	HV-T107B	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Glycol Recirculation Pump P-T108 Inlet	HV-T108A	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pump P-T108 Outlet	CV-T108	1-0102-PPID-T102	Check	V603	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pump P-T108 Outlet	HV-T108B	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pumps Loop	HV-T105E	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pumps Loop	HV-T105F	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pumps Loop	HV-T105G	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Glycol Recirculation Pumps Loop	HV-T105H	1-0102-PPID-T102	Ball	V307	75	GS	Glycol Supply	Supplied by Biofilter vendor
Winterization System Bypass Outlet	HV-T110B	1-0102-PPID-T103	Isolation Damper	V965	1200	FOA	Foul Air	
Humidifier Tower HUM-T110 Inlet	HV-T110A	1-0102-PPID-T103	Isolation Damper	V965	900	FOA	Foul Air	
Humidifier Tower HUM-T110 Outlet	HV-T110C	1-0102-PPID-T103	Isolation Damper	V965	900	FOA	Foul Air	
Humidifier Tower HUM-T110 Drain	HV-T110E	1-0102-PPID-T103	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Humidifier Tower HUM-T110 Drain	HV-T110F	1-0102-PPID-T103	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Humidifier Tower HUM-T110 Drain	HV-T110J	1-0102-PPID-T103	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Humidifier Tower HUM-T110 Drain	HV-T110D	1-0102-PPID-T103	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Recirculation Pump P-T111 Inlet	HV-T111A	1-0102-PPID-T104	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T111 Outlet	CV-T111	1-0102-PPID-T104	Check	V609	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T111 Outlet	HV-T111B	1-0102-PPID-T104	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T112 Inlet	HV-T112A	1-0102-PPID-T104	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T112 Outlet	CV-T112	1-0102-PPID-T104	Check	V609	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T112 Outlet	HV-T112B	1-0102-PPID-T104	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Humidifier Tower Recirculation	HV-T110H	1-0102-PPID-T104	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Humidifier Tower Recirculation	HV-T110I	1-0102-PPID-T104	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Humidifier Tower HUM-T120 Inlet	HV-T120A	1-0102-PPID-T105	Isolation Damper	V965	900	FOA	Foul Air	
Humidifier Tower HUM-T120 Outlet	HV-T120C	1-0102-PPID-T105	Isolation Damper	V965	900	FOA	Foul Air	
Humidifier Tower HUM-T120 Drain	HV-T120E	1-0102-PPID-T105	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Humidifier Tower HUM-T120 Drain	HV-T120H	1-0102-PPID-T105	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Humidifier Tower HUM-T120 Drain	HV-T120G	1-0102-PPID-T105	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Humidifier Tower HUM-T120 Drain	HV-T120D	1-0102-PPID-T105	Ball	V330	100	PD	Process Drain	Supplied by Package Vendor
Recirculation Pump P-T121 Inlet	HV-T121A	1-0102-PPID-T106	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T121 Outlet	CV-T121	1-0102-PPID-T106	Check	V609	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T121 Outlet	HV-T121B	1-0102-PPID-T106	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T122 Inlet	HV-T122A	1-0102-PPID-T106	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T122 Outlet	CV-T122	1-0102-PPID-T106	Check	V609	100	FOA	Foul Air	Supplied by Package Vendor
Recirculation Pump P-T122 Outlet	HV-T122B	1-0102-PPID-T106	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Humidifier Tower Recirculation	HV-T120F	1-0102-PPID-T106	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Humidifier Tower Recirculation	HV-T120I	1-0102-PPID-T106	Ball	V330	100	FOA	Foul Air	Supplied by Package Vendor
Biofilter Microstrainer Inlet	HV-T140A	1-0102-PPID-T107	Ball	V307	75	FSW	Flushing Water	
Biofilter Microstrainer Inlet	HV-T140B	1-0102-PPID-T107	Ball	V307	75	FSW	Flushing Water	
Biofilter Microstrainer Outlet	HV-T140D	1-0102-PPID-T107	Ball	V307	75	FSW	Flushing Water	
Biofilter Microstrainer By-pass	HV-T140C	1-0102-PPID-T107	Ball	V307	75	FSW	Flushing Water	
Biofilter Microstrainer Outlet	HV-T140J	1-0102-PPID-T107	Ball	V307	75	FSW	Flushing Water	
Biofilter TK-210 Inlet	HV-T210A	1-0102-PPID-T201	Isolation Damper	V965	900	FOA	Foul Air	
Biofilter TK-210 Outlet	HV-T210B	1-0102-PPID-T201	Isolation Damper	V965	900	FOA	Foul Air	
Biofilter TK-220 Inlet	HV-T220A	1-0102-PPID-T202	Isolation Damper	V965	900	FOA	Foul Air	
Biofilter TK-220 Outlet	HV-T220B	1-0102-PPID-T202	Isolation Damper	V965	900	FOA	Foul Air	
Biofilter TK-230 Inlet	HV-T230A	1-0102-PPID-T203	Isolation Damper	V965	900	FOA	Foul Air	
Biofilter TK-230 Outlet	HV-T230B	1-0102-PPID-T203	Isolation Damper	V965	900	FOA	Foul Air	
Process Sump Pump P-T261 Outlet	CV-T261	1-0102-PPID-T204	Check	V609	75	SPD	Sump Pump Discharge	
Process Sump Pump P-T261 Outlet	HV-T261A	1-0102-PPID-T204	Ball	V307	75	SPD	Sump Pump Discharge	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Process Sump Pump P-T262 Outlet	CV-T262	1-0102-PPID-T204	Check	V609	75	SPD	Sump Pump Discharge	
Process Sump Pump P-T262 Outlet	HV-T262A	1-0102-PPID-T204	Ball	V307	75	SPD	Sump Pump Discharge	
Process Sump Vent	HV-T260A	1-0102-PPID-T204	Ball	V307	100	PV	Process Vent	
Process Sump Foul Air	HV-T260B	1-0102-PPID-T204	Ball	V307	100	FOA	Foul Air	
Biofilter Bypass	HV-T300A	1-0102-PPID-T301	Isolation Damper	V965	1200	FOA	Foul Air	
Biofilter Exhaust Fan EF-T301 Outlet	HV-T301A	1-0102-PPID-T301	Isolation Damper	V965	1200	FOA	Foul Air	
Biofilter Exhaust Fan EF-T302 Outlet	HV-T302A	1-0102-PPID-T301	Isolation Damper	V965	1200	FOA	Foul Air	
AREA C - CHEMICAL BUILDING / ELECTRICAL BUILDING								
Sodium Bisulphite Fill	HV-C300A	1-0102-PPID-C001	Ball	V330	75	SBS	Sodium Bisulphite	
Sodium Hypochlorite Fill	HV-C200A	1-0102-PPID-C001	Ball	V330	75	SBS	Sodium Bisulphite	
Sodium Hydroxyde Fill	HV-C200B	1-0102-PPID-C001	Ball	V330	75	SBS	Sodium Bisulphite	
Ferric Chloride Fill	HV-C100A	1-0102-PPID-C001	Ball	V330	75	SBS	Sodium Bisulphite	
Flushing water	HV-C416A	1-0102-PPID-C402	Ball	V307	75	FSW	Flushing Water	
Flushing water	CV-C416	1-0102-PPID-C402	Check	V609	75	FSW	Flushing Water	
Flushing water	HV-C416B	1-0102-PPID-C402	Ball	V307	75	FSW	Flushing Water	
Polymer to RDT-D415	HV-C416C	1-0102-PPID-C402	Ball	V330	75	MP	Mixed Polymer	
Flushing water	HV-C417A	1-0102-PPID-C403	Ball	V307	75	FSW	Flushing Water	
Flushing water	CV-C417	1-0102-PPID-C403	Check	V609	75	FSW	Flushing Water	
Flushing water	HV-C417B	1-0102-PPID-C403	Ball	V307	75	FSW	Flushing Water	
Polymer to RDT-D416	HV-C417C	1-0102-PPID-C403	Ball	V330	75	MP	Mixed Polymer	
Flushing water	HV-C418A	1-0102-PPID-C404	Ball	V307	75	FSW	Flushing Water	
Flushing water	CV-C418	1-0102-PPID-C404	Check	V609	75	FSW	Flushing Water	
Flushing water	HV-C418B	1-0102-PPID-C404	Ball	V307	75	FSW	Flushing Water	
Polymer to RDT-D417	HV-C418C	1-0102-PPID-C404	Ball	V330	75	MP	Mixed Polymer	
Downstream MXR-C418	HV-C415C	1-0102-PPID-C404	Ball	V330	75	MP	Mixed Polymer	
Flushing water	HV-C456A	1-0102-PPID-C409	Ball	V307	75	FSW	Flushing Water	
Flushing water	CV-C456	1-0102-PPID-C409	Check	V609	75	FSW	Flushing Water	
Flushing water	HV-C456B	1-0102-PPID-C409	Ball	V307	75	FSW	Flushing Water	
Flushing water	HV-C457A	1-0102-PPID-C410	Ball	V307	75	FSW	Flushing Water	
Flushing water	CV-C457	1-0102-PPID-C410	Check	V609	75	FSW	Flushing Water	
Flushing water	HV-C457B	1-0102-PPID-C410	Ball	V307	75	FSW	Flushing Water	
Flushing water	HV-C476A	1-0102-PPID-C412	Ball	V307	75	FSW	Flushing Water	
Flushing water	CV-C476	1-0102-PPID-C412	Check	V609	75	FSW	Flushing Water	
Flushing water	HV-C476B	1-0102-PPID-C412	Ball	V307	75	FSW	Flushing Water	
Polymer to Mixed Liquor Channel	HV-C471H	1-0102-PPID-C412	Ball	V330	75	MP	Mixed Polymer	
BUILDING MECHANICAL								
AREA G - HEADWORKS								
Sump Pump Discharge	CV-G522	1-0102-PPID-G505	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	CV-G521	1-0102-PPID-G505	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-G521A	1-0102-PPID-G505	Ball	V315	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-G522A	1-0102-PPID-G505	Ball	V315	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	CV-G532	1-0102-PPID-G506	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	CV-G531	1-0102-PPID-G506	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-G531A	1-0102-PPID-G506	Ball	V315	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-G532A	1-0102-PPID-G506	Ball	V315	75	SPD	Sump Pump Discharge	
HC-G620-2 Feed Isolation	HV-G620C	1-0102-PPID-G608	Ball	V315	100	GS	Glycol Supply	
HC-G620-2 Return Isolation	HV-G620D	1-0102-PPID-G608	Ball	V315	100	GR	Glycol Return	
HC-G620-2 Bypass Balancing	HV-G620A	1-0102-PPID-G608	Balancing	V472	100	GR	Glycol Return	

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Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
HC-G620-2 Balancing	HV-G620B	1-0102-PPID-G608	Balancing	V472	100	GR	Glycol Return	
HC-G620-1 Feed Isolation	HV-G620G	1-0102-PPID-G608	Ball	V315	75	GS	Glycol Supply	
HC-G620-1 Return Isolation	HV-G620H	1-0102-PPID-G608	Ball	V315	75	GR	Glycol Return	
HC-G620-1 Balancing	HV-G620J	1-0102-PPID-G608	Balancing	V472	75	GR	Glycol Return	
HC-G610-2 Feed Isolation	HV-G610M	1-0102-PPID-G617	Ball	V315	75	GS	Glycol Supply	
HC-G610-2 Return Isolation	HV-G610J	1-0102-PPID-G617	Ball	V315	75	GR	Glycol Return	
HC-G610-2 Bypass Balancing	HV-G610G	1-0102-PPID-G617	Balancing	V472	75	GR	Glycol Return	
HC-G610-2 Balancing	HV-G610H	1-0102-PPID-G617	Balancing	V472	75	GR	Glycol Return	
HC-G610-1 Feed Isolation	HV-G610A	1-0102-PPID-G617	Ball	V315	75	GS	Glycol Supply	
HC-G610-1 Return Isolation	HV-G610B	1-0102-PPID-G617	Ball	V315	75	GR	Glycol Return	
HC-G610-1 Balancing	HV-G610C	1-0102-PPID-G617	Balancing	V472	75	GR	Glycol Return	
HC-G630-2 Feed Isolation	HV-G630M	1-0102-PPID-G618	Ball	V315	75	GS	Glycol Supply	
HC-G630-2 Return Isolation	HV-G630J	1-0102-PPID-G618	Ball	V315	75	GR	Glycol Return	
HC-G630-2 Bypass Balancing	HV-G630G	1-0102-PPID-G618	Balancing	V472	75	GR	Glycol Return	
HC-G630-2 Balancing	HV-G630H	1-0102-PPID-G618	Balancing	V472	75	GR	Glycol Return	
HC-G630-1 Feed Isolation	HV-G630A	1-0102-PPID-G618	Ball	V315	75	GS	Glycol Supply	
HC-G630-1 Return Isolation	HV-G630B	1-0102-PPID-G618	Ball	V315	75	GR	Glycol Return	
HC-G630-1 Balancing	HV-G630C	1-0102-PPID-G618	Balancing	V472	75	GR	Glycol Return	
P-G677 Suction Isolation	HV-G677A	1-0102-PPID-G623	Ball	V315	75	CDS	Condensing Water Supply	
P-G677 Discharge Isolation	HV-G677B	1-0102-PPID-G623	Ball	V315	75	CDS	Condensing Water Supply	
P-G677 Discharge Check	CV-G677	1-0102-PPID-G623	Tripple Duty	V475	75	CDS	Condensing Water Supply	
P-G678 Suction Isolation	HV-G678A	1-0102-PPID-G623	Ball	V315	75	CDS	Condensing Water Supply	
P-G678 Discharge Isolation	HV-G678B	1-0102-PPID-G623	Ball	V315	75	CDS	Condensing Water Supply	
P-G678 Discharge Check	CV-G678	1-0102-PPID-G623	Tripple Duty	V475	75	CDS	Condensing Water Supply	
Flushing Water to heat exchanger HE-G673	BVA-G673	1-0102-PPID-G623	Check	V604	100	FSW	Flushing Water	
HE-G673 Flushing Feed Isolation	HV-G673B	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
HE-G673 Glycol Isolation	HV-G673A	1-0102-PPID-G623	Ball	V315	100	GR	Glycol Return	
HE-G673 Glycol Isolation	HV-G673C	1-0102-PPID-G623	Ball	V315	100	GR	Glycol Return	
TV-G6731 Isolation	HV-G673D	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
TV-G6731 Isolation	HV-G673E	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
TV-G6739-2 Isolation	HV-G673G	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
TV-G6761 Isolation	HV-G675K	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
TV-G6761 Isolation	HV-G675J	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
Heat Pump Condenser Water	HV-G676C	1-0102-PPID-G623	Balancing	V472	75	CDR	Condensing Water Return	
Heat Pump Condenser Water	HV-G675C	1-0102-PPID-G623	Balancing	V472	75	CDR	Condensing Water Return	
Heat Pump Conderser Loop Isolation	HV-G676B	1-0102-PPID-G623	Ball	V315	75	FSW	Flushing Water	
TV-G6761 Bypass	HV-G676K	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
TV-G6761 Isolation	HV-G676J	1-0102-PPID-G623	Ball	V315	100	FSW	Flushing Water	
P-G674 Suction Isolation	HV-G674A	1-0102-PPID-G623	Ball	V315	100	GS	Glycol Supply	
P-G674 Discharge Isolation	HV-G674B	1-0102-PPID-G623	Ball	V315	100	GS	Glycol Supply	
P-G674 Discharge Check	CV-G674	1-0102-PPID-G623	Tripple Duty	V475	100	GS	Glycol Supply	
FIT-G6621 Isolation	HV-G660J	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
FIT-G6621 Isolation	HV-G660K	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
P-G660 Suction Isolation	HV-G660A	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
P-G660 Discharge Isolation	HV-G660B	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
P-G660 Discharge Check	CV-G660	1-0102-PPID-G624	Tripple Duty	V475	150	HWS	Hot Water Supply	
P-G661 Suction Isolation	HV-G661A	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
P-G661 Discharge Isolation	HV-G661B	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
P-G661 Discharge Check	CV-G661	1-0102-PPID-G624	Tripple Duty	V475	150	HWS	Hot Water Supply	

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Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Primary Loop Isolation	HV-G660H	1-0102-PPID-G624	Ball	V315	150	HWS	Hot Water Supply	
Primary Loop Isolation	HV-G661H	1-0102-PPID-G624	Ball	V315	150	HWR	Hot Water Return	
Primary Loop Balancing	HV-G661J	1-0102-PPID-G624	Balancing	V472	150	HWR	Hot Water Return	
Primary Loop Isolation	HV-G661K	1-0102-PPID-G624	Ball	V315	150	HWR	Hot Water Return	
P-G665 Suction Isolation	HV-G665A	1-0102-PPID-G625	Ball	V315	150	GS	Glycol Supply	
P-G665 Discharge Isolation	HV-G665B	1-0102-PPID-G625	Ball	V315	150	GS	Glycol Supply	
P-G665 Discharge Check	CV-G665	1-0102-PPID-G625	Tripple Duty	V475	150	GS	Glycol Supply	
P-G666 Suction Isolation	HV-G666A	1-0102-PPID-G625	Ball	V315	150	GS	Glycol Supply	
P-G666 Discharge Isolation	HV-G666B	1-0102-PPID-G625	Ball	V315	150	GS	Glycol Supply	
P-G666 Discharge Check	CV-G666	1-0102-PPID-G625	Tripple Duty	V475	150	GS	Glycol Supply	
HE-G663 Glycol Isolation	HV-G663P	1-0102-PPID-G625	Ball	V315	150	GR	Glycol Return	
HE-G663 Glycol Isolation	HV-G663A	1-0102-PPID-G625	Ball	V315	150	GS	Glycol Supply	
HE-G663 Hot Water Isolation	HV-G663C	1-0102-PPID-G625	Ball	V315	150	HWS	Hot Water Supply	
HE-G663 Hot Water Isolation	HV-G663F	1-0102-PPID-G625	Ball	V315	150	HWR	Hot Water Return	
HE-G663 Bypass Balancing	HV-G663D	1-0102-PPID-G625	Balancing	V472	150	HWR	Hot Water Return	
HE-G663 Balancing	HV-G663E	1-0102-PPID-G625	Balancing	V472	150	HWR	Hot Water Return	
AREA R - BIOREACTORS / BLOWER BUILDING								
Glycol Pump Discharge	HV-R610A	1-0102-PPID-R603	Ball	V315	75	GS	Glycol Supply	
Glycol Pump Suction	HV-R610B	1-0102-PPID-R603	Ball	V315	75	GR	Glycol Return	
Glycol Pump Discharge	HV-R626C	1-0102-PPID-R604	Ball	V315	75	GS	Glycol Supply	
Glycol Pump Discharge	HV-R626F	1-0102-PPID-R604	Ball	V315	75	GS	Glycol Supply	
Glycol Pump Discharge	CV-R626	1-0102-PPID-R604	Check	V604	75	GS	Glycol Supply	
Glycol Pump Suction	HV-R626B	1-0102-PPID-R604	Ball	V315	75	GR	Glycol Return	
Glycol Pump Diverting	HV-R626A	1-0102-PPID-R604	Balancing	V472	75	GR	Glycol Supply	
Glycol Pump Suction	HV-R626D	1-0102-PPID-R604	Balancing	V472	75	GR	Glycol Supply	
Glycol Pump Suction	HV-R626E	1-0102-PPID-R604	Ball	V315	75	GR	Glycol Supply	
Sump Pump Discharge	CV-R501	1-0102-PPID-R501	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	CV-R502	1-0102-PPID-R501	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-R501A	1-0102-PPID-R501	Ball	V315	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-R502A	1-0102-PPID-R501	Ball	V315	75	SPD	Sump Pump Discharge	
Bioreactor 1 Foul Air Suction	HV-R101G	1-0102-PPID-R601	Vol. Control Damper	V960	600	FOA	Foul Air	
Bioreactor 2 Foul Air Suction	HV-R111G	1-0102-PPID-R601	Vol. Control Damper	V960	600	FOA	Foul Air	
Bioreactor 3 Foul Air Suction	HV-R121G	1-0102-PPID-R601	Vol. Control Damper	V960	600	FOA	Foul Air	
Primary Effluent Channel Foul Air Suction	HV-R101N	1-0102-PPID-R601	Vol. Control Damper	V960	300	FOA	Foul Air	
Primary Effluent Channel Foul Air Suction	HV-R111L	1-0102-PPID-R601	Vol. Control Damper	V960	300	FOA	Foul Air	
Primary Effluent Channel Foul Air Suction	HV-R121L	1-0102-PPID-R601	Vol. Control Damper	V960	300	FOA	Foul Air	
RAS Effluent Channel Foul Air Suction	HV-R101M	1-0102-PPID-R601	Vol. Control Damper	V960	250	FOA	Foul Air	
RAS Effluent Channel Foul Air Suction	HV-R111K	1-0102-PPID-R601	Vol. Control Damper	V960	250	FOA	Foul Air	
RAS Effluent Channel Foul Air Suction	HV-R121M	1-0102-PPID-R601	Vol. Control Damper	V960	250	FOA	Foul Air	
WAS Sump Foul Air Suction	HV-R101Q	1-0102-PPID-R601	Vol. Control Damper	V960	250	FOA	Foul Air	
EF-R601 Outlet	HV-R601A	1-0102-PPID-R602	Isolation Damper	V965	1000	FOA	Foul Air	
EF-R602 Outlet	HV-R602A	1-0102-PPID-R602	Isolation Damper	V965	1000	FOA	Foul Air	
AREA S - SECONDARY CLARIFIERS								
Glycol Pump Discharge	CV-S664	1-0102-PPID-S627	Triple Duty	V475	100	GS	Glycol Supply	
Glycol Pump Suction	HV-S664A	1-0102-PPID-S627	Ball	V315	100	GR	Glycol Return	
Glycol Pump Discharge	HV-S664B	1-0102-PPID-S627	Ball	V315	100	GS	Glycol Supply	
Flushing Water Intake	HV-S663C	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Glycol Return	HV-S663D	1-0102-PPID-S627	Ball	V315	100	GR	Glycol Return	
Glycol Return	HV-S663E	1-0102-PPID-S627	Ball	V315	100	GR	Glycol Return	

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Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Flushing Water Return	HV-S663F	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Flushing Water Intake	BVA-S663A	1-0102-PPID-S627	Check	V604	100	FSW	Flushing Water	
Glycol Supply to AHU-S630	HV-S630A	1-0102-PPID-S622	Ball	V315	75	GS	Glycol Supply	
Glycol Return from AHU-S630	HV-S630B	1-0102-PPID-S622	Ball	V315	75	GR	Glycol Return	
Glycol Return from AHU-S630	HV-S630D	1-0102-PPID-S622	Balancing	V472	75	GR	Glycol Return	
Glycol Supply to AHU-S650	HV-S650A	1-0102-PPID-S623	Ball	V315	75	GS	Glycol Supply	
Glycol Return from AHU-S650	HV-S650B	1-0102-PPID-S623	Ball	V315	75	GR	Glycol Return	
Glycol Return from AHU-S650	HV-S650D	1-0102-PPID-S623	Balancing	V472	75	GR	Glycol Return	
Flushing Water Intake	HV-S674A	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Flushing Water drain from Automatic Strainer	HV-S674E	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Flushing Water Intake	HV-S674F	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Flushing Water Intake	HV-S673G	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Flushing Water drain from Automatic Strainer	HV-S673J	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
Flushing Water Intake	HV-S673K	1-0102-PPID-S627	Ball	V315	100	FSW	Flushing Water	
AREA K - HIGH RATE CLARIFIERS								
Glycol Supply to AHU-K610	HV-K610A	1-0102-PPID-K601	Balancing	V472	100	GS	Glycol Supply	
Glycol Return from AHU-K610	HV-K610B	1-0102-PPID-K601	Balancing	V472	100	GR	Glycol Return	
Glycol Supply to AHU-K610	HV-K610C	1-0102-PPID-K601	Ball	V315	100	GS	Glycol Supply	
Glycol Return from AHU-K610	HV-K610D	1-0102-PPID-K601	Ball	V315	100	GR	Glycol Return	
Glycol Supply to AHU-K620	HV-K620A	1-0102-PPID-K602	Balancing	V472	65	GS	Glycol Supply	
Glycol Return from AHU-K620	HV-K620B	1-0102-PPID-K602	Balancing	V472	65	GR	Glycol Return	
Glycol Supply to AHU-K620	HV-K620C	1-0102-PPID-K602	Ball	V315	65	GS	Glycol Supply	
Glycol Return from AHU-K620	HV-K620D	1-0102-PPID-K602	Ball	V315	65	GR	Glycol Return	
Glycol Supply to AHU-K630	HV-K630A	1-0102-PPID-K603	Balancing	V472	65	GS	Glycol Supply	
Glycol Return from AHU-K630	HV-K630B	1-0102-PPID-K603	Balancing	V472	65	GR	Glycol Return	
Glycol Supply to AHU-K630	HV-K630C	1-0102-PPID-K603	Ball	V315	65	GS	Glycol Supply	
Glycol Return from AHU-K630	HV-K630D	1-0102-PPID-K603	Ball	V315	65	GR	Glycol Return	
Glycol Supply to AHU-K640	HV-K640A	1-0102-PPID-K604	Balancing	V472	38	GS	Glycol Supply	
Glycol Return from AHU-K640	HV-K640B	1-0102-PPID-K604	Balancing	V472	38	GR	Glycol Return	
Glycol Supply to AHU-K640	HV-K640C	1-0102-PPID-K604	Ball	V315	38	GS	Glycol Supply	
Glycol Return from AHU-K640	HV-K640D	1-0102-PPID-K604	Ball	V315	38	GR	Glycol Return	
Hot Water Pump Discharge Valve	CV-K660	1-0102-PPID-K605	Triple Duty	V475	100	HWS	Hot Water Supply	
Hot Water Pump Discharge Valve	CV-K661	1-0102-PPID-K605	Triple Duty	V475	100	HWS	Hot Water Supply	
Hot Water Pump Suction Isolation Valve	HV-K660A	1-0102-PPID-K605	Ball	V315	100	HWS	Hot Water Supply	
Hot Water Pump Discharge Isolation Valve	HV-K660B	1-0102-PPID-K605	Ball	V315	100	HWS	Hot Water Supply	
Flow Element Isolation Upstream	HV-K660J	1-0102-PPID-K605	Ball	V315	100	HWS	Hot Water Supply	
Flow Element Isolation Downstream	HV-K660K	1-0102-PPID-K605	Ball	V315	100	HWS	Hot Water Supply	
Hot Water Supply Main Line Isolation	HV-K660H	1-0102-PPID-K605	Ball	V315	100	HWR	Hot Water Return	
Hot Water Return Main Line Balancing	HV-K661J	1-0102-PPID-K605	Balancing	V500	100	HWS	Hot Water Supply	
Hot Water Return Secondary Isolation	HV-K661K	1-0102-PPID-K605	Ball	V315	100	HWR	Hot Water Return	
Hot Water Return Main Line Isolation	HV-K661H	1-0102-PPID-K605	Ball	V315	100	HWR	Hot Water Return	
Hot Water Pump Suction Isolation Valve	HV-K661A	1-0102-PPID-K605	Ball	V315	100	HWS	Hot Water Supply	
Hot Water Pump Discharge Isolation Valve	HV-K661B	1-0102-PPID-K605	Ball	V315	100	HWS	Hot Water Supply	
Glycol Pump Discharge Check Valve	CV-K665	1-0102-PPID-K606	Triple Duty	V475	100	HWS	Hot Water Supply	
Glycol Pump Discharge Check Valve	CV-K666	1-0102-PPID-K606	Triple Duty	V475	100	HWS	Hot Water Supply	
Glycol Supply from Heat Exchanger	HV-K663A	1-0102-PPID-K606	Ball	V315	100	GS	Glycol Supply	
Glycol Return to Heat Exchanger	HV-K663P	1-0102-PPID-K606	Ball	V315	100	GR	Glycol Return	
Hot Water Return from Heat Exchanger	HV-K663F	1-0102-PPID-K606	Ball	V315	100	HWR	Hot Water Return	
Hot Water Supply to Heat Exchanger	HV-K663C	1-0102-PPID-K606	Ball	V315	100	HWS	Hot Water Supply	

SEWPCC UPGRADING/EXPANSION PROJECT

Manual Valve Schedule (75 mm and Larger)

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Remarks
Heat Exchanger Balancing Valve	HV-K663E	1-0102-PPID-K606	Balancing	V472	100	HWS	Hot Water Supply	
Hot Water Bypass Balancing Valve	HV-K663D	1-0102-PPID-K606	Balancing	V472	100	HWR	Hot Water Return	
Glycol Pump Suction Isolation	HV-K665A	1-0102-PPID-K606	Ball	V315	100	HWS	Hot Water Supply	
Glycol Pump Discharge Isolation	HV-K665B	1-0102-PPID-K606	Ball	V315	100	HWS	Hot Water Supply	
Glycol Pump Suction Isolation	HV-K666A	1-0102-PPID-K606	Ball	V315	100	GS	Glycol Supply	
Glycol Pump Discharge Isolation	HV-K666B	1-0102-PPID-K606	Ball	V315	100	HWS	Hot Water Supply	
AREA C - CHEMICAL BUILDING / ELECTRICAL BUILDING								
Sump Pump Discharge	CV-C501	1-0102-PPID-C502	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	CV-C502	1-0102-PPID-C502	Check	V604	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-C501A	1-0102-PPID-C502	Ball	V315	75	SPD	Sump Pump Discharge	
Sump Pump Discharge	HV-C502A	1-0102-PPID-C502	Ball	V315	75	SPD	Sump Pump Discharge	
Potable water supply from City of Winnipeg watermain	HV-C530G	1-0102-PPID-C503	Ball	V315	100	PW	Potable Water	
Potable water supply from City of Winnipeg watermain	HV-C530H	1-0102-PPID-C503	Ball	V315	100	PW	Potable Water	
Potable water supply from City of Winnipeg watermain	HV-C530I	1-0102-PPID-C503	Ball	V315	100	PW	Potable Water	
Potable water supply from City of Winnipeg watermain	HV-C530J	1-0102-PPID-C503	Ball	V315	100	PW	Potable Water	
Natural gas supply	HV-C511B	1-0102-PPID-C505	Lubricated Plug	V422	100	NG	Natural Gas	
Natural gas supply	HV-C511C	1-0102-PPID-C505	Lubricated Plug	V422	100	NG	Natural Gas	
Natural gas supply	HV-C511E	1-0102-PPID-C505	Lubricated Plug	V422	75	NG	Natural Gas	

General Notes:

1. This schedule is provided for the Contractor's convenience and shall not be taken as complete.
2. Valves to be supplied and installed under this contract unless otherwise indicated.
3. n/a = not applicable; valve supplied by others, installed under this contract.
4. Refer to the scope of pre-purchased equipment for valves that are supplied by others to be installed under this contract.

SEWPCC UPGRADING/EXPANSION PROJECT

Electric Motor Actuated Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	Service [Note 1]	NEMA 250 Type	Voltage/ Phase	Travel Time (sec)	Control Features [Note 2]	Remarks
PROCESS MECHANICAL															
AREA G - HEADWORKS															
Raw Sewage Pumping															
Raw Sewage Pump P-G101 Recycle Inlet	XV-G1062	1-0102-PPID-G101	Knife gate	V150	300	RS	Raw Sewage			O/C	6	600/3	≤ 60	C,D,H	
Flushing Water to Raw Sewage Pump P-G101 Recycle	XV-G1063	1-0102-PPID-G101	Ball	V308	50	FSW	Flushing Water			O/C	6	120/1	≤ 30	C,E	
Raw Sewage Pump P-G102 Inlet	XV-G1221	1-0102-PPID-G103	Knife gate	V155	900	RS	Raw Sewage	60	1435	O/C	6	600/3	≤ 120	C,D,I	
Screening															
Screenings to Washer/Compactor WCP-G231	XV-G2311	1-0102-PPID-G203	Knife gate	V150	400	SCS	Screenings		18.9	O/C	7	600/3	≤ 60	C,D,H	Supplied by screening equipment vendor including remote control station.
Screenings to Washer/Compactor WCP-G232	XV-G2321	1-0102-PPID-G203	Knife gate	V150	400	SCS	Screenings		18.9	O/C	7	600/3	≤ 60	C,D,H	Supplied by screening equipment vendor including remote control station.
Screenings Sluice Isolation Valve	XV-G2301	1-0102-PPID-G203	Gate	V138	400	SCS	Screenings		18.9	O/C	7	600/3	≤ 60	C,D	Provide actuator with intumescent coating for fire protection. Provide remote control station.
Grit Removal															
Flushing Water to Grit Tank 1	XV-G3211	1-0102-PPID-G301	Ball	V308	25	FSW	Flushing Water		1.3	O/C	4X	120/1	≤ 30	C,E	
Flushing Water to Grit Tank 2	XV-G3221	1-0102-PPID-G301	Ball	V308	25	FSW	Flushing Water		1.3	O/C	4X	120/1	≤ 30	C,E	
Grit Slurry Pumps Suction Cross-connection	XV-G3236	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	
Grit Slurry Pumps Suction Cross-connection	XV-G3256	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	
Grit Slurry Pumps Discharge Cross-connection	XV-G3237	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Slurry Pumps Discharge Cross-connection	XV-G3257	1-0102-PPID-G302	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Cyclone CYC-G341-1 Inlet	XV-G3411	1-0102-PPID-G305	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Cyclone CYC-G341-2 Inlet	XV-G3412	1-0102-PPID-G305	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Cyclone CYC-G341-3 Inlet	XV-G3413	1-0102-PPID-G305	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Cyclone CYC-G342-1 Inlet	XV-G3421	1-0102-PPID-G305	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Cyclone CYC-G342-2 Inlet	XV-G3422	1-0102-PPID-G305	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Grit Cyclone CYC-G342-3 Inlet	XV-G3423	1-0102-PPID-G305	Knife gate	V150	100	GRS	Grit Slurry		18.9	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station.
Wash Water															
Wash Water to Screen SCR-G211	XV-G2112	1-0102-PPID-G201	Ball	V308	38	FSW	Flushing Water		2.5	O/C	7	120/1	≤ 30	J	Supplied by screen vendor.
Wash Water to Screen SCR-G212	XV-G2122	1-0102-PPID-G201	Ball	V308	38	FSW	Flushing Water		2.5	O/C	7	120/1	≤ 30	J	Supplied by screen vendor.
Wash Water to Screen SCR-G213	XV-G2132	1-0102-PPID-G202	Ball	V308	38	FSW	Flushing Water		2.5	O/C	7	120/1	≤ 30	J	Supplied by screen vendor.
Wash Water to Screen SCR-G214	XV-G2142	1-0102-PPID-G202	Ball	V308	38	FSW	Flushing Water		2.5	O/C	7	120/1	≤ 30	J	Supplied by screen vendor.
Wash Water to Screen SCR-G211	XV-G5341	1-0102-PPID-G508	Three-way ball	V321	38	FSW	Flushing Water		2.5	O/C	4X	120/1	≤ 30	C,E	
Wash Water to Screen SCR-G212	XV-G5342	1-0102-PPID-G508	Three-way ball	V321	38	FSW	Flushing Water		2.5	O/C	4X	120/1	≤ 30	C,E	
Wash Water to Screen SCR-G213	XV-G5343	1-0102-PPID-G508	Three-way ball	V321	38	FSW	Flushing Water		2.5	O/C	4X	120/1	≤ 30	C,E	
Wash Water to Screen SCR-G214	XV-G5344	1-0102-PPID-G508	Three-way ball	V321	38	FSW	Flushing Water		2.5	O/C	4X	120/1	≤ 30	C,E	
Wash Water to Grit Classifier GRP-G341	XV-G3414	1-0102-PPID-G305	Ball	V308	25	FSW	Flushing Water		1	O/C	4X	120/1	≤ 30	C,E	
Wash Water to Grit Classifier GRP-G342	XV-G3424	1-0102-PPID-G305	Ball	V308	25	FSW	Flushing Water		1	O/C	4X	120/1	≤ 30	C,E	
Non-Potable Water (backup) for Wash Water	XV-G5345	1-0102-PPID-G508	Ball	V308	38	NPW	Non-Potable Water		2.5	O/C	4X	120/1	≤ 30	C,E	
Non-Potable Water (backup) for Wash Water	XV-G2303	1-0102-PPID-G203	Ball	V308	25	NPW	Non-Potable Water			O/C	4X	120/1	≤ 30	C,E	
Non-Potable Water (backup) for Wash Water	XV-G3401	1-0102-PPID-G305	Ball	V308	25	NPW	Non-Potable Water			O/C	4X	120/1	≤ 30	C,E	
Automatic Strainer STR-G535 Backwash Outlet	XV-G5351	1-0102-PPID-G508	Ball	V308	25	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by automatic strainer vendor.
Automatic Strainer STR-G536 Backwash Outlet	XV-G5361	1-0102-PPID-G508	Ball	V308	25	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by automatic strainer vendor.
Channel Aeration															
Air Low Pressure to Grit Tanks 3 & 4 Effluent Channel	XV-G3312	1-0102-PPID-G303	Butterfly	V510	150	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	
Air Low Pressure to Grit Tanks 3 & 4 Influent Channel	XV-G3322	1-0102-PPID-G303	Butterfly	V510	100	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	
AREA R - BIOREACTORS / BLOWER BUILDING															
Bioreactor 1															
Primary Effluent to Pre-anoxic Zone Inlet	FV-R1011	1-0102-PPID-R101	Butterfly	V500	350	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	
RAS to Pre-anoxic Zone Inlet	LV-R1014	1-0102-PPID-R101	Butterfly	V500	600	RAS	Return Activated Sludge			M	4X	600/3	≤ 60	C,D,G,H	
Fermented Sludge Filtrate to Anaerobic Zone Inlet	FV-R1013	1-0102-PPID-R101	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
Fermented Sludge Filtrate to Anoxic Zone Inlet	FV-R1023	1-0102-PPID-R101	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
Primary Effluent to Anaerobic Zone Inlet	LV-R1024	1-0102-PPID-R101	Rectang. Butterfly valve	V515	711 x 2372	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	Rectangular butterfly gate. See drawings for details.
Primary Effluent to Anoxic Zone Inlet	LV-R1034	1-0102-PPID-R101	Rectang. Butterfly valve	V515	711 x 2372	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	Rectangular butterfly gate. See drawings for details.
Flushing Service Water to Spray Nozzles	XV-R1049	1-0102-PPID-R102	Eccentric plug	V405	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Air Low Pressure to IFAS Distribution Channel	XV-R1046	1-0102-PPID-R102	Butterfly	V514	100	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to IFAS Zone	FV-R1047	1-0102-PPID-R102	Butterfly	V514	400	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Air Low Pressure to IFAS Media Screens	XV-R1048	1-0102-PPID-R102	Butterfly	V514	75	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to Post Aerobic Zone	FV-R1056	1-0102-PPID-R102	Butterfly	V514	100	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Air Low Pressure to Post Aerobic Zone	FV-R1057	1-0102-PPID-R102	Butterfly	V514	100	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Bioreactor 2															
Primary Effluent to Pre-anoxic Zone Inlet	FV-R1111	1-0102-PPID-R103	Butterfly	V500	350	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	
RAS to Pre-anoxic Zone Inlet	LV-R1114	1-0102-PPID-R103	Butterfly	V500	600	RAS	Return Activated Sludge			M	4X	600/3	≤ 60	C,D,G,H	

SEWPCC UPGRADING/EXPANSION PROJECT

Electric Motor Actuated Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	Service [Note 1]	NEMA 250 Type	Voltage/ Phase	Travel Time (sec)	Control Features [Note 2]	Remarks
Fermented Sludge Filtrate to Anaerobic Zone Inlet	FV-R1113	1-0102-PPID-R103	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
Fermented Sludge Filtrate to Anoxic Zone Inlet	FV-R1123	1-0102-PPID-R103	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
Primary Effluent to Anaerobic Zone Inlet	LV-R1124	1-0102-PPID-R103	Rectang. Butterfly valve	V515	711 x 2372	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	Rectangular butterfly gate. See drawings for details.
Primary Effluent to Anoxic Zone Inlet	LV-R1134	1-0102-PPID-R103	Rectang. Butterfly valve	V515	711 x 2372	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	Rectangular butterfly gate. See drawings for details.
Flushing Service Water to Spray Nozzles	XV-R1149	1-0102-PPID-R104	Eccentric plug	V405	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Air Low Pressure to IFAS Distribution Channel	XV-R1146	1-0102-PPID-R104	Butterfly	V514	100	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to IFAS Zone	FV-R1147	1-0102-PPID-R104	Butterfly	V514	400	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Air Low Pressure to IFAS Media Screens	XV-R1148	1-0102-PPID-R104	Butterfly	V514	75	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to Post Aerobic Zone	FV-R1156	1-0102-PPID-R104	Butterfly	V514	100	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Air Low Pressure to Post Aerobic Zone	FV-R1157	1-0102-PPID-R104	Butterfly	V514	100	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Bioreactor 3															
Primary Effluent to Pre-anoxic Zone Inlet	FV-R1211	1-0102-PPID-R105	Butterfly	V500	350	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	
RAS to Pre-anoxic Zone Inlet	LV-R1214	1-0102-PPID-R105	Butterfly	V500	600	RAS	Return Activated Sludge			M	4X	600/3	≤ 60	C,D,G,H	
Fermented Sludge Filtrate to Anaerobic Zone Inlet	FV-R1213	1-0102-PPID-R105	Eccentric plug	V405	100	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
Fermented Sludge Filtrate to Anoxic Zone Inlet	FV-R1223	1-0102-PPID-R105	Eccentric plug	V405	75	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
Primary Effluent to Anaerobic Zone Inlet	LV-R1224	1-0102-PPID-R105	Rectang. Butterfly valve	V515	711 x 2372	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	Rectangular butterfly gate. See drawings for details.
Primary Effluent to Anoxic Zone Inlet	LV-R1234	1-0102-PPID-R105	Rectang. Butterfly valve	V515	711 x 2372	PE	Primary Effluent			M	4X	600/3	≤ 60	C,D,G,H	Rectangular butterfly gate. See drawings for details.
Flushing Service Water to Spray Nozzles	XV-R1249	1-0102-PPID-R106	Eccentric plug	V405	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Air Low Pressure to IFAS Distribution Channel	XV-R1246	1-0102-PPID-R106	Butterfly	V514	100	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to IFAS Zone	FV-R1247	1-0102-PPID-R106	Butterfly	V514	400	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Air Low Pressure to IFAS Media Screens	XV-R1248	1-0102-PPID-R106	Butterfly	V514	75	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to Post Aerobic Zone	FV-R1256	1-0102-PPID-R106	Butterfly	V514	100	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Air Low Pressure to Post Aerobic Zone	FV-R1257	1-0102-PPID-R106	Butterfly	V514	100	ALP	Air, Low Pressure			M	4X	600/3	≤ 30	C,D,G,H	Provide remote control station
Miscelleaneous															
WAS RDT Feed Pumps Discharge Cross-connection	XV-R3013	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge			O/C	4X	600/3	≤ 30	C,D,H	
WAS RDT Feed Pumps Discharge Cross-connection	XV-R3033	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge			O/C	4X	600/3	≤ 30	C,D,H	
WAS Mixing Pump P-R304 Outlet to Scum Nozzle	XV-R3041	1-0102-PPID-R301	Eccentric plug	V405	150	WAS	Waste Activated Sludge			O/C	4X	600/3	≤ 30	C,D,H	
Blower Building															
Blower B-R201 Blowoff Outlet	XV-R2015	1-0102-PPID-R201	N/A	N/A	N/A	ALP	Air, Low Pressure			O/C	4X			J	Supplied by blower vendor.
Blower B-R202 Blowoff Outlet	XV-R2025	1-0102-PPID-R201	N/A	N/A	N/A	ALP	Air, Low Pressure			O/C	4X			J	Supplied by blower vendor.
Blower B-R203 Blowoff Outlet	XV-R2035	1-0102-PPID-R202	N/A	N/A	N/A	ALP	Air, Low Pressure			O/C	4X			J	Supplied by blower vendor.
Blower B-R204 Blowoff Outlet	XV-R2045	1-0102-PPID-R202	N/A	N/A	N/A	ALP	Air, Low Pressure			O/C	4X			J	Supplied by blower vendor.
Blower B-R205 Blowoff Outlet	XV-R2055	1-0102-PPID-R203	N/A	N/A	N/A	ALP	Air, Low Pressure			O/C	4X			J	Supplied by blower vendor.
Blower B-R206 Blowoff Outlet	XV-R2065	1-0102-PPID-R203	N/A	N/A	N/A	ALP	Air, Low Pressure			O/C	4X			J	Supplied by blower vendor.
Air Low Pressure to Hoar Frost	XV-R2001	1-0102-PPID-R201	Butterfly	V514	150	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	
Air Low Pressure to PE Channel	XV-R2201	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to RAS Channel	XV-R2202	1-0102-PPID-R102	Butterfly	V514	150	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
Air Low Pressure to Mixed Liquor Channel	XV-R1305	1-0102-PPID-R107	Butterfly	V514	150	ALP	Air, Low Pressure			O/C	4X	600/3	≤ 30	C,D,H	Set valve opening limit to 25%
AREA S - SECONDARY CLARIFIERS															
Clarifier 4 ML Inlet	FV-S1421	1-0102-PPID-S105	Butterfly	V500	900	ML	Mixed Liquor		1100	M	4X	600/3	≤ 60	C,D,G,H	
Clarifier 5 ML Inlet	FV-S1521	1-0102-PPID-S106	Butterfly	V500	900	ML	Mixed Liquor		1100	M	4X	600/3	≤ 60	C,D,G,H	
Sludge transfer pump P-S401 outlet	XV-S4013	1-0102-PPID-S208	Ball	V315	200	STS	Southend Thickened Sludge	400	8.3	O/C	4X	600/3	≤ 30	C,D,H	
Sludge transfer pump P-S402 outlet	XV-S4023	1-0102-PPID-S208	Ball	V315	200	STS	Southend Thickened Sludge	400	8.3	O/C	4X	600/3	≤ 30	C,D,H	
Flushing water for scum pumps P-S316 and P-S317	XV-S3162	1-0102-PPID-S303	Ball	V315	38	FSW	Flushing Water	800	3.2	O/C	4X	120/1	≤ 30	C,E	
Scum pumps P-S316 and P-S317 recirculation	XV-S3163	1-0102-PPID-S303	Ball	V315	100	SC	Scum	200	10	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station
Scum pumps P-S316 and P-S317 Outlet	XV-S3172	1-0102-PPID-S303	Ball	V315	100	SC	Scum	200	10	O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station
Scum header	XV-S3002	1-0102-PPID-S304	Ball	V315	150	SC	Scum	150		O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station
Scum piping between new 150 pipe and exist. 100 pipe	XV-S3001	1-0102-PPID-S304	Ball	V315	100	SC	Scum	150		O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station
Instrument Air Supply	XV-S5408	1-0102-PPID-S107												J	Supplied by Package Sampler Vendor
AREA K - HIGH RATE CLARIFIERS															
Flushing Water to HRC Influent Channel 1	XV-G3622	1-0102-PPID-K101	Butterfly	V500	100	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to HRC Influent Channel 2	XV-G3632	1-0102-PPID-K101	Butterfly	V500	100	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Sodium Hypochlorite to HRC Train 1 Inlet	XV-K1103	1-0102-PPID-K102	Ball	V330	38	SHC	Sodium Hypochlorite			O/C	7	120/1	≤ 30	C,E	
Sodium Hypochlorite to HRC Train 2 Inlet	XV-K1203	1-0102-PPID-K104	Ball	V330	38	SHC	Sodium Hypochlorite			O/C	7	120/1	≤ 30	C,E	
Sodium Hypochlorite to HRC Train 1 Maturation Tank	XV-K1134	1-0102-PPID-K103	Ball	V330	38	SHC	Sodium Hypochlorite			O/C	7	120/1	≤ 30	C,E	
Sodium Hypochlorite to HRC Train 2 Maturation Tank	XV-K1234	1-0102-PPID-K105	Ball	V330	38	SHC	Sodium Hypochlorite			O/C	7	120/1	≤ 30	C,E	
Drain from HRC Train 1 Maturation Tank	XY-K1131	1-0102-PPID-K103	Mud	V915	150	PD	Process Drain			O/C	7	600/3	≤ 30	C,D,H	
Drain from HRC Train 2 Maturation Tank	XY-K1231	1-0102-PPID-K105	Mud	V915	150	PD	Process Drain			O/C	7	600/3	≤ 30	C,D,H	
HRC Train 1 Lamella Drain	XV-K1145	1-0102-PPID-K103	Eccentric plug	V405	150	PD	Process Drain			T	4X	600/3	≤ 30	C,D,H	
HRC Train 2 Lamella Drain	XV-K1245	1-0102-PPID-K105	Eccentric plug	V405	150	PD	Process Drain			T	4X	600/3	≤ 30	C,D,H	
Flushing Water to HRC Effluent Drop Shaft Spray Nozzle	XV-K1512	1-0102-PPID-K106	Ball	V308	12	FSW	Flushing Water			O/C	4X	120/1	≤ 30	C,E	
HRC Train 1 Effluent Sample Line Inlet	XV-K1155	1-0102-PPID-K106	Ball	V330	25	SAM	Sample			O/C	4X	120/1	≤ 30	C,E	

SEWPCC UPGRADING/EXPANSION PROJECT

Electric Motor Actuated Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	Service [Note 1]	NEMA 250 Type	Voltage/ Phase	Travel Time (sec)	Control Features [Note 2]	Remarks
HRC Train 2 Effluent Sample Line Inlet	XV-K1255	1-0102-PPID-K106	Ball	V330	25	SAM	Sample			O/C	4X	120/1	≤ 30	C,E	
Polymer to HRC Train 1 Cyclone K211 Underflow	XV-K1123	1-0102-PPID-K107	Ball	V330	25	MP	Mixed Polymer			O/C	7	120/1	≤ 30	C,E	
Polymer to HRC Train 1 Cyclone K212 Underflow	XV-K1124	1-0102-PPID-K107	Ball	V330	25	MP	Mixed Polymer			O/C	7	120/1	≤ 30	C,E	
Polymer to HRC Train 1 Cyclone K213 Underflow	XV-K1125	1-0102-PPID-K107	Ball	V330	25	MP	Mixed Polymer			O/C	7	120/1	≤ 30	C,E	
Polymer to HRC Train 2 Cyclone K221 Underflow	XV-K1223	1-0102-PPID-K107	Ball	V330	25	MP	Mixed Polymer			O/C	7	120/1	≤ 30	C,E	
Polymer to HRC Train 2 Cyclone K222 Underflow	XV-K1224	1-0102-PPID-K107	Ball	V330	25	MP	Mixed Polymer			O/C	7	120/1	≤ 30	C,E	
Polymer to HRC Train 2 Cyclone K223 Underflow	XV-K1225	1-0102-PPID-K107	Ball	V330	25	MP	Mixed Polymer			O/C	7	120/1	≤ 30	C,E	
HRS to Primary Influent Channel	XV-K2543	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge			O/C	4X	600/3	≤ 30	C,D,H	
HRS to Fermenters Cell No. 4	XV-K2544	1-0102-PPID-K203	Eccentric plug	V405	300	HRS	High Rate Clarifier Sludge			O/C	4X	600/3	≤ 30	C,D,H	
Sand Slurry to HRC Train 1 Injection Zone	XV-K1121	1-0102-PPID-K301	Eccentric plug	V405	50	SNS	Sand Slurry			-	-	600/3	-	C,D,H	Supplied by HRC vendor
Sand Slurry to HRC Train 2 Injection Zone	XV-K1221	1-0102-PPID-K301	Eccentric plug	V405	50	SNS	Sand Slurry			-	-	600/3	-	C,D,H	Supplied by HRC vendor
AREA D - FERMENTERS / THICKENERS															
Fermenters															
Flushing Water to PS Fermenters Train 1 Cell 1	FV-D3013	1-0102-PPID-D301	Ball	V308	75	FSW	Flushing Water			M	7	600/3	≤ 30	C,D,G,H	
Flushing Water to PS Fermenters Train 1 Cell 1	XV-D3012	1-0102-PPID-D301	Ball	V308	75	FSW	Flushing Water			O/C	7	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 1 Cell 2	XV-D3022	1-0102-PPID-D301	Ball	V308	75	FSW	Flushing Water			O/C	7	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 1 Cell 3	XV-D3032	1-0102-PPID-D301	Ball	V308	75	FSW	Flushing Water			O/C	7	600/3	≤ 30	C,D,H	
Primary Sludge to PS Fermenters Train 1 Cell 1	XV-D3011	1-0102-PPID-D301	Eccentric plug	V405	150	PS	Primary Sludge			O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station
Primary Sludge to PS Fermenters Train 1 Cell 4	XV-D3043	1-0102-PPID-D301	Eccentric plug	V405	150	PS	Primary Sludge			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 1 Cell 4	XV-D3048	1-0102-PPID-D301	Ball	V315	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 1 Cell 4	XV-D3049	1-0102-PPID-D301	Ball	V315	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 2 Cell 1	FV-D3113	1-0102-PPID-D302	Ball	V308	75	FSW	Flushing Water			M	7	600/3	≤ 30	C,D,G,H	
Flushing Water to PS Fermenters Train 2 Cell 1	XV-D3112	1-0102-PPID-D302	Ball	V308	75	FSW	Flushing Water			O/C	7	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 2 Cell 2	XV-D3122	1-0102-PPID-D302	Ball	V308	75	FSW	Flushing Water			O/C	7	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 2 Cell 3	XV-D3132	1-0102-PPID-D302	Ball	V308	75	FSW	Flushing Water			O/C	7	600/3	≤ 30	C,D,H	
Primary Sludge to PS Fermenters Train 2 Cell 1	XV-D3111	1-0102-PPID-D302	Eccentric plug	V405	150	PS	Primary Sludge			O/C	4X	600/3	≤ 30	C,D,H	Provide remote control station
Primary Sludge to PS Fermenters Train 2 Cell 4	XV-D3143	1-0102-PPID-D302	Eccentric plug	V405	150	PS	Primary Sludge			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 2 Cell 4	XV-D3148	1-0102-PPID-D302	Ball	V315	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to PS Fermenters Train 2 Cell 4	XV-D3149	1-0102-PPID-D302	Ball	V315	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	
Thickeners															
WAS RDT RDT-D403 Inlet	XV-D4031	1-0102-PPID-D402	Eccentric plug	V405	150	WAS	Waste Activated Sludge			O/C	4X	600/3	≤ 30	C,D,H	
WAS RDT RDT-D404 Inlet	XV-D4041	1-0102-PPID-D402	Eccentric plug	V405	150	WAS	Waste Activated Sludge			O/C	4X	600/3	≤ 30	C,D,H	
Flushing Water to WAS RDT RDT-D403 Inlet Piping	XV-D4032	1-0102-PPID-D402	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	C,E	
Flushing Water to WAS RDT RDT-D404 Inlet Piping	XV-D4042	1-0102-PPID-D402	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	C,E	
Flushing Water to WAS RDT RDT-D403	XV-D4034	1-0102-PPID-D402	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by RDT vendor
Flushing Water to WAS RDT RDT-D404	XV-D4044	1-0102-PPID-D402	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by RDT vendor
FSL RDT Feed Pumps Discharge Cross-connection	XV-D4113	1-0102-PPID-D404	Eccentric plug	V405	150	FSL	Fermented Sludge			O/C	4X	600/3	≤ 30	C,E	
FSL RDT Feed Pumps Discharge Cross-connection	XV-D4123	1-0102-PPID-D404	Eccentric plug	V405	150	FSL	Fermented Sludge			O/C	4X	600/3	≤ 30	C,E	
FSL RDT Feed Pumps Discharge Cross-connection	XV-D4133	1-0102-PPID-D405	Eccentric plug	V405	150	FSL	Fermented Sludge			O/C	4X	600/3	≤ 30	C,E	
FSL RDT RDT-D415 Inlet	XV-D4151	1-0102-PPID-D406	Eccentric plug	V405	150	FSL	Fermented Sludge			O/C	4X	600/3	≤ 30	C,E	
FSL RDT RDT-D416 Inlet	XV-D4161	1-0102-PPID-D406	Eccentric plug	V405	150	FSL	Fermented Sludge			O/C	4X	600/3	≤ 30	C,E	
FSL RDT RDT-D417 Inlet	XV-D4171	1-0102-PPID-D407	Eccentric plug	V405	150	FSL	Fermented Sludge			O/C	4X	600/3	≤ 30	C,E	
Flushing Water to FSL RDT RDT-D415 Inlet Piping	XV-D4152	1-0102-PPID-D406	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	C,E	
Flushing Water to FSL RDT RDT-D416 Inlet Piping	XV-D4162	1-0102-PPID-D406	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	C,E	
Flushing Water to FSL RDT RDT-D417 Inlet Piping	XV-D4172	1-0102-PPID-D407	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	C,E	
Flushing Water to FSL RDT RDT-D415	XV-D4154	1-0102-PPID-D406	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by RDT vendor
Flushing Water to FSL RDT RDT-D416	XV-D4164	1-0102-PPID-D406	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by RDT vendor
Flushing Water to FSL RDT RDT-D417	XV-D4174	1-0102-PPID-D407	Ball	V308	38	FSW	Flushing Water			O/C	4X	120/1	≤ 30	J	Supplied by RDT vendor
Automatic Strainer STR-D433 Backwash Outlet	XV-D4331	1-0102-PPID-D410	Ball	V308	25	PD	Process Drain			O/C	4X	120/1	≤ 30	J	Supplied by automatic strainer vendor
Automatic Strainer STR-D434 Backwash Outlet	XV-D4341	1-0102-PPID-D410	Ball	V308	25	PD	Process Drain			O/C	4X	120/1	≤ 30	J	Supplied by automatic strainer vendor
WAS Filtrate Pump P-D451 Outlet	LV-D4513	1-0102-PPID-D411	Butterfly	V514	150	WSF	Waste Activated Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
WAS Filtrate Pump P-D452 Outlet	LV-D4523	1-0102-PPID-D411	Butterfly	V514	150	WSF	Waste Activated Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
FSL Filtrate Pump P-D461 Outlet	LV-D4613	1-0102-PPID-D412	Butterfly	V514	150	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
FSL Filtrate Pump P-D462 Outlet	LV-D4623	1-0102-PPID-D412	Butterfly	V514	150	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
FSL Filtrate Pump P-D463 Outlet	LV-D4633	1-0102-PPID-D413	Butterfly	V514	150	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
FSL Filtrate Pump P-D464 Outlet	LV-D4643	1-0102-PPID-D413	Butterfly	V514	150	FSF	Fermented Sludge Filtrate			M	4X	600/3	≤ 30	C,D,G,H	
AREA T - BIOFILTER / ODOUR CONTROL															
Glycol Recirculation	TV-T1042	1-0102-PPID-T102	Threeway	-	75	GS	Glycol Supply			M	7	600/3	≤ 30	J	Supplied by Biofilter vendor, Expl. Proof. Class1 Div 2
Recirculation Pumps P-T111 and P-T112	XV-T1109	1-0102-PPID-T104	Ball	V330	25	PD	Process Drain			O/C	7	120/1	≤ 30	J	Supplied by Biofilter vendor, Expl. Proof. Class1 Div 2
Recirculation Pumps P-T121 and P-T122	XV-T1209	1-0102-PPID-T106	Ball	V330	25	PD	Process Drain			O/C	7	120/1	≤ 30	J	Supplied by Biofilter vendor, Expl. Proof. Class1 Div 2
Biofilter Microstrainer Blowdown	XV-T1401	1-0102-PPID-T107	Ball	V330	25	PD	Process Drain			O/C	4X	120/1	≤ 30	J	Supplied by Microstrainer vendor.
Biofilter Microstrainer Outlet	XV-T1402	1-0102-PPID-T107	Ball	V307	75	FSW	Flushing Water			O/C	4X	600/3	≤ 30	C,D,H	

SEWPCC UPGRADING/EXPANSION PROJECT

Electric Motor Actuated Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	Service [Note 1]	NEMA 250 Type	Voltage/ Phase	Travel Time (sec)	Control Features [Note 2]	Remarks
Non Potable Water Feed	XV-T1406	1-0102-PPID-T107	Ball	V307	38	NPW	Non-Potable Water			O/C	4X	120/1	≤ 30	C,E	
FSW Feed to Biofilter TK-T210	XV-T2101	1-0102-PPID-T107	Ball	V307	25	FSW	Flushing Water			O/C	7	-	≤ 30	J	Supplied by Biofilter vendor, Expl. Proof. Class1 Div 2
FSW Feed to Biofilter TK-T220	XV-T2201	1-0102-PPID-T107	Ball	V307	25	FSW	Flushing Water			O/C	7	-	≤ 30	J	Supplied by Biofilter vendor, Expl. Proof. Class1 Div 2
FSW Feed to Biofilter TK-T230	XV-T2301	1-0102-PPID-T107	Ball	V307	25	FSW	Flushing Water			O/C	7	-	≤ 30	J	Supplied by Biofilter vendor, Expl. Proof. Class1 Div 2
Biofilter Exhaust Fan EF-T301 Inlet	XV-T3011	1-0102-PPID-T301	Isolation Damper	V965	1200	FOA	Foul Air			O/C	8	600/3	≤ 30	C,D,H	Explosion Proof, Class 1 Div 2
Biofilter Exhaust Fan EF-T302 Inlet	XV-T3021	1-0102-PPID-T301	Isolation Damper	V965	1200	FOA	Foul Air			O/C	8	600/3	≤ 30	C,D,H	Explosion Proof, Class 1 Div 2
AREA C - CHEMICAL BUILDING / ELECTRICAL BUILDING															
Ferric Chloride System															
Chemical fill line to TK-C101 isolation valve	XV-C1012	1-0102-PPID-C101	Ball	V330	75	FC	Ferric Chloride			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Chemical fill line to TK-C102 isolation valve	XV-C1022	1-0102-PPID-C101	Ball	V330	75	FC	Ferric Chloride			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Chemical fill line to TK-C103 isolation valve	XV-C1032	1-0102-PPID-C101	Ball	V330	75	FC	Ferric Chloride			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C101 outlet isolation valve	XV-C1013	1-0102-PPID-C101	Ball	V330	50	FC	Ferric Chloride		0.55	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C102 outlet isolation valve	XV-C1023	1-0102-PPID-C101	Ball	V330	50	FC	Ferric Chloride		0.55	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C103 outlet isolation valve	XV-C1033	1-0102-PPID-C101	Ball	V330	50	FC	Ferric Chloride		0.55	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Sodium Hypochlorite System															
Chemical fill line to TK-C201 isolation valve	XV-C2012	1-0102-PPID-C201	Ball	V330	75	SHC	Sodium Hypochlorite			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Chemical fill line to TK-C202 isolation valve	XV-C2022	1-0102-PPID-C201	Ball	V330	75	SHC	Sodium Hypochlorite			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C201 outlet isolation valve	XV-C2013	1-0102-PPID-C201	Ball	V330	50	SHC	Sodium Hypochlorite		0.53	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C202 outlet isolation valve	XV-C2023	1-0102-PPID-C201	Ball	V330	50	SHC	Sodium Hypochlorite		0.53	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Sodium hypochlorite skid pump P-C222 isolation valve	XV-C2223	1-0102-PPID-C205	Ball	V330	25	SHC	Sodium Hypochlorite		0.33	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Sodium hypochlorite skid pump P-C222 isolation valve	XV-C2224	1-0102-PPID-C205	Ball	V330	25	SHC	Sodium Hypochlorite		0.33	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Sodium Hydroxide System															
Chemical fill line to TK-C205 isolation valve	XV-C2052	1-0102-PPID-C201	Ball	V330	75	SHD	Sodium Hydroxide			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C205 outlet isolation valve	XV-C2053	1-0102-PPID-C201	Ball	V330	50	SHD	Sodium Hydroxide		0.05	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Sodium Bisulphite System															
Chemical fill line to TK-C301 isolation valve	XV-C3012	1-0102-PPID-C301	Ball	V330	75	SBS	Sodium Bisulphite			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Tank TK-C301 outlet isolation valve	XV-C3013	1-0102-PPID-C301	Ball	V330	50	SBS	Sodium Bisulphite		0.11	O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Flushing Water	FV-C3104	1-0102-PPID-C301	Ball	V307	50	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Polymer System FSL RDT															
Polymer fill to tank TK-C401 isolation valve	XV-C4014	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer		1.25	O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C402 isolation valve	XV-C4024	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer		1.25	O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C403 isolation valve	XV-C4034	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer		1.25	O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C402 isolation valve	XV-C4025	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C403 isolation valve	XV-C4035	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Aging tanks interconnection isolation valve	XV-C4037	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Aging tank TK-C402 outlet isolation valve	XV-C4026	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Aging tank TK-C403 outlet isolation valve	XV-C4036	1-0102-PPID-C401	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Flushing service water dilution isolation valve	FV-C4162	1-0102-PPID-C402	Ball	V307	75	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Flushing service water dilution isolation valve	FV-C4172	1-0102-PPID-C403	Ball	V307	75	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Flushing service water dilution isolation valve	FV-C4182	1-0102-PPID-C404	Ball	V307	75	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Polymer skid pump P-C414 isolation valve	XV-C4145	1-0102-PPID-C403	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Polymer skid pump P-C414 isolation valve	XV-C4146	1-0102-PPID-C403	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Polymer System WAS RDT															
Polymer fill to tank TK-C421 isolation valve	XV-C4212	1-0102-PPID-C405	Ball	V330	25	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C422 isolation valve	XV-C4222	1-0102-PPID-C405	Ball	V330	25	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C422 isolation valve	XV-C4223	1-0102-PPID-C405	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Flushing service water dilution isolation valve	FV-C4362	1-0102-PPID-C406	Ball	V307	50	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Flushing service water dilution isolation valve	FV-C4372	1-0102-PPID-C407	Ball	V307	50	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Polymer skid pump P-C432 isolation valve	XV-C4325	1-0102-PPID-C406	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Polymer skid pump P-C432 isolation valve	XV-C4326	1-0102-PPID-C406	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Polymer System HRC															
Polymer fill to tank TK-C441 isolation valve	XV-C4414	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C442 isolation valve	XV-C4424	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymerr fill to tank TK-C443 isolation valve	XV-C4434	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C442 isolation valve	XV-C4425	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C443 isolation valve	XV-C4435	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Aging tanks interconnection isolation valve	XV-C4437	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Aging tank TK-C442 outlet isolation valve	XV-C4426	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Aging tank TK-C442 outlet isolation valve	XV-C4436	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Tank TK-C441 outlet isolation valve	XV-C4415	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Tanks feed pipe to pumps isolation valve	XV-C4416	1-0102-PPID-C408	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Non Potable Water Supply pipe	XV-C4417	1-0102-PPID-C408	Ball	V307	25	NPT	Non-Potable Tempered Water			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Flushing service water dilution isolation valve	FV-C4562	1-0102-PPID-C409	Ball	V307	75	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Polymer feed to HRC Train 1 isolation valve	XV-C4563	1-0102-PPID-C409	Ball	V330	75	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service

SEWPCC UPGRADING/EXPANSION PROJECT

Electric Motor Actuated Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	Service [Note 1]	NEMA 250 Type	Voltage/ Phase	Travel Time (sec)	Control Features [Note 2]	Remarks
Polymer feed to mixed liquor channel	XV-C4564	1-0102-PPID-C409	Ball	V330	75	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Flushing service water dilution isolation valve	FV-C4572	1-0102-PPID-C410	Ball	V307	75	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Polymer feed to HRC Train 2 isolation valve	XV-C4573	1-0102-PPID-C410	Ball	V330	75	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Polymer feed to mixed liquor channel	XV-C4574	1-0102-PPID-C410	Ball	V330	75	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service
Polymer skid pump P-C452 isolation valve	XV-C4525	1-0102-PPID-C406	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Polymer skid pump P-C452 isolation valve	XV-C4526	1-0102-PPID-C406	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	C,F	Electric actuator for chemical service - by skid supplier
Polymer System Secondary Clarifiers															
Polymer fill to tank TK-C461 isolation valve	XV-C4612	1-0102-PPID-C411	Ball	V330	25	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C462 isolation valve	XV-C4622	1-0102-PPID-C411	Ball	V330	25	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Polymer fill to tank TK-C462 isolation valve	XV-C4623	1-0102-PPID-C411	Ball	V330	50	MP	Mixed Polymer			O/C	4X	120/1	< 60	J	Electric actuator for chemical service - by skid supplier
Flushing service water dilution isolation valve	FV-C4762	1-0102-PPID-C412	Ball	V307	75	FSW	Flushing Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
Non Potable Water															
Non Potable Water to Polymer Makedown Systems	FV-C5101	1-0102-PPID-C504	Ball	V307	100	NPT	Non-Potable Tempered Water			O/C	4X	120/1	< 60	C,E,G	Electric actuator for chemical service
BUILDING MECHANICAL															
AREA G - HEADWORKS															
Propylene glycol to AHU-G610	TV-G6106	1-0102-PPID-G617	Three-way	V240	65	GS	Glycol Supply	35	8.82	M	1	24	<60	C,G	
Propylene glycol to AHU-G620	TV-G6206	1-0102-PPID-G608	Three-way	V240	100	GS	Glycol Supply	35	15.91	M	1	24	<60	C,G	
Propylene glycol to AHU-G630	TV-G6306	1-0102-PPID-G618	Three-way	V240	65	GS	Glycol Supply	35	7.34	M	1	24	<60	C,G	
Propylene glycol from HE-G663	TV-G6631	1-0102-PPID-G625	Three-way	V240	125	HWR	Hot Water Return	35	29.4	M	1	24	<60	C,G	
Flushing water for Glycol Heat Recovery	TV-G6731	1-0102-PPID-G623	Two-way	V307	100	FSW	Flushing Water			O/C			<60		
Flushing water for Heat Pump Condenser Water	TV-G6761	1-0102-PPID-G623	Three-way	V240	75	CDR	Condenser Water			M			<60		
AREA R - BIOREACTORS / BLOWER BUILDING															
Propylene glycol to AHU-R610	TV-R6202	1-0102-PPID-R604	Three-way	V240	65	GS	Glycol Supply	30	4.73	O/C	1	24	<60	C,G	Electric actuator by valve supplier
EF-R601 Inlet	XV-R6011	1-0102-PPID-R602	Isolation Damper	V965	1000	FOA	Foul Air			O/C	8	600/3	≤ 30	C,D	Explosion Proof, Class 1 Div 2
EF-R602 Inlet	XV-R6021	1-0102-PPID-R602	Isolation Damper	V965	1000	FOA	Foul Air			O/C	8	600/3	≤ 30	C,D	Explosion Proof, Class 1 Div 2
AREA S - SECONDARY CLARIFIERS															
Flushing for glycol heat recovery system	XV-S6634	1-0102-PPID-S627	Two-way	V307	100	FSW	Flushing Water	30		O/C	1	24	<60	C,G	Electric actuator by valve supplier
Backwash drain for flushing water automatic strainer	XV-S6732	1-0102-PPID-S627	Two-way	V308	25	FSW	Flushing Water	30		O/C	1	24	<60	J	Electric actuator by valve supplier
Backwash drain for flushing water automatic strainer	XV-S6742	1-0102-PPID-S627	Two-way	V308	25	FSW	Flushing Water	30		O/C	1	24	<60	J	Electric actuator by valve supplier
AREA K - HIGH RATE CLARIFIERS															
Propylene glycol to AHU-K610	TV-K6104	1-0102-PPID-K601	Three-way	V240	75	GS	Glycol Supply	35	8.44	M	1	24	<60	C,G	Electric actuator by valve supplier
Propylene glycol to AHU-K620	TV-K6204	1-0102-PPID-K602	Three-way	V240	50	GS	Glycol Supply	35	2.95	M	1	24	<60	C,G	Electric actuator by valve supplier
Propylene glycol to AHU-K630	TV-K6304	1-0102-PPID-K603	Three-way	V240	50	GS	Glycol Supply	35	3.31	M	1	24	<60	C,G	Electric actuator by valve supplier
Propylene glycol to AHU-K640	TV-K6404	1-0102-PPID-K604	Three-way	V240	32	GS	Glycol Supply	35	0.33	M	1	24	<60	C,G	Electric actuator by valve supplier
Propylene glycol to HE-K663	TV-K6631	1-0102-PPID-K606	Three-way	V240	75	HWR	Hot Water Return	35	13.8	M	1	24	<60	C,G	Electric actuator by valve supplier

General Notes:

1. This schedule is provided for the Contractor's convenience and shall not be taken as complete.
2. Valves to be supplied and installed under this contract unless otherwise indicated.
3. n/a = not applicable; valve supplied by others, installed under this contract.
4. Refer to the scope of pre-purchased equipment for valves that are supplied by others to be installed under this contract.

Notes:

1. Service:
   - O/C = Open-Close
   - T = Throttling
   - M = Modulating
2. Control Features:
   - A = Actuator shall open valve upon loss of signal.
   - B = Actuator shall close valve upon loss of signal.
   - C = Actuator shall maintain valve in last position upon loss of signal.
   - D = Local LOCAL-REMOTE hand switch with local OPEN-CLOSE momentary pushbuttons that must be continuously depressed to initiate/maintain valve travel; travel stops when pushbutton is released, or when end of travel limit is reached.
   - E = Remote OPEN-CLOSE maintained control signal; travel stops when end of travel limit is reached.
   - F = Local LOCAL-REMOTE hand switch with local OPEN-CLOSE hand switch and remote OPEN-CLOSE maintained control signal; travel stops when LOCAL mode selected, or when end of travel limit is reached.
   - G = Valve position controlled by a modulating analog signal with feedback signal in proportion to valve position, either through a PROFIBUS DP interface or 4-20 mA signals.
   - H = PROFIBUS DP option card required
   - I = Modbus RTU option card required
   - J = Control features as per packaged system vendor requirements

SEWPCC UPGRADING/EXPANSION PROJECT

Solenoid Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	NEMA Rating	Control Features [Note 1]	Remarks
PROCESS MECHANICAL												
AREA G - HEADWORKS												
Raw Sewage Pumping												
Seal Water to Raw Sewage Pump P-G102	YV-G1023	1-0102-PPID-G103	Solenoid	V940	12	NPW	Non-Potable Water			4	NC,B	
Grit Removal												
Seal Water to Grit Slurry Pump P-G323	YV-G3235	1-0102-PPID-G302	Solenoid	V940	12	NPW	Non-Potable Water		0.1	4	NC,B	
Seal Water to Grit Slurry Pump P-G324	YV-G3245	1-0102-PPID-G302	Solenoid	V940	12	NPW	Non-Potable Water		0.1	4	NC,B	
Seal Water to Grit Slurry Pump P-G325	YV-G3255	1-0102-PPID-G302	Solenoid	V940	12	NPW	Non-Potable Water		0.1	4	NC,B	
Wash Water												
Wash Water to Washer/Compactor WCP-G231	XV-G2314	1-0102-PPID-G203	Solenoid	V940	25	FSW	Flushing Water			4	J	Supplied by washer/compactor vendor.
Wash Water to Washer/Compactor WCP-G232	XV-G2324	1-0102-PPID-G203	Solenoid	V940	25	FSW	Flushing Water			4	J	Supplied by washer/compactor vendor.
AREA R - BIOREACTORS / BLOWER BUILDING												
Instrument Panel Instrument Air	XV-R1041-1	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1041-2	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1022	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1032	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1051	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1052	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1141-1	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1141-2	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1122	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1132	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1151	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1152	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1241-1	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1241-2	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1222	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1232	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1251	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
Instrument Panel Instrument Air	XV-R1252	1-0102-PPID-R109	Solenoid	V940	25	IAS	Instrument Air Supply			4X	NC,B	Coordinate with instrument vendor and size accordingly
AREA S - SECONDARY CLARIFIERS												
Seal Water to RAS Pump P-S216	YV-S2163	1-0102-PPID-S204	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to RAS Pump P-S217	YV-S2173	1-0102-PPID-S205	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to RAS Pump P-S218	YV-S2183	1-0102-PPID-S205	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to Scum Pump P-S316	YV-S3161	1-0102-PPID-S303	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to Scum Pump P-S317	YV-S3171	1-0102-PPID-S303	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to Flushing Water Pump P-S550	YV-S5501	1-0102-PPID-S506	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Instrument Air Supply	XV-S5408	1-0102-PPID-S107	Solenoid	V940	-	IAS	Instrument Air Supply			4X	J	Supplied by Package Sampler Vendor
AREA U - UV DISINFECTION BUILDING												
UV system lamp service system	XV-U2111	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2112	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2121	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2122	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2131	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2132	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2141	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2142	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2151	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2152	1-0102-PPID-U201	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2211	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2212	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2221	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2222	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2231	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2232	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2241	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2242	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2251	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor
UV system lamp service system	XV-U2252	1-0102-PPID-U202	Solenoid	-						4X	J	Supplied by UV Vendor

SEWPCC UPGRADING/EXPANSION PROJECT

Solenoid Valve Schedule

Location / Description	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Maximum ΔP (kPa)	Maximum Flow (L/s)	NEMA Rating	Control Features [Note 1]	Remarks
AREA K - HIGH RATE CLARIFIERS												
Non-Potable Water for Flushing HRC Train 1 Sample Line	XV-K1156	1-0102-PPID-K106	Solenoid	-	20	NPW	Non-Potable Water			4X	NC,B	
Non-Potable Water for Flushing HRC Train 2 Sample Line	XV-K1256	1-0102-PPID-K106	Solenoid	-	20	NPW	Non-Potable Water			4X	NC,B	
Air Scour to HRC Train 1 North Corner Grid	XV-K1141	1-0102-PPID-K108	Solenoid	-	50	ALP	Air, Low Pressure			-	J	Supplied by HRC vendor
Air Scour to HRC Train 1 South Corner Grid	XV-K1142	1-0102-PPID-K108	Solenoid	-	50	ALP	Air, Low Pressure			-	J	Supplied by HRC vendor
Air Scour to HRC Train 1 Rotating Grid	XV-K1143	1-0102-PPID-K108	Solenoid	-	50	ALP	Air, Low Pressure			-	J	Supplied by HRC vendor
Air Scour to HRC Train 2 North Corner Grid	XV-K1241	1-0102-PPID-K108	Solenoid	-	50	ALP	Air, Low Pressure			-	J	Supplied by HRC vendor
Air Scour to HRC Train 2 South Corner Grid	XV-K1242	1-0102-PPID-K108	Solenoid	-	50	ALP	Air, Low Pressure			-	J	Supplied by HRC vendor
Air Scour to HRC Train 2 Rotating Grid	XV-K1243	1-0102-PPID-K108	Solenoid	-	50	ALP	Air, Low Pressure			-	J	Supplied by HRC vendor
Ballast Addition Skid Non-Potable Water Control	XV-K3105	1-0102-PPID-K301	Solenoid	-	50	NPW	Non-Potable Water			-	J	Supplied by HRC vendor as part of Ballast Addition Skid
Ballast Addition Skid Non-Potable Water Control	XV-K3106	1-0102-PPID-K301	Solenoid	-	6	NPW	Non-Potable Water			-	J	Supplied by HRC vendor as part of Ballast Addition Skid
AREA D - FERMENTERS / THICKENERS												
Seal Water to Fermenter Recirculation Pump P-D321	YV-D3213	1-0102-PPID-D303	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to Fermenter Recirculation Pump P-D322	YV-D3223	1-0102-PPID-D303	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
Seal Water to Fermenter Recirculation Pump P-D323	YV-D3233	1-0102-PPID-D303	Solenoid	V940	12	NPW	Non-Potable Water			4X	NC,B	
AREA T - BIOFILTER / ODOUR CONTROL												
Natural Gas Supply to Glycol Heater	XV-T1063	1-0102-PPID-T102	Solenoid	-	32	NG	Natural Gas			-	J	Supplied by Biofilter vendor, explosion proof
Natural Gas Supply to Glycol Heater	XV-T1064	1-0102-PPID-T102	Solenoid	-	32	NG	Natural Gas			-	J	Supplied by Biofilter vendor, explosion proof
Humidifier Tower HUM-T110 Washer Sprays Inlet	XV-T1101	1-0102-PPID-T103	Solenoid	-	12	FSW	Flushing Water			-	J	Supplied by Biofilter vendor, explosion proof
Humidifier Tower HUM-T120 Washer Sprays Inlet	XV-T1201	1-0102-PPID-T105	Solenoid	-	12	FSW	Flushing Water			-	J	Supplied by Biofilter vendor, explosion proof
AREA C - CHEMICAL BUILDING / ELECTRICAL BUILDING												
Non-potable Tempered Water to FPS/HRC Polymer Make Dow	XV-C4043	1-0102-PPID-C401	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to FPS/HRC Polymer Make Dow	XV-C4044	1-0102-PPID-C401	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to WAS Polymer Make Down Sy	XV-C4243	1-0102-PPID-C405	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to WAS Polymer Make Down Sy	XV-C4244	1-0102-PPID-C405	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to HRC Polymer Make Down Sys	XV-C4441	1-0102-PPID-C408	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to HRC Polymer Make Down Sys	XV-C4442	1-0102-PPID-C408	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to Secondary Clarifier Polymer M	XV-C4643	1-0102-PPID-C411	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Non-potable Tempered Water to Secondary Clarifier Make Dow	XV-C4644	1-0102-PPID-C411	Solenoid	-	-	NPT	Non-Potable Tempered Water			-	J	Supplied by Polymer Make Down Vendor
Diesel Fuel Supply from P-C561 Pump	XV-C5611	1-0102-PPID-C510	Solenoid	-	-	DFS	Diesel Fuel Supply			-	J	Supplied by Diesel Fuel Storage System Vendor
Diesel Fuel Supply from P-C562 Pump	XV-C5621	1-0102-PPID-C510	Solenoid	-	-	DFS	Diesel Fuel Supply			-	J	Supplied by Diesel Fuel Storage System Vendor
Diesel Fuel Supply to Tank TK-C570	XV-C5705	1-0102-PPID-C511	Solenoid	-	-	DFS	Diesel Fuel Supply			-	J	Supplied by Diesel Fuel Storage System Vendor
Diesel Fuel Supply to Tank TK-C580	XV-C5805	1-0102-PPID-C512	Solenoid	-	-	DFS	Diesel Fuel Supply			-	J	Supplied by Diesel Fuel Storage System Vendor

General Notes:

1. This schedule is provided for the Contractor's convenience and shall not be taken as complete.
2. Valves to be supplied and installed under this contract unless otherwise indicated.
3. n/a = not applicable; valve supplied by others, installed under this contract.
4. Refer to the scope of pre-purchased equipment for valves that are supplied by others to be installed under this contract.

Notes:

1. Control Features:
   NO = Open when de-energized
   NC = Closed when de-energized
   A = Slow closing
   B = Manual override button
   J = Control features as per packaged system vendor requirements

SEWPCC UPGRADING/EXPANSION PROJECT

Self-Contained Valve Schedule

Description / Location	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Inlet Pressure (kPag) [Note 1]	Outlet Pressure (kPag)	Maximum Flow (L/s)	Remarks
PROCESS MECHANICAL											
AREA G - HEADWORKS											
Raw Sewage Pumping											
Seal Water to Raw Sewage Pump P-G102	PCV-G1029	1-0102-PPID-G103	Pressure reducing	V711	12	NPW	Non-Potable Water	685-750	250	0.1	
Grit Removal											
Flushing Water to Grit Tank 1	PCV-G3219	1-0102-PPID-G301	Pressure reducing	V711	25	FSW	Flushing Water	685-750	60	1.3	
Flushing Water to Grit Tank 2	PCV-G3229	1-0102-PPID-G301	Pressure reducing	V711	25	FSW	Flushing Water	685-750	60	1.3	
Seal Water to Grit Slurry Pump P-G323	PCV-G3239	1-0102-PPID-G302	Pressure reducing	V711	12	NPW	Non-Potable Water	685-750	350	0.1	
Seal Water to Grit Slurry Pump P-G324	PCV-G3249	1-0102-PPID-G302	Pressure reducing	V711	12	NPW	Non-Potable Water	685-750	350	0.1	
Seal Water to Grit Slurry Pump P-G325	PCV-G3259	1-0102-PPID-G302	Pressure reducing	V711	12	NPW	Non-Potable Water	685-750	350	0.1	
Wash Water											
Wash Water to Screen SCR-G211	PCV-G2119	1-0102-PPID-G201	Pressure reducing	V711	38	FSW	Flushing Water	685-750	410	2.5	
Wash Water to Screen SCR-G212	PCV-G2129	1-0102-PPID-G201	Pressure reducing	V711	38	FSW	Flushing Water	685-750	410	2.5	
Wash Water to Screen SCR-G213	PCV-G2139	1-0102-PPID-G202	Pressure reducing	V711	38	FSW	Flushing Water	685-750	410	2.5	
Wash Water to Screen SCR-G214	PCV-G2149	1-0102-PPID-G202	Pressure reducing	V711	38	FSW	Flushing Water	685-750	410	2.5	
Wash Water to Washer/Compactor WCP-G231	PCV-G2319	1-0102-PPID-G203	Pressure reducing	V711	25	FSW	Flushing Water	685-750	410	3	
Wash Water to Washer/Compactor WCP-G232	PCV-G2329	1-0102-PPID-G203	Pressure reducing	V711	25	FSW	Flushing Water	685-750	410	3	
Wash Water to Grit Classifier GRP-G341	PCV-G3419	1-0102-PPID-G305	Pressure reducing	V711	25	FSW	Flushing Water	685-750	150	0.5	
Wash Water to Grit Classifier GRP-G342	PCV-G3429	1-0102-PPID-G305	Pressure reducing	V711	25	FSW	Flushing Water	685-750	150	0.5	
AREA R - BIOREACTORS / BLOWER BUILDING											
FSF Pipe	N/A	1-0102-PPID-R101	Air release	V752	50	FSF	Fermented Sludge Filtrate	80-120			
Ferric Chloride Application Point for bioreactor 1	PCV-R1059	1-0102-PPID-R102	Back Pressure	V724	25	FC	Ferric Chloride	300	25		
Ferric Chloride Application Point for bioreactor 2	PCV-R1159	1-0102-PPID-R104	Back Pressure	V724	25	FC	Ferric Chloride	300	25		
Ferric Chloride Application Point for bioreactor 3	PCV-R1259	1-0102-PPID-R106	Back Pressure	V724	25	FC	Ferric Chloride	300	25		
FSF Pipe	N/A	1-0102-PPID-R105	Air release	V752	50	FSF	Fermented Sludge Filtrate	80-120			
RAS pipe	PCV-R4009	1-0102-PPID-R108	Back Pressure	V724	25	SHC	Sodium Hypochlorite	300	25		
RAS Pipe	N/A	1-0102-PPID-R108	Air release	V752	50	RAS	Return Activated Sludge	80-120			
RAS Pumps P-S217 and P-S218 outlet pipe	N/A	1-0102-PPID-R108	Air release	V752	50	RAS	Return Activated Sludge	80-120			
Instrument Air Cleaning	PCV-R1041-1	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1042-1	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1041-2	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1042-2	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1022	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1032	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1051	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1052	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1141-1	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1142-1	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1141-2	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1142-2	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1122	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1132	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1151	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1152	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1241-1	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1242-1	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1241-2	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1242-2	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1222	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1232	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1251	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
Instrument Air Cleaning	PCV-R1252	1-0102-PPID-R109	Pressure reducing	V710	25	IAS	Instrument Air Supply	550-650			Coordinate with instrument vendor and size accordingly
WAS RDT Feed Pump P-R301 Pressure Relief	PSV-R3019	1-0102-PPID-R301	Pressure relief	V735	100	WAS	Waste Activated Sludge	340	10-40	22.2	
WAS RDT Feed Pump P-R302 Pressure Relief	PSV-R3029	1-0102-PPID-R301	Pressure relief	V735	100	WAS	Waste Activated Sludge	340	10-40	22.2	
WAS RDT Feed Pump P-R303 Pressure Relief	PSV-R3039	1-0102-PPID-R301	Pressure relief	V735	100	WAS	Waste Activated Sludge	340	10-40	22.2	
AREA S - SECONDARY CLARIFIERS											
Clarifier 4 RAS Outlet	N/A	1-0102-PPID-S105	Air release	V752	50	RAS	Return Activated Sludge	80-120			
Clarifier 5 RAS Outlet	N/A	1-0102-PPID-S106	Air release	V752	50	RAS	Return Activated Sludge	80-120			

SEWPCC UPGRADING/EXPANSION PROJECT

Self-Contained Valve Schedule

Description / Location	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Inlet Pressure (kPag) [Note 1]	Outlet Pressure (kPag)	Maximum Flow (L/s)	Remarks
Seal Water Supply to RAS Pump P-S216	PCV-S2169	1-0102-PPID-S204	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to RAS Pump P-S217	PCV-S2179	1-0102-PPID-S205	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to RAS Pump P-S218	PCV-S2189	1-0102-PPID-S205	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to Scum Pump P-S316	PCV-S3169	1-0102-PPID-S303	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to Scum Pump P-S317	PCV-S3179	1-0102-PPID-S303	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to Flushing Water Pump P-S550	PCV-S5509	1-0102-PPID-S506	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Sludge Transfer Pump P-S401 Pressure Relief	PSV-S4019	1-0102-PPID-S208	Pressure relief	V735	150	STS	Southend Thickened Sludge	320-400	60		
Sludge Transfer Pump P-S402 Pressure Relief	PSV-S4029	1-0102-PPID-S208	Pressure relief	V735	150	STS	Southend Thickened Sludge	320-401	60		
Potable water backflow preventer	BFP-S544A	1-0102-PPID-S504	RP backflow preventer	V642	50	PW	Potable Water				
Potable water backflow preventer	BFP-S544B	1-0102-PPID-S504	RP backflow preventer	V642	50	PW	Potable Water				
Potable water backflow preventer	BFP-S544C	1-0102-PPID-S504	RP backflow preventer	V642	50	PW	Potable Water				
Potable water backflow preventer	BFP-S544D	1-0102-PPID-S504	RP backflow preventer	V642	50	PW	Potable Water				
Sodium Hypochlorite Application	PCV-S5541	1-0102-PPID-S507	Back-Pressure	V722	12	SHC	Sodium Hypochlorite				
Instrument Air Supply	PCV-S5409-1	1-0102-PPID-S107	Pressure reducing	V710	-	IAS	Instrument Air Supply	550-650			Supplied by Package Sampler Vendor
AREA K - HIGH RATE CLARIFIERS											
Sodium Hydroxide to HRC Train 1	PCV-K1107	1-0102-PPID-K102	Back-Pressure	V722	25	SHD	Sodium Hydroxide				
Sodium Hydroxide to HRC Train 2	PCV-K1207	1-0102-PPID-K104	Back-Pressure	V722	25	SHD	Sodium Hydroxide				
Ferric Chloride to HRC Train 1	PCV-K1108	1-0102-PPID-K102	Back-Pressure	V722	25	FC	Ferric Chloride				
Ferric Chloride to HRC Train 2	PCV-K1208	1-0102-PPID-K104	Back-Pressure	V722	25	FC	Ferric Chloride				
Sodium Hypochlorite to HRC Train 1	PCV-K1109	1-0102-PPID-K102	Back-Pressure	V722	38	SHC	Sodium Hypochlorite				
Sodium Hypochlorite to HRC Train 2	PCV-K1209	1-0102-PPID-K104	Back-Pressure	V722	38	SHC	Sodium Hypochlorite				
Sodium Hypochlorite to HRC Train 1 Effluent Channel and Maturation Tank 1	PCV-K1133	1-0102-PPID-K103	Back-Pressure	V722	38	SHC	Sodium Hypochlorite				
Sodium Hypochlorite to HRC Train 2 Effluent Channel and Maturation Tank 2	PCV-K1233	1-0102-PPID-K105	Back-Pressure	V722	38	SHC	Sodium Hypochlorite				
Sodium Hydroxide to HRC Effluent Channel	PCV-K1509	1-0102-PPID-K106	Back-Pressure	V722	25	SHD	Sodium Hydroxide				
Non-Potable Water to HRC Ballast Addition Skid	PCV-K3109	1-0102-PPID-K301	Pressure reducing	V710	50	NPW	Non-Potable Water		414	3.8	
Flushing Water Lamella Hose Station for HRC Train 1	PCV-K1144	1-0102-PPID-K103	Pressure reducing	V710	20	FSW	Flushing Water		345		
Flushing Water Lamella Hose Station for HRC Train 2	PCV-K1244	1-0102-PPID-K105	Pressure reducing	V710	20	FSW	Flushing Water		345		
AREA D - FERMENTERS / THICKENERS											
Fermenters											
Seal Water Supply to Fermenter Recirculation Pump P-D321	PCV-D3219	1-0102-PPID-D303	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to Fermenter Recirculation Pump P-D322	PCV-D3229	1-0102-PPID-D303	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Seal Water Supply to Fermenter Recirculation Pump P-D323	PCV-D3239	1-0102-PPID-D303	Pressure reducing	V710	12	NPW	Non-Potable Water	685-750	150	0.025	
Thickeners											
Flushing Water to WAS RDT RDT-D403 Inlet Piping	PCV-D404	1-0102-PPID-D402	Pressure reducing	V710	38	FSW	Flushing Water	685-750	50-100	3.5	
Flushing Water to WAS RDT RDT-D404 Inlet Piping	PCV-D4049	1-0102-PPID-D402	Pressure reducing	V710	38	FSW	Flushing Water	685-750	50-100	3.5	
Flushing Water to WAS RDT RDT-D403	PCV-D4038	1-0102-PPID-D402	Pressure reducing	V710	38	FSW	Flushing Water	965	TBD	2.2	Supplied by RDT vendor
Flushing Water to WAS RDT RDT-D404	PCV-D4048	1-0102-PPID-D402	Pressure reducing	V710	38	FSW	Flushing Water	965	TBD	2.2	Supplied by RDT vendor
TWAS Pump P-D405 Pressure Relief	PSV-D4059	1-0102-PPID-D403	Pressure relief	V735	100	TWAS	Thickened Waste Activated Sludge	1035	0-10	4.4	
TWAS Pump P-D406 Pressure Relief	PSV-D4069	1-0102-PPID-D403	Pressure relief	V735	100	TWAS	Thickened Waste Activated Sludge	1035	0-10	4.4	
FSL RDT Feed Pump P-D411 Pressure Relief	PSV-D4119	1-0102-PPID-D404	Pressure relief	V735	100	FSL	Fermented Sludge	360	20-60	22.2	
FSL RDT Feed Pump P-D412 Pressure Relief	PSV-D4129	1-0102-PPID-D404	Pressure relief	V735	100	FSL	Fermented Sludge	360	20-60	22.2	
FSL RDT Feed Pump P-D413 Pressure Relief	PSV-D4139	1-0102-PPID-D405	Pressure relief	V735	100	FSL	Fermented Sludge	360	20-60	22.2	
FSL RDT Feed Pump P-D414 Pressure Relief	PSV-D4149	1-0102-PPID-D405	Pressure relief	V735	100	FSL	Fermented Sludge	360	20-60	22.2	
Flushing Water to FSL RDT RDT-D415 Inlet Piping	PCV-D4159	1-0102-PPID-D406	Pressure reducing	V710	38	FSW	Flushing Water	685-750	50-100	3.5	
Flushing Water to FSL RDT RDT-D416 Inlet Piping	PCV-D4169	1-0102-PPID-D406	Pressure reducing	V710	38	FSW	Flushing Water	685-750	50-100	3.5	
Flushing Water to FSL RDT RDT-D417 Inlet Piping	PCV-D4179	1-0102-PPID-D407	Pressure reducing	V710	38	FSW	Flushing Water	685-750	50-100	3.5	
Flushing Water to FSL RDT RDT-D415	PCV-D4158	1-0102-PPID-D406	Pressure reducing	V710	38	FSW	Flushing Water	965	TBD	2.2	Supplied by RDT vendor
Flushing Water to FSL RDT RDT-D416	PCV-D4168	1-0102-PPID-D406	Pressure reducing	V710	38	FSW	Flushing Water	965	TBD	2.2	Supplied by RDT vendor
Flushing Water to FSL RDT RDT-D417	PCV-D4178	1-0102-PPID-D407	Pressure reducing	V710	38	FSW	Flushing Water	965	TBD	2.2	Supplied by RDT vendor
TFS Pump P-D418 Pressure Relief	PSV-D4189	1-0102-PPID-D408	Pressure relief	V735	100	TFS	Thickened Fermented Sludge	1035	0-10	9.2	
TFS Pump P-D419 Pressure Relief	PSV-D4199	1-0102-PPID-D408	Pressure relief	V735	100	TFS	Thickened Fermented Sludge	1035	0-10	9.2	
TFS Pump P-D420 Pressure Relief	PSV-D4209	1-0102-PPID-D409	Pressure relief	V735	100	TFS	Thickened Fermented Sludge	1035	0-10	9.2	
RDT Wash Water Hydropneumatic Tank Pressure Relief	PSV-D4309	1-0102-PPID-D410	Pressure relief	-	TBD	FSW	Flushing Water	TBD	TBD	TBD	Supplied by booster pump vendor
FSF Piping Upstream Flowmeter FE-D4605	N/A	1-0102-PPID-D413	Air release	V752	50	FSF	Fermented Sludge Filtrate	30-50			
FSF Piping Downstream Flowmeter FE-D4605	N/A	1-0102-PPID-D413	Air release	V752	50	FSF	Fermented Sludge Filtrate	30-50			
AREA T - BIOFILTER / ODOUR CONTROL											
Biofilter Cell 1	ARV-T2101	1-0102-PPID-T201	Vacuum	V738	300	FOA	Foul Air				Factory set at 5000 Pascals vacuum
Biofilter Cell 2	ARV-T2201	1-0102-PPID-T202	Vacuum	V738	300	FOA	Foul Air				Factory set at 5000 Pascals vacuum

SEWPCC UPGRADING/EXPANSION PROJECT

Self-Contained Valve Schedule

Description / Location	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Inlet Pressure (kPag) [Note 1]	Outlet Pressure (kPag)	Maximum Flow (L/s)	Remarks
Biofilter Cell 3	ARV-T2301	1-0102-PPID-T203	Vacuum	V738	300	FOA	Foul Air				Factory set at 5000 Pascals vacuum
Glycol Recirculation Pumps Loop Vent	ARV-T1059	1-0102-PPID-T102	Air release	V752		GS	Glycol Supply				Supplied by Biofilter vendor
Natural Gas Supply	PCV-T1069-1	1-0102-PPID-T102	Pressure Regulator	-	32	NG	Natural Gas	-	-	-	Supplied by Biofilter vendor
Natural Gas Supply	PCV-T1069-2	1-0102-PPID-T102	Pressure Regulator	-	32	NG	Natural Gas	-	-	-	Supplied by Biofilter vendor
Natural Gas Pressure Relief	PRV-T1069-1	1-0102-PPID-T102	Pressure Relief	-	25	NG	Natural Gas	-	-	-	Supplied by Biofilter vendor
Natural Gas Pressure Relief	PRV-T1069-2	1-0102-PPID-T102	Pressure Relief	-	25	NG	Natural Gas	-	-	-	Supplied by Biofilter vendor
Biofilter Heater Coil Glycol Recirculation	PRV-T1059	1-0102-PPID-T102	Pressure Relief	-	25	GS	Glycol Supply	-	-	-	Supplied by Biofilter vendor
NPW Supply to Biolfilters	PRV-T1409	1-0102-PPID-T107	Pressure Reducing	V710	38	NPW	Non-Potable Water	685-750	150	2.5	
AREA C - CHEMICAL BUILDING / ELECTRICAL BUILDING											
Flushing water	PCV-C4169	1-0102-PPID-C402	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4179	1-0102-PPID-C403	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4189	1-0102-PPID-C404	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4369	1-0102-PPID-C406	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4379	1-0102-PPID-C407	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4569	1-0102-PPID-C409	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4579	1-0102-PPID-C410	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Flushing water	PCV-C4762	1-0102-PPID-C412	Pressure reducing	V710	75	FSW	Flushing Water	685-750	150-350		
Potable water backflow preventer	BFP-C530K	1-0102-PPID-C503	RP backflow preventer	V642	100	PW	Potable Water				
Potable water backflow preventer	BFP-C530L	1-0102-PPID-C503	RP backflow preventer	V642	100	PW	Potable Water				
Potable water backflow preventer	BFP-C530M	1-0102-PPID-C503	RP backflow preventer	V642	100	PW	Potable Water				
Potable water backflow preventer	BFP-C530N	1-0102-PPID-C503	RP backflow preventer	V642	100	PW	Potable Water				
Potable water backflow preventer	BFP-C510D	1-0102-PPID-C503	RP backflow preventer	V642	32	DHW	Domestic Hot Water				
Potable water backflow preventer	BFP-C510E	1-0102-PPID-C503	RP backflow preventer	V642	32	DHW	Domestic Hot Water				
Bioreactor Ferric Chloride Pump P-C111 Pressure Relief Valve	PSV-C1119	1-0102-PPID-C102	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
Bioreactor Ferric Chloride Pump P-C112 Pressure Relief Valve	PSV-C1129	1-0102-PPID-C102	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
Bioreactor Ferric Chloride Pump P-C113 Pressure Relief Valve	PSV-C1139	1-0102-PPID-C102	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
Bioreactor Ferric Chloride Pump P-C114 Pressure Relief Valve	PSV-C1149	1-0102-PPID-C103	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
Bioreactor Ferric Chloride Pump P-C115 Pressure Relief Valve	PSV-C1159	1-0102-PPID-C103	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
Bioreactor Ferric Chloride Pump P-C116 Pressure Relief Valve	PSV-C1169	1-0102-PPID-C103	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
HRC Ferric Chloride Pump P-C121 Pressure Relief Valve	PSV-C1219	1-0102-PPID-C104	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
HRC Ferric Chloride Pump P-C122 Pressure Relief Valve	PSV-C1229	1-0102-PPID-C104	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
HRC Ferric Chloride Pump P-C123 Pressure Relief Valve	PSV-C1239	1-0102-PPID-C104	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
HRC Ferric Chloride Pump P-C131 Pressure Relief Valve	PSV-C1319	1-0102-PPID-C105	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
HRC Ferric Chloride Pump P-C132 Pressure Relief Valve	PSV-C1329	1-0102-PPID-C105	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
HRC Ferric Chloride Pump P-C133 Pressure Relief Valve	PSV-C1339	1-0102-PPID-C105	Pressure relief	-	-	FC	Ferric Chloride	-	-	-	Supplied by chemical pump skid supplier
Sodium Hydroxide Pump P-C231 Pressure Relief Valve	PSV-C2319	1-0102-PPID-C202	Pressure relief	-	-	SHD	Sodium Hydroxide	-	-	-	Supplied by chemical pump skid supplier
Sodium Hydroxide Pump P-C232 Pressure Relief Valve	PSV-C2329	1-0102-PPID-C202	Pressure relief	-	-	SHD	Sodium Hydroxide	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C241 Pressure Relief Valve	PSV-C2419	1-0102-PPID-C203	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C242 Pressure Relief Valve	PSV-C2429	1-0102-PPID-C203	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C211 Pressure Relief Valve	PSV-C2119	1-0102-PPID-C204	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C212 Pressure Relief Valve	PSV-C2129	1-0102-PPID-C204	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C221 Pressure Relief Valve	PSV-C2219	1-0102-PPID-C205	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C222 Pressure Relief Valve	PSV-C2229	1-0102-PPID-C205	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C223 Pressure Relief Valve	PSV-C2239	1-0102-PPID-C205	Pressure relief	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Bisulphite Pump P-C311 Pressure Relief Valve	PSV-C3119	1-0102-PPID-C301	Pressure relief	-	-	SBS	Sodium Bisulphite	-	-	-	Supplied by chemical pump skid supplier
Sodium Bisulphite Pump P-C312 Pressure Relief Valve	PSV-C3129	1-0102-PPID-C301	Pressure relief	-	-	SBS	Sodium Bisulphite	-	-	-	Supplied by chemical pump skid supplier
Carrier water for SBS service	PCV-C3109	1-0102-PPID-C301	Pressure reducing	V710	50	FSW	Flushing Water	685-750	150-350		
FSL RDT Post Dilution Polymer Pump P-C411 Pressure Relief Valve	PSV-C4119	1-0102-PPID-C402	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
FSL RDT Post Dilution Polymer Pump P-C412 Pressure Relief Valve	PSV-C4129	1-0102-PPID-C402	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
FSL RDT Post Dilution Polymer Pump P-C413 Pressure Relief Valve	PSV-C4139	1-0102-PPID-C403	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
FSL RDT Post Dilution Polymer Pump P-C414 Pressure Relief Valve	PSV-C4149	1-0102-PPID-C403	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
FSL RDT Post Dilution Polymer Pump P-C415 Pressure Relief Valve	PSV-C4159	1-0102-PPID-C404	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
WAS RDT Post Dilution Polymer Pump P-C431 Pressure Relief Valve	PSV-C4319	1-0102-PPID-C406	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
WAS RDT Post Dilution Polymer Pump P-C432 Pressure Relief Valve	PSV-C4329	1-0102-PPID-C406	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
WAS RDT Post Dilution Polymer Pump P-C433 Pressure Relief Valve	PSV-C4339	1-0102-PPID-C407	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
HRC Post Dilution Polymer Pump P-C451 Pressure Relief Valve	PSV-C4519	1-0102-PPID-C409	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
HRC Post Dilution Polymer Pump P-C452 Pressure Relief Valve	PSV-C4529	1-0102-PPID-C409	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
HRC Post Dilution Polymer Pump P-C453 Pressure Relief Valve	PSV-C4359	1-0102-PPID-C410	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier

SEWPCC UPGRADING/EXPANSION PROJECT

Self-Contained Valve Schedule

Description / Location	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Inlet Pressure (kPag) [Note 1]	Outlet Pressure (kPag)	Maximum Flow (L/s)	Remarks
Secondary Clarifier Post Dilution Polymer Pump P-C471 Pressure Relief Valve	PSV-C4719	1-0102-PPID-C412	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
Secondary Clarifier Post Dilution Polymer Pump P-C472 Pressure Relief Valve	PSV-C4729	1-0102-PPID-C412	Pressure relief	-	-	MP	Mixed Polymer	-	-	-	Supplied by chemical pump skid supplier
Sodium Hydroxide Pump P-C231 Pressure Regulating Valve	PCV-C2319	1-0102-PPID-C202	Pressure Regulator	-	-	SHD	Sodium Hydroxide	-	-	-	Supplied by chemical pump skid supplier
Sodium Hydroxide Pump P-C232 Pressure Regulating Valve	PCV-C2329	1-0102-PPID-C202	Pressure Regulator	-	-	SHD	Sodium Hydroxide	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C241 Pressure Regulating Valve	PCV-C2419	1-0102-PPID-C203	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C242 Pressure Regulating Valve	PCV-C2429	1-0102-PPID-C203	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C211 Pressure Regulating Valve	PCV-C2119	1-0102-PPID-C204	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C212 Pressure Regulating Valve	PCV-C2129	1-0102-PPID-C204	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C221 Pressure Regulating Valve	PCV-C2219	1-0102-PPID-C205	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C222 Pressure Regulating Valve	PCV-C2229	1-0102-PPID-C205	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Hypochlorite Pump P-C223 Pressure Regulating Valve	PCV-C2239	1-0102-PPID-C205	Pressure Regulator	-	-	SHC	Sodium Hypochlorite	-	-	-	Supplied by chemical pump skid supplier
Sodium Bisulphite Pump P-C311 Pressure Regulating Valve	PCV-C3119	1-0102-PPID-C301	Pressure Regulator	-	-	SBS	Sodium Bisulphite	-	-	-	Supplied by chemical pump skid supplier
Sodium Bisulphite Pump P-C312 Pressure Regulating Valve	PCV-C3129	1-0102-PPID-C301	Pressure Regulator	-	-	SBS	Sodium Bisulphite	-	-	-	Supplied by chemical pump skid supplier
BUILDING MECHANICAL											
AREA G - HEADWORKS											
Flushing Water to glycol heat recovery	PCV-G6739-1	1-0102-PPID-G623	Pressure reducing	V716	100	FSW	Flushing Water	685-750	150-350		
Flushing Water to glycol heat recovery	PCV-G6739-2	1-0102-PPID-G623	Pressure reducing	V716	100	FSW	Flushing Water	685-750	150-350		
AREA R - BIOREACTORS / BLOWER BUILDING											
Natural Gas to Air Handling Unit AHU-R610	PCV-R6109	1-0102-PPID-R603	Pressure Reducing	V754	32	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater GUH-R654	PCV-R6541	1-0102-PPID-R608	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater GUH-R624	PCV-R6249	1-0102-PPID-R607	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater GUH-R625	PCV-R6259	1-0102-PPID-R607	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
AREA S - SECONDARY CLARIFIERS											
Natural Gas to Air Handling Unit AHU-S630	PCV-S6309	1-0102-PPID-S622	Pressure Reducing	V754	38	NG	Natural Gas	34.4	2		
Natural Gas to Air Handling Unit AHU-S650	PCV-S6509	1-0102-PPID-S623	Pressure Reducing	V754	38	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-S655	PCV-S6559	1-0102-PPID-S626	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-S656	PCV-S6569	1-0102-PPID-S626	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-S659	PCV-S6599	1-0102-PPID-S626	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Flushing water pressure reducing valve	PCV-S6639	1-0102-PPID-S627	Pressure Reducing	V716	100	FSW	Flushing Water				
AREA U - UV DISINFECTION BUILDING											
Natural Gas to Air Handling Unit AHU-U640	PCV-U6409	1-0102-PPID-U601	Pressure Reducing	V754	25	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-U650	PCV-U6509	1-0102-PPID-U602	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-U651	PCV-U6519	1-0102-PPID-U602	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-U652	PCV-U6529	1-0102-PPID-U602	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
Natural Gas to Unit Heater UH-U654	PCV-U6549	1-0102-PPID-U602	Pressure Reducing	V754	12	NG	Natural Gas	34.4	2		
AREA D - FERMENTERS / THICKENERS											
Natural Gas to Air Handling Unit AHU-D610	PCV-D6109	1-0102-PPID-D601	Pressure Reducing	V754	50	NG	Natural Gas	34.4	2		
Natural Gas to Air Handling Unit AHU-D620	PCV-D6209	1-0102-PPID-D602	Pressure Reducing	V754	25	NG	Natural Gas	34.4	2		
AREA T - BIOFILTER / ODOUR CONTROL											
Odour Control Biofilter TK--T210		1-0102-PPID-T201	Vacuum Relief	V738	300	FOA	Foul Air				Set at minus 5000 Pascals
Odour Control Biofilter TK--T220		1-0102-PPID-T201	Vacuum Relief	V738	300	FOA	Foul Air				Set at minus 5000 Pascals
Odour Control Biofilter TK--T230		1-0102-PPID-T201	Vacuum Relief	V738	300	FOA	Foul Air				Set at minus 5000 Pascals
Natural gas to AHU gas burner	PCV-T6109	1-0102-PPID-T601	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
AREA C - CHEMICAL BUILDING / ELECTRICAL BUILDING											
Natural gas to gas water heater	PCV-C5309-1	1-0102-PPID-C503	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
Natural gas to gas water heater	PCV-C5309-2	1-0102-PPID-C503	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
Natural gas to gas water heater	PCV-C5309-3	1-0102-PPID-C503	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
Non-potable Water	PCV-C5109	1-0102-PPID-C504	Pressure reducing	V716	100	NPW	Non-Potable Water	685-750	150-350		
Natural gas to AHU gas burner	PCV-C6119	1-0102-PPID-C601	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
Natural gas to AHU gas burner	PCV-C6129	1-0102-PPID-C602	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
Natural gas to AHU gas burner	PCV-C6209	1-0102-PPID-C603	Pressure reducing	V754	32	NG	Natural Gas	34.4	2		
Natural gas to Heater Unit	PCV-C6179	1-0102-PPID-C607	Pressure reducing	V754	12	NG	Natural Gas	34.4	2		
Natural gas to Heater Unit	PCV-C6639	1-0102-PPID-C608	Pressure reducing	V754	12	NG	Natural Gas	34.4	2		
Natural gas to Heater Unit	PCV-C6649	1-0102-PPID-C608	Pressure reducing	V754	12	NG	Natural Gas	34.4	2		
Potable water pressure reducing	PCV-C5309	1-0102-PPID-C503	Pressure reducing	V710	50	PW	Potable Water				

General Notes:

SEWPCC UPGRADING/EXPANSION PROJECT

Self-Contained Valve Schedule

Description / Location	Tag Number	P&ID Number	Valve Type	Valve Type Number	Size (mm)	Commodity Code	Commodity	Inlet Pressure (kPag) [Note 1]	Outlet Pressure (kPag)	Maximum Flow (L/s)	Remarks

1. This schedule is provided for the Contractor's convenience and shall not be taken as complete.
2. Valves to be supplied and installed under this contract unless otherwise indicated.
3. n/a = not applicable; valve supplied by others, installed under this contract.
4. Refer to the scope of pre-purchased equipment for valves that are supplied by others to be installed under this contract.

Notes:

1. Inlet Pressure = Set pressure for pressure relief valve or upstream pressure for pressure reducing valve.

SECTION 40 41 13

PIPE HEAT TRACING

PART 1 GENERAL

1.1 REFERENCES

A. Manitoba Building Code (MBC).

B. The following is a list of standards which may be referenced in this section:
   1. Factory Mutual.
   2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
   3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. Underwriters Laboratories, Inc. (UL).

1.2 DESIGN REQUIREMENTS

A. Design equipment, anchorage, and support systems for vertical and lateral loading in accordance with MBC.

B. Refer to Electrical Drawings for the scope and technical specification for pipe heat tracing.

1.3 SUBMITTALS

A. Submit written certification from Professional Engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment have been designed according to requirements of the National Building Code of Canada (NBC). Specifically, the design shall meet the requirements of NBC for post-disaster structures at time of Shop Drawing submittals.

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

PART 2 PRODUCTS

REFER TO ELECTRICAL DRAWINGS

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Electrical Heating Tape:
1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.
4. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

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

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 5 degrees C. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:
1. Install in accordance with manufacturer's instructions and as approved by Contract Administrator.

3.2 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.
1. Insulation Resistance: Minimum 1,000 megohms per 300 meters.

END OF SECTION

SECTION 40 42 13

PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.
   2. ASTM International (ASTM):
      a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by means of the Guarded-Hot-Plate Apparatus.
      b. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      c. C518, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      d. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      e. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
      g. C552, Standard Specification for Cellular Glass Thermal.
      h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
      i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
      j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
      k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      l. E96, Test Methods for Water Vapor Transmission of Materials.
   3. International Code Council (ICC) International Energy Conservation Code (IECC).
   4. Underwriters Laboratories Inc. (UL).
   5. Underwriters Laboratories of Canada (ULC).

1.2 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Manufacturer’s descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.1 PIPE INSULATION

A. Type 1:
1. Material: Flexible elastomeric pipe insulation, closed cell structure in accordance with ASTM C534.
2. Temperature Rating: Minus 40 degrees C to 82 degrees C.
3. Nominal Density: 96 kg/m^3.
4. Conductivity in accordance with ASHRAE 90.1 and minimum of 24 degrees C per ASTM C177 or ASTM C518.
5. Minimum water vapor transmission of 5.75 ng/Pa·s·m^2 per ASTM E96.
6. Joints: Manufacturer's adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Manufacturers and Products:
   a. Rubatex; Insul-Tube 180 or Insul-Sheet 1800.
   b. Armstrong; Armaflex AP.

B. Type 2:
1. Material: UL-rated, preformed, sectional rigid fiberglass with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Temperature Rating: Minus 18 degrees C to 455 degrees C.
3. Conductivity in accordance with ASHRAE 90.1 and minimum of 0.039 w/m·degrees C.
4. Minimum water vapor transmission for jacket of 1.15 ng/Pa·s·m^2 per ASTM E96.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Manufacturers and Products:
   a. Owens-Corning Fiberglass; ASJ/SSL-11.
   b. Manville; Micro-Lock 650 with AP-T Jacket.

C. Type 2A – Flexible Blanket, Nonjacketed, High Temperature:
1. Description: Roll form complying with ASTM C553.
2. Thermal Conductivity: 0.27 at 24 degrees C mean temperature.
3. Nonjacketed.
4. Density: 2 pcf.
5. Maximum Operating Temperature: 538 degrees C.
6. Acceptable Manufacturers:
   a. Johns Manville HTB 23.
   b. Owens Corning – Fiber Glass TTW Type 1.
   c. Knauf Fiber Glass GmbH Type ET.

D. Type 3:
1. Material: Cellular glass.
2. Temperature Rating: Minus 179 degrees C to 482 degrees C.
3. Following manufacturer's direction based upon temperature of piping to be insulated.
4. Manufacturer and Product: Pittsburgh Corning; FOAMGLAS.

E. Type 4:
   1. Material: Calcium silicate, minimum density of 192 kg/m^3, maximum K factor of 0.066 W/m·degrees C at 149 degrees C mean (ASTM C533), without factory-applied jacket.
   2. Temperature Rating: 649 degrees C, maximum.
   3. Manufacturers and Products:
      a. Owens/Corning Fiberglass; Kaylo 10.
      b. Schuller (Manville); Thermo-12.
      c. Calsilite; 1,200-degree thermal insulation.

F. Type 5 Noise Insulation for Pipes and Ducts:
   1. Material: Foil faced mass loaded vinyl noise barrier bonded to 50 mm
   2. quilted fiberglass sound absorber. 2 pounds per square foot noise
   3. barrier.
   4. Temperature Rating: Minus 25 degrees C to 150 degrees C.
   5. Class A Fire Rating.
   6. Sound Reduction: 20 decibels.
   7. Manufacturers: Sound Seal Corp.

2.2 ROOF DRAIN AND OVERFLOW DRAIN SUMPS INSULATION

A. Type 1: 25 mm thick.

2.3 FITTING INSULATION

A. Type 1: Same as pipe.

B. Type 2:
   1. Wired in-place premolded insulation or mitered segments, or soft fiberglass insulation inserts covered with premolded 20-mil minimum thickness PVC fitting covers.
   2. Manufacturers:
      a. Manville Zeston.
      b. CEEL-CO.
      c. Knauf-Proto.

C. Type 3: Same as pipe.

2.4 INSULATION AT PIPE HANGERS AND SUPPORTS

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

B. Type 1:
   1. Copper and Nonmetallic Pipe 50 mm and Smaller and Steel Pipe 40 mm and Smaller: Use insulation shields.
   2. Larger Sizes: Use insulation saddles or Type 3 rigid insulation insert 250 mm long.

C. Type 2: UL-rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 250 mm in length, with factory applied, vinyl-coated and embossed vapor barrier jacket with self-sealing lap.

2.5 INSULATION FINISH SYSTEMS

A. Type F1 – PVC:
   1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 70 degrees C.
   2. Manufacturers and Products:
      a. Knauf; Proto.
      b. Johns Manville; Zeston.

B. Type F2 – Paint:
   1. Acrylic latex paint, white, and suitable for outdoor use.
   2. Manufacturers and Products:
      a. Armstrong; WB Armaflex finish.
      b. Rubatex; 374, white finish.

C. Type F3 – Aluminum:
   1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, minimum 0.4 mm thickness, with smooth mill finish.
   2. Vapor Barrier: Provide factory applied vapor barrier, consisting of kraft paper with 1 mil thick low density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
   3. Fitting Covers: Material as for aluminum roll jacketing, pre-molded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.
   4. Manufacturers:
      a. RPR Products; Insul-Mate.
      b. Childers.
      c. Pabco.

D. Type 4 – Buried for Type 3 Insulation: Jacket system to be foam glass manufacturer's standard Pittwrap bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, heat-sealed at overlap.

PART 3 EXECUTION

3.1 APPLICATION

A. General:
   1. Insulate valve bodies, flanges, and pipe couplings.
   2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
   3. Do not insulate flexible pipe couplings and expansion joints unless they are located outdoors.

4. Service and Insulation Thickness: Refer to Insulation Schedule below and to Process Piping Schedule in Section 40 27 00, Process Piping – General.

Insulation Schedule

Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees C)*	Insulation	Finish Systems			
					Concealed from View	Indoors Exposed	Outdoors	Buried
Air Low Pressure	ALP	50 mm noise insulation	- 25 to 120	Type 5	Type F3	Type F3	Type F3	N/A
Foul Air (outdoors only)	FOA	50 mm noise insulation	- 25 to 40	Type 5	Type F3	N/A	Type F3	N/A
Flushing Service Water (outdoors only)	FSW	40 mm (up to 100 mm pipe) 50 mm (above 100 mm pipe)	0 to 25	Type 1	Type F3	N/A	Type F3	N/A
Vent, and Vent to Atmosphere	V, VTA	40 mm (up to 100 mm pipe) 50 mm (above 100 mm pipe)	0 to 25	Type 1	Type F3	N/A	Type F3	N/A
Ferric Chloride (outdoors only)	FC	40 mm	0 to 25	Type 1	Type F3	N/A	Type F3	N/A
Scum (buried outdoors only)	SC	75 mm	1 to 25	Type 3	N/A	N/A	N/A	Type 4
Mixed Polymer (buried outdoors only)	MP	75 mm	1 to 25	Type 3	N/A	N/A	N/A	Type 4
Sodium Bisulphite	SBS	25 mm	5 to 25	Type 1	Type F1	Type F1	Type F3	N/A
Sodium Bisulphite	SBS	25 mm	5 to 25	Type 3 (to 300 mm above grade)	N/A	N/A	N/A	Type F4
Sodium Hypochlorite	SHC	25 mm	5 to 25	Type 1	Type F1	Type F1	N/A	N/A
Sodium Hydroxide (heat traced)	SHD	25 mm	15 to 25	Type 1	Type F1	Type F1	N/A	N/A
Heating Systems	HWR, HWS, GS, GR	40 mm (up to 100 mm pipe) 50 mm (above 100 mm pipe)	21 to 121	Type 2	N/A	F2	F3	N/A
Diesel Fuel Supply (outdoors only, heat traced)	DFS	25mm	5 to 15	Type 1	Type F3	N/A	F3	N/A
Potable Water and Domestic Hot Water Systems, Non potable Water	PW, DHW, NPW	25 mm	4 to 60	Type 1	N/A	F1	F3	N/A
Cooling Systems (Condensate chilled water, and refrigerant)	CON, RWL, CWS, CWR, R, CHS, CHR	20 mm (Condensate) 20 mm (Refrigerant) 25 mm (Roof Drain) 40 mm CWS, CWR, CHS, CHR (up to 100 mm pipe) 50 mm CWS, CWR, CHS, CHR (above 100 mm pipe)	4 to 15	Type 1	N/A	F2	F3	N/A

Insulation Schedule								
					Finish Systems			
Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees C)*	Insulation	Concealed from View	Indoors Exposed	Outdoors	Buried
HT-Piping requiring heat tracing	D	Pipe Size: Insulation Thickness Inches: [a b] 25 mm (pipe up to 75 mm) 40 mm (pipe from 100 mm to 250 mm)	10 to 40	All Outdoors: Type 1 Insulate and heat trace outside lines 1' above grade. Use Type 3 insulation from 1' above grade to frost depth	N/A	N/A	F3	F4 on Type 3

*Use these fluid temperatures unless otherwise noted in the Process Piping Schedule.
[a]Based upon insulation with glass fiber per ASTM C547, outdoors with 9 L/s wind with 10% safety and no value assigned to cladding or air space at cladding.
[b]Matches the watts per meter in Section 40 41 13, Pipe Heat Tracing

3.2 INSTALLATION

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

B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

C. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

E. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

F. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

G. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.

H. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

I. Insulate valve bodies, flanges, and pipe couplings.

J. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

K. Do not insulate flexible pipe couplings and expansion joints.

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

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

N. Placement:
   1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
   2. Insulate valves and fittings with sleeved or cut pieces of same material.
   3. Seal and tape joints.

O. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

P. Heat Traced Piping: Apply insulation after heat-tracing work is completed and approved.

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

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

S. PVC Jacketing:
   1. Overlap jacketing minimum 50 mm. Seal and band longitudinal and circumferential joints and seams with sealing compound and pre-formed aluminum or stainless steel straps and fasteners.

2. Make special provision, according to manufacturer's instructions, to allow uniform expansion on jacket to avoid joint opening on piping with 50 mm or greater layer of insulation.
3. Provide removable sections at inspection openings, arranged to allow removal and replacement without cutting cover or retaining system.
4. Design covers for flanges, fittings and expansion pieces with hinged locking arrangement to allow removal and replacement without cutting cover or retaining system.

3.3 FIELD FINISHING

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

B. Where pipe labels or banding are specified for a piping system they shall be applied to the finished insulation and not to the pipe.

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

END OF SECTION

SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.1 SUBMITTALS

A. Informational Submittals:
   1. Testing Plan: Submit prior to testing and include at least the information that follows.
      a. Testing dates.
      b. Piping systems and section(s) to be tested.
      c. Test type.
      d. Method of isolation.
      e. Calculation of maximum allowable leakage for piping section(s) to be tested.
   2. Certifications of Calibration: Testing equipment.
   3. Certified Test Report.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 PREPARATION

A. Notify Contract Administrator in writing 5 days in advance of testing. Perform testing in presence of Contract Administrator.

B. Pressure Piping:
   1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
   2. Wait 10 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 5 days.
   3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
   4. New Piping Connected to Existing Piping:
      a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Contract Administrator.
      b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Contract Administrator.
   5. Items that do not require testing include: Piping between wetwells and wetwell isolation valves, equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.
   6. Test Pressure: As indicated on Piping Schedule or as specified by equipment manufacturer as applicable.

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

D. Gravity Piping:
   1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
   2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Contract Administrator.
   3. Pipe 1050 mm Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:
   1. Perform testing on installed piping prior to application of insulation.
   2. Maximum Filling Velocity: 0.76 meter per second, applied over full area of pipe.
   3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
   4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
   5. Examine joints and connections for leakage.
   6. Correct visible leakage and retest as specified.
   7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:
   1. Test after backfilling has been completed.
   2. Expel air from piping system during filling.
   3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
   4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
   5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
   6. Maximum Allowable Leakage:

$$L = \frac{S \times D \times \sqrt{P}}{715{,}400}$$

where:

L = Allowable leakage (L/hr)
S = Length of pipe tested (m)
D = Nominal diameter of pipe (mm)
P = Test pressure during leakage test (kPa)

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

3.3 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:
   1. PVC or CPVC pipe.
   2. Piping larger than 450 mm.
   3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:
   1. Apply preliminary pneumatic test pressure of 172 kPa maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
   2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
   3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
   4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
   5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.4 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1.9 litre water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.078 litre per hour per millimeter diameter per 100 m. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 4.6 m of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 4.6 m in height, test systems in 4.6 m vertical sections as piping is installed.

D. Exfiltration Test:
   1. Hydrostatic Head:
      a. At least 1.8 meter above maximum estimated groundwater level in section being tested.
      b. No less than 1.8 meter above inside top of highest section of pipe in test section, including service connections.
   2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 9.1 m of water column.

E. Infiltration Test:
   1. Groundwater Level: At least 1.8 meter above inside top of highest section of pipe in test section, including service connections.

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

G. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.5 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:
   1. Calibrate gauges with standardized test gauge provided by Contract Administrator at start of each testing day. Contract Administrator will witness calibration.
   2. Install gauges, air piping manifolds, and valves at ground surface.
   3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 41.4 kPa or less.
   4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:
   1. Require that no person enter manhole where pipe is under pressure.
   2. Slowly introduce air into pipe section until internal air pressure reaches 27.6 kPa greater than average back pressure of groundwater submerging pipe.
   3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 24.1 kPa to 17.2 kPa greater than average back pressure of groundwater submerging pipe is less than that computed utilizing values from following table:

TABLE 1*

A Pipe Diameter (mm)	B Time per Meter up to Length in Col C (Seconds)	C Test Length (m)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (m)	F Time per Meter for Total Length (Seconds)
100	0.59	193.9	1:54	339.5	0.33
150	1.31	129.2	2:50	226.5	0.75
200	2.33	96.9	3:47	169.8	1.34
250	3.64	77.7	4:43	135.9	2.07
300	5.25	64.5	5:40	111.3	2.98
375	8.20	51.8	7:05	89.1	4.66
450	11.90	43.0	8:30	74.4	6.75
525	16.13	36.9	9:55	63.9	9.21
600	21.05	32.3	11:20	56.1	12.03

TABLE 1*					
A Pipe Diameter (mm)	B Time per Meter up to Length in Col C (Seconds)	C Test Length (m)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (m)	F Time per Meter for Total Length (Seconds)
EXAMPLE: 375 mm diameter pipe: For 50 m, T = 8.20 sec (Col B) x 50 m = 410 sec = 6:50 For 75 m, T = 7:05 (Col D) For 150 m, T = 4.66 sec (Col F) x 150 m = 699 sec = 11:39					
*Based on 0.015 L/s/m^2 with a minimum significant loss of 0.94 L/s and a maximum loss of 1.65 L/s.					

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

E. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.6 FIELD QUALITY CONTROL

A. Test Report Documentation:
   1. Test date.
   2. Description and identification of piping tested.
   3. Test fluid.
   4. Test pressure.
   5. Remarks, including:
      a. Leaks (type, location).
      b. Repair/replacement performed to remedy excessive leakage.
   6. Signed by Contractor and Contract Administrator to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 00

INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This section gives general requirements for Instrumentation and Control related items. It is supplemental to the requirements defined in other specification sections.

B. Comply with latest edition of all applicable codes and standards whether referenced in this section or not.

C. In the event any inconsistency is discovered between the specifications, codes or standards, the most stringent shall apply.

1.2 REFERENCES

A. The following is a list of codes and standards are applicable as required:
   1. Institute of Electrical and Electronics Engineers (IEEE).
      a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
      b. IEEE 802.3u, 100BASE-TX, 100BASE-FX Ethernet at 100 Mbit/s
      c. IEEE 802.3z, 1000BASE-X Gbit/s Ethernet over Fibre Optic
      d. IEEE 802,3ab, 1000BASE-T Gbit/s Ethernet over twisted pair
      e. IEEE 802,3x, Flow Control
   2. The International Society of Automation (ISA).
      a. S5.1, Instrumentation Symbols and Identification.
      b. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
      c. 62443, Security for Industrial Automation and Control Systems
   3. Canadian Standards Association (CSA).
      a. C22.1 Canadian Electrical Code
      b. C22.2, Electrical Safety Code
   4. National Electrical Manufacturers Association (NEMA).
   5. National Fire Code, National Fire Protection Association (NFPA).
      a. NFPA 820, Fire Protection in Wastewater Treatment Plants.

B. Comply with the following City of Winnipeg Standards documents:
   1. Identification Standard 510276-0000-40ER-0002 – See Appendix CC
   2. Tagname Identification Standard 612620-0014-40ER-0001 – See Appendix EE
   3. HMI Layout and Animation Plan 612620-0015-40ER-0001 – See Appendix DD
   4. Historical Data Retention Standard 612620-0016-40ER-0001 – See Appendix BB

C. See the City of Winnipeg Automation Design Guide 612620-0013-40ER-0001 (Appendix FF), Sections 1 to 16 for general design philosophy. Sections 3 and 7 relate to control system network architecture.

D. Complete installation in accordance with the latest version of CSA C22.1.

E. Comply with all laws, ordinances, rules, regulations, codes, and orders of all Authorities Having Jurisdiction relating to this Work.

1.3 ACRONYMS AND ABBREVIATIONS:

A. CP: Control Panel

B. DCS: Distributed Control System

C. FAT: Factory Acceptance Test

D. FOCS: Fibre Optic Communication Subsystem

E. HVAC: Heating, Ventilating, and Air Conditioning

F. I&C: Instrumentation and Control

G. I/O or IO: Input and Output

H. HMI: Human-Machine Interface, alias for Operator Interface

I. LCP: Local Control Panel

J. MCC: Motor Control Center

K. O&M: Operation and Maintenance

L. OWS Operator Work Station

M. PC: Personal Computer

N. PCS: Process Control System comprising PLC's, and HMIs, communications systems and related hardware and software

O. PCU: Process Control Unit, a DCS subsystem

P. PICS: Process Instrumentation and Control System

Q. P&ID: Process and Instrument Diagram.

R. PLC: Programmable Logic Controller

S. SAT: Site Acceptance Test

T. SIT: Site Integration Test

U. SIFT: System Integration Functional Test

V. UPS: Uninterruptible Power Supply

W. VFD: Variable Frequency Drive

1.4 SUPPLEMENTAL DOCUMENTS

A. The following appendices contain documents that are related to the Automation work:
   1. Appendix N - Process Control Narratives
   2. Appendix O - Functional Requirements Specifications
   3. Appendix P - Instrument Lists
      a. Instrument lists are provided as an aid to the Contractor's work. If there are any discrepancies between these documents and the Drawings and Specifications, the Drawings and Specifications shall take precedence.
   4. Appendix Q - IO Lists
      a. IO lists are provided as an aid to the Contractor's work. If there are any discrepancies between these documents and the Drawings and Specifications, the Drawings and Specifications shall take precedence.
   5. Appendix R – Instrument Datasheets
      a. See 40 91 01 Instrumentation and Control Components for details on datasheets.
   6. Appendix S - DCS Migration Plan and Exchange Tables
   7. Appendix T - Manual Control Details
   8. Appendix U - Cable Lists
   9. Appendix V - Automation Equipment List (A-0102-AELI-A001)
   10. Appendix W - Miscellaneous Automation Documents – Including the following:
      a. PLC Module List (A-0102-AELI-A002)
      b. Third Party Interface List Sample (A-0102-AELI-A020)– See 40 96 00 Application Software for details.
      c. Existing Equipment Interface List (A-0102-AELI-A021) – See 40 96 00 Application Software for details.
      d. Existing Equipment Interim Interface List (A-0102-AELI-A022) – See 40 96 00 Application Software for details.
      e. VFD Settings Sheet Sample (A-0102-EDTS-A001) – See 26 29 23 Variable Frequency Drives for details.
      f. Existing Instruments to Re-Tag List (A-0102-AELI-A012)

B. The Comprehensive Instrument List (A-0102-AELI-A011 – This is a collection of all area specific instrument lists), the PLC Module List (A-0102-AELI-A002), and the Automation Equipment List (A-0102-AELI-A001) are provided in native Microsoft Excel format as an aid to the Contractor's work. If there are any discrepancies between these documents and the Drawings and Specifications, the Drawings and Specifications shall take precedence.

1.5 SUBMITTALS

A. General:
   1. Submit proposed Submittal breakdown list consisting of all PICS component submittals. Sequencing and packaging of information to be in accordance with Progress Schedule.
   2. Partial Submittals not in accordance with Progress Schedule will not be accepted.
   3. Obtain Contract Administrator’s approval if Submittals for a PICS subsystem are to be made in multiple packages.

4. Provide submittals sufficiently in advance of requirements to allow ample time for review.

B. Shop Drawings and Product Data
1. Prior to delivery of any Products to job site, submit Shop Drawings and Product Data as specified in Section 01 33 00, Submittal Procedures for all equipment as required in the Specifications
2. Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.
3. The term “Shop Drawing” means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work. Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross-references to design drawings and specifications. Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the contract price. If adjustments affect the value of the Work, state such in writing to the Contract Administrator prior to proceeding with the Work.
4. Equipment identifiers shall be included on all shop drawing and product data submittals to clearly identify the equipment they apply to.
5. Manufacture of Products shall conform to revised Shop Drawings.

C. Informational Submittals
1. Provide informational submittals in accordance with other specification sections including but not limited to the following:
   a. Training Plan: In accordance with other specification sections.
   b. Testing and Commissioning Forms: In accordance with other specification sections.
   c. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data and in addition to the following:
      1) Outline of O&M data.
      2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component.
   d. As-Built Drawings: In accordance with Section 01 77 00, Closeout Procedures.
2. Extra Materials:
   a. List of proposed spares, expendables, and test equipment. Separate Submittals for each PICS subsystem.
   b. Recommended Spare Parts: List of, and descriptive literature for, additional spares, expendables, and test equipment recommended by PICS Integrator. Include quantities, unit prices, and total costs.

1.6 DRAWINGS AND SPECIFICATIONS

A. The intent of the Drawings and Specifications is to indicate labor, products, and services necessary for a complete, installed, tested, commissioned and functional installation.

B. PICS drawings may indicate approximate route to be followed by conduits and cables and general location of electrical equipment. They do not show all structural, architectural and mechanical details. The details on exact cable or conduit routing, and exact equipment installation location is to be determined on site and coordinated with all other trades.

C. There are many loop diagrams and motor starter schematics that depict existing equipment connected to the existing DCS that were based on existing documentation. The control and monitoring of this equipment will be included in the migration of the DCS. Some notes on these drawings are marked as "Field Check" which are indications of inconsistencies on the existing documentation and it is not within the Contractor's scope of work to resolve them.

D. To provide sufficient detail and maximum degree of clarity on the drawings, symbols used for various electrical devices, particularly wall mounted devices, take up more space on the drawings than devices physically do. Locate devices with primary regard for convenience of operation, accessibility and space utilization, rather than locating devices to comply with the exact scaled locations of the electrical symbols.

E. The PICS specifications and drawings and the specifications of all other divisions shall be considered as an integral part of the work. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified by the drawings or specifications of other divisions, shall be considered as properly and sufficiently specified and shall be provided.

F. If discrepancies or omissions in the drawings or specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting a bid.

G. Provide all minor items and work not shown or specified but which are reasonably necessary to complete the work.

H. Various package unit types of equipment are included in the work. It is the responsibility of the Contractor to familiarize himself with the requirements of the equipment vendor, and to include all materials and labor for a complete and working installation. In some cases this means that control panels, instruments, actuators, etc need to be wired and connected in the field. The Contractor shall include all costs to perform such services as part of his tender submittal. Coordination between the equipment vendor and the contractor shall be performed prior to tender bid closing date, and all costs shall be included in the tender. Request for extras due to lack of coordination between the Contractor and the equipment vendors will not be accepted.

I. Cables schedules / lists where shown do not include all cables required to perform the complete facility installation. They shall be used as a general guide. Accurate cable lists, quantities, take-offs remain the responsibility of the Contractor.

1.7 CARE, OPERATION AND START-UP

A. Instruct City maintenance and operating personnel in the operation, care and maintenance of systems, system equipment and components.

B. Where services of a manufacturer's factory service engineer is required, arrange and pay for services to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

C. Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

1.8 PERMITS, FEES AND INSPECTION

A. The Contract Administrator will submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

B. The Contractor shall pay associated fees as required by the Electrical Inspections and Permitting department.

C. Notify the Contract Administrator of changes required by Electrical Inspection Department prior to making changes.

D. Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

1.9 MATERIALS AND EQUIPMENT

A. Provide materials and equipment in accordance with Section 01 61 00, Common Product Requirements.

B. Equipment and material to be CSA or cUL certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.

C. Minimum enclosure type to be used is NEMA 12 unless otherwise specified.

D. Junction Boxes
   1. All field wiring connections to be located in junction boxes with terminals. The design documents show the expected junction boxes to be required. However, the Contractor must provide all junction boxes required, whether or not the junction boxes are shown in the design documents.

1.10 PICS COORDINATION

A. Coordinate work with all other trades to ensure that conflicts do not occur.

B. Coordinate requirement of mechanical equipment requiring electrical connection with the Mechanical contractor.

1.11 FINISHES

A. Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
   1. Paint enclosures light grey to ANSI 61 grey enamel, unless otherwise specified.

B. Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

C. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

D. Refer to Section 09 90 00, Painting and Coating for additional information.

1.12 EQUIPMENT IDENTIFICATION

A. Identify PICS equipment with nameplates.

B. All identifiers shall be consistent with City of Winnipeg Water and Waste Department Identification Standard 510276-0000-40ER-0002 and as shown on drawings.

C. Nameplates:
   1. Lamacoid, 3 mm thick plastic nameplates, mechanically attached with self tapping stainless steel screws, white face with black lettering. Note: “Sheet Metal Screws” or other sharp pointed screws are NOT acceptable.
   2. Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	40 x 90 mm	2 lines	8 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	5 mm high letters
Size 8	35 x 100 mm	3 lines	5 mm high letters
Size 9	45 x 100 mm	4 lines	5 mm high letters
Size 10	75 x 160 mm	3 or 4 lines	8 mm high letters
Size 11	150 x 250 mm	3 or 4 lines	10 mm high letters

D. Wording on nameplates to be approved by Contract Administrator prior to manufacture.

E. Allow for average of fifty (50) letters per nameplate.

F. Identification to be in English.

G. Provide nameplates for the following, sizes as shown:
   1. Cabinets – Size 8
   2. Small Junction Boxes (150mm x 150mm or smaller) – Size 1
   3. Large Junction Boxes – Size 2

4. Control panels – Size 8
5. Field Devices (Instruments, Actuators, etc.) – Size 4

1.13 WIRING IDENTIFICATION

A. Identify wiring with permanent indelible identifying markings on both ends as shown on drawings.

B. Wire tags to be heat shrink type with mechanically printed black letters on white background.

1.14 CONDUIT AND CABLE IDENTIFICATION

A. Colour code conduits, boxes and cables.

B. Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.

C. Colours: 38 mm wide prime colour and 19 mm wide auxiliary colours.

System	**Prime Band**	**Aux. Band**
Medium Voltage (>750 V)	Orange	
347/600 V	Yellow	
120/208/240 V Power	Black	
UPS 120/208/240 V Power	Black	Green
Control Wiring (120 V)	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring (<50 V)	Blue	Orange
Intrinsically Safe	Blue	White
Ground	Green	
Fibre Optic	Purple	

D. Cable Identification: Supply and install lamacoid type cable identification tags for all cables. Install identification tag at both ends.

1.15 AS-BUILT DRAWINGS AND DOCUMENTS

A. Refer to Section 01 77 00, Closeout Procedures - for additional requirements for as-built drawings and documents.

B. The Contractor shall keep one (1) complete set of white prints at the Site during the work, including all addenda, change orders, Site Instructions, clarifications, and revisions for the purpose of As-Built Drawings. As the Work on-site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions, which deviate from the original Contract Documents.

C. The Contractor shall keep one completed set of automation documents at the Site during the work, including all addenda, change orders, Site Instructions, clarifications, and revisions for the purpose of As-Built documents. This includes, but is not limited to the following:
1. I/O Lists

2. Instrument Lists
3. IP Address Lists
4. Functional Requirements Specifications
5. Automation Equipment List
6. PLC Module List

D. On completion of the work, minimum of four (4) weeks prior to final inspection, submit As-Built drawings and documents to Contract Administrator for review. The Contractor shall certify, in writing signed and dated, that the As-Built drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

E. Comply with all other City of Winnipeg standards and requirements.

1.16 OPERATIONS AND MAINTENANCE (O & M) MANUALS

A. Provide operation and maintenance manuals as specified herein and in accordance with the general conditions. Refer to Section 01 78 23, Operations and Maintenance Data.

B. Include in the operations and maintenance manuals a minimum of:
1. Cover page including project name, year, name of owner and electrical consultant. Cover page shall be enclosed in a clear plastic cover.
2. Index.
3. List of manufacturers and supplier for all items.
4. Names, address and phone number of all local suppliers for items included in maintenance manual.
5. Stamped and signed shop drawings.
6. Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of portions or features of the installation.
7. Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items and parts lists. Advertising or sales literature not acceptable.
8. All test results performed. This includes, but is not limited to fibre optic tests; Control System network tests; Profibus Network Tests; FAT, SIFT, SIT and SAT tests.
9. PLC and HMI Programs on USB memory stick
10. As-Built drawings.
11. Signed and dated warranty certificate.
12. Signed and dated approval by the local Electrical Inspections Department.
13. All other requirements outlined in the specifications.

C. Submit draft document prior to the start of commissioning.

1.17 ENVIRONMENTAL CONDITIONS

A. Equipment and systems are to be rated to correctly operate in the environment in which they are to be installed.

B. Exterior devices shall be rated to operate in an exterior environment with temperature range of minus 40 degrees C to plus 40 degrees C.

1.18 QUALITY ASSURANCE

A. Qualifications
   1. For work involving specialties, including, but not limited to, the installation of sound and intercommunication systems, fire alarm systems, lightning protection systems, grounding systems, instrumentation, controls, electronic access, security systems, fibre optics systems, etc. employ only workers fully trained, qualified and experienced in the aspects of such work.

PART 2 PRODUCTS

2.1 GENERAL

A. The design is based upon the manufacturers and model numbers shown on the drawings and in the specifications. If a manufacturer chosen after project award is different from that on which the design is based, the design must be modified by the Contractor based on the chosen manufacturer. If additional engineering work is required, the Contractor must provide an Engineer's seal for the change to the design.

B. Substitutes:
   1. Provide all additional and modified wiring, raceway, enclosures, intrinsically safe barriers, and accessories at no additional cost associated with approved substitutes.

C. Like Equipment Items:
   1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
   2. Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

PART 3 EXECUTION

3.1 PREPARATION AND PROTECTION

A. Schedule expediting of materials and execution of work in conjunction with associated work of other trades in order to meet the required work schedule.

B. Post engraved warning signs to meet requirements of local bylaws, Inspection Authority and Contract Administrator.

C. Protect those working on or in vicinity of exposed electrically energized equipment from physical danger. Shield and mark live parts in accordance with local regulations. Indicate the appropriate voltage.

D. Arrange for installation of temporary doors, barriers and similar items for access to rooms and areas containing electrical equipment. Keep these doors locked at all times, except when under direct supervision.

E. Permanently identify with lamacoid nameplate, equipment energized from multiple power sources, noting voltages, power source locations, supply disconnect designations and grounding electrode location.

3.2 WARNING SIGNS

A. As specified and to meet the requirements of Electrical Inspection Department and the Contract Administrator.

B. Lamacoid 3 mm thick plastic engraving sheet, red face, white core, mechanically attached with self tapping stainless steel screws, 20mm text.

3.3 MOUNTING HEIGHTS

A. Unless otherwise noted, or in contravention of codes and standards, mount equipment replacing existing equipment at the same height.

B. Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise.

C. Typical mounting heights are as follows:

1.	Wall mounted instruments:	1.5 m Above Finished Floor (AFF)
2.	Wall mounted junction boxes:	1.5 m AFF
3.	Wall mounted small panels:	1.5 m AFF
4.	Wall mounted large panels:	Top of cabinet at 2.0 m AFF
5.	Gas detection horns and strobes:	2.0 m to 4.0 m AFF
6.	Motor control hand switches:	1.5 m AFF
7.	Valve actuator control stations:	1.5 m AFF

D. If mounting height of equipment is not indicated, verify with the Contract Administrator before proceeding with the installation.

3.4 MODIFICATIONS TO EXISTING CABINETS

A. Where significant modifications are made to existing cabinets, the cabinet shall be inspected by the Authority Having Jurisdiction.

3.5 IP ADDRESSES

A. IP Addresses will be provided to the Contractor for all network devices after project award. The Contractor will be required to sign a Non-disclosure Agreement and confidentiality agreement in relation to the IP Addresses.

3.6 DEVICES WITH INTEGRAL LEADS

A. For devices with integral leads, if the location of the device does not allow the leads to reach the junction box as shown on the drawings, provide additional wiring, conduit and boxes as required to extend the leads to the associated junction box.

3.7 LOCATION OF DEVICES

A. Allow for change of location of devices at no extra cost or credit, provided that the distance does not exceed 3000mm (10’) from that shown on the drawings, when the requirement is made known prior to installation.

3.8 CONDUIT AND CABLE INSTALLATION

A. Sleeves through concrete: schedule 40 galvanized steel pipe, sized for free passage of conduit.

B. For wall, partitions, and ceilings the sleeve ends shall be flush with the finish on both sides but for floors they shall extend 25 mm (1”) above finished floor level.

C. Fire stop opening with ULC approved assembly for the installation conditions.

D. Provide a detailed proposed conduit routing plan to the Contract Administrator prior to proceeding with the installation of conduit.

E. If possible, avoid routing conduits through hazardous area.

F. Separate cables of different voltage levels when cables are installed parallel to each other.

3.9 CUTTING, PATCHING, DRILLING

A. Provide all cutting and patching as required.

B. Return exposed surfaces to an as-found condition.

C. Exercise care where cutting/drilling holes in existing concrete elements so as not to damage existing reinforcing, or any other systems run in the concrete.
   1. Locate reinforcing and other existing systems using ground penetrating radar, X-Ray or other suitable means. Mark out on the surface of the concrete the locations of rebar and all other systems.
   2. For all holes larger than 50mm passing through reinforced concrete, mark the location of the desired hole and all embedded systems. Obtain approval from the Contract Administrator prior to cutting.

D. Firestop and seal all penetrations.

E. Ensure that water ingress will not occur.

F. Provide expansion joints for penetrations where shifting can occur.

3.10 ANCHOR INSTALLATION

A. The Contractor shall exercise care where installing anchors into existing concrete elements so as not to damage existing reinforcing. All anchors shall be installed utilizing carbide tip drill bits. The existing reinforcing shall be located utilizing a reinforcing bar locator and marked out on the surface of the concrete. The drill holes shall be advanced

to the required depth for installation of the anchors. Should reinforcement be encountered while drilling, the hole shall be terminated and repositioned to clear the reinforcement. Do not use core bits that can easily intercept and damage/cut the reinforcing during drilling.

3.11 FIELD QUALITY CONTROL

A. All electrical work to be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties. A maximum of one apprentice is permitted per qualified electrician.

B. The work of this division to be carried out by a contractor who holds a valid Master Electrical contractor license as issued by the Province of Manitoba.

3.12 TOUCH-UP PAINTING

A. Clean and touch up surfaces of shop painted equipment scratched or marred during shipment or installation, to match original paint.

B. Obtain necessary touch-up paint of original type and quality from equipment manufacturer.

C. Clean surfaces to be painted. Feather out edges of scratch marks. Make patch inconspicuous.

D. Apply one or more coats until damaged surface has been restored to original finish condition.

E. Clean and prime exposed non galvanized hangers, racks and fastenings to prevent rusting.

F. Do not paint nameplates, tags, CSA labels, warning plates and operating instructions. Observe field painting of electrical equipment or raceways. Labels shall be visible and legible after the equipment is installed.

3.13 CLEANING

A. Clean construction debris and materials from enclosures, before final electrical tests. Vacuum the interior and exterior of enclosures to ensure all equipment is free from debris. No loose items shall be in the bottom of cabinet before the final electrical tests. Any spare parts, drawings, documentation, etc. should be stored in the appropriate area in the cabinet.

3.14 PROVISION FOR FUTURE EXPANSION

A. In each location where space for future equipment is indicated, leave such space clean. Install conduit, wiring and other work in such a manner that necessary connections can be made in future without dismantling existing equipment, raceways or wiring. Consult with Contract Administrator whenever necessary.

END OF SECTION

SECTION 40 90 21

AUTOMATION WIRES AND CABLES

PART 1 GENERAL

1.1 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in Section 40 90 00, Instrumentation and Control for Process Systems 1.2 and this section.

B. The following is a list of standards which may be applicable in this section:
   1. Canadian Standards Association (CSA).
      a. CSA C22.1, Canadian Electrical Code, Part I - Safety Standard for Electrical Installations.
      b. CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables.
      c. CAN/CSA-C22.2 No. 38, Thermoset-Insulated Wires and Cables.
      d. CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.
      e. CAN/CSA-C22.2 No. 174, Cables and Cable Glands for use in Hazardous locations.
      f. CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.
      g. CAN/CSA-C22.2 No. 214, Communications Cables.

1.2 SUBMITTALS

A. Submit product data in accordance with Section 01 33 00, Submittal Procedures.

PART 2 PRODUCTS

2.1 CONDUITS

A. See Electrical Specification 26 05 34, Conduit, Conduit Fasteners, and Conduit Fittings – Electrical for general conduit requirements.

2.2 WIRES IN CONDUIT

A. Wire-: to CAN/CSA-C22.2 No. 38

B. Conductors:
   1. Size as indicated.
   2. Copper conductors.

C. Insulation: chemically cross-linked thermosetting polyethylene rated type RW90.
   1. Insulation Voltage Rating:
      a. Circuits 120 V and less: 600 V

D. Wire Color Coding
   1. Utilize the following wire colours for the types of voltage/signals indicated:
      a. 120VAC Line: Black
      b. 120VAC Control: Red
      c. 120VAC Neutral: White
      d. 24VDC Supply: Blue
      e. 24VDC Control: Blue
      f. 24VDC Common: Brown
      g. 4-20mA Signal: White (+), Black (-)
      h. Protective Earth: Green
      i. Signal Ground: Green/Yellow
      j. Profibus: Red/Green

2.3 TECK90 MULTICONDUCTOR CABLE

A. Cable: to CAN/CSA-C22.2 No. 131.

B. Conductors:
   1. Grounding conductor: copper.
   2. Circuit conductors: copper, size as indicated.

C. Insulation: chemically cross-linked thermosetting polyethylene (XLPE), rated type RW90.
   1. Insulation Voltage Rating: 600 V

D. Inner jacket: polyvinyl chloride material.

E. Armour: interlocking aluminum.

F. Overall covering: polyvinyl chloride material.

G. Fastenings:
   1. One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole aluminum straps for cables larger than 50 mm.
   2. Channel type supports for two (2) or more cables at 1000 mm centers.
   3. Threaded rods: 6 mm dia. to support suspended channels.

H. Cable Fittings:
   1. Minimum requirement: Watertight, approved for TECK cable.
   2. Hazardous Locations:
      a. CSA approved.
      b. Watertight type with:
         1) an elastomeric bevelled bushing.
         2) a funnel entry, splined gland nut.
         3) a non-magnetic, stainless steel grounding device with dual grounding action.
         4) a taper threaded hub.
         5) a hexagonal body and gland nut
      c. Integral seal type with metal-to-metal contact construction.
      d. Sealing of multi-conductor cable shall be accomplished with a liquid type polyurethane compound.

e. The fitting must:
   1) Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.
   2) Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding or the explosion proof seal.
f. All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily-removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.
g. Approved products:
   1) T&B Startech XP series
   2) Or approved equal in accordance with B8.

2.4 ACIC/CIC CONTROL CABLE

A. Cable: to CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.

B. Conductors: copper, stranded, size as indicated.

C. Insulation: chemically cross-linked thermosetting polyethylene(XLPE) rated type RW90.
   1. Voltage: As noted.

D. Shielding as indicated on the drawings:
   1. ISOS – Individually shielded pairs with overall shield
   2. OS – Overall shield

E. Armour Type: Aluminum Interlocked

F. RoHS compliant.

G. Fastenings:
   1. One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole aluminum straps for cables larger than 50 mm.
   2. Channel type supports for two (2) or more cables at 1000 mm centers.
   3. Threaded rods: 6 mm dia. to support suspended channels.

H. Cable Fittings:
   1. Minimum requirement: Watertight, approved for TECK cable.
   2. Hazardous Locations:
      a. CSA approved.
      b. Watertight type with:
         1) an elastomeric bevelled bushing.
         2) a funnel entry, splined gland nut.
         3) a non-magnetic, stainless steel grounding device with dual grounding action.
         4) a taper threaded hub.
         5) a hexagonal body and gland nut
      c. Integral seal type with metal-to-metal contact construction.

d. Sealing of multi-conductor cable shall be accomplished with a liquid type polyurethane compound.
e. The fitting must:
   1) Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.
   2) Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding or the explosionproof seal.
f. All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily-removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.
g. Approved products:
   1) T&B Startech XP series
   2) Or approved equal in accordance with B8.

2.5 ETHERNET CABLE – SHIELDED - 300V –NON-ARMORED – LOW BEND RADIUS FOR USE ONLY IN AUTOMATION PANELS PATCH CORDS AND BETWEEN GANGED AUTOMATION PANELS

A. Requirements:
1. Cable: Industrial Grade Cat 6, 300V, Shielded, Ethernet cable
2. Shield Design: Overlapped aluminum-clad foil, sheathed in a braided screen of tin-plated copper wires.
3. Conductors: 4 pair, 24 AWG, copper, solid.
4. Insulation: Polypropylene
5. Operating temperature: -40 degrees C to 85°C
6. Installation temperature: -40 degrees C to 85 degrees C
7. c(UL)us, CMG, RoHS compliant.
8. Traction stress maximum: 100 N
9. Minimum bending radius: 24mm single bend / 40 mm multiple bends
10. Manufacturer:
    a. Siemens 6XV1878-2A
    b. Or approved equal in accordance with B8.

2.6 ETHERNET CABLE - SHIELDED - 600V –NON-ARMORED

A. Requirements:
1. Cable: Industrial Grade Cat 6, 600V, Shielded
2. Shield Design: 100 percent coverage Foil Shielded
3. Conductors: 4 pair, Bonded pair, 23 AWG, copper, solid.
4. Insulation: Polypropylene
5. Operating temperature: -40 degrees C to 75 degrees C
6. Installation temperature: -25 degrees C to 75 degrees C
7. Flame test: CSA FT4
8. cUL, CMR, RoHS compliant.
9. Traction stress maximum: 177.928 N
10. Minimum bending radius: 101.600 mm

11. Manufacturer:
    a. Belden 7953A
    b. Or approved equal in accordance with B8.

2.7 ETHERNET CABLE UNSHIELDED - 300V -ARMORED

A. Requirements:
1. Cable: Industrial Grade, Enhanced Cat 6 Cable, 300V, Solid, Unshielded, Aluminum Interlocked Armor
2. Conductors: 4 Pair, Bonded pair, 23 AWG, copper, solid.
3. Conductor insulation: PO-Polyolefin
4. Outer jacket: Industrial Grade PVC
5. Temperature rating: -40 degrees C to 75 degrees C.
6. Flame test: CSA FT4
7. Approvals: CMG, CSA or equivalent.
8. Manufacturer:
    a. Belden, 121872A
    b. Or approved equal in accordance with B8.

2.8 PROFIBUS DP CABLE, NON-ARMOURED AND OUTDOOR INSTALLATION

A. Cable Requirements:
1. Cable: to CAN/CSA-C22.2 No. 214.
2. Type: Profibus DP Class A
3. Impedance: 150 Ohm nominal, 135 to 165 Ohm at frequency of 3 to 20 MHz.
4. Cable capacitance: < 30 pF per meter.
5. DC Resistance: ≤ 110 Ohm per km.
6. Conductors: Copper, Solid, 0.326 mm^2 corresponding to 22 AWG.
7. Conductor insulation: Red and green in colour.
8. Geometry: 1 twisted pair, shielded.
9. Shielding: Overlapped aluminum-clad foil, sheathed in a braided screen of tin-plated copper wires.
10. Outer jacket: PVC, violet in colour.
11. Temperature rating: -40 degrees C to 75 degrees C.
12. Voltage rating: 600V
13. Flame test: CSA FT4
14. Approvals: CMG, CSA or equivalent.
15. Manufacturer:
    a. Siemens 6XV1830-0EH10
    b. Or approved equal in accordance with B8.

B. Outdoor Installation Conduit Requirements
1. Manufacturer requires that cable not be exposed to water.
2. Installation of this cable outdoors must be in a watertight NEMA 4 conduit system.
3. Manufacturer and products:
    a. Thomas and Betts Red Dot Hazardous Location fittings
    b. Or approved equal in accordance with B8.

2.9 PROFIBUS DP CABLE, ARMOURED– NON-HAZARDOUS INDOOR INSTALLATION ONLY

A. Requirements:

1.	Cable:	to CAN/CSA-C22.2 No. 214.
2.	Type:	Profibus DP Class A
3.	Impedance:	150 Ohm nominal, 135 to 165 Ohm at frequency of 3 to 20 MHz.
4.	Cable capacitance:	< 30 pF per meter.
5.	DC Resistance:	≤ 110 Ohm per km.
6.	Conductors:	Copper, Solid, 0.326 mm^2 corresponding to 22 AWG.
7.	Conductor insulation:	Red and green in colour.
8.	Geometry:	1 twisted pair, shielded.
9.	Shielding:	Aluminum foil (tape) and tinned copper braid.
10.	Inner sheath:	PVC, violet in colour.
11.	Armour:	Continuously corrugated Aluminum armour.
12.	Outer jacket:	PVC.
13.	Temperature rating:	-30 degrees C to 60 degrees C.
14.	Voltage rating:	300V
15.	Flame test:	CSA FT4
16.	Approvals:	CMG, CSA or equivalent.
17.	Manufacturer:	

a. Belden 183079A
b. Or approved equal in accordance with B8.

2.10 PROFIBUS DP CABLE, ARMOURED – HAZARDOUS LOCATION

A. Requirements:

1.	Type:	Profibus DP Class A
2.	Impedance:	150 Ohm nominal, 135 to 165 Ohm at frequency of 3 to 20 MHz.
3.	Cable capacitance:	≤ 30 pF per meter.
4.	DC Resistance:	≤ 110 Ohm per km.
5.	Conductors:	Copper, Solid, 0.326 mm^2 corresponding to 22 AWG.
6.	Conductor insulation:	Red and green in colour.
7.	Geometry:	1 twisted pair, shielded.
8.	Shielding:	Aluminum/Polyester foil (tape) / 38 AWG tinned copper braided.
9.	Inner sheath:	PVC, violet in colour.
10.	Armour:	Interlocking aluminum armour.
11.	Outer jacket:	PVC, violet in colour.
12.	Temperature rating:	-40 degrees C to 90 degrees C.
13.	Voltage rating:	300V
14.	Flame test:	CSA FT4
15.	Hazardous Location:	HL-ABCD CSA or equivalent.
16.	Approvals:	ACIC, CMG CSA or equivalent.
17.	Manufacturer:	

a. Turck 101550875

b. Or approved equal in accordance with B8.

2.11 PROFIBUS PA CABLE, NON-ARMOURED

A. Requirements:

1.	Type:	ISA/SP-50 Type A.
2.	Impedance:	100 Ohm nominal at 31.25 kHz.
3.	Cable capacitance:	< 80 pF per meter.
4.	DC Resistance:	< 44 Ohm per km.
5.	Conductors:	Copper, Solid, 0.8 mm^2 corresponding to 18 AWG.
6.	Conductor insulation:	Brown and blue in colour.
7.	Geometry:	1 twisted pair, shielded.
8.	Shielding:	Aluminum/Polyester foil (tape) / 38 AWG tinned copper braided.
9.	Outer jacket:	PVC, orange in colour.
10.	Temperature rating:	-40 degrees C to 105 degrees C
11.	Voltage rating:	600V
12.	Flame test:	CSA FT4
13.	Approvals:	CIC/TC, CMG, CSA or equivalent.
14.	Manufacturer:	

a. Turck 101550785
b. Or approved equal in accordance with B8.

2.12 PROFIBUS PA CABLE, ARMOURED

A. Requirements:

1.	Type:	ISA/SP-50 Type A.
2.	Impedance:	100 Ohm nominal at 31.25 kHz.
3.	Cable capacitance:	< 80 pF per meter.
4.	DC Resistance:	< 44 Ohm per km.
5.	Conductors:	Copper, Solid, 0.8 mm^2 corresponding to 18 AWG.
6.	Conductor insulation:	Brown and blue in colour.
7.	Geometry:	1 twisted pair, shielded.
8.	Shielding:	Aluminum/Polyester foil (tape).
9.	Inner sheath:	PVC, black in colour.
10.	Armour:	Interlocked aluminum armour.
11.	Outer jacket:	PVC, orange in colour.
12.	Temperature rating:	-40 degrees C to 105 degrees C
13.	Voltage rating:	300V
14.	Flame test:	CSA FT4
15.	Hazardous Location:	HL-BCD CSA or equivalent.
16.	Approvals:	ACIC, CMG CSA or equivalent.
17.	Manufacturer:	

a. Turck 101550929
b. Or approved equal in accordance with B8.

PART 3 EXECUTION

3.1 GENERAL

A. Do not splice cables. A continuous length is required for all feeds.

B. Install in accordance with manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.

C. Exercise care in stripping insulation from wire. Do not nick conductors.

3.2 INSTALLATION OF WIRES IN CONDUIT

A. Install in conduit as per Section 26 05 34, Conduits, Conduit Fasteners, and Conduit Fittings.

B. Ensure conduit is dry and clean prior to pulling wire. If moisture is present, thoroughly dry conduits. Vacuum as required.

C. Utilize wire-pulling lubricant.

3.3 INSTALLATION OF TECK CABLE 0-600 V

A. Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

B. Perform an insulation-resistance test on each conductor, prior to termination, utilizing a megohmmeter with a voltage output of 1000 volts DC. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 50 megaohms, or deviations between parallel conductors. Conductors with insulation resistance values, at one minute, less than 25 megaohms, or that deviate from other similar conductors by more than 50 percent will be rejected.

3.4 INSTALLATION OF CONTROL CABLES

A. Install control cables in conduit or cable tray as indicated.

B. Provide separation of cables from sources of noise, including other cables.
   1. For analog signals, provide separation distances as follows:
      a. 120 VAC, 8 AWG and smaller: 100 mm
      b. 120 VAC, >8 AWG: 300 mm
      c. 600 VAC power: 300 mm
      d. VFD or other high harmonic cable: 300 mm in metallic conduit/600 mm other raceway
      e. Medium Voltage: 450 mm
   2. For control signals < 50V, provide separation distances as follows:
      a. 120 VAC, 8 AWG and smaller: 50 mm
      b. 120 VAC, >8 AWG: 300 mm
      c. 600 VAC power: 300 mm

d. VFD or other high harmonic cable: 300 mm in metallic conduit/600 mm other raceway
e. Medium Voltage: 450 mm

3. For 120 VAC control signals, provide separation distances as follows:
   a. 120 VAC, 8 AWG and smaller: none
   b. 120 VAC, >8 AWG: metal barrier or 150 mm
   c. 600 VAC power: metal barrier or 150 mm
   d. VFD or other high harmonic cable: 150 mm in metallic conduit/300 mm other raceway
   e. Medium Voltage: 450 mm
4. Advise the Contract Administrator if these separations cannot be achieved.

C. Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

D. Ground shields at one end only. Where possible, ground shields at the end where power is supplied to the cable. Utilize shield grounding bar in panels, where present, to ground overall shields. Individual pair shields to be grounded on appropriate terminals.

E. Shield drain wires, at the ungrounded end, are to be taped back to the cable. Do not cut the shield drain wire off.

F. CIC cable may not be installed in cable tray. Protection in conduit is required over the entire length.

G. ACIC cable may be installed in cable tray, provided that:
   1. There is a barrier separating power and control cables within the tray, or
   2. The cable tray does not contain power cables, unless specifically authorized by the Contract Administrator in writing, and
   3. The ACIC cable voltage rating is equal or greater than the highest voltage contained in the cable tray.

3.5 INSTALLATION OF ETHERNET COPPER CABLES

A. Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

B. Provide separation of Ethernet cables from sources of noise, including other cables.
   1. Provide separation distances as follows:
      a. Instrumentation/Control < 50: 50 mm
      b. 120 VAC, 8 AWG and smaller: 100 mm
      c. 120 VAC, >8 AWG: 300 mm
      d. 600 VAC power: 300 mm
      e. VFD or other high harmonic cable: 300 mm in metallic conduit/600 mm other raceway
      f. Medium Voltage: 450 mm
   2. Advise the Contract Administrator if these separations cannot be achieved.

C. Ethernet cables may be installed in cable tray, provided that:
   1. There is a barrier separating power and control cables within the tray, or
   2. The cable tray does not contain power cables, unless specifically authorized by the Contract Administrator in writing, and
   3. The cable voltage rating is equal to or greater than the highest voltage contained in the cable tray.

D. Prior to placing a Ethernet copper network into service, perform Ethernet copper cable test utilizing a approved testing equipment and provide complete test results to the Contract Administrator for review.
   1. Submit product datasheets of proposed testing equipment to the Contract Administrator for review prior to performing the test.

E. Provide a lightning protection device whenever copper Ethernet cables are routed outside.

3.6 INSTALLATION OF PROFIBUS CABLES

A. Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

B. Provide separation of Profibus cables from sources of noise, including other cables.
   1. Provide separation distances as follows:
      a. Instrumentation/Control < 50: 50 mm
      b. 120 VAC, 8 AWG and smaller: 100 mm
      c. 120 VAC, >8 AWG: 300 mm
      d. 600 VAC power: 300 mm
      e. VFD or other high harmonic cable: 300 mm in metallic conduit/600 mm other raceway
      f. Medium Voltage: 450 mm
   2. Advise the Contract Administrator if these separations cannot be achieved.

C. Ground cable shields at every device, not at one end only.

D. Where cables must cross they should always do so at right angles.

E. Provide a lightning protection device whenever Profibus cables are routed outside.

F. Provide and install cable terminations as indicated on the drawings.

G. Estimate trunk and spur cable lengths before they are installed and compare to the lengths shown on the drawings. Where actual lengths will be longer by more than 20 percent from lengths shown on the drawings, or where actual lengths will be longer than Profibus installation guideline maximums, inform the Contract Administrator. Total trunk cable length must be longer than the longest spur cable length for Profibus PA to minimize wave reflections.

H. Do not mix different classes of cable or different manufacturers in the same segment.

I. When installing the cables:
   1. Do not use excessive pulling force beyond the manufacturer's specifications.
   2. Do not bend the cables beyond the manufacturer's specifications.
   3. Do not twist the cables.

J. Prior to placing a Profibus network into service, perform bus analysis of each segment utilizing a approved bus testing equipment and provide complete test results to the Contract Administrator for review.
   1. Submit product datasheets of proposed bus testing equipment to the Contract Administrator for review prior to performing bus testing.

3.7 TERMINATIONS AND SPLICES

A. Wire nuts are permitted only in the following circuits:
   1. Lighting circuits.
   2. Receptacle circuits.

B. Exercise care in stripping insulation from wire. Do not nick conductors.

C. Strictly follow manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

D. Where screw-type terminals are provided on equipment and instrumentation, terminate field wiring with insulated fork tongue terminals.
   1. Manufacturer: Thomas and Betts, Sta-Kon, or approved equal in accordance with B8.

3.8 RE-USE OF EXISTING WIRING

A. Except where specifically identified or approved, reuse of existing wiring is not permitted.

B. Ensure all existing wiring is tagged prior to disconnection of equipment.

C. Tag spare wires as "Spare" and indicate the location of the other end of the wire.

3.9 INSTALLATION IN CONDUIT

A. Utilize cable grips, appropriately selected to accommodate the type and geometry of the cable.

B. Utilize cable pulling lubricant, compatible with the cable and conduit.

3.10 CABLE INDENTIFICATION

A. Install cable tags at both ends of cable.

3.11 TESTING

A. Perform an insulation resistance test on all new and existing power conductors that are being terminated as part of the work.

B. Perform TIA-568-C.2 for category 6 cabling and connecting hardware on all ethernet cables. The installation will not be considered complete if it fails any of the tests even if communication is occurring.

C. Perform bus analysis and waveform capture of all Profibus network segments and verify that there are no errors. The profibus installation will not be considered complete if it has communication errors even if communication is occurring.

END OF SECTION

SECTION 40 91 01

I&C COMPONENTS

PART 1 GENERAL

1.1 REFERENCES

A. Comply with the latest edition of the codes and standards referenced.

B. The following is a list of standards which may be referenced in this section:
1. American wire gauge (AWG).
2. Canadian Electrical Code (CEC)
3. Canadian Standards Association (CSA)
4. Canadian Underwriters Laboratory, Inc. (cUL)
5. National Electrical Manufacturers Association (NEMA)
6. National Pipe Thread (NPT)
7. International Protection Code (IP)

1.2 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01 33 00 Submittal Procedures.

B. Instrument datasheets are provided as part of the tender documents for many instruments for use by the Contractor in procuring instruments (see Appendix R). Where instrument datasheets are provided, coordinate with vendors as required to provide all pertinent and additional information in the datasheet. Submit the revised datasheets with instrument product data submittals. Datasheets in their native file format can be provided to the Contractor after project award.

1.3 ACRONYMS AND ABBREVIATIONS

A. CPVC: Chlorinated Polyvinyl Chloride

B. DO: Dissolved Oxygen

C. DPDT: Double Pole Double Throw

D. HART: Highway Addressable Remote Transducer

E. LCD: Liquid Crystal Display

F. LED: Light Emitting Diode

G. ORP: Oxidation Reduction Potential

H. NTU: Nephelometric Turbidity Unit

I. PVC: Polyvinyl Chloride

J. RTD: Resistance Temperature Detectors

K. SPDT: Single Pole, Double Throw

L. SPST: Single Pole, Single Throw

M. SS: Suspended Solids

PART 2 PRODUCTS

2.1 COMPONENT SPECIFICATIONS – ANALYSIS INSTRUMENTS

A. General
1. All wastewater analysis instruments, sensors and transmitters must be provided by the same manufacturer.

B. Analyzer – Bioreactor Tanks
1. Controller
a. General:
1) Approvals: CSA or cUL
2) Function: Measure, indicate and transmit process fluid pH, ORP, DO and SS.
3) Type: Multi-parameter analyzer.
4) Corrosion resistant for corrosive areas.
b. Display Module:
1) Mounting: Display module is mounted directly to the probe module and connected via a plug-and-play connection. The display module can be removed and transported to be used with multiple probe modules.
2) Type: VGA graphical backlit TFT Color Glass/Glass-Touch Screen.
3) Enclosure: Plastic housing, IP65 rating.
4) Operating Temperature: –20 to 55 degrees C.
c. Probe module
1) Enclosure: Metal housing with corrosion-resistant, IP65 rating.
2) Input: Accepts up to eight sensors.
3) Operating Temperature: –20 to 55 degrees C.
4) Power requirement: 100-240 VAC
5) Probe modules of the analyzer can be networked together.
6) Humidity Requirements: 0 to 95 percent relative humidity, non-condensing
7) Expansion Cards:
a) Analog input card: Analog/digital inputs 4–20 mA.
b) Fieldbus interface card: Profibus DP
d. Enclosure:
1) Provide weatherproof enclosure as shown on the drawings.
2) Pipe or wall mount as applicable.
e. Manufacturer and model:
1) HACH SC1000 controller
2) Or approved equal in accordance with B8.

2. Sensors
   a. Differential pH:
      1) General:
         a) Approvals: CSA or cUL
         b) Function: continuously measures pH in aqueous solutions.
         c) Method of measuring: differential electrode.
         d) Connect to digital controller.
         e) Corrosion resistant and fully immersible
      2) Feature:
         a) Measurement range: 0 to 14 pH.
         b) Sensitivity: 0.01 pH
         c) Stability: 0.03 pH per 24 hours, non-cumulative
         d) Accuracy: 0.02 pH
         e) Mounting: Convertible
      3) Operational Criteria:
         a) Temperature range: -5 to 70 degrees C.
         b) Sample flow rate: 3 meters per second, maximum
         c) Pressure: 6.9 bar at 70 degrees C
         d) Transmission distance: 1000 meters maximum
      4) Accessories
         a) Air blast cleaning assembly
      5) Mounting kit: Pole Mount Assembly
      6) Manufacturer and model:
         a) HACH pH sensor DPD1P1
         b) Or approved equal in accordance with B8
   b. Differential ORP:
      1) General:
         a) Approvals: CSA or cUL
         b) Function: Continuously measures ORP in aqueous solutions.
         c) Method of measuring: differential electrode.
         d) Connect to digital controller.
         e) Corrosion resistant and fully immersible
      2) Feature:
         a) Measurement range: -1500 to +1500 mV.
         b) Sensitivity: plus or minus 0.5 mV
         c) Stability: 2 mV per 24 hours, non-cumulative
         d) Mounting: Convertible
      3) Operational Criteria:
         a) Temperature range: -5 to 70 degrees C.
         b) Sample flow rate: 3 meters per second, maximum
         c) Pressure: 6.9 bar at 70 degrees C
         d) Transmission distance: 1000 meters, maximum
      4) Accessories
         a) Air blast cleaning assembly.
         b) Mounting kit: Pole Mount Assembly.
         c) ORP reference solutions.
      5) Manufacturer and model:
         a) HACH ORP sensor DRD1P5
         b) Or approved equal in accordance with B8

c. Dissolved Oxygen:
   1) General:
      a) Approvals: CSA or cUL
      b) Function: continuous measurement of dissolved oxygen (DO) in aqueous solutions.
      c) Method of measuring: Luminescent sensor technology.
      d) Connect to digital controller.
      e) Corrosion resistant and fully immersible
   2) Feature:
      a) Measurement range: 0.01 to 20.00 mg/L
      b) Resolution: 0.01 mg/L
      c) Accuracy
         (1) Less than 5 ppm: plus or minus 0.1 ppm
         (2) Greater than 5 ppm: plus or minus 0.2 ppm
      d) Repeatability: plus or minus 0.1 ppm
      e) Response Time:
         (1) Less than 40 seconds to 90 percent at 20 degrees C
         (2) Less than 60 seconds to 95 percent at 20 degrees C
      f) Temperature sensor: PT100 integrated, external sensor
         (1) Temperature range: 0 to 50 degrees C
         (2) Temperature accuracy: plus or minus 0.2 degrees C
   3) Operational Criteria:
      a) Operating temperature: 0 to 50 degrees C
      b) Relative humidity: 95 percent, non condensing
      c) Immersion depth: 15 meters, maximum
      d) Immersion pressure: 345 kPa, maximum
      e) Sample pH range: 0.0 to 12.0
      f) Distance, analyzer to sensor: 1000 meters, maximum
   4) Accessories
      a) Mounting kit: Pole Mount Assembly.
      b) Air blast cleaning assembly
   5) Manufacturer and model:
      a) HACH DO sensor 9020000
      b) Or approved equal in accordance with B8

d. Turbidity and suspended solids
   1) General:
      a) Approvals: CSA or cUL
      b) Function: Monitoring water and sludge concentrations and turbidity values.
      c) Method of measuring: Dual-beam infrared/scattered light photometer.
      d) Connect to digital controller.
      e) Corrosion resistant and fully immersible
   2) Feature:
      a) Measurement range
         (1) Turbidity: 0.001 to 4000 NTU
         (2) Suspended solids: 0.001 mg/l to 50 g/L (ts-line or inline), or 0.001 mg/l to 500 g/L (hs line or highline)
      b) Accuracy
         (1) Turbidity: Less than 1 percent of reading or plus or minus 0.001 NTU

(2) Suspended solids: Less than 5 percent of reading (depends on homogeneity of municipal activated sludge)
c) Mounting: Immersion
d) Repeatability
(1) Turbidity: Less than 1 percent of reading
(2) Suspended solids: Less than 3 percent of reading (depends on homogeneity of municipal activated sludge)
e) Detection limit
(1) Turbidity: 0.001 NTU
(2) Suspended solids: 0.001 mg/L
f) Response time: Initial response 1 second
g) Signal Averaging Time: User selectable ranging from 1 to 300 seconds
h) Units of measure:
(1) Turbidity: User Selectable NTU, and others
(2) Suspended Solids: User Selectable g/L, mg/L, ppm, or percent solids
3) Operational Criteria:
(1) Sample flow velocity: 3 m/s maximum
(2) Sample pressure: 6 bar maximum
(3) Sample temperature: 0 to 40 degrees C
(4) Operating temperature: 0 to 40 degrees C
4) Accessories
(1) Mounting kit: Pole Mount kit.
(2) Wiper blades
(3) Calibration kit
5) Manufacturer and model:
(1) HACH Turbidity and suspended solids sensor LXV423.99.00200
(2) Or approved equal in accordance with B8

C. Analyzer – Bioreactor IFAS Tanks Sample Line
1. Controller
a. General:
1) Approvals: CSA or cUL
2) Function: Measure, indicate and transmit process IFAS sample line fluid NH3.
3) Type: Single or dual channel controller.
4) Corrosion resistant finish.
b. Features:
1) Components:
a) Microprocessor-controlled and menu-driven controller that operates the sensor and displays measured values.
b) Enclosure: NEMA 4X metal enclosure.
c. Specifications:
1) Operating Temperature: –20 to 60 degrees C.
2) Power requirement: 120 VAC, 60 Hz
3) Communication: Profibus DP.
4) Humidity Requirements: 0 to 95 percent relative humidity, non-condensing
5) Accessories:
a) Profibus DP output card.
b) Pipe or wall mount as applicable.
d. Manufacturer and model:
1) HACH SC200 controller

2) Or approved equal in accordance with B8.

2. Ammonia Analysis System
   a. General:
      1) Approval: CSA or cUL
      2) Function: Monitors the ammonium in water. Measures ammonium by gas sensitive electrode (GSE) that uses liquid to gas-phase conversion.
   b. Features:
      1) Equipped with self-diagnostic feature.
      2) Automatic self calibration and cleaning.
      3) Data transmission is made with a data cable with the controller.
      4) Number of channels: 1
   c. Performance:
      1) Measurement range: 0.05 to 20 mg/L
      2) Accuracy: 3 percent plus or minus 0.05 mg/L
      3) Reproducibility: 2 percent plus or minus- 0.05 mg/L
   d. Operational requirements
      1) Sample temperature: 4 to 40 degrees C
      2) Sample pH: 5 to 9
      3) Operating temperature: -20 to 45 degrees C
      4) Operating humidity: 95 percent relative humidity, non condensing
   e. Enclosure: UV resistant, IP 55 rated
   f. Mounting: Rail or wall-mount as applicable.
   g. Accessories: Power Box
   h. Manufacturer and model:
      1) HACH AMTAXsc Ammonium analyzer
      2) Or approved equal in accordance with B8
3. Sampling System
   a. General:
      1) Approval: CSA or cUL
      2) Function: Removes suspended solids from water using membrane modules.
   b. Features:
      1) Consists of a Control Unit, membrane plates (submerged in the water) and sample hose to Analyzer.
      2) Control unit contains: sample pumps, air compressor for filter cleaning, electronic controller and two programmable relays.
      3) Internally heated for outdoor installation.
   c. Operational requirements:
      1) Operating temperature: -20 to 40 degrees C
      2) Sample temperature: 5 to 40 degrees C
      3) Sample pH: 5 to 9
      4) Sample flow rate: Approx. 900 mL/h
   d. Enclosure rating: IP55
   e. Power supply: 120 VAC, 60 Hz
   f. Sample Hose length: 10 or 20 m (Heated) as required
   g. Accessories: Maintenance kit, Mounting Brackets
   h. Manufacturer and model:
      1) HACH Filtrax
      2) Or approved equal in accordance with B8.

4. Sampling Vessel
   a. General:
      1) Approval: CSA or cUL
      2) Function: Overflow vessel enclose sampling system membrane modules to deliver sample water to Ammonia Analysis System.
   b. Features:
      1) Adapter for overflow prevention
      2) Sample outflow
      3) Ball valve for sludge removal
      4) Sample inflow
      5) Sample bypass ball valve
      6) Inflow regulating stop valve
   c. Operational requirements:
      1) Ambient temperature: 10 to 40 degrees C
      2) Sample temperature: 5 to 50 degrees C
      3) Flow rate: 1-100 L/h
   d. Accessories: Mounting Brackets
   e. Manufacturer and model:
      1) HACH PVC Filtrax Bypass
      2) Or approved equal in accordance with B8.

D. Analyzer – UV Disinfection Building
   1. Controller
      a. General:
         1) Approvals: CSA or cUL
         2) Function: Measure, indicate and transmit UV Disinfection Building effluent NH3.
         3) Type: Single or dual channel controller.
         4) Corrosion resistant finish.
      b. Features:
         1) Components:
            a) Microprocessor-controlled and menu-driven controller that operates the sensor and displays measured values.
            b) Enclosure: NEMA 4X metal enclosure.
      c. Specifications:
         1) Operating Temperature: –20 to 60 degrees C.
         2) Power requirement: 120 VAC, 60 Hz
         3) Communication: Profibus DP.
         4) Humidity Requirements: 0 to 95 percent relative humidity, non-condensing
         5) Accessories:
            a) Profibus DP output card.
            b) Pipe or wall mount as applicable.
      d. Manufacturer and model:
         1) HACH SC200 controller
         2) Or approved equal in accordance with B8.
   2. Ammonia Analysis System
      a. General:
         1) Approval: CSA or cUL
         2) Function: Monitors the ammonium in water. Measures ammonium by gas sensitive electrode (GSE) that uses liquid to gas-phase conversion.

b. Features:
   1) Equipped with self-diagnostic feature.
   2) Automatic self calibration and cleaning.
   3) Data transmission is made with a data cable with the controller.
   4) Number of channels: 1
c. Performance:
   1) Measurement range: 0.05 to 20 mg/L
   2) Accuracy: 3 percent plus or minus 0.05 mg/L
   3) Reproducibility: 2 percent plus or minus 0.05 mg/L
d. Operational requirements
   1) Sample temperature: 4 to 40 degrees C
   2) Sample pH: 5 to 9
   3) Operating temperature: -20 to 45 degrees C
   4) Operating humidity: 95 percent relative humidity, non condensing
e. Enclosure: UV resistant, IP 55 rated
f. Mounting: Rail or wall-mount as applicable.
g. Accessories: Power Box
h. Manufacturer and model:
   1) HACH AMTAXsc Ammonium analyzer
   2) Or approved equal in accordance with B8

3. Sampling System
   a. General:
      1) Approval: CSA or cUL
      2) Function: Removes suspended solids from water using membrane modules.
   b. Features:
      1) Consists of a Control Unit, membrane plates (submerged in the water) and sample hose to Analyzer.
      2) Control unit contains: sample pumps, air compressor for filter cleaning, electronic controller and two programmable relays.
      3) Internally heated for outdoor installation.
   c. Operational requirements:
      1) Operating temperature: -20 to 40 degrees C
      2) Sample temperature: 5 to 40 degrees C
      3) Sample pH: 5 to 9
      4) Sample flow rate: Approx. 900 mL/h
   d. Enclosure rating: IP55
   e. Power supply: 120 VAC, 60 Hz
   f. Sample Hose length: 10 or 20 m (Heated) as required
   g. Accessories: Maintenance kit, Mounting Brackets
   h. Manufacturer and model:
      1) HACH Filtrax
      2) Or approved equal in accordance with B8.

E. Analyzer – Effluent Sampling Building
   1. Controller
      a. General:
         1) Approvals: CSA or cUL
         2) Function: Measure, indicate and transmit plant effluent ORP
         3) Type: Single or dual channel controller.
         4) Corrosion resistant finish.

b. Features:
   1) Components:
      a) Microprocessor-controlled and menu-driven controller that operates the sensor and displays measured values.
      b) Enclosure: NEMA 4X metal enclosure.
c. Specifications:
   1) Operating Temperature: –20 to 60 degrees C.
   2) Power requirement: 120 VAC, 50/60 Hz
   3) Communication: Profibus DP.
   4) Humidity Requirements: 0 to 95 percent relative humidity, non-condensing
   5) Accessories:
      a) Profibus DP output card.
      b) Pipe or wall mount as applicable.
d. Manufacturer and model:
   1) HACH SC200 controller
   2) Or approved equal in accordance with B8.

2. Sensor
   a. Differential ORP:
      1) General:
         a) Approvals: CSA or cUL
         b) Function: Continuously measures ORP in sample line.
         c) Method of measuring: differential electrode.
         d) Connect to digital controller.
         e) Corrosion resistant and fully immersible
      2) Feature:
         a) Measurement range: -1500 to +1500 mV.
         b) Sensitivity: plus or minus 0.5 mV
         c) Stability: 2 mV per 24 hours, non-cumulative
      3) Operational Criteria:
         a) Temperature range: -5 to 70 degrees C.
         b) Sample flow rate: 3 meters per second, maximum
         c) Pressure: 6.9 bar at 70 degrees C
         d) Transmission distance: 1000 meters, maximum
         e) Mounting type: Sanitary mount
      4) Accessories
         a) Sanitary mounting kits.
         b) ORP reference solutions.
      5) Manufacturer and model:
         a) HACH ORP sensor.
         b) Or approved equal in accordance with B8

2.2 COMPONENT SPECIFICATIONS – FLOW INSTRUMENTS

A. Flow Element and Transmitter, Electromagnetic:
   1. These products were standardized by the City via RFP 449-2014.
   2. No alternates or substitutes will be accepted.
   3. All requests for purchase or quotation shall reference RFP 449-2014 to receive standardized pricing that the City has negotiated with the vendor.
   4. Refer to the data sheets for further details

5. Manufacturer and Model:
    a. Siemens MAG6000 transmitter
    b. MAG3100 flow tube, unless shown otherwise

B. Flow Element, Rotameter:
1. General:
    a. Approvals: CSA or cUL
    b. Function: Indicate flow rate.
    c. Type: Variable area; float and tapered tube.
    d. Corrosion resistant for corrosive areas
2. Service Conditions:
    a. As noted
3. Performance:
    a. Flow rate Range: As noted.
    b. Accuracy: Plus or minus 1 percent of maximum flow, uncalibrated, over 12.5:1 turndown.
    c. Repeatability: 0.5 percent of full scale.
4. Features:
    a. Nominal Length: minimum 250 millimeters.
    b. Float Material: Type 316 stainless steel, unless otherwise noted.
    c. Tube: Borosilicate glass, unless otherwise noted.
    d. Seal:
        1) Type: O-ring, unless otherwise noted.
        2) Material: Buna-N, unless otherwise noted.
    e. Meter Body: As noted.
    f. Polycarbonate operator protection shield.
    g. Mounting: In-line, unless otherwise noted.
    h. Scales: Direct-reading metal behind blank tube, unless otherwise noted.
    i. Pressure Drop Design: Standard, unless otherwise noted.
5. Size and Process Connections:
    a. Connection Size: As noted.
    b. Tube Size: As noted.
    c. Connection Material: Type 316 stainless steel, unless otherwise noted.
    d. Connection Type: NPT, unless otherwise noted.
    e. Connection Orientation: Vertical, unless otherwise noted.
6. Signal Interface: None, unless otherwise noted.
7. Manufacturer:
    a. Brooks.
    b. Chemline
    c. Or approved equal in accordance with B8.

C. Flow Element and Switch, Thermal Mass Flow:
1. General:
    a. Approvals: CSA or cUL
    b. Function: Monitor process fluid flow and provide contact closure at set point.
    c. Type: Thermal dispersion flow switch using a heated active RTD and a reference RTD temperature sensor to detect rate of flow as a function of the temperature difference between the two sensors.
2. Service:
    a. Fluid: Water, unless otherwise noted.

b. Operating Pressure: As noted.
c. Operating Temperature: As noted.

3. Performance:
   a. Set Point: Field adjustable.
   b. Repeatability: <1 percent at constant temperature
   c. Temperature, Operating: Sensor Element: Minus 73 to plus 200 degrees C.
   d. Pressure, Operating: To 2.4MPa at 21 degrees C.
4. Features:
   a. Wetted Surfaces Materials: Type 316 stainless steel.
5. Process Connections:
   a. Type: 3/4 inch (19 mm) MNPT.
   b. Pipe Size: As noted.
   c. Connection Type: Insertion.
6. Conduit Connection: 1-inch (25 mm) FNPT.
7. Probe:
   a. Type: Spherical for liquids, twin tip for gases
   b. Element: Insertion Length (From Tip of Probe to Process Connection): 50 mm, unless otherwise noted.
8. Electronics:
   a. Location: Integral with element.
   b. Operating Temperature: Minus 40 to 50 degrees C.
9. Signal Interface:
   a. Contacts: Field selectable two SPDT or one DPDT, rated 6 amps at 115VAC, 220VAC or 24 VDC
10. Enclosure:
    a. Type: NEMA 4X.
    b. Approval: Hazardous locations, Classes I and II, Divisions 1 and 2, Groups B, C, D, E, F and G.
11. Power:
    a. 120 VAC, 60 Hz, unless otherwise noted.
    b. Field selectable: 115 plus or minus15VAC, 230 plus or minus 30VAC, 21 to 28VDC, 18 to 26VAC.
12. Manufacturer and Model:
    a. Magnetrol TD1/TD2.
    b. Or approved equal in accordance with B8.

D. Flow Element and Transmitter, Thermal Mass Flow:
1. General:
   a. Approvals: CSA or cUL
   b. Function: Directly measure, indicate, and transmit the mass flow of the gas in the duct or pipeline.
   c. Type: Insertion type, thermal dispersion detection probe using platinum resistance temperature detectors (RTD).
   d. Parts: Element and transmitter.
2. Performance:
   a. Range:
      1) As noted.
   b. Flow Turndown: As noted, to 100:1.
   c. Accuracy:
      1) Flow: Plus or minus 1 percent of reading or 0.5 percent full scale.

2) Temperature: N/A.
d. Repeatability:
1) Flow: Plus or minus 0.4 percent of reading.
2) Temperature: N/A.
e. Temperature, Operating:
1) Flow Element: Minus 40 to plus 30 degrees C, unless otherwise noted.
2) Transmitter Housing: Minus 40 to plus 30 degrees C.
f. Pressure, Operating, Flow Element: Up to 10 000 kPa, unless otherwise noted.
g. Integral temperature compensation for process temperature variation
3. Flow Element:
a. Features:
1) Insertion Length: As noted or as required by manufacturer's recommendation.
2) Wetted Surfaces Materials: Type 316 stainless steel, unless otherwise noted.
b. Process Connections:
1) Line Size: As noted or shown.
2) Connection Type: Threaded 25 mm (1”) NPT full bore ball valve.
3) Connection Material: Type 316 stainless steel, unless otherwise noted.
c. Sensor Termination Enclosure:
1) Type: Aluminum, NEMA 4X, rated for Hazardous locations, Class 1 Zone 2, Group IIA; unless otherwise noted.
d. Process Orientation: Horizontal, unless otherwise noted.
4. Transmitter:
a. Features: Minimum 2-line by 16-character LCD, keypad programmable.
b. Nonvolatile memory.
c. Signal Interface:
1) Outputs:
a) 4 to 20 mA with HART for maximum 600 ohm load, unless otherwise noted.
2) Communication Protocols:
a) Capable of both PROFIBUS DP and PROFIBUS PA.
b) Provide communication protocol as shown on design documents.
d. Power:
1) Selectable: 115VAC, 230VAC, 24 VDC.
e. Electrical Connection: 2 x 3/4-inch NPT.
f. Transmitter Enclosure:
1) Type: Aluminum NEMA 4X, unless otherwise noted.
2) Mounting: Remote or integral to sensor.
5. Cables:
a. Supply cable as required between sensor and transmitter.
6. Manufacturer and model:
a. Endress and Hauser 65I
b. Or approved equal in accordance with B8.

E. Flow Element and Transmitter, Open Channel Flow – Multipath Ultrasonic:
1. General:
a. Approvals: CSA (special inspection may be required)
b. Function: Directly measure, indicate, and transmit flow rate of process fluid in an open channel.
c. Type: Multipath ultrasonic
d. Parts: Sensors and transmitter.

2. Performance:
   a. Fluid: Wastewater.
   b. Operating Temperature (Transmitter): Minus 10 to plus 60 degrees C
   c. Accuracy: 1 percent of measurement value
   d. Repeatibility: 0.3 percent of measurement value
3. Flow Element:
   a. Features:
      1) Low profile internal mount
      2) Suitable for outdoor installations
      3) Rated for Hazardous locations, Class 1 Zone 2, Group IIA; unless otherwise noted
   b. Service: Wastewater, unless otherwise noted.
   c. Temperature, Operating: 0 to 50 degrees C
   d. Pressure, Operating: Up to 1700kPa
4. Transmitter:
   a. Features: Local backlit display, keypad programmable.
   b. Nonvolatile memory for saving programming and settings
   c. Signal Interface:
      1) Outputs:
         a) Analog: Two 4 to 20 mA maximum 500 ohm load, unless otherwise noted.
         b) Discrete:
            (1) Two independently adjustable 2 amp at 115VAC or 24 VDC
            (2) Configurable as high or low flow.
      2) Communication: Modbus TCP.
   d. Power: 115VAC
   e. Transmitter Enclosure:
      1) Type: NEMA 4X, unless otherwise noted.
      2) Mounting: Wall mounted, remote to sensor.
5. Cables:
   a. Supply cable and connectors as required between sensor and transmitter.
6. Manufacturer and Model:
   a. Accusonic 8510 transmitter and 7658 transducer
   b. Or approved equal in accordance with B8.

F. Flow Element and Transmitter, Open Channel Flow – Doppler Shift:
1. General:
   a. Approvals: CSA (special inspection may be required)
   b. Function: Directly measure, indicate, and transmit flow rate of process fluid in an open channel.
   c. Type: Correlation sensor using velocity, level, and temperature measurement.
   d. Parts: Element and transmitter.
2. Performance:
   a. Fluid: Wastewater.
   b. Range:
      1) Flow: minus 1 to plus 6 m/s.
      2) Level: 0 to 2 m
      3) Temperature: Minus 20 to plus 60 degrees C
   c. Accuracy:
      1) Velocity > 1 m/s: Error <= 1 percent of measurement value
      2) Velocity < 1 m/s: Error <= 0.5 percent of measurement value plus 0.005 m/s

3) Depth: +/- 2mm (for ultrasonic depth sensor)

3. Flow Element:
   a. Features:
      1) Wedge sensor for installation on channel bottom
      2) Wetted Surfaces Materials: 316K Stainless steel or other approved by Contract Administrator
   b. Service:
      1) Liquid; water, wastewater, unless otherwise noted.
   c. Sensor Termination Enclosure:
      1) Type: IP 68, rated for Hazardous locations, Class 1 Zone 2, Group IIA; unless otherwise noted.
   d. Process Orientation: Horizontal, unless otherwise noted.
   e. Temperature, Operating: Minus 20 to plus 40 degrees C, unless otherwise noted.
   f. Pressure, Operating, Flow Element: Up to 400kPa, unless otherwise noted.
   g. Cable: Compatible with sensor, and of length sufficient to span distance to transmitter as shown.
4. Transmitter:
   a. Features: Local backlit display, keypad programmable.
   b. Nonvolatile memory for saving programming and settings
   c. Signal Interface:
      1) Outputs:
         a) Analog: Two 4 to 20 mA maximum 500 ohm load, unless otherwise noted.
         b) Discrete:
            (1) Two independently adjustable 2 amp at 115VAC or 12VDC
            (2) Configurable as high or low flow.
      2) Communication: Modbus TCP.
   d. Power: 115VAC
   e. Transmitter Enclosure:
      1) Type: NEMA 4, unless otherwise noted.
      2) Mounting: Wall mounted, remote to sensor.
   f. Performance:
      1) Operating Temperature: -20 to 50 degrees C.
      2) Operating Humidity: maximum 80 percent, noncondensing.
5. Cables:
   a. Supply cable as required between sensor and transmitter.
6. Manufacturer and Model:
   a. NIVUS OCM Pro CF transmitter and POA sensor
   b. or approved equal in accordance with B8.

G. Flow Element and Switch, Ultrasonic Flow
   1. General:
      a. Approvals: CSA (special inspection may be required)
      b. Function: Non-intrusive Doppler type flow switch
      c. Parts: Transducer and Controller
   2. Performance:
      a. Fluid: Wastewater.
      b. Accuracy: plus or minus 2 percent
      c. Repeatability: plus or minus 1 percent

3. Transducer:
   a. Features:
      1) Single-Head Doppler sensor
      2) Operating temperature: -40 to +150 degrees C.
4. Controller:
   a. Features:
      1) Enclosure: NEMA 4X
      2) Operating temperature: -23 to +60 degrees C.
      3) Power input: 100-240VAC
      4) Relay: 1x DPDT, 5A, with time delay adjustment 0-80 sec.
      5) Set point: Adjustable between 0.076 to 3 m/sec.
5. Cables:
   a. Supply cable and connectors as required between sensor and transmitter.
6. Manufacturer and Model:
   a. Greyline DFS 5.1 flow switch
   b. Or approved equal in accordance with B8.

2.3 COMPONENT SPECIFICATIONS – LEVEL INSTRUMENTS

A. Level Element and Transmitter, Ultrasonic:
   1. These products were standardized by the City via RFP 449-2014.
   2. No alternates or substitutes will be accepted.
   3. All requests for purchase or quotation shall reference RFP 449-2014 to receive standardized pricing that the City has negotiated with the vendor.
   4. Refer to the datasheets for further details
   5. Manufacturer and Models:
      a. Siemens Milltronics Multiranger 100 with XPS 15 sensor
      b. Siemens Sitrans Probe LU

B. Level Transmitter, Submersible Hydrostatic:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Directly measure, indicate, and transmit level of process fluid.
      c. Type: Hydrostatic level measurement.
   2. Service: Wastewater, unless otherwise noted.
   3. Performance:
      a. Range: As noted.
      b. Temperature: –10 to +70 degrees C.
   4. Features:
      a. Ambient Temperature Range (sensor): minus 10 to plus 70 degree C(for 42 mm diameter)
      b. Ambient Temperature Range (Terminal Box) : minus 40 to plus 80 degree C
      c. Ambient Temperature Range (Cable) : minus 40 to plus 80 degree C

      d. Transmitter Material and Size: stainless steel housing, external diameter of 42 mm
   5. Accessories:
      a. Terminal box IP66/IP67 with GORE-TEX filter.
   6. Signal Interface:
      a. Output: Analog 4 to 20 mA.
      b. Communication: HART 6.0 Protocol.

7. Manufacturer and model:
    a. Endress and Hauser, Waterpilot FMX21.
    b. Or approved equal in accordance with B8.

C. Level Switch, Float:
1. General:
    a. Approvals: CSA or cUL
    b. Function: Actuate contact at preset liquid level.
    c. Type: Direct-acting float with an enclosed switch and integral cable.
2. Service: Wastewater, unless otherwise noted.
3. Performance:
    a. Set Point: As noted.
    b. Temperature: 0 to 50 degrees C.
4. Features:
    a. Entire Assembly: Watertight and impact-resistant.
    b. Float Material and Size: Polyethylene/foam filled; 114 mm diameter max.
5. Signal Interface:
    a. Switch Type: Mercury free
    b. Switch Contacts: Form C Dry Contact rated 4.5 A continuous at 120 VAC
6. Manufacturer and model:
    a. Flygt ENM-10
    b. Or approved equal in accordance with B8.

D. Level Switch, Capacitance:
1. General:
    a. Approvals: CSA or cUL
    b. Function: Actuate contact at preset liquid level.
    c. Type: Direct-acting capacitance probe.
2. Operating Conditions:
    a. Operating Pressure: 0 to 3500 kPa.
    b. Operating Temperature: Minus 40 to plus 85 degrees C.
    c. Minimum Relative Dielectric Constant: 1.5.
3. Performance:
    a. Set Point: As noted
    b. Sensitivity: Plus or minus 1 percent change in capacitance.
    c. Repeatability: Plus or minus 1 percent of measurement.
    d. Temperature, Operating: Sensor Element: Minus 40 to plus 85 degrees C.
4. Features:
    a. Wetted Surfaces Materials: Type 316 stainless steel, PFA
5. Process Connections:
    a. Type: Flanged
    b. Connection Type: Insertion.
6. Conduit Connection: 2 x 1/2-inch (12 mm) FNPT.
7. Probe:
    a. Type: Flexible, insulated extension cable
    b. Length: For activation as per design documents.
8. Electronics:
    a. Location: Integral with switch, with LCD display.
    b. Operating Temperature: Minus 40 to plus 85 degrees C.
        1) Display Operating Temperature: Minus 30 to plus 85 degrees C

9. Signal Interface:
    a. Type: Field selectable NO/NC SPDT Form C contact
    b. Rating: 5 amps at 30VDC; 8 amps at 250VAC
10. Enclosure:
    a. Type: NEMA 4.
    b. Approval: Hazardous locations, Class I Div 1, Groups B, C, D.
11. Power:
    a. 24 VDC, 2 Watt max, unless otherwise noted.
12. Manufacturer and model:
    a. Siemens Pointek CLS300.
    b. Or approved equal in accordance with B8.

E. Level Controller – Sump Pit:
1. General:
    a. Approvals: CSA or cUL
    b. Ratings: NEMA 4
    c. Function: Mechanical Alternator – Contacts alternate closing when operating within first switch set points, when higher set point is reached, both contacts close
    d. Temperature: Minus 30 to 121 degrees C.
2. Service: Liquid; water, wastewater, unless otherwise noted.
3. Switch Contacts:
    a. Isolated, rated 10A continuous at 120 VAC.
    b. Close on liquid rise.
4. Float
    a. Center Hole
    b. Material: Stainless Steel
5. Manufacturer and Model:
    a. Square D 9038AW1
    b. Or approved equal in accordance with B8.

F. Sludge Blanket Level Transmitter
1. General:
    a. Approvals: CSA or cUL
    b. Function: Measure, indicate and transmit secondary clarifier tanks process sludge blanket level.
    c. Type: Single or dual channel controller and sensor.
    d. Corrosion resistant.
2. Transmitter:
    a. Feature:
        1) Microprocessor-controlled and menu-driven controller that operates the sensor and displays measured values.
        2) Enclosure: NEMA 4X metal enclosure.
    b. Specifications:
        1) Operating Temperature: –20 to 60 degrees C.
        2) Power requirement: 120 VAC, 60 Hz
        3) Communication: Profibus DP.
        4) Humidity Requirements: 0 to 95 percent relative humidity, non-condensing
        5) Accessories:
            a) Profibus DP output card.
            b) Pipe or wall mount as applicable.

3. Sludge Blanket Level sensor:
   a. Feature:
      1) Measurement range: As required for new Secondary Clarifiers.
      2) Measuring Principal: Ultrasonic
      3) Accuracy: plus or minus 0.1 m.
      4) Resolution: 0.03 m Sludge level.
      5) Response time: 10-600 s (adjustable).
   b. Specifications:
      1) Operating temperature: 2–50 degrees C.
      2) Temperature compensation: Automatic.
      3) Pressure range: ≤ 0.3 bar or ≤ 3 m
      4) Flow speed: Max. 3 m/s.
      5) Power consumption: 12 V, 2.4 W, (200 mA) provided by controller.
      6) Probe construction:
         a) Wiper: Silicon
         b) Body: Stainless steel
         c) Face: Polyoxymethylene
   c. Accessories :
      1) Extension power cable.
      2) Wiper BladeMounting: Pivoting pole mount kit.
4. Manufacturer and model:
   a. Transmitter: HACH sc200
   b. Sensor: HACH SONATAX sc
   c. Or approved equal in accordance with B8

2.4 COMPONENT SPECIFICATIONS – PRESSURE INSTRUMENTS

A. Pressure Differential Switch:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Monitor differential pressure, and provide contact closure(s) when differential pressure is at the noted set point.
      c. Type: Diaphragm actuated.
   2. Performance:
      a. Set Point:
         1) Adjustable over the full range.
         2) As noted.
      b. Range: The noted set point shall fall between 20 and 80 percent of the range.
      c. Set Point Repeatability: Plus or minus 1.0 percent of range span.
      d. Maximum Pressure: Minimum 400 percent over range.
   3. Features:
      a. Actuator Seal: Buna-N, unless otherwise noted.
      b. Pressure Connection: Nickel-plated brass, unless otherwise noted.
   4. Process Connection: 6.35 mm NPT female connection, unless otherwise noted.
   5. Enclosure: NEMA 4X, unless otherwise noted.
   6. Signal Interface:
      a. Contact Type: SPDT, rated for 10 amps at 120 VAC.
      b. Hermetically sealed switch, if noted.
   7. Manufacturers:
      a. Ashcroft.

b. United Electric.
c. Or approved equal in accordance with B8.

B. Pressure Gauge:
1. General:
a. Function: Pressure indication.
b. Type: Bourdon tube.
2. Performance:
a. Scale Range: As noted.
b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
a. Vibration Dampening:
1) Required – Liquid filled or otherwise
b. Dial: 114 mm diameter, unless otherwise noted.
c. Case Material: Black phenolic plastic, unless otherwise noted.
d. Element Material: Phosphor-bronze, unless otherwise noted.
e. Throttling Devices.
1) Pulsation Dampener required, unless otherwise noted.
2) Brass, unless otherwise noted.
f. Pointer: Micrometer-adjustable.
g. Movement: Stainless steel, teflon coated bearings, rotary geared.
h. Window: Glass, unless otherwise noted.
i. Socket Materials: brass, unless otherwise noted.
j. Threaded reinforced polypropylene front ring for easy zero adjustment.
k. Case Type: Solid front with solid wall between window and element. Rear of case, gasketed pressure relief.
4. Process Connection:
a. Mounting: Lower stem, unless otherwise noted.
b. Size: 13 mm, unless otherwise noted.
c. Connection Type: Threaded (NPT).
5. Manufacturers and Products:
a. Ashcroft.
b. or approved equal in accordance with B8.

C. Pressure Gauge, Low Range:
1. General:
a. Function: Local pressure indication for ranges 69 kPa and below.
b. Type: Bellows-actuated mechanism.
2. Performance:
a. Scale Range: As noted.
b. Accuracy: 2 percent ASME Grade A.
3. Features:
a. Dial Size: 114 mm, unless otherwise noted.
b. Bellows and Socket Material: Brass, unless otherwise noted.
c. Case Material: Black phenolic, unless otherwise noted.
d. Ring Style: Threaded polypropylene.
e. Pulsation Dampener: Required, unless otherwise noted.
4. Process Connection:
a. Size: 6.35 mm, unless otherwise noted.
b. Threaded.

c. Location: Lower stem, unless otherwise noted.
5. Manufacturers and Products:
a. Ashcroft.
b. Or approved equal in accordance with B8.

D. Pressure Seal, Diaphragm:
1. General:
a. Function: Isolate sensing element from process fluid.
b. Type: Fluid filled, corrosion resistant.
2. Service:
a. Pressure: Same as associated sensor.
b. Temperature: As noted.
3. Features:
a. Materials:
1) Lower Housing: 316 stainless steel, unless otherwise noted.
2) Diaphragm Material: 316 stainless steel, unless otherwise noted.
b. Bleed screw in upper housing.
c. Fill Fluid: As noted. Factory filled and assembled when possible.
d. NPT flushing port in lower housing with stainless steel plug.
4. Process Connections:
a. Instrument: 13 mm female NPT, unless otherwise noted.
b. Process: 13 mm female NPT, unless otherwise noted.
c. Connection Material: As noted.
5. Manufacturers:
a. Ashcroft.
b. Or approved equal in accordance with B8.

E. Pressure Switch, Fixed Dead Band:
1. General:
a. Approvals: CSA or cUL
b. Function: Monitor pressure and provide contact closure(s) when pressure is at the noted set point.
c. Type: Diaphragm sealed piston actuator.
2. Performance:
a. Set Point: As noted.
1) Adjustable over the full range.
2) Set as noted.
b. Range: The noted set point shall fall between 30 percent and 70 percent of the range.
c. Set Point Repeatability: Plus or minus 1 percent of range.
3. Features:
a. Diaphragm Material: Buna-N, unless otherwise noted.
b. Pressure Connection: Stainless steel, unless otherwise noted.
c. Reset: Automatic, unless otherwise noted.
4. Enclosure: NEMA 4X, unless otherwise noted.
5. Signal Interface:
a. Contact Type: SPDT, snap action switch, rated for 15 amps at 120 VAC.
b. Number of Switch Elements: One, unless otherwise noted.
6. Manufacturer and Model:
a. Ashcroft B-Series,
b. Or approved equal in accordance with B8.

F. Pressure Switch, With Display (for seal water):
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Monitor pressure and provide contact closure(s) when pressure is at the noted set point.
      c. Type: Thin film transducer.
   2. Performance:
      a. Set Point: As noted.
         1) Adjustable over the full range.
         2) Set as noted.
      b. Range: The noted set point shall fall between 30 percent and 70 percent of the range.
      c. Set Point Repeatability: Plus or minus 1 percent of range.
   3. Features:
      a. Diaphragm Material: Buna-N, unless otherwise noted.
      b. Pressure Connection: Stainless steel, unless otherwise noted.
      c. Reset: Automatic, unless otherwise noted.
      d. Display: 5 digit, 7 segment LED
      e. Adjustable deadband
   4. Enclosure: NEMA 4X, unless otherwise noted.
   5. Signal Interface:
      a. Contact Type: SPDT, snap action switch, rated for 10 amps at 120 VAC.
      b. Number of Switch Elements: One, unless otherwise noted.
   6. Power Supply: 120 VAC
   7. Manufacturer and Model:
      a. Ashcroft NPI,
      b. Or approved equal in accordance with B8.

G. Pressure Transmitter and Hydrostatic Level Transmitter, Electronic:
   1. This product was standardized by the City via RFP 449-2014.
   2. No alternates or substitutes will be accepted.
   3. All requests for purchase or quotation shall reference RFP 449-2014 to receive standardized pricing that the City has negotiated with the vendor.
   4. Refer to the datasheets for further details.
   5. Provide factory installed block and bleed manifold, unless otherwise shown.
   6. Manufacturer and Model:
      a. Siemens Sitrans P DSIII.

H. Pressure Differential Transmitter, Electronic:
   1. This product was standardized by the City via RFP 449-2014.
   2. No alternates or substitutes will be accepted.
   3. All requests for purchase or quotation shall reference RFP 449-2014 to receive standardized pricing that the City has negotiated with the vendor.
   4. Refer to the datasheets for further details.
   5. Provide factory installed 5-way manifold, unless otherwise shown.
   6. Manufacturer and Model:
      a. Siemens Sitrans P DSIII.

2.5 COMPONENT SPECIFICATIONS – TEMPERATURE INSTRUMENTS

A. Temperature Element and Transmitter, RTD – Process applications:
   1. This product was standardized by the City via RFP 449-2014.
   2. No alternates or substitutes will be accepted.
   3. All requests for purchase or quotation shall reference RFP 449-2014 to receive standardized pricing that the City has negotiated with the vendor.
   4. Manufacturer and Model:
      a. Siemens TF400

B. Temperature Element and Transmitter, RTD – HVAC applications:
   1. This product was standardized by the City via RFP 449-2014.
   2. No alternates or substitutes will be accepted.
   3. All requests for purchase or quotation shall reference RFP 449-2014 to receive standardized pricing that the City has negotiated with the vendor.
   4. Manufacturer and Model:
      a. Siemens TH300

C. Temperature Transmitter, Wall-Mount for Electrical/Automation/Control Rooms:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Provide 4-20 mA signal in proportion to room temperature
      c. Mounting:
         1) Wall mount on device box.
      1. Temperature Range:
         a. 4 to 32 degrees C
      2. Manufacturer and Model:
         1) Siemens Series 1000

D. Temperature Switch:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Provide change in contacts as temperature rises or falls through the noted set point.
      c. Type:
         1) Vapor pressure thermal bulb sensing element.
         2) Fixed differential, unless otherwise noted.
         3) Direct mount, unless otherwise noted.
         d. Parts: Switch/element assembly and thermowell.
   2. Performance:
      a. Set Point: As noted.
      b. Range: Such that the noted set point falls between 30 and 70 percent of the range.
      c. Repeatability: Plus or minus 1 percent of span.
   3. Switch:
      a. Type: Snap action, SPDT, sealed environment proof, unless otherwise noted.
      b. Rating: 125VAC 15A, unless otherwise noted.
      c. Differential: Fixed, unless otherwise noted.
      d. Reset: Automatic.
      e. Enclosure:
         1) Type: NEMA 4X, unless otherwise noted.

2) Mounting: Direct mount, unless otherwise noted.

4. Element:
   a. Type: Bulb.
   b. Process Connection: Stem mounted in thermowell, unless otherwise noted.
   c. Length: Coordinate with thermowell insertion length.
5. Thermowell:
   a. Process Connection: 19 mm NPT(M) unless otherwise noted.
   b. Material: 316 stainless steel.
   c. Insertion Length: 89 mm minimum immersion for liquids and 140 mm minimum immersion for gases.
6. Electrical Connections:
   a. Conduit: 19 mm NPT(F) unless otherwise noted.
7. Manufacturers:
   a. Ashcroft
   b. United Electric
   c. Barksdale
   d. Or approved equal in accordance with B8.

E. Thermostat for HVAC applications
1. General:
   a. Approvals: CSA or cUL
   b. Industrial Grade
   c. Type: Wall mount Thermostat
2. Enclosure:
   a. Hazardous locations, Class I Zone 2, Groups C, D.
   b. Explosion proof.
3. Specifications:
   a. Temperature Rating: 2 degrees C to 28 degrees C
   b. Contact Type : SPDT, Snap Action
   c. Electrical Rating: 120 VAC
4. Conduit connection: ¾” – 14 NPT
5. Manufacturer and Model:
   a. Ruffneck XT-312
6. Or approved equal in accordance with B8.

F. Thermometer, Bimetallic, Adjustable Angle:
1. General:
   a. Function: Indicate process temperature.
   b. Type: Bi-metallic, circular dial.
   c. Parts: Temperature gauge and thermowell.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: 1 percent of full scale.
3. Thermometer Features:
   a. Stem Length: 100 mm, unless otherwise noted.
   b. Stem Type:
      1) Every angle, unless otherwise noted.
         a) Adjustable 90 degrees vertical, 360 degrees horizontal.
   c. Dial:
      1) Heavy-duty glass, unless otherwise noted.

2) 125 mm circular, unless otherwise noted.
3) Hermetically sealed.

d. Construction: All-welded, stainless steel.

4. Thermowell:
   a. Type: 13 mm NPT connection, Type 316 stainless steel.
   b. Extension Neck: When noted, with length as noted.
5. Manufacturers:
   a. Ashcroft
   b. WIKA
   c. Or approved equal in accordance with B8

2.6 COMPONENT SPECIFICATIONS – MISCELLANEOUS INSTRUMENTS

A. Humidity Transmitter:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Humidity measurement.
   2. Performance:
      a. Transmitter Operating Temperature: -1 to +60 degrees C.
      b. Probe Operating Temperature: -50 to +100 degrees C
      c. Maximum humidity at sensor: 100 percent RH up to 80 degrees C.
      d. Probe Measuring Range: 0-100 percent RH
      e. Maximum air velocity at probe: 20 m/s
   3. Transmitter Features:
      a. Display: Liquid Crystal.
      b. Housing type: IP65.
      c. Accuracy: plus or minus µA
      d. Cable connection: 1 x M16x1.5, on NPT.
      e. Signal type: 4-20mA Output signal.
      f. Circuit type: 2-wire loop powered
   4. Probe Features:
      a. Housing Metal: Polycarbonate, PEEK or stainless steel.
      b. Accuracy: plus or minus 0.8 percentRH.
      c. Filter: wire mesh filter
      d. Options: Remote mount sensor assembly with 5 M cable.
   5. Manufacturers and Model:
      a. Rotronic HF52
      b. Or approved equal in accordance with B8.

B. Density Meter:
   1. General:
      a. Approvals: CSA or cUL
      b. Measuring Principal: Microwave Phase Difference method
   2. Performance:
      a. Repeatability: 0.01 percent TS (Total Solid) to 0.02 percent TS
      b. Measuring Range: 0- 50 percent TS
      c. Resolution: 0.001 percent to 0.002 percent TS
   3. Environmental conditions:
      a. Temperature: 0-50 degrees C
   4. Converter Specification:

a. Output Signal: 4-20 mA isolated + HART, < 1000 Ω resistance, powered by device
b. Housing Type: IP65
c. Display: LED 7-Segment, 4- Character
d. Power Supply: 120 VAC
e. Mounting: Wall mount

5. Manufacturers and Model:
   a. Toshiba LQ500
   b. Or approved equal in accordance with B8.

C. Horn, Indoor/Outdoor:
1. General:
   a. Approvals: CSA or cUL
   b. Function: Audible alarm.
2. Performance:
   a. Temperature, Operating: Minus 40 to plus 65 degrees C.
   b. Sound Output Level: 100 dB nominal at 3 meters.
3. Features:
   a. Dimensions: 111 mm in height and width, and 63.5 mm in depth, for horn and enclosure.
   b. Diaphragm: Stainless steel.
   c. Projector: None, unless otherwise noted.
4. Enclosure:
   a. Type: Corrosion resistant NEMA 4X
   b. Mounting: Surface mount.
5. Voltage: 120 VAC, 60 Hz, unless otherwise noted.
6. Current: less than 0.2 A
7. Manufacturers:
   a. Federal Signal 350WB
   b. Or approved equal in accordance with B8.

D. Horn, Hazardous Area Rated:
1. General:
   a. Approvals: CSA or cUL
   b. Function: Audible alarm.
   c. Rating: Class I, Zone 2, Group IIA
2. Performance:
   a. Temperature, Operating: Minus 4 to plus 40 degrees C.
   b. Sound Output Level: 100 dB nominal at 3 meters.
3. Features:
   a. Diaphragm: Stainless steel.
   b. Projector: None, unless otherwise noted.
4. Enclosure:
   a. Type: Corrosion resistant NEMA 4X
   b. Mounting: Surface mount.
5. Voltage: 120 VAC, 60 Hz, unless otherwise noted.
6. Current: less than 0.2 A
7. Manufacturer and model:
   a. Federal Signal 350WBX
   b. Or approved equal in accordance with B8.

E. Warning Light, Indoor/Outdoor:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Visual alarm.
      c. Type: Rotating reflector or flashing bulb.
      d. Provide means to synchronize flashes within corridors or rooms in the same field of view.
   2. Performance:
      a. Temperature, Operating: Minus 37 to 87 degrees C.
      b. Flash Rate: Minimum 80 per minute.
      c. Light Intensity: 800,000 candela or greater
   3. Features:
      a. Dome Colour: Red, unless noted otherwise.
      b. Lamp Life: 60,000 hours minimum.
      c. Lamp: LED.
   4. Enclosure:
      a. Type: Corrosion resistant NEMA 4X
      b. Mounting: Wall bracket, unless otherwise noted.
      c. Indoor/outdoor use.
   5. Voltage: 120 VAC, 60 Hz, unless otherwise noted.
   6. Current: less than 0.2 A
   7. Manufacturer and model:
      a. Federal Signal SLM100
      b. Or approved equal in accordance with B8.

F. Warning Light, Indoor/Outdoor, Hazardous Area Rated:
   1. General:
      a. Approvals: CSA or cUL
      b. Rating: Class I, Zone 2, Group IIA
      c. Function: Visual alarm.
      d. Type: Rotating reflector or flashing bulb.
      e. Provide means to synchronize flashes within corridors or rooms in the same field of view.
   2. Performance:
      a. Temperature, Operating: Minus 37 to 87 degrees C.
      b. Flash Rate: Minimum 60 per minute.
      c. Light Intensity: 800,000 candela or greater
   3. Features:
      a. Dome Colour: Red, unless noted otherwise.
      b. Lamp Life: 60,000 hours.
      c. Lamp: LED
   4. Enclosure:
      a. Type: Corrosion resistant NEMA 4X
      b. Mounting: Wall bracket, unless otherwise noted.
      c. Indoor/outdoor use.
   5. Voltage: 120 VAC, 60 Hz, unless otherwise noted.
   6. Current: less than 0.4 A
   7. Manufacturer and model:
      a. Federal Signal 191XL
      b. Or approved equal in accordance with B8.

G. Intrusion Switch, Door
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Monitor intrusion of standard door.
      c. Type: Magnetic, indoor use.
      d. Parts: Magnet on door, switch on door frame.
   2. Features:
      a. Type: Aluminum housing with 914 mm (36") armored cable, unless otherwise noted.
      b. Gap Distance/Type: 76mm (3") Make
   3. Signal Interface.
      a. Voltage: 24 VDC
      b. Contact Type: SPDT
      c. Contact Rating: 0.25 A @ 24 VDC
      d. Connection: 914 mm (36") lead wires
   4. Manufacturer and model:
      a. GE Security 2507A
      b. Or approved equal in accordance with B8.

H. Intrusion Switch, Door, Hazardous Area Rated
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Monitor intrusion of standard door.
      c. Type: Magnetic, indoor use.
      d. Parts: Magnet on door, switch on door frame.
      e. Rating: Class I, Zone 2, Group IIA
   2. Features:
      a. Type: Aluminum housing
      b. Gap Distance/Type: 64mm (2.5") Make
      c. Material: Die-cast aluminum
   3. Signal Interface.
      a. Voltage: 24 VDC
      b. Contact Type: SPDT
      c. Contact Rating: 0.25 A @ 24 VDC
   4. Manufacturer and model:
      a. GE Security 2844TW-M
      b. Or approved equal in accordance with B8.

I. Motion Detector:
   1. General:
      a. Approvals: CSA or cUL
      b. Function: Monitor occupancy.
      c. Type: Dual Technology Ultrasonic and Passive Infrared.
   2. Features:
      a. Type: plastic Casing
      b. Coverage: 150 square meter (1600 square feet).
      c. Mounting: Mounting base provided.
      d. Operating temperature: 0 degrees to 40 degrees C
      e. Relative humidity: 0 percent to 95 percent

f. Power Requirements:
   1) Voltage: 24 VDC
   2) Power: ≤ 20 W
3. Signal Interface.
   a. Voltage: 24 VDC
   b. Contact Type: SPDT
   c. Contact Rating: 500 mA @ 24 VDC
4. Manufacturer and model:
   a. Hubbell LODTRP
   b. Or approved equal in accordance with B8.

J. Sampler
1. Requirements:
   a. Sample volume withdrawn per cycle: 25cc.
   b. Maximum cycle range: 30 samples / minute.
   c. Minimum cycle range: 1 sample each 170 minutes.
   d. Plunger seals: polyurethane.
   e. Process line:15 psig
   f. Body construction: type 316 stainless steel
   g. Plunger construction: type 316 stainless steel
   h. Air cylinder construction: type 316 stainless steel.
   i. Air cylinder seals: PTFE
   j. Static seals: fluoroelastomer.
   k. Ports: colour coded.
2. Manufacturer and model
   a. Sentry Equipment Corp. Isolok Series SAB-25.
   b. Or approved equal in accordance with B8.
3. Provide clear 38mm diameter polyethylene hose between the sampler and the refrigerator. Secure hose to sampler with stainless steel clamp

K. Sampler Controller
1. Requirements:
   a. CSA or cUL approved
   b. Sampler operation: flow proportional / time base cycle control
   c. Enclosure environmental rating: NEMA 4X
   d. Auto and manual operation
   e. Remote start operation
      1) Provide 24 VDC control power for PLC discrete output relay contact.
   f. Remote status signals: At minimum RUNNING and FAULT statuses
      1) Provide voltage free contacts for 24 VDC PLC discrete input
   g. Pushbutton controls
   h. LCD screen
2. Manufacturer and model
   a. Sentry Equipment Corp. SBC Controller
   b. Or approved equal in accordance with B8.

L. Sampler Airset and solenoid
1. Requirements:
   a. All devices incorporated on a panel for wall mounting.
   b. Provide inlet and outlet pressure gauge

c. Accepts 30 to 80 psig air pressure
d. Solenoid configured to work with sampler controller.

2. Manufacturer
   a. Sentry Equipment Corp.
   b. Or approved equal in accordance with B8.

M. Sampler Refrigerator
1. Requirements:
   a. Power 120 VAC 1 Ph 60 Hz.
   b. Outer construction materials: Manufacturer Standard
   c. Inner construction materials: Manufacturer Standard
   d. Self contained evaporator and condenser.
   e. Provide 42 mm diameter hose port for 38 mm polyvinyl sample tubing. Center opening in both directions on refrigerator top.

N. Emergency Stop Switch Station
1. Requirements:
   a. Type: Red Mushroom Head, Maintained Contact
   b. Seal (if required): Integral Sealing Well or External Hazardous Seal
   c. Electrical Classification: Class I, Zone 2
   d. Temperature Code: T2A
   e. Contact Type: Minimum two N.C. contacts.
   f. Contact Rating: 6 A @ 120 VAC.
   g. Operating Temperature: 0 degrees C to 40 degrees C (indoor), -40 degrees C to 40 degrees C (outdoor).
   h. Enclosure Rating: NEMA 4
   i. Approvals: CSA or cUL
   j. Durability: 300 000 operating cycles
2. Manufacturer:
   a. Schneider Electric
   b. Or approved equal in accordance with B8.

O. General Process Stop Switch Station
1. Requirements:
   a. Type: Black Mushroom Head, Maintained Contact
   b. Size: 30mm
   c. Seal (if required): Integral Sealing Well or External Hazardous Seal
      1) Electrical Classification: Class I, Zone 2
      2) Temperature Code: T2A
   d. Contact Type: Minimum two N.C. contacts.
   e. Contact Rating: 6 A @ 120 VAC.
   f. Operating Temperature: 0 degrees C to 40 degrees C (indoor), -40 degrees C to 40 degrees C (outdoor).
   g. Enclosure Rating: NEMA 4
   h. Approvals: CSA or cUL
   i. Durability: 300 000 operating cycles
2. Manufacturer:
   a. Schneider Electric
   b. Or approved equal in accordance with B8.

P. Equipment Start/Stop Pushbutton Station
   1. Requirements:
      a. Type: momentary contact
      b. Size: 30mm
      c. Seal (if required): Integral Sealing Well or External Hazardous Seal
         1) Electrical Classification: Class I, Zone 2
         2) Temperature Code: T2A
      d. Contact Type: Minimum one NO and one NC contact per pushbutton
      e. Contact Rating: 6 A @ 120 VAC
      f. Operating Temperature: 0 degrees C to 40 degrees C (indoor), -40 degrees C to 40 degrees C (outdoor).
      g. Enclosure Rating: NEMA 4
      h. Approvals: CSA or cUL
      i. Durability: 1 000 000 operating cycles
   2. Manufacturer:
      a. Schneider Electric
      b. Or approved equal in accordance with B8.

Q. Hand-Off-Remote Selector Switch Station
   1. Requirements:
      a. Type: 3 position selector switch, non spring-return
      b. Size: 30mm
      c. Seal (if required): Integral Sealing Well or External Hazardous Seal
         1) Electrical Classification: Class I, Zone 2
         2) Temperature Code: T2A
      d. Contact Type:
         1) Minimum two N.O. contacts to close on left ("Hand") position selection
         2) Minimum two N.O. contacts to close on right ("Remote") position selection
      e. Contact Rating: 6 A @ 120 VAC
      f. Operating Temperature: 0 degrees C to 40 degrees C (indoor), -40 degrees C to 40 degrees C (outdoor).
      g. Enclosure Rating: NEMA 4
      h. Approvals: CSA or cUL
      i. Durability: 1 000 000 operating cycles
   2. Manufacturer:
      a. Schneider Electric
      b. Or approved equal in accordance with B8.

R. Exterior Key Switch
   1. See Section 08 71 00 Door Hardware

S. Stand Alone Process Meter
   1. Requirements:
      a. Display: Upper and lower lines, 5 digits minimum, 17.8 mm hig minimum
      b. Input signal: 4-20 mA
      c. Features: Noise filter, password, alarm indication, back light option
      d. Mounting: Wall mount
   2. Manufacturer and Model:
      a. Precision Digital PD6700

b. Or approved equal in accordance with B8.

2.7 COMPONENT SPECIFICATIONS – CONTROL DEVICES

A. Control Valves and Actuators:
1. See Process Valves and Operators Section 40 27 02.

B. 2 and 3-Way Solenoid Valves
1. See Process Valves and Operators Section 40 27 02.

C. Damper Actuators
1. See Metal Ducts and Accessories Section 23 31 13.

PART 3 EXECUTION

3.1 INSTALLATION

A. General
1. Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
2. Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
3. Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
4. Electrical:
   a. Complete installation in accordance with Section 40 90 00, Instrumentation and Control for Process Systems.
   b. Install wiring in conduit or ACIC cabling as shown on the drawings or specifications.
      1) Provide complete conduit /cable system to link instrumentation and the control panel(s).
      2) Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
      3) Maximum conduit fills not to exceed 40 percent.
      4) Design drawings do not show conduit layout.
5. Locations of all field instruments are subject to modification by the Contract Administrator who reserves the right to move any item up to 3 meters from the position shown, without change to the contract price, provided notice is given before the related work has commenced.
6. Exact locations of all field instruments shall be site determined by the Contractor to the satisfaction of the Contract Administrator to ensure proper operation of the device.
7. All equipment shall be mounted in accordance with manufacturer's recommendations.
8. Install gas detection equipment as per location drawings and installation details.
9. Install a lamacoid nameplate directly on or adjacent to equipment with equipment name and description.
10. Equipment installed in Category 2 wet locations shall be mounted a minimum of 12 mm from supporting surface as per the Canadian Electrical Code Section 22.

B. Temperature Sensors
   1. Stabilize to ensure minimum field adjustments or calibrations.
   2. Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
   3. Duct installations:
      a. Do not mount in dead air space.
      b. Locate within sensor vibration and velocity limits.
      c. Securely mount extended surface sensor used to sense average temperature.
      d. Thermally isolate elements from brackets and supports to respond to air temperature only.
      e. Support sensor element separately from coils, filter racks.
   4. Averaging duct type temperature sensors.
      a. Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

C. Submersible Level Transmitters
   1. Install in a manner to allow easy removal of the transducer and cable assembly for maintenance purposes.
   2. Survey and document the exact elevation of the pressure transmitter installation.

D. Pressure Switches and Transmitters
   1. Where vibration or access to instrument may be an issue, mount transmitter remotely from process piping.

E. Differential Pressure Transmitters
   1. Install a valve and tee on each line coming into transmitter to allow tubing to be blown out.

3.2 IDENTIFICATION

A. Identify field devices with lamacoids. Install in a conspicuous location on a permanent structure, as close as practical to the device. If distance to the lamacoid would be excessive, affix the lamacoid to the device.

B. Follow project standard for instruments and cables identification. See Section 40 90 00, Instrumentation and Control for Process Systems

3.3 TESTING AND COMMISSIONING

A. Calibrate and test field devices for accuracy and performance in accordance with Section 40 80 11, Automation Commissioning.

3.4 CITY TRAINING

A. General:
   1. Provide an integrated training program for the City's personnel.
   2. Perform training to meet specific needs of the City's personnel.
   3. Provide a detailed training manual covering all aspects of the training provided.

4. Include training sessions, classroom and field, for maintenance personnel.
5. Provide instruction on all working shift(s) as needed to accommodate the City's personnel schedule.
6. The City reserves the right to make and reuse recordings of all training sessions.

B. Training Requirements
1. Provide three days of hands-on training for typical instruments used on the project, including but not limited to:
   a. Analysis Instruments and Transmitters
   b. Flow Transmitters
   c. Level Transmitters
   d. Pressure Transmitters
   e. Temperature Transmitters
   f. Density Meter

END OF SECTION

SECTION 40 94 43

PROGRAMMABLE LOGIC CONTROLLERS AND REMOTE I/O

PART 1 GENERAL

1.1 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in section 40 90 00 1.2 and this section.

B. Canadian Standards Association (CSA International).
   1. C22.2 No.142, Process Control Equipment.
   2. CSA-E61131-2 Programmable Controllers

C. International Electrotechnical Commission (IEC)
   1. IEC 61131, Programmable Controllers

1.2 DEFINITIONS

A. FAT Factory Acceptance Test

B. SIFT System Integration Function Test

C. SAT Site Acceptance Test

D. SIT Site Integration Test

E. HMI Human-Machine Interface

F. I/O Input/Output

G. PLC Programmable Logic Controller

H. RIO Remote I/O

1.3 APPROVED MANUFACTURER

A. The City has standardized on Schneider Electric Inc. for all control system equipment via Request For Proposal 756-2013. All questions, requests for quotations and purchasing shall be addressed to them. Contact information is as follows:
   Schneider Electric Inc.
   Omand Creek Blvd
   Winnipeg, MB R2R 2V2

B. All requests for purchase or quotation shall reference RFP 756-2013 to receive standardized pricing that the City has negotiated with the vendor.

1.4 SOFTWARE OWNERSHIP

A. The City will fully own all PLC programming logic supplied, and may utilize the software provided for any purpose including:
   1. Modification and revision.
   2. Use at other City facilities.

B. The City may turn the software over to a 3rd party, for use at any City owned facility.

C. Provide source code for all custom software and function blocks, or any other software logic utilized in the application.
   1. Source code for base function blocks provided by the PLC manufacturer is not required.

1.5 DESIGN REQUIREMENTS

A. Design and implement a complete operating PLC and RIO system.

B. The design is to be based upon the supplied Functional Requirements Specification.
   1. Utilize a tag naming convention that extends, and does not conflict with the tag scheme utilized in the Functional Requirements Specification.

C. The PLC and HMI software design is to be supervised and authenticated by a Professional Engineer licensed to practice in Manitoba.

D. Do not assume that the Contractor's internal standards or standard programming methodology will be acceptable for this project. No additional payment will be made for assumptions made regarding standard methods utilized by the Contractor.

E. The Contract Administrator will review the overall design. Make changes as requested by the Contract Administrator.

1.6 SUBMITTALS

A. All submittals are to be in accordance with Section 01 33 0, Submittal Procedures, 40 95 13 Control Panels, and 40 96 00, Application Software.

1.7 O&M MANUALS

A. Include the following in the O&M Manuals:
   1. Product datasheets.
   2. Hardware and software user manuals.
   3. Letter stating that the PLC and HMI application software has been reviewed and authenticated. The letter is to be signed and sealed by a Professional Engineer licensed to practice in Manitoba.
   4. HMI interface map.
   5. Third Party Interface List
   6. PLC database listing and logic printout.
   7. CD sleeve with CD containing HMI, PLC and any other application program or software configuration.

8. CD sleeve with CDs containing all used software and firmware.
9. CD sleeve for record purposes with CD containing :
   a. PDF printout of HMI and PLC application program
   b. HMI interface data map in excel and pdf format.
   c. PLC database map in excel and pdf format.
   d. Any other application program or software configuration in pdf format and excel for lists.

1.8 FAT, SIFT, SIT, and SAT PROCEDURE

A. Refer to 40 99 91 and 40 99 92 for FAT, SIFT, SIT and SAT Procedures

PART 2 PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER & REMOTE I/O HARDWARE

A. These products were standardized by the City via RFP 756-2013.

B. No alternates or substitutes will be accepted.

C. Part or Model numbers shall be as shown on Automation-Cabinet Layout drawings

D. Provide all required hardware for a complete installation.

2.2 PLC PROGRAMMING SOFTWARE

A. These products were standardized by the City via RFP 756-2013.

B. No alternates or substitutes will be accepted.

C. See Section 40 96 00, Application Software for requirements.

2.3 ACCESSORIES

A. Include the following accessories:
   1. Serial or USB connection cable for downloading program.
   2. RJ45 connection cable for Modbus port on CPU.

2.4 USB MEMORY STICK

A. Provide a USB memory stick with the following:
   1. Latest PLC, HMI and any other application programs, with documentation.
   2. PLC, HMI and any other used software and hardware user manuals

B. Turn over memory stick to Contract Administrator prior to commencement of commissioning.

2.5 SPARE PARTS

A. Supply the following spare parts:
   1. Two power supply module of each type used.
   2. One backplane of each type used.
   3. One processor module of each type used.
   4. One communication module of each type used.
   5. Two DI 120 VAC I/O module of each type used.
   6. Three DI 24 VDC I/O module of each type used.
   7. Three DO 24 VDC I/O module of each type used.
   8. Three AI module of each type used.
   9. Three AO module of each type used.

B. Complete set of spare parts to be supplied prior to commencement of commissioning.

C. Spare parts may include those utilized for the DCS migration temporary panel, provided they are in acceptable condition.

PART 3 EXECUTION

3.1 HARDWARE INSTALLATION

A. Install the PLCs and RIOs as per manufacturer instructions and recommendations.

B. Follow Cabinet Layout drawings for hardware layout.

3.2 FIRMWARE AND SOFTWARE UPDATE REQUIREMENTS

A. Update the processor and all updatable modules with the latest firmware before FAT and SIFT. Any latter firmware update requires rechecking plan to be provided by the contractor and approved by the contract administrator. The application rechecking plan should include a recheck of the general PLC function blocks from the general FRS and any other part of the application software impacted by the firmware changes.

B. The Contractor shall inform the Contract Administrator of any new firmware or software updates issued by the manufacturer after FAT and SIFT. The Contractor shall inform the Contract Administrator if the installation of the new firmware or software update is required.

C. Application rechecking due to firmware or software updates shall be performed at no additional cost.

3.3 PLC PROGRAMMING SERVICES

A. Follow Functional Requirements Specification documents for general PLC programming requirements.

B. Provide an organized structure and comprehensive commenting for better debugging and readability of the program.

C. Use Derived Function Blocks for encapsulation of the code that is going to be used repeatedly.

D. Avoid creating unnecessary tags and variables. Any unused and/or obsolete and/or non-functional tags, logic, logic sections, etc. to be removed and purged from the final version of the program.

E. Purge and pack memory periodically to reduce memory fragmentation

F. See Section 40 96 00, Application Software for additional requirements

3.4 PLC COMMISSIONING SERVICES

A. Provide all required PLC and RIO commissioning services as per Commissioning Procedure (CP) documents.

B. Upon completion of commissioning load latest used firmware onto spare processors.

END OF SECTION

SECTION 40 95 13

CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. All Control Panels shall be built by a CSA/cUL approved manufacturer and shall bear the CSA/cUL seal with the manufacturer's file number.

B. All new Control Panels shall be factory assembled and pre-wired. The Control Panel wiring shall be verified at the manufacturer's factory and completely tested before being shipped to the site. Do not ship control panels until approval from the Contract Administrator is received.

C. Existing Control Panels that are substantially modified from the original installation shall have a new CSA/cUL seal applied.

D. Supply, install, wire and test all components inside the Control Panels according to the specifications herein and the drawings.

1.2 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in Section 40 90 00 1.2 and this Section.

B. The following is a list of standards which may be applicable in this Section:
   1. Canadian Standards Association (CSA).
      a. CSA C22.1, Canadian Electrical Code, Part I - Safety Standard for Electrical Installations.
      b. CSA C22.2 No. 14-13, Industrial control equipment.
   2. National Electrical Manufacturers Association (NEMA).

1.3 ACRONYMS AND ABBREVIATIONS

A. FAT Factory Acceptance Test

B. PLC Programmable Logic Controller

C. SIFT System Integration Functional Test

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01 33 00, Submittal Procedures.

B. Shop Drawings:
   1. Complete specifications, catalog cuts, and descriptive literature, which shall include make and model of all components.
   2. Control panel layout drawings.
   3. Complete bill of materials.
   4. Electrical schematic and wiring diagrams, interconnection diagram showing power and control interfaces among all control panel components. The diagrams are to be fully comprehensive so that every circuit loop can be followed completely.
   5. Configuration/parameter sheets including switch settings, parameter settings, and addresses. Show factory default settings and proposed settings.
   6. Diagram showing dip switches complete with proposed settings

C. Prior to construction:
   1. Submit stamped red-line mark-ups of any proposed control panel modifications. If significant modifications are proposed/required, AutoCAD drawings will be supplied to the Contractor for revision.

D. FAT and SIFT requirements
   1. Refer to Section 40 99 91 FAT and SIFT Procedures for submittal requirements.

E. Prior to shipment:
   1. Submit electronic pictures of enclosure exterior and interior, including door interior. For enclosures that are similar, one set of photos for each type may be submitted.
      a. Pictures to be of sufficient resolution to read component labels.
   2. Submit as-built drawings. Minor changes may be made via red-line mark-ups. Significant changes shall be made via red-line mark-ups with the associated change submitted on separate AutoCAD drawings.

1.5 INSPECTION

A. A factory inspection of the control panels will be performed at the discretion of the Contract Administrator based upon the pre-shipment submittals.

B. Demonstrate and test the control panel in the presence of the Contract Administrator designated representative as part of the FAT and SIFT.

PART 2 PRODUCTS

2.1 GENERAL

A. Construction of the control panels is required in accordance with the supplied drawings.

B. Devices of each function shall be of the same type and manufacturer.

2.2 ENCLOSURES – WALL MOUNT

A. Install lamacoids as per the control panel layout drawings, with stainless steel screws.

B. Minimum NEMA ratings are as follow:
   1. For Electrical and Automation Rooms - NEMA 12
   2. For Mechanical Rooms and light process areas – NEMA 12
   3. Form general process areas– NEMA 4
   4. In areas where corrosive gases are present and outdoors – NEMA 4X

C. All enclosure angles and cut-outs shall be free of dents, gouges or weld marks, and shall present a clean, smooth appearance.

D. No screws, fittings or other fastenings shall be used on external panel faces, which must be free of any marks, scratches or defaults.

E. Minimum Metal Thickness: 14 gauge.

F. The exterior of the control panel shall be painted ANSI 61 grey.

G. The interior of the control panel shall be painted gloss white.

H. Component mounting plates shall be three (3) mm thick steel and shall be painted with one (1) coat of primer and one (1) coat of white baked enamel.

I. All control panel doors shall be 900 mm (36 inches) wide maximum.

J. All control panel doors shall open through 180 degrees without restriction.

K. Provide door mount document pocket in each panel.

L. Manufacturers:
   1. Hoffman
   2. Or approved equal in accordance with B8.

2.3 ENCLOSURES – AUTOMATION AND ELECTRICAL ROOMS FREE STANDING CABINETS

A. Modular enclosures with plinth base.
   1. Frame
      a. Welded corners with steel corner blocks
      b. Flange trough collar on door and side openings deflect liquids away from the enclosure interior
      c. Accommodate 25 mm DIN standard
      d. Rectangular frame holes designed for BV-M6 fasteners or metric cage nut fasteners
      e. Round frame holes accommodate M5 self-tapping screws and allow numerous grounding locations using M5 thread-forming screws
      f. Universal frame member used for both horizontal and vertical frame sections to simplify component installation
      g. Uniform internal frame width to simplify component installation
      h. Removable rear centerpost for frames ≥1200 mm wide
      i. Integral frame channels support the full weight of the subpanels

2. Mounting Sub-panels
   a. Includes four sets of EZ Load Mounting Blocks which accommodate five loading options: vertical front, vertical side, vertical rear, horizontal rear (frame over subpanel), horizontal front (subpanel lowered into frame)
   b. Depth adjustable, accommodates back-to-back subpanels
   c. Subpanels can be mounted in 25 mm increments from front to rear and on the sides
   d. Side mount subpanels can be mounted on the sides
3. Door
   a. Door bar system on all doors (including window doors)
   b. Single/primary door includes three-point roller latch system with timed latch engagement (two-point latching for heights ≤800mm)
   c. Two-door enclosures include overlapping double doors to provide full-width open front; secondary door latches with one center lever
   d. Reversible hinging on single and overlapping double doors
   e. Two grounding studs
4. Gasket
   a. Seamless foam-in-place gasket (UL component recognized) on all external components
5. Provide all required hardware and accessories for a complete installation.

B. Manufacturer and Model:
   1. Hoffman Proline Type 12 modular enclosures
   2. Or approved equal in accordance with B8

2.4 HAVC PLC and HVAC RIO ENCLOSURES –TWO DOOR TYPE 12 WITH FLOOR STANDS

A. Two Door Type 12 With Floor Stands
   1. Seams continuously welded and ground smooth; no holes or knockouts.
   2. Gasketed overlapping doors with no centerpost.
   3. 3-point latch mechanism operated by oil-tight key-lock handle.
   4. Latch rod rollers for easy door closing.
   5. Data pocket is high-impact thermoplastic.
   6. 12-in. floor stands welded to enclosure.
   7. Heavy-duty lifting eyes.
   8. Oil-resistant gasket.
   9. Bonding provision on door.
   10. Provide all required hardware and accessories for a complete installation.

B. Manufacturer and Model:
   1. Hoffman two door type 12 floor mount enclosure with floor stands
   2. Or approved equal in accordance with B8

2.5 POWER SOURCE

A. Each power source must be protected by a CSA approved circuit breaker or fuse.

B. The location of each power source must be clearly shown.

C. Panels powered by more than one electrical source shall display on their door; "Caution: This panel is electrically powered by more than one source".

2.6 COMPONENTS

A. Unless written approval for use of unapproved components is received from the Contract Administrator, all electrical materials (e.g., conduit, fittings, wireways, etc.) shall be CSA or cUL approved.

B. Rails (DIN Rails)
   1. Rails used must be DIN Rail style TS 35mm, slotted.
   2. When used to mount terminals, rails shall be mounted on straight raisers (rail support / mounting feet) so as to raise them so that the top of the terminals are at the same height as the top of the adjacent wiring duct.
   3. Raisers (rail support / mounting feet) shall not be used when rail hosts heavy components.

C. Terminals
   1. Quantity:
      a. Accommodate present and spare indicated needs.
      b. One wire per terminal for field wires entering/exiting enclosures.
      c. Maximum of 2 wires on each side of a terminal for internal enclosure wiring.
      d. Installed Spare Terminals: As shown on the drawings.
   2. General:
      a. Connection Type: Screw compression clamp.
      b. Compression Clamp:
         1) Complies with DIN-VDE 0611.
         2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
         3) Guides strands of wire into terminal.
      c. Screws: Hardened steel, captive, and self-locking.
      d. Current Bar: Copper or treated brass.
      e. Insulation:
         1) Thermoplastic rated for minus 55 to plus 110 degree C.
         2) Two funneled shaped inputs to facilitate wire entry.
      f. Mounting:
         1) Standard DIN rail.
         2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
         3) End Stops: Minimum of one at each end of rail.
      g. Jumpers: Allow jumper installation without loss of space on terminal or rail.
      h. Marking System:
         1) Terminal number shown on both sides of terminal block.
         2) Markings must be machine printed. Hand written markings are not allowed.
         3) Terminal strip numbers shown on end stops.
         4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.

i. Terminal blocks shall be designed for the size of the wires to be connected to them. Terminal blocks used for analog, digital, and power cables shall be identified and physically separated from each other.
j. Drawings and templates supplied may not detail all hardware components such as labels, stoppers, rail lifters, end plates, separators, etc. The supplier must supply and install such components when required.
k. Loose Spare Requirements
    1) Provide either thirty or 3 percent, whichever is less, of each type of terminal used on the project.

3. Terminal Block Types:
    a. Control wiring
        1) General:
            a) Connection type: Screw connection.
            b) Mounting: NS 35 mm DIN rail.
            c) Approval: CSA.
        2) Manufacturer and Series:
            a) Phoenix Contact UT 4 and UTTB 4 series
            b) or approved equal in accordance with B8
        3) Standard of Acceptance
            a) Terminal Block, Feed-through:
                (1) Rated Voltage: 600V ac.
                (2) Rated Current: 30 amp.
                (3) Wire Size: 26 to 10 AWG.
                (4) Color: Gray body.
                (5) Width: 6.2 mm.
                (6) Bridging: Plug-in bridge.
                (7) Standard of acceptance: Phoenix Contact 3046184.
            b) Terminal Block, Ground:
                (1) Wire Size: 26 to 10 AWG.
                (2) Color: Green and yellow body.
                (3) Width: 6.2mm.
                (4) Grounding: Electrically grounded to mounting rail.
                (5) Standard of acceptance: Phoenix Contact 3046207
            c) Terminal Block, Knife Disconnect:
                (1) Rated Voltage: 600V ac.
                (2) Rated Current: 16 amp.
                (3) Wire Size: 26 to 10 AWG.
                (4) Color: Gray body, orange switch.
                (5) Width: 6.2 mm.
                (6) Bridging: Plug-in bridge.
                (7) Standard of acceptance: Phoenix Contact 3046139.
            d) Terminal Block, Fused:
                (1) Rated Voltage: 600V ac.
                (2) Rated Current: 6.3 amp.
                (3) Wire Size: 26 to 10 AWG.
                (4) Color: Gray body.
                (5) Width: 6.2 mm.
                (6) Bridging: Plug-in bridge.

(7) Fuse: 5 mm x 20 mm.
(8) Standard of acceptance: Phoenix Contact 3046142, 3036806.

e) Terminal Block, Double Level, Fused:
(1) Rated Voltage: 500V ac.
(2) Rated Current: 6.3A.
(3) Wire Size: 26 to 10 AWG.
(4) Color: Gray.
(5) Width: 6.2mm.
(6) Bridging: Plug-in bridge.
(7) Fuse: 5 mm x 20mm.
(8) Standard of acceptance: Phoenix Contact 3044720, 3036806.

b. Power wiring over 6.3 A
1) General:
a) Connection type: Screw connection.
b) Mounting: NS 35 mm DIN rail.
c) Approval: CSA.
2) Manufacturer and Series:
a) Phoenix Contact UK 10/16 series
b) or approved equal in accordance with B8
3) Standard of Acceptance
a) Terminal Block, Feed-through:
(1) Rated Voltage: 600V ac.
(2) Rated Current: 85 A.
(3) Wire Size: 14 to 4 AWG / 12 to 6 AWG flexible.
(4) Color: Gray body.
(5) Width: 12.2 mm.
(6) Bridging: Fixed Bridge.
(7) Standard of acceptance: Phoenix Contact 3006043 (UK 16 N).
b) Terminal Block, Fused:
(1) Rated Voltage: 300V ac.
(2) Rated Current: 10amp.
(3) Wire Size: 20 to 6 AWG.
(4) Color: Gray body.
(5) Width: 12 mm.
(6) Bridging: Fixed Bridge.
(7) Fuse: 6.3 mm x 32 mm.
(8) Standard of acceptance: Phoenix Contact 3005507.

D. Electronic Circuit Protector – Class 2 current limiting
1. Electronic Circuit Protectors for disconnection of 24 VDC loads as per control panel layout drawings.
2. Requirements:
a. Overload disconnection,
b. Active current limitation,
c. Manual On/Off button,
d. Current rating: As required,
e. Approvals: CSA,
f. DIN rail mounting.

3. Manufacturer and Model:
   a. Weidmuller, ESX10-T series.

E. Ground Bus Bar
1. Supply a ground bus bar in each control panel. Supply an isolated ground bus bar where shown on the drawings.
2. Requirements:
   a. Tapped holes with screws,
   b. Bar to have sufficient connection points for all cables entering the control panel, plus 25 percent spare,
   c. Maximum one wire termination per screw,
3. Manufacturer and Model:
   a. ILSCO D167 series
   b. or approved equal in accordance with B8

F. Pushbutton, Non-Illuminated
1. General:
   a. Function: Initiate discrete control functions.
   b. Type: 30 mm, heavy-duty, oiltight, industrial, momentary contact.
   c. Approvals: CSA.
2. Mounting:
   a. Panel cut out: 30.6 mm single round hole.
   b. Panel thickness: 1.59 mm to 4.76 mm.
3. Pushbutton Features:
   a. Operator: Pushbutton, flush or extended head as noted.
   b. Cap colour: Black, unless otherwise noted.
   c. Cap text: None, unless otherwise noted.
   d. Boot: None, unless otherwise noted.
4. Legend Plate:
   a. Standard size (46.4 H x 45.2 W, mm), unless otherwise noted.
   b. Text: As noted or shown.
   c. Material:
      1) Non-corrosive environment: Aluminum
      2) Corrosive environment: Plastic
5. Signal Interface:
   a. Contact Block:
      1) Type: Silver-coated butting, unless otherwise noted.
      2) Rating: 10 amps continuous at 120 VAC or as noted.
      3) Sequence: Break-before-make, unless otherwise shown.
      4) Arrangement: Normally open or normally closed as shown, or perform functions noted.
      5) Electrical design life: 1,000,000 cycles.
      6) Terminals: Screw with strap clamp, unless otherwise noted.
6. NEMA Rating:
   a. Dry and Non-corrosive environment: Type 12.
   b. Wet and Non-corrosive environment: Type 4.
   c. Corrosive environment: Type 4X.

7. Manufacturers:
    a. Schneider Type K or SK
    b. or approved equal in accordance with B8

G. Pushbutton, Emergency Stop
1. General:
    a. Function: Initiate shutdown of equipment.
    b. Type: 30 mm, heavy-duty, oiltight, industrial, push-pull, maintained position.
2. Mounting:
    a. Panel cutout: 30.6 mm single round hole.
    b. Panel thickness: 1.59 mm to 4.76 mm.
3. Pushbutton Features:
    a. Operator: Pushbutton, mushroom head.
    b. Cap colour: Red.
    c. Text: None.
    d. Illumination: None.
    e. Boot: None, unless otherwise noted.
4. Legend Plate:
    a. Standard size (46.4 H x 45.2 W, mm), unless otherwise noted.
    b. Text: As noted or shown.
    c. Material:
        1) Non-corrosive environment: Aluminum
        2) Corrosive environment: Plastic
5. Signal Interface:
    a. Contact Block:
        1) Type: Silver-coated butting, unless otherwise noted.
        2) Rating: 10 amps continuous at 120 VAC or as noted.
        3) Sequence: Break-before-make, unless otherwise shown.
        4) Arrangement: Normally open or normally closed as shown, or perform functions noted.
        5) Electrical design life: 1,000,000 cycles.
        6) Terminals: Screw with strap clamp, unless otherwise noted.
6. NEMA Rating:
    a. Dry and Non-corrosive environment: Type 12.
    b. Wet and Non-corrosive environment: Type 4.
    c. Corrosive environment: Type 4X.
7. Manufacturers:
    a. Schneider Type K or SK
    b. or approved equal in accordance with B8

H. Pilot Light
1. General:
    a. Function: Display discrete control functions.
    b. Type: 30 mm, heavy-duty, oiltight, industrial.
    c. Approvals: CSA.
2. Mounting:
    a. Panel cutout: 30.6 mm single round hole.
    b. Panel thickness: 1.59 mm to 4.76 mm.

3. Light Features:
    a. Lights: LED, unless otherwise noted.
    b. Voltage: As noted.
    c. Lens Color: As noted.
4. Legend Plate:
    a. Standard size (46.4 H x 45.2 W, mm), unless otherwise noted.
    b. Text: As noted or shown.
    c. Material:
        1) Non-corrosive environment: Aluminum
        2) Corrosive environment: Plastic
5. Signal Interface:
    a. Terminals: Screw with strap clamp, unless otherwise noted.
6. NEMA Rating:
    a. Dry and Non-corrosive environment: Type 12.
    b. Wet and Non-corrosive environment: Type 4.
    c. Corrosive environment: Type 4X.
7. Manufacturers:
    a. Schneider Type K or SK
    b. or approved equal in accordance with B8

I. Pilot Light, Push-to-Test
1. General:
    a. Function:
        1) Push to test light, display discrete control functions, or
        2) Initiate and display discrete control functions.
    b. Type: 30 mm, heavy-duty, oiltight, industrial, momentary contact.
    c. Approvals: CSA.
2. Mounting:
    a. Panel cutout: 30.6 mm single round hole.
    b. Panel thickness: 1.59 mm to 4.76 mm.
3. Light Features:
    a. Lights: LED, unless otherwise noted.
    b. Voltage: As noted.
    c. Lens Color: As noted.
4. Pushbutton Features:
    a. Operator: Pushbutton.
    b. Boot: None, unless otherwise noted.
5. Legend Plate:
    a. Standard size (46.4 H x 45.2 W, mm), unless otherwise noted.
    b. Text: As noted or shown.
    c. Material:
        1) Non-corrosive environment: Aluminum
        2) Corrosive environment: Plastic
6. Signal Interface:
    a. Contact Block:
        1) Type: Silver-coated butting, unless otherwise noted.
        2) Rating: 10 amps continuous at 120 VAC or as noted.
        3) Sequence: Break-before-make, unless otherwise shown.

4) Arrangement: Normally open or normally closed as shown, or perform functions noted.
5) Electrical design life: 1,000,000 cycles.
6) Terminals: Screw with strap clamp, unless otherwise noted.

7. NEMA Rating:
   a. Dry and Non-corrosive environment: Type 12.
   b. Wet and Non-corrosive environment: Type 4.
   c. Corrosive environment: Type 4X.
8. Manufacturers:
   a. Schneider Type K or SK
   b. or approved equal in accordance with B8

J. Selector Switch
1. General:
   a. Function: Select discrete control functions.
   b. Type: 30 mm, heavy-duty, oiltight, industrial, maintained contact.
   c. Approvals: CSA.
2. Mounting:
   a. Panel cutout: 30.6 mm single round hole.
   b. Panel thickness: 1.59 mm to 4.76 mm.
3. Switch Features:
   a. Operator: Black non-illuminated lever on switch, unless otherwise noted.
   b. Boot: None, unless otherwise noted.
   c. Positive indexing with stops to limit travel to the number of positions shown.
4. Legend Plate:
   a. Standard size (46.4 H x 45.2 W, mm), unless otherwise noted.
   b. Text: As noted or shown.
   c. Material:
      1) Non-corrosive environment: Aluminum
      2) Corrosive environment: Plastic
5. Signal Interface:
   a. Contact Block:
      1) Type: Silver-coated butting, unless otherwise noted.
      2) Rating: 10 amps continuous at 120 VAC or as noted.
      3) Sequence: Break-before-make, unless otherwise shown.
      4) Arrangement: Normally open or normally closed contact(s) as shown, or perform functions noted.
      5) Electrical design life: 1,000,000 cycles.
      6) Terminals: Screw with strap clamp, unless otherwise noted.
6. NEMA Rating:
   a. Dry and Non-corrosive environment: Type 12.
   b. Wet and Non-corrosive environment: Type 4.
   c. Corrosive environment: Type 4X.
7. Manufacturers:
   a. Schneider Type K or SK
   b. or approved equal in accordance with B8

K. Potentiometer
1. General:
   a. Function: Adjustable analog setpoint.
   b. Type: Heavy-duty, industrial, oiltight.
2. Performance:
   a. Resistance: 1000 ohms, unless otherwise noted.
   b. Temperature, operating: 0 to 55 degrees C.
   c. Humidity, operating: 50 percent at 40 degrees C.
   d. Mechanical design life: 25,000 cycles.
   e. Rated for 300V AC maximum.
3. Mounting:
   a. 30.6 mm single round hole.
   b. Panel thickness:
      1) 1.59 to 4.76 millimeters.
      2) Counterboring required for thicknesses greater than 4.76 millimeters.
4. Legend Plate:
   a. Standard size (46.4 H x 45.2 W, mm), unless otherwise noted.
   b. Scale: 0 to 100 percent, unless otherwise noted.
   c. Legend: As noted or shown.
   d. Material:
      1) Non-corrosive environment: Aluminum
      2) Corrosive environment: Plastic
5. Signal interface: Three-wire.
6. NEMA rating:
   a. Dry and Non-corrosive environment: Type 12.
   b. Wet and Non-corrosive environment: Type 4.
   c. Corrosive environment: Type 4X.
7. Manufacturer:
   a. Schneider Type K or SK
   b. or approved equal in accordance with B8

L. Pilot Device Colours
1. The following pilot device colours shall be used:

a.	Running Status Light:	Green
b.	Stopped Status Light:	Blue
c.	Position Open Status Light:	Green
d.	Position Closed Status Light:	Blue
e.	Alarm Status Light – Major or Safety:	Red
f.	Warning or Minor Alarm Status Light:	Amber
g.	Ready Status Light:	Blue
h.	Operating Mode – Normal Mode:	Blue
i.	Operating Mode – Alternate Mode:	Amber
j.	Start Pushbutton:	Green or Black
k.	Stop Pushbutton:	Red or Black
l.	Test Pushbutton:	Black
m.	Reset Pushbutton:	Black
n.	E-Stop Pushbutton:	Red push-pull with mushroom
o.	Overload Reset Pushbutton:	Blue with White “R”

p. Selector Switch: Black with White Insert

M. Programmable Logic Controllers
1. See Section 40 94 43.

N. Relays – General Purpose Miniature industrial relays
1. General:
   a. Approvals: CSA
   b. Coil voltage: As Noted.
   c. Relay Mounting: plug-in type socket.
   d. Socket type: Screw terminal.
   e. Socket mounting: 35mm DIN rail.
2. Control Circuit Switching Relay:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: As noted.
   c. Contact Rating: As noted or shown.
   d. Contact material: Silver tin oxide alloy.
   e. Coil voltage: As noted or shown.
   f. Coil operating voltage display: LED.
   g. Operation temperature: -40 to 70 degrees C.
   h. Expected mechanical life: 10,000,000 cycles.
3. Manufacturer and Series:
   a. Finder 46 Series.
   b. or approved equal in accordance with B8.

O. Relays – I/O
1. General:
   a. Approvals: CSA
   b. Relay Mounting: plug-in type socket.
   c. Socket type: Screw terminal.
   d. Socket mounting: 35mm DIN rail.
2. Control Circuit Switching Relay:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: As noted.
   c. Contact Rating: As noted or shown.
   d. Coil voltage: As noted or shown.
   e. Coil operating voltage display: LED.
   f. Operation temperature: -40 to 55°C.
   g. Expected mechanical life: 20,000,000 cycles.
3. Manufacturer and Series:
   a. Phoenix Contact PLC-RSC Series.
   b. or approved equal in accordance with B8.
4. Standard of Acceptance
   a. Relay interface for PLC Discrete Inputs, 1PDT :
      1) Coil rating: 3.5 mA at 120 VAC.
      2) Contact material: Gold-plated silver tin oxide alloy.
      3) Contact switching voltage: 36 V dc max.
      4) Contact minimum switching current: 1 mA

5) Contact maximum inrush current: 50 mA
6) Wire Size: 26 to 14 AWG for both input and output side.
7) Color: Gray body.
8) Width: 6.2 mm.
9) Bridging: Plug-in bridge.
10) Approvals: cULus
11) Standard of acceptance: Phoenix Contact 2966281

b. Relay interface for PLC Discrete Outputs, 1PDT :
1) Coil rating: 9 mA at 24V dc.
2) Contact material: Silver tin oxide alloy.
3) Contact switching voltage: 5V ac min, 250 V ac max.
4) Contact limiting continuous current: 6A.
5) Wire Size: 26 to 14 AWG for both input and output side.
6) Color: Gray body.
7) Width: 6.2 mm.
8) Bridging: Plug-in bridge.
9) Approvals: cULus
10) Standard of acceptance: Phoenix Contact 2966171

c. Relay interface between PLCs, 1PDT :
1) Coil rating: 11 mA at 24V AC/DC.
2) Contact material: Gold-plated silver tin oxide alloy.
3) Contact switching voltage: 36 V dc max.
4) Contact minimum switching current: 1 mA
5) Contact maximum inrush current: 50 mA
6) Wire Size: 26 to 14 AWG for both input and output side.
7) Color: Gray body.
8) Width: 6.2 mm.
9) Bridging: Plug-in bridge.
10) Approvals: cULus
11) Standard of acceptance: Phoenix Contact 2966278

P. Relays –Motor Starting and Solenoids
1. General:
a. Approvals: CSA
b. Coil voltage: As per the drawings.
c. Relay Mounting: Plug-in type socket.
d. Socket Type: Screw terminal interface with wiring.
e. Socket Mounting: Rail.
f. Furnish hold-down clips.
2. Control Circuit Switching Relay:
a. Type: Compact general purpose plug-in.
b. Contact Arrangement: As noted.
c. Contact Rating: 16A.
d. Contact single phase motor rating: 1/3 Hp at 120 VAC
e. Contact Dielectric Strength: 1000 VAC.
f. Contact Material: Silver cadmium oxide alloy.
g. Coil Voltage: As noted or shown.
h. Coil Power: 0.5 watts (dc), 1.2 VA (ac).

i. Expected Mechanical Life: 10,000,000
j. Indication Type: LED indicator lamp.
k. Ambient temperature: -40 to 70 degrees C.

3. Manufacturer:
   a. Finder 48.61 Series
   b. or approved equal in accordance with B8.

Q. Analog Signal Isolators:
1. Provide galvanic isolation between analog signals where not already provided by the programmable logic controller or other components.
2. Input: 0-5V, 1-5V, 0-10V, and 4-20 mA (switch selectable).
3. Output: 4-20 mA.
4. Channels per isolator: 2 or 4.
5. DC input resistance:
   a. Current inputs: 50 Ω.
   b. Voltage inputs: 1 MΩ.
6. Performance:
   a. Output ripple: < 10 mV peak-to-peak measured across a 250 Ω resistor.
   b. Isolation: 1000V rms input-to-output and channel-to-channel.
   c. Common mode rejection: > 95dB @ 60 Hz, 500V rms maximum.
7. Features:
   a. Adjustable zero and span for each channel via potentiometers.
   b. Removable wiring connectors.
8. Environmental:
   a. Temperature range, operating: -40 to 70 degrees C.
   b. Relative humidity, operating: 0-95 percent non-condensing.
   c. Ambient temperature effect: plus or minus 0.015 percent of span/ degrees C maximum.
9. Manufacturers:
   a. Acromag,
   b. Moore Industries,
   c. MTL Instruments,
   d. Phoenix Contact.

R. Intrinsic Safety Barriers:
1. Monitor discrete signals that originate in hazardous area and are used in a safe area.
2. Interface analog signals as they pass from hazardous area to safe area.
3. Isolation Method: Galvanic Isolation
4. Approvals: CSA or cUL
5. Manufacturers:
   a. Phoenix Contact.
   b. Pepperl+Fuchs.
   c. MTL Instruments.

S. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.
1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.

2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.

T. Wiring
1. All analog signal wiring shall be 18 AWG shielded twisted pair.
   a. Shield wires exiting the jacket must be covered with a black heat shrink, and the overall cable at the jacket end must also be covered with a heat shrink.
   b. Standard of Acceptance:
      1) Belden No. 8760.
2. All 24 VDC discrete signal panel wiring shall be 16 AWG TEW/MTW stranded conductor with 300V, 105 degrees C insulation.
3. All 120 VAC discrete signal panel wiring shall be 14 AWG TEW/MTW stranded conductor with 300V, 105 degrees C insulation.
4. All 24 VDC and 120 VAC power wiring shall be 12 AWG minimum unless shown otherwise.
5. The sizes and colours of wires shall be in accordance with the CSA and the Canadian Electrical Code, and Wire Colour Coding.
6. Provide wire barrel ferules where possible.
7. Ethernet Patch Cords
   a. Requirements:
      1) Cat-6, shielded, as per Section 40 90 21, Automation Wires and Cables.
8. Wiring Duct
   a. All wires shall be run in narrow slot wiring duct, unless shown otherwise.
   b. Wiring Duct shall be installed on both sides of the panel and between the DIN rails as per the drawings.
   c. Wire or cable, connected to internal device or arriving from external device, shall be uncovered by Wiring Duct for a maximum of 10 cm or as required by its minimum bending radius.
   d. 120 VAC wires cannot share wiring duct with 12 VDC, 24 VDC or 4-20 mA wires, but may cross their path.
   e. All DC, AC, and communication wiring shall be routed in separate wireways to prevent signal interference. 24 VDC Class 2 circuits and communication wiring may share the same wiring duct.
   f. Wire ties shall be non-metallic.
   g. Where the voltage level and/or type of signal is shown on the drawings, provide an adhesive label to the cover of the wiring duct with this information.
   h. g. Manufacturer:
      1) Panduit
      2) or approved equal in accordance with B8
9. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Standard of Acceptance:
      1) Brady PermaSleeve.
      2) Tyco Electronics.
10. Wire Color Coding
   a. Utilize the following wire colours for the types of voltage/signals indicated:
      1) 120 VAC Line: Black

2) 120 VAC Control: Red
3) 120 VAC Neutral: White
4) 24 VDC Supply: Blue
5) 24 VDC Control: Blue
6) 24 VDC Common: Brown
7) 4-20mA Signal: White (+), Black (-)
8) Protective Earth Green
9) Signal Ground: Green/Yellow
10) Profibus: Red/Green

U. Overcurrent Protection
1. Panel-mounted devices and all control circuits shall be protected by appropriately sized fuses or circuit breakers.

V. Control Power Transformer
1. Function: Provide required secondary voltage level with high degree of stability.
2. Type: Single phase, indoor, industrial.
3. Ratings:
   a. Power Rating: As shown on the drawings.
   b. Primary voltage: 120 VAC.
   c. Secondary voltage: 24 VAC.
   d. Frequency: 60 Hz.
   e. Temperature rise 55 degrees C, insulation class 105 degrees C
4. Mounting: Directly to enclosure back panel with mounting feet made of heavy steal and welded or bolted to the core.
5. Standard secondary and optional primary fuse kits.
6. With Finger Guards
7. Approvals: cULus.
8. Manufacturer and model:
   a. Hammond PH100PG, FG2.
   b. or approved equal in accordance with B8

W. 24 VDC Power Supplies and Redundancy Modules
1. Approvals: CSA.
2. Type: Regulated switch mode.
3. Watt Rating: As noted.
4. Input: 100-240 V ac, 45-65 Hz.
5. Output: 24V dc.
6. Mounting: NS 35 DIN rail.
7. Capable of redundant operation with redundancy module.
8. Redundancy module:
   a. MOSFET based.
   b. Adjustable output voltage
   c. Loss of redundancy alarm LED and contact
   d. Power fail alarm contact
9. Performance:
   a. Load regulation: < 2 percent.
   b. Temperature derating: 2.5 percent/ degrees C from 60 degrees C.

c. Output ripple: < 30 mV peak-to-peak.
d. Efficiency: 93 percent or greater.

10. Features:
    a. Capable of parallel operation.
    b. Power boost: 130 percent handle start up loads and temperature derating effect.
    c. Input transient surge protection.
    d. Input overcurrent protection
    e. Output overcurrent protection.
11. Status lights:
    a. DC OK LED: active, green;
    b. Alarm LED: red.
    c. Power boost LED: power boost active, yellow
12. Status contacts:
    a. Power supply failure, qty 1 normally open (Form A), contact closed during normal operation.
13. Environmental:
    a. Temperature, operating: -25 to 60 degrees C.
    b. Humidity, operating: max 95 percent, non-condensing.
14. Manufacturer and series:
    a. Phoenix Contact, Quint Series.
    b. Or approved equal in accordance with B8.

X. Process Meters
1. Display digital reading of process value.
2. Display:
    a. Type: Alpha-numeric, LED.
    b. Update rate: 5/second (200 ms) minimum.
    c. Character colour: red.
3. Features:
    a. Internal 24V dc loop power supply for providing loop power to external devices.
4. Inputs:
    a. 0-20 mA, 4-20 mA, plus or minus 10V, 0-5V, 1-5V, 0-10V, field selectable.
    b. Input impedance:
        1) Voltage ranges: > 1 M Ω.
        2) Current ranges: 50 - 100 Ω.
5. Output relays:
    a. Qty 4, Form C, unless otherwise noted.
    b. Electrical rating: 3 Amps at 30 VDC and 125/250 VAC resistive.
6. Mounting: panel mount, 1/8 DIN (92 mm x 45 mm) cutout.
7. Power supply: 12/24 V dc.
8. Communication:
    a. Modbus RTU (serial) or Modbus TCP as indicated in the drawings.
9. Manufacturer:
    a. Precision Digital.

Y. Internal Lighting
1. All control panels of a depth greater than or equal to twelve (12) inches shall be equipped with a lighting device with a door switch. Whenever the door is opened, the lighting system shall automatically be activated.
2. Fixture mounting: top-centre of enclosure, unless otherwise noted.
3. Lights: LED, white.
4. Power supply: 24 VDC.
5. Manufacturer:
a. Hoffman.
b. Or approved equal in accordance with B8.

Z. Cooling and Heating Systems
1. Control panels shall be designed for the environmental conditions of the installation location. Cooling and heating systems shall be in accordance with the specific NEMA rating required by NEMA ICS 6 and NEMA 250.

AA. Networking Equipment
1. See Section 40 95 33, Fieldbus and 40 95 53, Network Equipment.

BB. Fibre Optic Equipment
1. See Section 40 95 80, Fibre Optic Network.

2.7 COMPONENTS - EXISTING PANELS

A. Pilot Light for existing Field Device Panels and existing MCCs
1. General:
a. Function: Display discrete control functions.
b. Type: 30 mm, heavy-duty, oil tight, industrial.
c. Approvals: CSA.
2. Mounting:
a. To fit in existing panels and MCCs.
3. Light Features:
a. Lights: LED
b. Voltage: To match existing (Typically 120 VAC).
c. Lens Color: As shown on the drawings.
4. Legend Plate:
a. As shown on the drawings.
5. Signal Interface:
a. Terminals.
6. Manufacturer and Model:
a. ABB GL-513
b. No alternatives will be allowed as these are to match lights on existing panels and MCCs

2.8 SPARE COMPONENTS

A. Provide the following in a clear plastic bag attached to the panel door interior of each panel:
1. Two spares of each fuse type and rating.
2. One spare of each Electronic Circuit Protector – Class 2 rating, as applicable

3. One spare of each type of door mounted pilot device.

B. Provide the following spare parts:
1. One 24 VDC power supply of each type
2. One 24 VDC power supply redundancy module of each type

C. For PLC spare part requirements, refer to Section 40 94 43, Programmable Logic Controllers and Remote I/O.

PART 3 EXECUTION

3.1 GENERAL

A. Construct control panels in accordance with CSA C22.2 No. 14-13.

3.2 WIRING

A. Panel wiring shall be installed in a neat and orderly manner.

B. All conductors shall be securely fastened to terminals at both ends; no splices are allowed inside the panel.

C. No more than two (2) conductors may be terminated under each terminal screw. All internal panel conductors shall be connected to the same side of a terminal block, and external conductors to the other side. The only exception is for fused terminals which require connection to the field side for internal wiring.

D. All wires and cables inside the control panels shall be identified on both ends using non-erasable labels.

E. Identification shall follow the supplied documents, such as wiring diagrams.
1. Label both ends of each wire.
2. Utilize machine printed non-slip labels. Wrap-around or self-adhesive markers shall not be permitted.
3. Wherever possible wire labels shall be positioned to be read from the panel opening without removal of wire duct covers or other wiring.

F. Individual conductors or wires exiting a cable shall be identified using non-erasable labels.

G. The routing of all analog, digital, and power cable wiring inside control panels shall be segregated as much as possible, in distinct wiring ducts, by the type of signal they are carrying. All wires shall be physically protected by wiring ducts with covers. The wiring ducts shall be of sufficient size to be filled to a maximum of 40 percent when all wires are inside.

H. Group and form wiring into a loop when going from a fixed part of the panel to a door such that there is sufficient slack to minimize strand fatigue and breaking. Secure at each end so

that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

I. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.

J. Connections to Screw Type Terminals:
   1. Locking-fork-tongue or ring-tongue lugs.
   2. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
   3. Wires terminated in a crimp lug, maximum of one.
   4. Lugs installed on a screw terminal, maximum of two.

K. Connections to Compression Clamp Type Terminals:
   1. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
   2. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.

L. The wiring arrangement shall not interfere with access to panel-mounted devices or spaces for future equipment.

M. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

N. Locate entry points of cables to control panel to allow for wiring duct designations to be utilized as shown on panel layout drawings.

3.3 GROUNDING

A. All control panel components shall be adequately grounded in accordance with the component manufacturer's instructions, especially control system components.

B. Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

C. Where ground bars are installed on to the rear or side wall of the enclosure, seal screw penetrations to maintain enclosure rating.

D. Ground terminal block rails to ground bus.

3.4 COMPONENT INSTALLATION

A. Components on the front of the panel shall be identified with an individual permanent nameplate installed in an organized manner. The nameplate must identify the component's function.

B. Install acorn nuts and rubber washers on all machine screws that protrude out of the panel.

C. Each component inside the control panel shall be identified with a nameplate corresponding to the drawings. Identification nameplates for relays shall be installed on the enclosure back-panel rather than the pluggable relay.

D. All non-DIN rail mountable devices in the control panel shall be mechanically affixed to the back panel with either tapped or self-tapping screws.

E. All control devices shall be mounted so that any component can be replaced without removing the sub-panel or other components.

F. Components and/or auxiliary instruments mounted at the rear of the panel shall be readily accessible and their installation shall not be affected by, or interfere with the removal of any panel instrument.

G. Nameplates shall be made of lamacoid material with a white background and engraved black letters for internal and external components. Nameplates must resist harsh industrial conditions. Fasten lamacoids using stainless steel self-tapping screws.

H. Supply and install all required fuses.

I. Control devices must be spaced adequately to allow for cooling, replacement, servicing, and wiring access.

J. Control devices shall be grouped according to voltage and function to reduce electrical noise.

K. Cut-outs for instruments shall be within the tolerances specified by the instrument manufacturer.

L. If cut-outs are specified for future instruments, the cut-outs shall be covered by removable steel plates 3 mm (1/8 inch) thick. The cover plates shall be finished and painted with the same paint as applied to the front panel.

M. If any panel-mounted item is not available for installation before the panel is scheduled for shipment, wiring from the terminal block to the panel location for the item shall be completed, wire ends shall be formed exactly to the configurations required, and identifying sleeves shall be applied, ready for connection.

N. Panel areas designated for future equipment shall be kept clear of stiffening members, rear-mounted equipment, wiring, and all other interferences.

O. Ample space shall be provided for the entrance of external cables into the panel and for routing the cables to terminating points within the panel.

P. Jumper bars shall be used instead of jumpers where possible.
   1. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

Q. Provide manufacturer-recommended clearances around heat-generating components such as 24V dc power supplies and programmable logic controllers.

3.5 IDENTIFICATION

A. Perform terminal identification using a computerized device. Handwriting is not acceptable.

B. Label terminals as shown on drawings.

C. Install label above each terminal block with terminal block name.

3.6 TESTING

A. Testing of the control panels shall be completed to the greatest extent possible prior to the FAT, and shall include at minimum:
   1. Provide a signed and dated inspection sheet with all tests performed listed on it.
   2. The list of the various test procedures described hereunder is not restrictive, and does not relieve the control panel manufacturer of his responsibility to perform any other work that is not mentioned but requested to verify the good operation of the control panels.
   3. Isolate all instruments and components of the control panels as required to protect them from any damage during tests.
   4. Provide the services of qualified personnel as well as tools and equipment required to perform all tests and inspection of the control panels.
   5. Tests to include:
      a. Power supply functionality
      b. PLC component functionality
      c. Point to point tests of all inputs and outputs
      d. Power terminal voltage verification
      e. Relays and switches functionality
      f. E-stop system component functionality
      g. Receptacle and lighting functionality
      h. Ethernet switch and fibre transceiver functionality
      i. Profibus and Modbus gateways, Profibus DP/PA link couplers, and associated components functionality
   6. If the panel is modified after tests have been performed, tests shall be repeated.

3.7 FAT REQUIREMENTS

A. Refer to Section 40 99 91, FAT and SIFT Procedures.

3.8 SHIPMENT

A. If any panel-mounted item is not available for installation before the panel is scheduled for shipment, wiring from the terminal block to the panel location for the item shall be completed, wire ends shall be formed exactly to the configurations required, and identifying sleeves shall be applied, ready for connection.

B. Shipment of any panel having shortages of equipment shall be approved in writing by the Contract Administrator.

C. Transportation method to site shall be in an air ride van or equivalent.

END OF SECTION

SECTION 40 95 33

FIELDBUS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. All networking panels shall be built by a CSA/cUL-approved manufacturer and shall bear the CSA/cUL seal with the manufacturer's file number.

B. All networking panels shall be factory assembled and pre-wired. The panel wiring shall be verified at the manufacturer's factory and completely tested before being shipped to the site.

C. Supply, install, wire and test all components inside the networking panels according to the specifications herein and the drawings.

1.2 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in Section 40 90 00, Instrumentation and Control for Process Systems 1.2 and this section.

1.3 SUBMITTALS

A. Prior to construction:
   1. Submit product datasheets, panel layout, and bill of material, internal wiring schematic and wait for approval, prior to construction of the Networking Panels.
   2. Submit stamped red-line mark-ups of the proposed modifications to the networking panels. If significant modifications are proposed/required, AutoCAD drawings will be supplied to the Contractor for revision.

B. Prior to shipment:
   1. Submit electronic pictures of enclosure exterior and interior, including door interior.
      a. Pictures to be of sufficient resolution to read component labels.
   2. As-built drawings:
      a. Submit as-built drawings. Minor changes may be made via red-line mark-ups.
      b. Draft significant changes on AutoCAD drawings.
   3. Do not ship networking panel until approval from Contract Administrator is received.

1.4 INSPECTION

A. A factory inspection of the networking panels will be performed at the discretion of the Contract Administrator based upon the pre-shipment submittals.

B. If requested, demonstrate and test the networking panel in presence of the Contract Administrator designated representative.

PART 2 PRODUCTS

2.1 GENERAL

A. Construction of the Networking Panels is required, in accordance with the supplied drawings.
   1. Devices of each category shall be of same type and manufacturer.

2.2 COMPONENTS

A. PROFIBUS REMOTE MASTER (PROFIBUS DP/MODBUS TCP GATEWAY)
   1. Requirements:
      a. This product was standardized by the City via RFP 756-2013.
      b. All requests for purchase or quotation shall reference RFP 756-2013 to receive standardized pricing that the City has negotiated with the vendor.
      c. Operating temperature range: 0 to 60 degrees C.
   2. Manufacturer and Model:
      a. Schneider Electric Profibus Remote Master (PRM) TCSEGPA23F14F,
      b. No alternates or substitutes will be accepted.

B. PROFIBUS HEAD STATION BACKPLANE
   1. Requirements:
      a. The Fixed backplane HS + 2 Sub fits 1 Head Station and 2 modules of any type and is extendible with standard backplane units on the right side.
   2. Manufacturer and Model:
      a. Procentec COMbricks 101-200023
      b. Or approved equal in accordance with B8

C. PROFIBUS REPEATER HEAD STATION
   1. Requirements:
      a. Headstation for permanent PROFIBUS monitoring,
      b. No bus address required,
      c. Can monitor one PROFIBUS network,
      d. Power supply: 10.8 to 26.4 Vdc, max 800 mA,
      e. Ports: Ethernet 10/100 Mbps, RJ45 connector,
      f. Supported protocols: HTTP, FTP, SMTP, TELNET, DHCP, SNMP.
      g. Internal Web Server,
      h. Compatible Backplane Units, 101-200023, 101-200012.
      i. Approvals: CSA or equivalent.
   2. Manufacturer and model:
      a. Procentec COMbricks 101-20011B,
      b. Or approved equal in accordance with B8.

D. PROFIBUS REPEATER POWER SUPPLY MODULE
   1. Requirements:
      a. Power module provides additional power to the backplane when Head Station cannot power all inserted modules,
      b. Power supply: 12- 30 VDC, 2 Amps max,
      c. Provides 6A to backplane.
      d. Approvals: CSA or equivalent.

2. Manufacturer and model:
   a. Procentec Combricks 101-230010,
   b. Or approved equal in accordance with B8.

E. PROFIBUS DP REPEATER, 2 CHANNEL
1. Requirements:
   a. Supported protocols: DP-V0, DP-V1, DP-V2, FDL, MPI, FMS, PROFIsafe and any other FDL based protocol,
   b. No bus address required,
   c. Transmission speed: Max 12 Mbps,
   d. Transmission speed auto detection,
   e. Integrated termination facility,
   f. Maximum 31 devices per channel,
   g. Screw terminations and DB9 connector for each channel,
   h. Operating temperature range: 0 to 60 degrees C.
   i. Approvals: CSA or equivalent.
2. Manufacturer and Model:
   a. Procentec Combricks 101-201102,
   b. Or approved equal in accordance with B8.

F. PROFIBUS DP/PA LINK MODULE
1. Requirements:
   a. Supported protocols: DP-V0, DP-V1, DP-V2, FDL, MPI, FMS, PROFIsafe and any other FDL based protocol,
   b. No bus address required on DP (Link has address 1 on PA),
   c. Fully transparent
   d. PA transmission speed: 31.25 kbps,
   e. DP transmission speed: 9.6 kbps to 12 Mbps (including 45.45 kbps),
   f. Maximum 32 devices,
   g. Trunk voltage: 10 to 27 VDC (customizable and Non-Ex),
   h. Trunk current: 500 mA,
   i. Current consumption: 10 mA,
   j. Screw terminals for each channel,
   k. PA termination: Automatic
   l. Operating temperature range: 0 to 60 degrees C.
   m. Approvals: CSA or equivalent.
   1. Manufacturer and model:
   a. Procentec Combricks 101-201610,
   b. Or approved equal in accordance with B8.

G. PROFIBUS FIBRE OPTIC MODULE
1. Requirements:
   a. 2 Fibre Channels,
   b. 4 ST/BFOC connectors,
   c. Supported Protocols: DP-V0, DP- V1, DP-V2, FDL, MPI, FMS, PROFIsafe, PROFIdrive and any other FDL based protocol
   d. Transmission Speed: 9.6 kbps to 12 Mbps,
   e. Fibre Optic Wavelength: Multimode 1310 nm.

f. Approvals: CSA or equivalent.

2. Manufacturer and Model Number:
   a. ComBricks , MM1, part Number 101-201530,
   b. Or approved equal in accordance with B8.

H. PROFIBUS PA SEGMENT PROTECTOR
1. Requirements:
   a. Connects several Field Devices to the network Trunk cable and provides short circuit protection,
   b. Short Circuit Protection,
   c. Mounting: DIN Rail,
   d. Degree Of Protection: IP20,
   e. Operating Temperature: -50 to +70 Degrees C,
   f. Minimum Input Voltage: 10V,
   g. Voltage drop main cable/outputs: 1.3V
   h. Spur Device Current: 43mA maximum (one device per spur),
   i. Spur Short Circuit Current: 58mA maximum,
   j. Terminating resistor: removable external type 100 Ω +/- 10 percent
   k. No. Of Ports: 6 and 12.
   l. Approvals: CSA or equivalent.
2. Manufacturer and Model:
   a. PEPPERL+FUCHS, R2-SP-IC6, R2-SP-IC12, with M-FT terminating resistor.
   b. Or approved equal in accordance with B8.

I. PROFIBUS DP PROTECTIOR MODULE
1. Requirements:
   a. This module protects Profibus/DP network against lightning strikes and surges,
   b. Max. Continues operating DC Voltage: 6.0 V,
   c. Nominal Current: 1A,
   d. Operating Temperature: -40 to +80 Degrees C,
   e. CSA approved,
   f. Mounting: DIN Rail.
   g. Approvals: CSA or equivalent.
2. Manufacturer and Model:
   a. DEHN, BXT ML4 BD HF 5 Module, part number: 920 371,
   b. DEHN, BXT BAS Protection Module Base, part number: 920 300,
   c. Or approved equal in accordance with B8.

J. PROFIBUS PA PROTECTOR MODULE
1. Requirements:
   a. This module protects Profibus PA network against lightning strikes and surges,
   b. Max. Continues Operating DC Voltage: 33 V,
   c. Nominal Current: 1A,
   d. Operating Temperature: -40 to +80 Degrees C,
   e. CSA Approved.
2. Manufacturer and Model:
   a. DEHN, BXT ML4 BD 24 Module, part number: 920 344,
   b. DEHN,BXT BAS Protection Module Base, part number: 920 300,

c. Or approved equal in accordance with B8.

K. INDUSTRIAL ETHERNET PROTECTOR MODULE
1. Requirements:
a. This module protects Ethernet network against lightning strikes and surges,
b. Max. Continuous Operating DC Voltage: 48 V,
c. Nominal Current: 1A,
d. Operating Temperature: -40 to +80 Degrees C,
e. CSA Approved.
2. Manufacturer and Model:
a. DEHN, DPA M CLE RJ45B 48 Module, part number: 929 121,
b. Or approved equal in accordance with B8.

L. LIGHTNING PROTECTION MODULE TEST DEVICE
1. Requirements:
a. Portable device for testing of BXT ML Lightning Protection Modules,
b. Voltage Supply: Lithium Battery,
c. RFID Transmission Frequency: 125 kHz,
d. Operating Temperature: -20 to +60 Degrees C.
2. Manufacturer and Model:
a. DEHN, DRC LC M1+, part number: 910 655,
b. Or approved equal in accordance with B8.

M. MODBUS SERIAL TO TCP GATEWAY
1. Requirements:
a. 1-port advanced Modbus gateway
b. Serial Port: 1 RS-232/422/485
c. Serial Port Isolation: 2 KV
d. Ethernet Interface: Modbus TCP
e. Supported Serial Protocols: Modbus RTU/ASCII Slave/Master
f. Operating Temperature: -40 to +80 Degrees C
g. Power Input: 12 to 48 VDC, 278 mA @ 24 V
h. Approvals: CSA or equivalent.
2. Manufacturer and model:
a. MOXA, MGate MB3170I
b. Or approved equal in accordance with B8.

N. COPPER ETHERNET MODULAR PATCH PANEL
1. Requirements:
a. Mounting: 35mm DIN Rail mount, TS-35 “U” Rail,
b. 2 X Single Copper Module,
c. Shielded Keystone RJ45 Cat 6 Connectors,
d. Ports: As noted,
e. Rated for Shielded Cat 6 wiring.
2. Manufacturer and model:
a. Belden MIPP-BD-CSD4 (as required),
b. Or approved equal in accordance with B8.

2.3 SPARE COMPONENTS

A. Provide the following spare components:
1. One PROFIBUS repeater headstation
2. One PROFIBUS power supply module
3. Two PROFIBUS two channel repeater modules
4. Two PROFIBUS DP/PA link modules
5. One PROFIBUS Fiber Optic Module
6. One PROFIBUS Remote Master
7. One 6 channel PROFIBUS PA segment protector
8. One 12 channel PROFIBUS PA segment protector
9. Ten PROFIBUS DP protector modules
10. One PROFIBUS PA protector module
11. One Ethernet protector module
12. One MODBUS serial to TCP gateway

PART 3 EXECUTION

3.1 WIRING

A. See Section 40 90 21, Automation Wire and Cables.

3.2 PROFIBUS NETWORK INSTALLATION AND COMMISSIONING

A. See section 40 90 21, Automation Wire and Cables for Profibus Cable installation guidelines.

B. Install network terminations as indicated on the drawings.

C. Verify operation of all network and devices on all Profibus network segments.

D. Provide bus analysis and waveform capture of all Profibus network segments and verify that there are no errors. The PROFIBUS installation will not be considered complete if it has communication errors even if communication is occurring.

E. See Commissioning Procedure documents for Profibus network commissioning details.

3.3 GENERAL INSTALLATION

A. Configure process control network equipment so as to create a correctly communicating installation.

B. Ethernet installations shall be certified to Category 6 standards.

C. Equipment shall be installed in panels by a CSA certified panel shop.

3.4 TESTING

A. Refer to Section 40 99 91 for FAT, SIFT, SAT and SIT procedures.

3.5 CITY TRAINING

A. General:
   1. Provide an integrated training program for the City's personnel.
   2. Perform training to meet specific needs of the City's personnel.
   3. Provide a detailed training manual covering all aspects of the training provided.
   4. Include training sessions, classroom and field, for maintenance personnel.
   5. Provide instruction on all working shift(s) as needed to accommodate the City's personnel schedule.
   6. The City reserves the right to make and reuse recordings of all training sessions.

B. PROFIBUS Training:
   1. Provide a minimum of 2 sessions of 2 day duration for training at the site indicated by the City for personnel in the operation and maintenance of the PROFIBUS network
   2. Topics to include, but not be limited to:
      a. General PROFIBUS overview
      b. Operation and maintenance of the PROFIBUS network
      c. Setup and configuration of PROFIBUS devices
      d. Troubleshooting

C. Modbus Training:
   1. Provide a minimum of 2 sessions of 2 day duration for training at the site indicated by the City for personnel in the operation and maintenance of the Modbus network
   2. Topics to include, but not be limited to:
      a. General Modbus overview
      b. Operation and maintenance of the Modbus network
      c. Setup and configuration of Modbus devices
      d. Troubleshooting

END OF SECTION

SECTION 40 95 34

CONTROL SYSTEM SERVERS AND WORKSTATIONS

PART 1 GENERAL

1.1 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in Section 40 90 00, Instrumentation and Control for Process Systems 1.2.

1.2 SUBMITTALS

A. Submit product data in accordance with Section 01 33 00, Submittal Procedures.

PART 2 PRODUCTS

2.1 SERVERS

A. All Servers shall be rack mounted and CSA or cUL certified.

B. Hardware Minimum Requirements:
   1. Processor: Intel Xeon 2.6 GHz 10 core
   2. RAM: 32 GB
   3. Form Factor: 2U (Rack chassis) LLF Large Form Factor
   4. Rail: 2U Large Form Factor Ball Bearing Kit
   5. Storage:
      a. One CD/DVD-ROM drive.
      b. Hot-plug SAS hardwired
         1) Historian / File Server: Two 2TB hard drives RAID 1
         2) Other Servers: Two 500GB hard drives RAID 1
   6. Four USB ports.
   7. Four 10Base-T/100Base-TX/1000Base-TX Gigabit Ethernet ports.
   8. ASHRAE Class A3 compliant.
      a. Server on operating temperature 5 degrees C to 40 degrees C
      b. 5 to 85 percent Humidity non-condensing
   9. System fans: minimum of N+ 1 redundant Hot-plug fans or as required to meet ASHRAE Class A3.
   10. Two 120 VAC Hot-plug power supplies (redundant). One power supply shall be connected to UPS, the other to filtered non-essential.
   11. Video adapter VGA 1280 x 1024
   12. Associated components and accessories as required

C. Manufacturer and Model:
   1. HP ProLiant DL 380 G9
   2. Or approved equal in accordance with B8.

2.2 SERVER CABINET

A. Cabinet General requirements
   1. Unused rack space below the keyboard tray shall have blanking panels
   2. Cables shall routed tidily to prevent air circulation restrictions
   3. Cabinet shall have perforated front, top and back panels for passive cooling. Cabinet passive cooling utilizes the equipments fans to exchange ambient air
   4. Rack Units: 45
   5. Monitor Shelf
   6. Size: 2161 x 606 x 1099 mm (Assuming 28.75 deep servers)
   7. Associated components and accessories as required
   8. Manufacturer and Model:
      a. Hoffman PROLINE™ FLOTEK™ PC (Passive Cooling) Server Cabinet with sides model PSCPC21611B with Shelf D19FVT912B and blanking panels P19RPP6UB
      b. Or approved equal in accordance with B8

B. Monitor
   1. Display: minimum 19” 1280 x 1024 and 1280 x720 Flat panel VGA monitor. 120 VAC Power
   2. Associated components and accessories as required

C. Keyboard and mouse
   1. Keyboard: Commercial Grade, USB, enhanced 101 key, US-layout.
   2. Mouse: USB, two button with mouse wheel, laser or optical sensor.
   3. Keyboard Shelf with Mouse Tray: Hoffman P19KBPVT or approved equal in accordance with B8
   4. Associated components and accessories as required

D. KVM Switch
   1. Keyboard and mouse: USB server and USB console
   2. Ports: 4
   3. Display: VGA, Minimum resolution 1280 x 1024
   4. Hot-plug keyboard and mouse ports
   5. Port selection: Front button
   6. KVM switch to server connection cables as required
   7. Power supply: 120 VAC
   8. Associated components and accessories as required

E. Power Distribution Units (PDUs)
   1. Operating temperature 5 degrees C to 40 degrees C
   2. 5 to 85 percent Humidity non-condensing
   3. Input voltage 120 VAC
   4. UPS and filtered non-essential power PDUs shall be grouped and clearly marked
   5. Associated components and accessories as required
   6. Manufacturer:
      a. APC Basic Rack Power Distribution
      b. Or approved equal in accordance with B8

2.3 CONTROL SYSTEM SOFTWARE

A. General Requirements:
1. Provide all software and licenses required for a complete and operational system, regardless of whether it is included in the specifications.
2. Provide the latest release of software that is compatible with all required applications.
3. Verify type and quantity of licenses requirements listed in this document.
4. Consult with control system manufacturer for selection of the AntiVirus software.
5. All servers and workstations shall have PDF printer drivers.

B. Provide Software Licenses including, but not limited to the following:
1. Windows Server 2012 / Domain Controller License (Qty. 2)
2. Windows Server 2012 License for Terminal Servers (Qty. 3)
3. Microsoft Windows Server CAL (Client Access License for Thin Clients) (Qty. 40)
4. Microsoft Windows TSCAL (Remote Desktop Service or Terminal Server CAL) (Qty. 10)
5. Windows 10 License for Maintenance/Programming Workstations (Qty. 2)
6. Microsoft Office package for each server and workstations
7. Microsoft CAL for Office package (Qty. 20)
8. Unity Pro XLarge License (Group 3 Stations) with AutoSave Change Management software (10 User) (Qty. 1)
9. Vijeo Citect Redundant Server License (Alarm, Trend, Report and I/O) (Qty. 2 –)
10. Vijeo Citect Client License (Includes programming license) (Qty. 13)
11. Vijeo Citect OPC Server License (Qty. 2)
12. Vijeo Citect OFSOPC driver (Qty. 2)
13. Schneider OPC Factory Server (OFS) (Qty. 2)
14. Vijeo Citect DNP3 Driver License (Qty. 2)
15. Vijeo Citect Ethernet IP Driver License (Qty. 2)
16. Vijeo Citect Native Driver Licenses for third party equipment, if available (as required)
17. Vijeo Historian Server License (Qty. 1)
18. Vijeo Historian Client License (Qty. 4)
19. AntiVirus software (McAfee Virus Scan Enterprise Edition) as required
20. Process Simulator (Qty. 1) and all associated software required for the PCS Demonstration System
21. Process Simulator License (Qty. 1)
22. Moxa MXStudio Industrial Network Management Suite (Qty. 1)
23. DRS Ethernet Switch Configurator (Qty. 2)
24. Procentec PROFITrace Software (Qty. 1)
25. Other programming/viewing software as required for third party devices (e.g. RSLogix)

C. ThinManager Software

General Requirements:
1. Latest Release
2. Full-Redundancy
3. (Minimum 20 ThinManager Clients), Multi Monitor, TermSecure, PXEBoot,WinTMC, Multisession, SmartSession,Remote Management, Automatic Failover, Instant Failover, Terminal Shadowing
4. Manufacturer: ACP; no equals will be accepted.

D. Provide temporary Software Licenses for the Contract Administrator prior to Stage 2 software design submittal that is valid until the end of commissioning:
   1. Unity Pro XLarge License (2 Temporary Individual Stations)
   2. Vijeo Citect Redundant Server (Alarm, Trend, Report and I/O) (2 Temporary Licenses)
   3. Vijeo Citect Client (Includes programming license) (2 Temporary Licenses)
   4. Vijeo Citect OPC Server (2 Temporary Licenses)
   5. Vijeo Citect OFSOPC driver (2 Temporary Licenses)
   6. Schneider OPC Factory Server (OFS) (2 Temporary Licenses)
   7. Vijeo Citect DNP3 Driver License (2 Temporary Licenses)

E. Alarm Notification Software

   General Requirements:
   1. Connectivity to OPC DA server Version 2.0
   2. E-mail notification: SMTP supporting all e-mail clients (desktop, tablet, mobile) with reply acknowledge (pop3), SSL support, file attachments, and failure retry.
   3. Licensing: Site License
   4. Manufacturer: TopView, no equals will be accepted

2.4 WORKSTATION HARDWARE

A. Thin Client Workstation (Operator Workstation)
   1. Thin client configuration: ACP ThinManager Ready
   2. Mounting: Panel Mount
   3. Processor: AMD G-series T40E 1.0 GHz, Dual core
   4. SDRAM: 2 GB minimum
   5. Video ports: (2 simultaneous, independent Multi Monitor digital Video ports)
      a. Qty 1, HDMI v1.3, (1920x1080p max)
      b. Qty 1, Display Port DP 1.1 (1920x1200max)
   6. Ethernet ports: Qty 1 Gigabit, (10/100/1000)
   7. USB ports: Qty 4, USB 2.0
   8. Serial port: RS-232/485
   9. Audio port: via HDMI port
   10. Power supply: 120 VAC
   11. Storage: Not required,
   12. Operating system: Not required,
   13. Operating temperature range: -10 to 60C
   14. Manufacturer and model:
      a. Advantech C-UNO-2362G-ACP
      b. Or approved equal in accordance with B8.

B. Maintenance/Programming Workstation
   1. Processor: Intel Xeon 3.5 GHz 4 core
   2. RAM: 8 GB
   3. Form Factor: Tower
   4. Storage:
      a. One CD/DVD-ROM drive.
      b. One 1TB SATA
   5. Four USB ports.

6. Four 100Base-TX/1000Base-TX Gigabit Ethernet ports.
7. Video adapter: Two DisplayPort outputs with DP to DVI cables
8. Associated components and accessories as required
9. Manufacturer and model:
   a. HP Z440 Workstation
   b. Or approved equal in accordance with B8.

C. Keyboard:
1. Layout: Commercial Grade, Enhanced 101 key, US-layout.
2. Colour: Black.
3. Connected: Corded, USB

D. Mouse:
1. Two (2) buttons with mouse wheel,
2. Sensor: laser or optical,
3. Colour: Black,
4. Connection: Corded, USB
5. Mousepad: fabric covered foam pad,

E. Operator Workstation Monitor:
1. Type: LED –backlit LCD
2. Size: 22” diagonal
3. Aspect Ratio: Widescreen
4. Resolution: 1920 X 1080 @60HZ,
5. Video Interface :VGA/HDMI/DP

F. Maintenance/ Programming Workstation Monitor:
1. Type: LED –backlit LCD
2. Size: 27” diagonal
3. Aspect Ratio: Widescreen
4. Resolution: 1920 X 1080 @60HZ,
5. Video Interface :VGA/HDMI/DP

2.5 OPERATOR WORKSTATION DESK

A. For use in Electrical and Automation Rooms.

B. Requirements:
1. Worktop style enclosure, complete with keyboard drawer, front and rear doors.
2. Width: 600 mm
3. Height: 1000 mm
4. Depth: 890 mm
5. Worktop: 610 mm x 465 mm
6. Plinth Base: 100 mm in height
7. Drawer: drawer tray pull-out (Qty. 2 per desk):
8. Protection category: IP 54 / NEMA 12
9. Manufacturer and model:
   a. Rittal IW 6901.100 with Two IW 6902.700 Drawers and Plinth Base PC 8800.920
   b. Or approved equal in accordance with B8.

2.6 PCS DEMONSTRATION SYSTEM

A. Provide a complete computer hardware and software system that simulates the PCS and the process (the "PCS Demonstration System") which includes, but is not limited to:
   1. An HMI Operator Workstation complete with CitectSCADA server and client software as required;
   2. A Process Simulator Workstation with Schneider Electric SimSci DynSim software;
   3. Other computer hardware as required to simulate the PLCs and other automation hardware;

B. The PCS Demonstration System shall utilize completely independent hardware from the PCS and be turned over to the City.

C. See Section 40 96 00, Applications Software for simulator programming requirements.

D. Integrate the PCS Demonstration System into any classroom training course where:
   1. The content includes equipment monitoring and control via the HMI;
   2. The content includes alarming and alarm response;
   3. The content includes coordination of maintenance events and states to PCS/HMI status indications; or
   4. The use of the PCS Demonstration System would clarify and/or aid in the training of the Training Participants.

E. Where use of the PCS Demonstration System is included in a training course, the Contractor shall:
   1. Provide the PCS Demonstration System in accordance with the specifications;
   2. Ensure that the PCS Demonstration System in no way impacts the actual operating PCS or in any other way expose the PCS to any risk of inadvertent operation; and
   3. Provide a second projector and screen to display the HMI Operator Workstation to all participants.

PART 3 EXECUTION

3.1 HARDWARE INSTALLATION

A. Install Operator Workstations in control rooms as shown on the drawings.
   1. Install computer, monitor, mouse, mouse pad, and keyboard on the operator desk within the control room.
   2. Install external power supplies below or behind the operator desk within the control room.
   3. Connect network cabling,
   4. Organize cabling in a neat and tidy fashion. Utilize tie-wraps to group and organize cabling.

B. Upon completed installation of HMI servers, HMI terminal servers, and historian, test the operation of the HMI runtime client and ancillary applications. Correct any and all deficiencies, including but not limited to those identified by the Contract Administrator, to provide a properly operating operator workstation.

END OF SECTION

SECTION 40 95 53

NETWORK EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in Section 40 90 00, Instrumentation and Control for Process Systems 1.2 and this section

B. Comply with latest revision of following standards that may be applicable in this section:
   1. Institute of Electrical and Electronics Engineers (IEEE).
      a. IEEE 802.1X, Port Based Network Access Control
      b. IEEE 802.1Q, Bridges and Bridged Networks
      c. IEEE 802.1s, Multiple Spanning Trees
      d. IEEE 802.1w, Rapid Configuration
      e. IEEE 802.3u, 100BASE-TX, 100BASE-FX Ethernet at 100 Mbit/s
      f. IEEE 802.3z, 1000BASE-X Gbit/s Ethernet over Fibre Optic
      g. IEEE 802,3ab, 1000BASE-T Gbit/s Ethernet over twisted pair
      h. IEEE 802.3az, Energy Efficient Ethernet
      i. IEEE 802,3x, Flow Control

1.2 SUBMITTALS

A. Submit product data in accordance with Section 01 33 00, Submittal Procedures.

PART 2 PRODUCTS

2.1 ETHERNET SWITCH – CONTROL, SERVER, AND SUPERVISORY NETWORKS

A. Requirements:
   1. Input voltage: 24 VDC, redundant dual inputs.
   2. Ethernet Ports:
      a. 10/100/1000 BaseT(X), quantity as indicated on the drawings,
      b. 100/1000 BaseSFP, quantity as indicated on the drawings,
   3. SFP modules:
      a. 1000Base SX, LC Connector, 0.5 km, minimum of three per switch, or as indicated on the drawings,
   4. Console port: USB
   5. Supported protocols:
      a. IGMPv1/v2/v3,
      b. GMRP,
      c. GVRP,
      d. SNMPv1/v2c/v3,
      e. DHCP Server/Client,
      f. DHCP Option 66/67/82,

g. BootP,
h. TFTP,
i. SNTP,
j. SMTP,
k. RARP,
l. RMON,
m. HTTP,
n. HTTPS,
o. Telnet,
p. SSH,
q. Syslog,
r. EtherNet/IP,
s. PROFINET,
t. Modbus/TCP,
u. SNMP Inform,
v. LLDP,
w. IEEE 1588 PTPv2,
x. IPv6,
y. NTP Server/Client.

6. Broadcast storm protection
7. Support for Port Trunking
8. Fanless design
9. DIN rail mount
10. Alarm relay dry contact: 1 A @ 24 VDC
11. IEEE 802.3x for Flow Control
12. Configuration via Web Browser
13. Operating temperature range: -10 to 60 degrees C
14. Ambient Relative Humidity range: 5 to 95 percent (non-condensing)
15. Enclosure: metal, IP30 protection.

B. Manufacturer and Model:
1. Moxa EDS-G512E-4GSFP with a minimum of threeSFP-1GSXLC modules per switch,
2. Moxa EDS-G516E-4GSFP with a minimum of three SFP-1GSXLC modules per switch,
3. Or approved equal in accordance with B8.

2.2 DUAL RING ETHERNET SWITCH (DRS) – DEVICE NETWORK

A. This product was standardized by the City via RFP 756-2013.

B. All requests for purchase or quotation shall reference RFP 756-2013 to receive standardized pricing that the City has negotiated with the vendor.

C. Manufacturer and Model:
1. Schneider Electric ConneXium TCSESM083F23F1for 8TX or TCSESM063F2CU1 for 6TX / 6FX multimode as shown on the drawings
2. No alternates or substitutes will be accepted.

2.3 ETHERNET SWITCH, UNMANAGED

A. Requirements:
   1. Input voltage: 24 VDC, redundant dual inputs.
   2. Ethernet Ports:
      a. 10/100/1000 BaseT(X), quantity as indicated on the drawings,
      b. 100/1000 BaseSFP slot, quantity as indicated on the drawings,
   3. Supported Standards:
      a. IEEE 802.3
      b. IEEE 802.3u
      c. IEEE 802.3ab
      d. IEEE 802.3z
      e. IEEE 802.3x
      f. IEEE 802.3az
   4. DIN rail mount
   5. Alarm Relay Contact: 1 A @ 24 VDC
   6. Operating temperature range: -10 to 60 degrees C
   7. Ambient Relative Humidity range: 5 to 95 percent (non-condensing)
   8. Enclosure: metal, IP30 protection.

B. Manufacturer and Model:
   1. Moxa EDS-G205-1GTXSFP,
   2. Or approved equal in accordance with B8.

2.4 LAYER 3 SWITCH

A. Requirements:
   1. Standalone
   2. Layer 3 IP services feature set. IP routing and full DHCP server.
   3. Support for IEEE 802.1D-2004 for Spanning Tree Protocol
   4. Support for IEEE 802.1w for Rapid STP
   5. Support for IEEE 802.1s for Multiple Spanning Tree Protocol
   6. 1 RU, rack mount kit RACK-KIT-T1 or approved equal in accordance with B8
   7. 120 VAC Dual power supply PWR-C2-250WAC or approved equal in accordance with B8, and fan FAN-T1 or approved equal in accordance with B8
   8. 2 North America power cords CAB-TA-NA or approved equal in accordance with B8
   9. Ethernet Ports:
      a. 10/100/1000 BaseT(X), 24 ports
      b. 100/1000 BaseSFP, 4 ports,

B. Manufacturer and Model
   1. Cisco WS-C3650-24TS-E
   2. Or approved equal in accordance with B8

2.5 WIRELESS NETWORK ACCESS POINT

A. Requirements:
   1. Dual band
   2. 802.11a/b/g/n/ac Wi-Fi standards

3. 802.11i, Wi-Fi Protected Access 2 (WPA2)
4. RSS-102 Compliant. Radio Frequency Exposure Compliance of Radio communication Apparatus
5. RSS-210 Compliant. Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
6. Ceiling or wall mounting options
7. Standalone deployment
8. Indoor access point
9. POE

B. Manufacturer and Model:
1. Cisco 1832i
2. Or approved equal in accordance with B8.

2.6 FIREWALL, NAT AND VPN ROUTER

A. Requirements:
1. ISA99 , IEC 62443 and NERC CIP compliant
2. Firewall/NAT/VPN/Router all-in-one
3. Stateful firewall and PacketGuard industrial protocol inspection
4. 2 Wide Area Network (WAN) ports
5. 1 Demilitarized zone (DMZ) port
6. 1 Local Area Network (LAN) port
   Virtual Private Networking (VPN) with IPSec (Server & Client Mode)
7. Protocols: SNMPv1/v2/v3, DHCP,TFTP,NTP.HTTP,HTTPS,Telnet,SSH,Syslog,SMTP,LLDP,PPPoE,DNS,QoS,VRRP
8. Alarm relay dry contact
9. Configuration via Web Browser
10. NAT: N-to-1, 1-to-1, and port forwarding
11. VPN: IPSec (client/server), L2TP (server), PPTP (client), Max. 100 tunnels
12. Encryption: DES, 3DES, AES-128/192/256
13. Authentication: Pre-shared key (PSK), X.509v3 certificates, MD5, SHA
14. Firewall:
    a. Stateful inspection
    b. Filter: IP and MAC address, ports, ICMP, DDoS, Ethernet Protocols
    c. Bridge mode firewall
    d. Deep Packet Inspection on Modbus TCP
15. Data Throughput: 300 Mbps (40000 fps)
16. VPN Throughput (AES-256, SHA-256): 150 Mbps

B. Manufacturer and Model
1. Moxa EDR-G903 Industrial secure router with Firewall/NAT/VPN
2. Or approved equal in accordance with B8

2.7 WALL MOUNT ADMIN NETWORKING PANELS

A. General Requirements
1. Industrial Wall mount with hinged body for rear access

2. Lexan-windowed door
3. Vertical cable management
4. Built-in 19” EIA standard 10-32 tapped mounting angles
5. Pad-lockable doors standard
6. Reversible swing with replacement hinges.
7. Acceptable U-Space: 21U to 23U

B. Standard of Acceptance
1. Cable Talk CTCWH-4428-DDSO-B

2.8 SPARE COMPONENTS

A. Provide the following spare components:
1. One 20 Port Ethernet Switch – Control, Server, and Supervisory Networks
2. One 16 Port Ethernet Switch – Control, Server, and Supervisory Networks
3. One Unmanaged Ethernet Switch,
4. One Dual Ring Ethernet Switch (DRS)

PART 3 EXECUTION

3.1 TESTING

A. Refer to Section 40 99 91 and 40 99 93 for FAT, SIFT, SAT and SIT procedures.

B. The installation will not be considered complete if there are errors even if communication is occurring.

3.2 CITY TRAINING

A. General:
1. Provide an integrated training program for the City's personnel.
2. Perform training to meet specific needs of the City's personnel.
3. Provide a detailed training manual covering all aspects of the training provided.
4. Include training sessions, classroom and field, for maintenance personnel.
5. Provide instruction on all working shift(s) as needed to accommodate the CIty's personnel schedule.
6. The City reserves the right to make and reuse recordings of all training sessions.

B. Networking:
1. Provide a minimum of 2 sessions of 2 day duration for training at the Site indicated by the City for personnel in the maintenance of the control system network
2. Topics to include, but not be limited to:
a. Network Architecture overview
b. Network Switch setup and maintenance
c. Troubleshooting

END OF SECTION

SECTION 40 95 74

AUTOMATION JUNCTION BOXES

PART 1 GENERAL

1.1 SUMMARY

A. All Junction Boxes shall be factory assembled and pre-wired. The Junction Box wiring shall be verified at the manufacturer's factory before being shipped to the site.

B. Supply, install, wire and test all components inside the Control Panels according to the specifications herein and the drawings.

1.2 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced in Section 40 90 00, Instrumentation and Control for Process Systems 1.2 and this section.

B. The following is a list of standards which may be applicable in this section:
   1. Canadian Standards Association (CSA).
      a. CSA C22.1-12, Canadian Electrical Code, Part I - Safety Standard for Electrical Installations.
      b. CSA C22.2 No. 14-13, Industrial control equipment.
      c. CSA C22.2 94.1, Enclosures for electrical equipment, non-environmental considerations.
      d. CSA C22.2 94.2, Enclosures for electrical equipment, environmental considerations.
   2. Underwriters Laboratories of Canada (cUL).
      a. cUL 508A, Industrial Control Panels
   3. German Institute for Standardization (DIN).
      a. VDE 0611: Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
   4. National Electrical Manufacturers Association (NEMA).

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01 33 00, Submittal Procedures.

B. Prior to construction:
   1. Submit product data sheets, and wait for approval, prior to construction of the Control Panels.
   2. Submit stamped red-line mark-ups of the proposed modifications to the control panels. If significant modifications are proposed/required, AutoCAD drawings will be supplied to the Contractor for revision.

C. Prior to shipment:
   1. Submit electronic pictures for junction boxes that contain components besides terminals of enclosure exterior and interior, including door interior.
      a. Pictures to be of sufficient resolution to read component labels.
   2. As-built drawings:
      a. Submit as-built drawings. Minor changes may be made via red-line mark-ups.
      b. Draft significant changes on AutoCAD drawings.
   3. Do not ship control panel until approval from the Contract Administrator is received.

1.4 INSPECTION

A. A factory inspection of the junction boxes will be performed at the discretion of the Contract Administrator based upon the pre-shipment submittals.

B. If requested, demonstrate and test the junction box in presence of the Contract Administrator designated representative.

PART 2 PRODUCTS

2.1 GENERAL

A. Construction of the junction boxes is required in accordance with the supplied drawings.

B. Devices of each category shall be of the same type and manufacturer.

C. All automation junction boxes shall have terminals for wire connections, unless otherwise shown.

2.2 ENCLOSURES

A. Install lamacoids as per the layout drawings, with stainless steel screws.

B. Minimum NEMA ratings are as follow:
   1. For Mechanical Rooms, Electrical Rooms and Automation Rooms - NEMA 12
   2. For all other indoor process areas – NEMA 4
   3. In Category 2, Category 2 Wet locations, or outdoors –NEMA 4X

C. All enclosure angles and cut-outs shall be free of dents, gouges or weld marks, and shall present a clean, smooth appearance.

D. The exterior of the junction box shall be painted ANSI 61 grey.

E. Manufacturers:
   1. Hoffman
   2. Or approved equal in accordance with B8.

2.3 COMPONENTS

A. Unless written approval for use of unapproved components is received from the Contract Administrator, all electrical materials (e.g., conduit, fittings, wireways, etc.) shall be CSA or cUL approved.

B. Rails (DIN Rails)
   1. Rails used must be DIN Rail style TS 35mm, slotted.
   2. When used to mount terminals, rails shall be mounted on straight raisers (rail support / mounting feet) so as to raise them to the same height as the highest adjacent wiring duct.
   3. Raisers (rail support / mounting feet) shall not be used when rail hosts heavy components.

C. Terminals
   1. Quantity:
      a. Accommodate present and spare indicated needs.
      b. One wire per terminal for field wires entering/exiting enclosures.
      c. Maximum of 2 wires on each side of a terminal for internal enclosure wiring.
      d. Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.
   2. General:
      a. Connection Type: Screw compression clamp.
      b. Compression Clamp:
         1) Complies with DIN-VDE 0611.
         2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
         3) Guides strands of wire into terminal.
      c. Screws: Hardened steel, captive, and self-locking.
      d. Current Bar: Copper or treated brass.
      e. Insulation:
         1) Thermoplastic rated for minus 55 to plus 110 degree C.
         2) Two funneled shaped inputs to facilitate wire entry.
      f. Mounting:
         1) Standard DIN rail.
         2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
         3) End Stops: Minimum of one at each end of rail.
      g. Jumpers: Allow jumper installation without loss of space on terminal or rail.
      h. Marking System:
         1) Terminal number shown on both sides of terminal block.
         2) Allow use of preprinted and field marked tags.
         3) Terminal strip numbers shown on end stops.
         4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
         5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

i. Terminal blocks shall be designed for the size of the wires to be connected to them. Terminal blocks used for analog, digital, and power cables shall be identified and physically separated from each other.
j. Drawings and templates supplied may not detail all hardware components such as labels, stoppers, rail lifters, end plates, separators, etc. The supplier must supply and install such components when required.

3. Terminal Block Types:
   a. Control wiring
      1) General:
         a) Connection type: Screw connection.
         b) Mounting: NS 35 mm DIN rail.
         c) Approval: CSA.
      2) Manufacturer and Series:
         a) Phoenix Contact UT 4 and UTTB 4 series
         b) Or approved equal in accordance with B8
      3) Standard of Acceptance
         a) Terminal Block, Feed-through:
            (1) Rated Voltage: 600V ac.
            (2) Rated Current: 30 amp.
            (3) Wire Size: 26 to 10 AWG.
            (4) Color: Gray body.
            (5) Width: 6.2 mm.
            (6) Bridging: Plug-in bridge.
            (7) Standard of acceptance: Phoenix Contact 3046184.
         b) Terminal Block, Ground:
            (1) Wire Size: 26 to 10 AWG.
            (2) Color: Green and yellow body.
            (3) Width: 6.2mm.
            (4) Grounding: Electrically grounded to mounting rail.
            (5) Standard of acceptance: Phoenix Contact 3046207
         c) Terminal Block, Knife Disconnect:
            (1) Rated Voltage: 600V ac.
            (2) Rated Current: 16 amp.
            (3) Wire Size: 26 to 10 AWG.
            (4) Color: Gray body, orange switch.
            (5) Width: 6.2 mm.
            (6) Bridging: Plug-in bridge.
            (7) Standard of acceptance: Phoenix Contact 3046139.
         d) Terminal Block, Fused:
            (1) Rated Voltage: 600V ac.
            (2) Rated Current: 6.3 amp.
            (3) Wire Size: 26 to 10 AWG.
            (4) Color: Gray body.
            (5) Width: 6.2 mm.
            (6) Bridging: Plug-in bridge.
            (7) Fuse: 5 mm x 20 mm.
            (8) Standard of acceptance: Phoenix Contact 3046142, 3036806.

e) Terminal Block, Double Level, Fused:
   (1) Rated Voltage: 500V ac.
   (2) Rated Current: 6.3A.
   (3) Wire Size: 26 to 10 AWG.
   (4) Color: Gray.
   (5) Width: 6.2mm.
   (6) Bridging: Plug-in bridge.
   (7) Fuse: 5 mm x 20mm.
   (8) Standard of acceptance: Phoenix Contact 3044720, 3036806.

D. Ground Bus Bar
   1. Supply a ground bus bar in each junction box.
   2. Requirements:
      a. Tapped holes with screws,
      b. Bar to have sufficient connection points for all cables entering the control panel, plus 25 percent spare,
      c. Maximum one wire termination per screw,
   3. Manufacturers:
      a. ILSCO D167 series.

E. Wiring
   1. All analog signal wiring shall be 18 AWG shielded twisted pair.
      a. Shield wires exiting the jacket must be covered with a black heat shrink, and the overall cable at the jacket end must also be covered with a heat shrink.
      b. Approved Products:
         1) Belden No. 8760.
         2) Or approved equal in accordance with B8.
   2. All 24 VDC and 120 VAC discrete signal panel wiring shall be 16 AWG TEW stranded conductor with 300V, 105°C insulation.
   3. All 24 VDC and 120 VAC power wiring shall be 12 AWG minimum.
   4. The sizes and colours of wires shall be in accordance with the CSA and the Canadian Electrical Code.
   5. Provide wire barrel ferules for all wiring.

F. Wiring Duct
   1. All wires shall be run in narrow slot wiring duct, unless shown otherwise
      a. Approved Manufacturer:
         1) Panduit.
         2) Or approved equal in accordance with B8.
   2. Wiring Duct shall be installed on both sides of the panel and between the DIN rails.
   3. Wire or cable, connected to internal device or arriving from external device, shall be uncovered by Wiring Duct for a maximum of 10 cm.
   4. 120 VAC wires cannot share wiring duct with 10 VDC, 24 VDC or 4-20 mA wires, but can cross their path.
   5. All DC, AC, and low voltage signal wiring shall be routed in separate wireways to prevent signal interference.
   6. Wire ties shall be non-metallic.

PART 3 EXECUTION

3.1 GENERAL

A. Construct control panels in accordance with CSA C22.2 No. 14-13 or cUL 508A.

3.2 WIRING

A. Panel wiring shall be installed in a neat and orderly manner.

B. All conductors shall be securely fastened to terminals at both ends; no splices are allowed inside the panel.

C. No more than two (2) conductors may be terminated under each terminal screw. All internal panel conductors shall be connected to the same side of a terminal block, and external conductors to the other side. The only exception is for fused terminals which require connection to the field side for internal wiring.

D. All wires and cables inside the control panels shall be identified on both ends with non-erasable markers.

E. Identification shall follow the supplied documents, such as wiring diagrams.
   1. Label both ends of each wire.
   2. Utilize machine printed non-slip labels. Wrap-around or self-adhesive markers shall not be permitted.
   3. Wherever possible wire labels shall be positioned to be read from the panel opening without removal of wire duct covers or other wiring.

F. Individual conductors or wires exiting a cable shall be identified using non-erasable markers.

G. The routing of all analog, digital, and power cable wiring inside control panels shall be segregated as much as possible, in distinct wiring ducts, by the type of signal they are carrying. All wires shall be physically protected by wiring ducts with covers. The wiring ducts shall be of sufficient size to be filled to a maximum of 40 percent when all wires are inside.

H. Group and form wiring into a loop when going from a fixed part of the panel to a door such that there is sufficient slack to minimize strand fatigue and breaking. Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

I. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.

J. Connections to Screw Type Terminals:
   1. Locking-fork-tongue or ring-tongue lugs.
   2. Use manufacturer’s recommended tool with required sized anvil to make crimp lug terminations.
   3. Wires terminated in a crimp lug, maximum of one.

4. Lugs installed on a screw terminal, maximum of two.

K. Connections to Compression Clamp Type Terminals:
1. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
2. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.

L. The wiring arrangement shall not interfere with access to panel-mounted devices or spaces for future equipment.

M. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

3.3 GROUNDING

A. Firmly bond all panel-mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

3.4 COMPONENT INSTALLATION

A. Nameplates shall be made of lamacoid material with a white background and engraved black letters for internal and external components. Nameplates must resist harsh industrial conditions. Fasten lamacoids using stainless steel self-tapping screws.

B. Jumper bars shall be used instead of jumpers where possible.
1. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

3.5 IDENTIFICATION

A. Perform terminal identification using a computerized device. Handwriting is not acceptable.

B. Label terminals and wires as shown on drawings.

C. Install label above each terminal block with terminal block name.

END OF SECTION

SECTION 40 95 80

FIBRE OPTIC NETWORK

PART 1 GENERAL

1.1 REFERENCES

A. Comply with latest edition of the codes and standards applicable and/or referenced Section 40 90 00, Instrumentation and Control for Process Systems 1.2 and this section.

B. The following is a list of standards that may be applicable in this section:
   1. National Electrical Code (NEC) OFCR-LS; Sunlight Resistant (SUN RES).
   2. Institute of Electrical & Electronic Engineers, Inc.IEEE-383/IEEE-1202 flame test suitable for direct burial.
   3. Telecommunications Industry Association (TIA); Electronics Industry Association (EIA):
      a. 568, Commercial Building Telecommunications Cabling Standard.
      b. 569-D, Telecommunications Pathways and Spaces.
      c. 607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
   4. Canadian Standard Association (CSA):
      a. CSA C22.2 No.2556, Wire and cable test methods
      b. CSA C22.2 No. 230, Tray cables
      c. CSA C22.2 No. 232, Optical fiber cables
      d. CSA C22.2 No 262, Optical Fiber Cable and Communication Cable Raceway Systems
   5. American National Standard (ANSI/NETA)
      a. ANSI/NETA ATS, Standard For Acceptance Testing Specification for Electrical Power Equipment and Systems.

1.2 ABBREVIATIONS

A. dB decibel

B. EIA Electronic Industries Association

C. m meter

D. MHz megahertz

E. μ, micro x 10^{-6}

F. n, nano x 10^{-9}

1.3 SYSTEM DESCRIPTION

A. This section covers requirements for the Fibre Optic Network and is in addition to Section 40 90 21, Automation Wires and Cables.

B. Function of Fibre Optic Network is to transmit digital data between network nodes.

C. Provide a Fiber Optic Network based on referenced standards for use in the site automation networks.

1.4 SUBMITTALS

A. Action Submittals: Shop Drawings:
   1. Subsystem detail design documents:
      a. Bill of Materials for Fibre Optic Network Components: Component number, manufacturer, model number, component description, and quantity.
   2. Cable schedule showing:
      a. Cable identification.
      b. Fiber counts for each cable and identification of used fiber pairs.
      c. Cable length and attenuation and planned number of splices. Splices, if any, shall be minimized. Splices require Contract Administrator approval.
   3. Component Data:
      a. Manufacturer and model number.
      b. General data and description.
      c. Engineering specifications and data sheet.
      d. Scaled drawings and mounting arrangements.
      e. Power and grounding requirements.
      f. Electrical and optic interfaces.

B. Informational Submittals:
   1. Manufacturer's statement that installer is certified to perform installation Work.
   2. Subcontractor Qualifications:
      a. Fibre Optic Network Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
      b. Fibre Optic Network Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.
      c. Acceptance of Fibre Optic Network Subcontractor does not exempt Subcontractor or Contractor from meeting Contract requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.
   3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
   4. Manufacturer's suggested installation practice.
   5. Testing related submittals.
   6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data including the following:
      a. Updated versions of Hardware Shop Drawings Submittals.
      b. Component Manufacturers' O&M Manuals: Instructions for installation, operation, maintenance, and troubleshooting.
      c. List of spare parts provided.
      d. List of recommended additional spare parts.

C. Factory Test Reports:
   1. Copy of Ethernet cable installer's factory certified installation certificate. Certificate shall have the name of the person who completed the training course and that person shall supervise all cable installation and termination for compliance with manufacturer recommendations.
   2. Copy of fibre optic cable installer's factory certified installation certificate. Certificate shall have the name of the person who completed training course and that person shall supervise all cable installations and terminations for compliance with manufacturer recommendations.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Optical Fibre Cable and Cable Splice Centers:
   1. Outside, Underground/Submerged: Minus 20 to 40 degrees C.
   2. Outside, Overhead: Minus 40 to 80 degrees C.
   3. Outside, Aboveground in Conduit: Minus 40 to 75 degrees C.
   4. Inside: 0 to 40 degrees C.

B. Equipment:
   1. Outside, Aboveground: Minus 40 to 75 degrees C.
   2. Control Rooms, Equipment Rooms and Telecommunications Closets: 30 to 55 percent relative humidity, 18 to 24 degrees C.
   3. Other Interior Areas: 0 to 100 percent relative humidity, 5 to 35 degrees C.

PART 2 PRODUCTS

2.1 FIBRE OPTIC CABLE

A. Fibre Requirements:
   1. Multimode
   2. Comply with the standards on References section.
   3. Fiber Core Diameter: 50 µm
   4. Fiber Category: OM3
   5. Wavelengths: 850 nm / 1300 nm
   6. Maximum Attenuation: 3.0 dB/km / 1.0 db/km

B. Cable Requirements:
   1. Type: Loose Tube, double jacket, chemical resistant, non conductive
   2. Application: Aerial, Direct Buried, Duct, Tray Rated
   3. Flame Rating: LSZH (OFN-LS)
   4. Product Type: Dielectric
   5. Temperature Range(operation): Minus 50 to plus 75 degrees C
   6. Fiber Count: 36
   7. Fibers per Tube: 12
   8. Tape: Water-swellable
   9. Inner Jacket: FRNC/LSZH Material
   10. Tensile Strength Elements: Dielectric strength members
   11. Outer Jacket: FRNC/LSZH Material

12. Max. Tensile Strength, Short-Term: 4500 N
13. Max. Tensile Strength, Long-Term: 1500 N
14. Compressive Loading: 2400 N/cm
15. Impact Resistance: 11.8 N*m
16. Min. Bend Radius Installation: 264 mm
17. Min. Bend Radius Operation: 176 mm
18. Nominal Outer Diameter: 17.6 mm
19. Chemical Resistance: RoHS
20. Approvals: CSA FT-4-ST1

C. Manufacturer and Model:
1. Corning 036TUL-T3680D2M
2. Or approved equal in accordance with B8.

2.2 FIBRE OPTIC CONNECTOR HOUSING (WCH)

A. Function: The WCH Housing provides interconnect capabilities between plant areas. It is installed inside plant Network Cabinets.

B. Requirements:
1. Splice Cassette option: Up to 6 CCH Pigtailed Splice cassettes, 24F, LC Duplex, OM3, Single Fibre Splicing
2. Maximum Fibre Capacity: 144
3. Dimension: 35.8 cm X 42.2 cm X 14.5X cm
4. RoHS Compliant
5. Included Lock Kit with hardware

C. Manufacturer and Model Number:
1. Corning WCH-06P,
2. Corning CCHA-LOCK-KIT, and
3. Corning CCH-CS24-E4-P00TE, Splice Cassette
4. Or approved equal in accordance with B8.

2.3 FIBRE OPTIC ENVIRONMENTAL DISTRIBUTION CENTER (EDC)

A. Function: Protects fibre optic connection and splices in indoor and outdoor environment.

B. Requirements:
1. 6 or 12 CCH connector panels. Quantity as indicated on the drawings. No Holes
2. Wall Mountable, NEMA 4X
3. Included Connector Housing Panel (CCH), LC Duplex,12 F, OM4
4. Included NEMA 4 Rated Conduit Fitting for 2 inch conduit
5. Splice Technology: Fusion Splice
6. Splice Protectors Type: Heat-Shrink
7. Splice Tray: Standard with organizers for heat-shrink fusion splice protectors. Quantity as indicated on the drawings
8. Splice Tray Capacity: 24 Splices

C. Manufacturer and Model:
   1. Corning EDC-6P-NH, EDC-12P-NH
   2. Corning CCH-CP12-E4-P03SH Connector Panel (CCH)
   3. Corning EDC-2N4-KIT Conduit Fitting
   4. Corning, M67-078 Splice Tray
   5. Or approved equal in accordance with B8.

2.4 FUSION SPLICE PROTECTOR

A. Heat shrinkable splice protects the fusion splice on fibers securely.

B. Requirements:
   1. Multifibre or single fibre Sleeve, 40 or 60 mm length.
   2. Fiber Diameter: 250 or 900 µm
   3. Heating Time: 64 Sec. for single fibre sleeve and 80 sec. for multi fibre sleeve.

C. Manufacturer and Model Number:
   1. Corning, 2806031-01
   2. Or approved equal according to B8.

2.5 PATCH CABLES

A. In accordance with requirements of EIT/EIA 568, section 12.5

B. Features:
   1. Low Loss,
   2. 2 fibres, LC duplex to LC duplex,
   3. 50 µm Multimode(OM3),
   4. Wavelengths: 850 nm / 1300 nm
   5. Zip Cord Tight buffered cable,
   6. Riser, 2.0 mm legs.
   7. Insertion loss, typical: 0.1 dB
   8. Insertion loss, max.: 0.15 dB
   9. Outer jacket material: LSZH/FRNC

C. Manufacturer:
   1. Corning E050502T5120001M and E050502T5120003M for 1, 2 and 3 meters
   2. Or approved equal in accordance with B8.

PART 3 EXECUTION

3.1 INSTALLATION

A. Coordinate network cable installation with contractor's and City's activities at site.

B. Install all network cabling in conduit or duct as indicated. Size conduit for the number of cable contained and observe the cable manufacturers recommended bending radius.

C. Rod and swab out existing ducts prior to installing new cables. Inspect existing raceways and boxes for allowable bending radius prior to installing cable and notify the Contract Administrator of any condition which would prevent the proper installation of the cable.

D. Install cable without splices between network components.

E. Follow manufacturer's installation practices.

3.2 CONDUIT SYSTEM

A. Ensure that installed conduit system conforms with fibre optic system requirements, including:
   1. Conduit size and number.
   2. Access Holes and Pull Boxes: Location and size, to ensure cables can be installed without exceeding manufacturer's limitations.
   3. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.

B. Expansion Plugs: Seal conduits to stop ingress of water and grit with fabricated expansion plugs.

3.3 FIBRE OPTIC CABLE

A. Installation by manufacturer certified installer.

B. Install cables in accordance with manufacturer's requirements.

C. Install cable directly from shipping reels. Ensure that cable is not:
   1. Dented, nicked, or kinked.
   2. Subjected to pull stress greater, or bend radius less, than manufacturer's specification.
   3. Subjected to treatment that may damage fibre strands during installation.

D. Cables Per Conduit: One cable maximum

E. If the link loss calculation indicates that the total cable system attenuation equals or exceeds the total link loss budget, rerouting may be allowed, if approved by Contract Administrator.

F. Splices: Install fibre optic cables in unspliced lengths between fibre centers.

G. Identification: Identify cable on both ends and in access holes and pull points it goes through. Identify with tags in accordance with Division 16. Use water proof tags.

H. Sealing: Seal cables to stop ingress of water and grit with fabricated expansion plugs.

I. Access Holes:
   1. Provide supports for cables in access and hand holes at minimum 600 mm centres along sides.
   2. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

3.4 FIELD QUALITY CONTROL

A. Test components of installation in accordance with standards and specifications.

B. Provide equipment, instrumentation, supplies and skilled staff necessary to perform testing.

C. Advise Contract Administrator at least 48 hours in advance of each test. Contract Administrator shall have option to witness and participate actively in tests.

D. Document test results of each cable to confirm that at least specified number of fibres meet standards.

E. Document results of repeater and transceiver tests.

3.5 TESTS AND INSPECTION

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup

B. Conduit:
   1. Testing and Sealing of Spare Conduits.
   2. Conduit Testing:
      a. Blow full-diameter mouse through each spare conduit to verify they are unrestricted over full length.
      b. If any conduit is not unrestricted over full length, advise Contract Administrator.
   3. Documentation: Confirm that conduit test As-Built Conduit

C. Cable Inspection:
   1. Compare cable, connector, and splice data with drawings and specifications.
   2. Inspect cable and connections for physical and mechanical damage.
   3. Clean fibre connectors with specialty formulated cleaning solution if required, Follow cleaning kit manufacturer's instruction.

D. Cable Testing:
   1. Field test all fibres for end to end attenuation of an installed link as per TIA-568-C.0Test all spare fibres from patch panel to patch panel.
   2. The total link attenuation shall be less than is corresponding networking equipment loss budget.
   3. All tests shall be bi-directional.
   4. Perform cable length measurement, fibre fracture inspection and construction defect inspection using an Optical Time Domain Reflectometer (OTDR). The OTDR signal shall be analyzed for excessive connection, splice or cable backscatter by viewing the reflected power/distance graph.
   5. Perform connector and splice integrity test using an OTDR. The OTDR signal shall be analyzed for excessive connection, splice or cable backscatter by viewing the reflected power/distance graph.
   6. Perform cable attenuation loss measurement with an optical power loss test set. Attenuation loss, of each fibre, in dB/km shall be within manufacturer's recommendation.

7. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set. Attenuation loss in shall be within manufacturer's recommendation.
8. Until requirements are met, replace and retest all cables that do not have specified number of fibres that meet attenuation standards. The installation will not be considered complete until all requirements are met in all fibres even if communication is occurring.

END OF SECTION

SECTION 40 96 00

APPLICATIONS SOFTWARE

PART 1 GENERAL

1.1 GENERAL

A. Work Includes but is not limited to:
   1. Designing, engineering, furnishing, testing, system startup, debugging and troubleshooting, documenting, training and starting up the complete Process Instrumentation and Control System (PICS) Applications Software.
   2. Gain a comprehensive understanding of the behavior of the process, the process equipment, and the instrumentation systems. Supply the design of all aspects of software architecture, code, and databases compatible with the process and associated equipment.
   3. Set up, configure, and program all hardware and software programs, databases, and environments in the systems and networks for a fully functional and operable Process Instrumentation and Control System (PICS). All programming modifications required to the PLC and HMI program over the course of commissioning to be included in the bid price.
   4. Modifying, tuning, and refining of the software components to ensure that the collective system runs correctly, smoothly, and efficiently. The collective system refers to:
      a. Process behavior including response over time.
      b. Process equipment and devices which affect and effect operation.
      c. Interface equipment and devices which connect active parts of the operation to passive parts.
      d. Operator and maintenance workstations and displays.
      e. PLC, HMI and network hardware and software.
      f. Bus communications (Profibus, Modbus/TCP, DNP3, Ethernet/IP, etc) hardware and software.
      g. Loops connected to the control system.
   5. Provide temporary programming of PLC and HMI systems for the phasing of the work required by the commissioning sequence. See the commissioning plan for details.
   6. Integrate software and screens provided as part of Package Control Systems for mechanical equipment, into a seamless, functional system.
   7. Integrate control and monitoring points of third party equipment into a seamless, functional system. When defined in the mechanical packaged system specification, provide redundant communications from the Package Control System to the Plant Control Network using two Ethernet connections with different subnets.
   8. Integrate control and monitoring points of existing equipment into a seamless, functional system. See A-0102-AELI-A021in Appendix W for existing signals to integrate.
   9. Integrate control and monitoring points of interim existing equipment. See A-0102-AELI-A022 in Appendix W for interim existing signals to integrate.
   10. When defined in the mechanical packaged system specification (e.g. Turboblower master controller, Polymer mixing systems, UV reactors, RDT systems and Biofilter system), provide HMI screens that full replicate the third party packaged control system's HMI.

Coordinate with the packaged control system to provide full HMI replication. Provide a means for operators to select either the local OIT or the Plant HMI as the active system.

11. Major items include but not be limited to:
    a. Work Sequence and Schedule.
    b. Workshops.
    c. Submittals.
    d. Software development.
    e. Testing.
    f. Installation.
    g. O&M manual development
    h. City Training.
    i. Startup.

B. Comply with the following City of Winnipeg Standards documents:
    1. Identification Standard 510276-0000-40ER-0002
    2. Tagname Identification Standard 612620-0014-40ER-0001
    3. HMI Layout and Animation Plan 612620-0015-40ER-0001
    4. Historical Data Retention Standard 612620-0016-40ER-0001

C. Environment Set-Up:
    1. Set up all hardware and software environments in the systems and networks.
    2. Hardware to Include: PLCs, computers, peripheral equipment, terminals, alarm notification, communications devices, and networks.
    3. Environments to include, but not be limited to:
        a. Dip switches, and jumpers.
        b. Operating Systems.
        c. Shells, Windows, Executives.
        d. Software Drivers.
        e. Utilities.
        f. Network support and management.
        g. Partitioning and utilization of peripheral memory, main RAM and additional RAM.
        h. Equipment initializations.

1.2 DEFINITIONS

A. Abbreviations:
    1. HMI: Human Machine Interface (e.g. Vijeo Citect).
    2. FAT: Factory Acceptance Test
    3. SIFT: System Integration Function Test
    4. SAT: Site Acceptance Test
    5. SIT: Site Integration Test
    6. PLC: Programmable Logic Controller
    7. PICS: Process Instrumentation and Control System
    8. FRS: Functional Requirement Specification

B. Software:
    1. Programming of digital devices using all types of programming language.
    2. Configuring of digital devices using all types of configuring process.

3. Programs or configuration data stored in read only memory, programmable read only memory, read/write memory, CD or other storage device.

C. Types of Software:
1. Standard Software: Software packages that are independent of project on which they are used. Standard software includes system software and process monitoring and control software.
2. System Software: Application independent software developed by Microsoft. Includes, but is not limited to, Microsoft's Windows or Windows Server operating system; file management utilities; text editors; debugging aids; and diagnostics.
3. Process Monitoring and Control Software (PMCS): Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing capability for, SCADA, data acquisition, monitoring, alarming, Human-machine interface, data collection, data retrieval, trending, report generation, control, and diagnostics.
4. Process Simulation Software: Software used for testing and training purposes prior to the commissioning of the control system.

D. Application Software:
1. Software to provide functions unique to this Project and that are not provided by standard software alone.
2. Configuring databases, tables, displays, reports, parameter lists, PLC programs, HMI programs, and control strategies required to implement functions unique to this Project.

1.3 APPROVED MANUFACTURER

A. The City has standardized on Schneider Electric Inc. for all control system equipment and programming software via Request For Proposal 756-2013. All questions, requests for quotations and purchasing shall be addressed to them. Contact information is as follows:

Schneider Electric Inc.
Omand Creek Blvd
Winnipeg, MB R2R 2V2

B. All requests for purchase or quotation shall reference RFP 756-2013 to receive standardized pricing that the City has negotiated with the vendor.

1.4 WORK SEQUENCE AND SCHEDULE

A. General: All work provided under this section shall be in accordance with a Milestone Breakdown and System Delivery Plan.

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

C. System Delivery Plan (SDP):
1. The intent of the SDP is to:
a. Coordinate and communicate applications software design and testing activities.
b. Coordinate interactions with the Contract Administrator regarding workshops, submittal reviews, contractor(s) progress, test witnessing, training, etc.

c. Communicate and clarify required work sequences and major milestone.

2. Minimum Content:
   a. Work Sequence and Schedule.
   b. Applications Software workshops.
   c. Applications Software Submittals.
   d. Applications software development.
   e. Software Testing.
   f. Software Installation.
   g. O&M development.
   h. City Training.
   i. Startup.

1.5 SOFTWARE DESIGN WORKSHOPS

A. Location: City's facility during the course of the project.

B. Objective: To provide a vehicle for the Contract Administrator to oversee the applications software development.

C. Documentation: Contractor summarizes resolutions reached in each workshop, including schedule impacts and distributes copies to the Contract Administrator.

D. Order and minimum topics to be covered in each Software Design Workshop.
   1. Applications Software Design Workshop (kick off) that establishes project processes, including:
      a. Contractor organization and reporting procedures.
      b. Software System Overview: Written overview description of each major software package. Programming language or configuration method to be used for each different type of application.
      c. Workshop objectives.
      d. Submittal process.
      e. Review Work Sequence and schedule.
   2. Functional Requirement Specifications (FRS) and P&ID Review Workshop:
      a. Contractor use P&IDs and FRS to present how the proposed control system design and Application Software will meet the functional requirements specified herein and in the FRS documents.
   3. The City of Winnipeg HMI Layout and Animation Plan Review workshop:
      a. Contractor will use the HMI Layout and Animation Plan document and FRS to present how the proposed HMI Application Software will meet the functional requirements specified in the City of Winnipeg HMI document and FRS documents. The Contractor may propose, discuss, and explain alternative methods, styles, hierarchy, modules, enhancements, refinements, and other considerations.
   4. Plant Process Reporting Workshop:
      a. Objective: To develop and document the number and types of reports.
      b. Identify and define each type of Process report including, but not limited to:
         1) Daily Flow and energy totals
         2) Weekly Flow and energy totals
         3) Monthly flow and energy totals

4) Yearly flow and energy totals

5. Pre-software development Workshops:
   a. Objective: To present to the Contract Administrator how the Contractor will implement functional requirements of this Section and FRS.
   b. Present information on:
      1) Program Tasks, Software Sections, Subroutines, Function Blocks, and their interrelationships.
      2) HMI/PLC I/O Database listing.
      3) Memory Allocations: Tables showing breakdown of relative percentages of CPU and memory required, including spare.
      4) HMI Screen sketches that illustrate dynamic objects, how control functions are controlled and monitored, how equipment is controlled and HMI screen navigation.

1.6 SUBMITTALS

A. Informational Submittals
   1. Applications Software Schedule of Values and Progress Schedule
      a. Submit within 30 days after first Preconstruction Conference.
      b. Upon acceptance by Contract Administrator, shall form basis and schedule of Submittal reviews, test witnessing, and partial payments.
      c. Prior to this acceptance, Contract Administrator will not review Submittals, witness tests, or consider requests for partial payment.
   2. City Training Plan: In accordance with Section 01 79 00, Demonstration and Training.

B. Shop Drawings for Applications Software Design and Development:
   1. Outline of applications software to be developed.
      a. Timing: before the initial (kick–off) Workshop.
      b. Content: An overview description of each major software package and programming language or configuration method to be used for each different type of application.
   2. PLC Software Standards Submittals:
      a. Developed in a Software Workshop.
      b. Documented and Submitted as PLC software standards.
   3. HMI Standards Submittal:
      a. Review and develop HMI standards in a participative workshop with the Contract Administrator.
      b. Content:
         1) Report Formats: For each report required for this Project:
            a) Name of program used to configure report.
            b) Page number references to user’s manual(s) that describe these programs.
            c) Examples of typical reports provided on other projects.
         2) Alarm/Status Printer Format: Examples of alarm/status printer output formats used on previous projects.
         3) Historical Trend Display Format Examples:
            a) Short-term trends (less than 24 hours).
            b) Long-term trends (several days and several months).
      c. Documented and Submitted as HMI software standards.

4. Pre-software Development Submittal: Updated version of material presented in Pre-software Development workshops.
5. Third Party Interface List Submittals:
   a. Submit a Third Party Interface List for each process area for all signals from third party devices. See sample list A-0102-AELI-A020 in Appendix W. Use this document as a template for each process area submittal.
   b. The list submitted should include all signals available from the equipment included. The Contractor shall identify in the list the signals to be included in the application development. The Contractor will submit the list to the Contract Administrator for review.
   c. This list shall include, but not be limited to:
      1) Packaged Control Systems connected to the control system network
      2) Electrical equipment monitored over the control system network (UPS, power meters, switchgear, etc.)
      3) Automation equipment monitored over the control system network (Gas detection controllers, network connected instruments, etc.)
6. Software Design Submittal:
   a. Stage 1
      1) Submit a HMI and PLC design criteria prior to initiating programming which includes:
         a) The general PLC function blocks from the general FRS
         b) The general PLC program structure.
         c) PLC memory map in broad categories (address ranges).
         d) The programming languages to be utilized.
         e) HMI Layout and animation criteria
   b. Stage 2
      1) Submit a 25 percent complete submittal, including Software Logic and HMI screens in pdf and native format.
      2) Third party interface list in excel and pdf format.
      3) The primary purpose of this submittal is to ensure that the methodology being utilized is as per requirements prior to bulk portion of work being completed. At this point, copies of code for similar pieces of equipment should not be completed.
   c. Stage 3
      1) Submit a 99 percent complete submittal a minimum of 20 working days prior to the FAT, including:
         a) Complete software logic and HMI screens in pdf and native format.
         b) PLC database and HMI interface data map in excel and pdf format.
         c) Third party interface list in excel and pdf format.
         d) FAT and SIFT procedure (see Section 40 99 91, FAT and SIFT Procedures for requirements).

C. Information Control Submittals:
   1. Testing related submittals:
      a. Suggested Startup Procedures.
      b. Training material.
      c. Test Procedures: Conduct tests using test procedures, forms, and checklists approved by the Contract Administrator.

d. Test Documentation: Copy of signed of test procedures when tests are completed.

2. Operations and Maintenance Manuals:
   a. In accordance with Section 01 78 23, Operations and Maintenance Data, unless otherwise specified in this section.
   b. User's manuals for Software packages in electronic format.
   c. Licensed copies of Software packages.
   d. Updated versions of material provided under Shop Drawing Submittals for Applications Software Design and Development.
   e. Initial values for database parameters–PMCS Error List:
      1) An alphabetical listing of all error, warning, and alarm messages logged by PMCS, except for process alarms.
      2) For each message, list message, description of condition, brief description of operator action required, and reference to manual covering condition.
   f. Complete systems generation data.
   g. Applications Software Source Files: One copy of fully commented program listings for high level language programs/documented Function Block Diagrams and source configuration data created for this Project. Include I/O databases, forms, queries, reports.
   h. System Programmer Operating Instructions: System operating procedures including system generation, system loading, and startup.
   i. System Operator Instructions: Computer operations procedures including system restarts, power failure and recovery, report generation, disk backup and reload, manual data entry, plot generation, and general troubleshooting.
   j. Process Operator Instructions: Operator oriented procedures for operators HMIs,
   k. Third Party Software: For system software that is not a product of the Contractor or his Subcontractors, include manufacturer's original disks and manuals with hardware shipments.

1.7 TUNING

A. Attain optimum system response and performance by tuning hardware and software components. Include the following:
   1. Poll block frequency and phasing.
   2. Point scan frequency.
   3. Trend scan frequency.
   4. Modbus RTU/TCP, LAN
   5. Profibus DP/PA
   6. Page change linkage.
   7. Regrouping of PLC points and files to optimize the quantity of blocks transmitted to process computers.
   8. Elimination of network transmission errors and time-out occurrences.

B. Optimize PLC, PC, and network software to impose minimum loads on the equipment, with the following priorities:
   1. Minimal network traffic.
   2. PC processing.
   3. PLC processing.
   4. Network processing.

1.8 SOFTWARE REPAIRS

A. When on-site commissioning and integration has begun, supply continuous services to effect startup, fine tuning, and removal of deficiencies in the software or data. Complete the integration and repairs within 1 month or less. If at the end of 1 month the software is not completely correct, then repair services may be provided by the Contract Administrator or an agent designated by the City and the actual cost incurred may be deducted from the Lump Sum Contract Price.

1.9 TEMPORARY PROGRAMMING REQUIREMENTS

A. See Specification Section 01 50 00, Temporary Facilities and Controls for temporary programming requirements.

PART 2 PRODUCTS

2.1 PLC APPLICATION SOFTWARE DESIGN CRITERIA

A. PLC Software
   1. Manufacturer and Model:
      a. Schneider UnityPro - latest version
      b. This product was standardized by the City via RFP 756-2013. No alternates or substitutes will be accepted.

B. PLC Program Design:
   1. The programmable logic controller system (PLC) provides facility automatic control, alarm functions (annunciator), and continuous loop control. All PLC functional requirements are described in FRS documents.
   2. Programming Language shall be Function Block, unless otherwise approved by the Contract Administrator.
   3. No control routines, control algorithms, or control logic shall be implemented in the HMI.
   4. Implement all control logic in the plant PLC(s).
   5. Format PLC page structure and function block layout to allow for correctly formatted printing on letter size paper.
   6. Perform necessary inversions on inputs and outputs only once using input and output conditioning routines with only one use of the actual input or output addressed tag and use the conditioned tag elsewhere in the program.
   7. Break PLC applications software into:
      a. Sections:
         1) Contains all logic for a specific unit operation.
         2) Each section consists of a general logic sub sections and, followed by unit operation sub sections.
      b. Sub-Sections:
         1) Contains logic for specific equipment or logic such as a pump, valve or loop.
      c. Time Event and I/O Event Tasks:
         1) These Tasks are used to reduce the response time of application program to events coming from I/O modules or from event timers.

d. Do not use indirect addressing without Contract Administrator approval
e. Functional blocks:
1) Building block for pumps, valves, loop control, analog processing, alarm switches, etc.
2) Requirements for standard HMI/PLC function blocks to be provided are specified in the Functional Requirement Specifications (FRS).

8. File Naming Convention
a. Files shall be named as per the City of Winnipeg Identification Standard 510276-0000-40ER-0002.

C. PLC Program Documentation:
1. Requirements:
a. General Information including comments on the project, hyper-links and/or bitmaps.
b. Configuration including Bus topology, Bus parameters, PLC and rack configuration, parameterization of the input/output modules and the communication modules.
c. Data types including name of the data structure and their elements, data structure types and data structure comments.
d. Function Block types including, names, description, properties of in/output variables, name of the program section, section comment, section code and etc.
e. Function Block variables and instances,
f. Application structure,
g. Communication including network communication parameters,
h. The program including Tasks, Events, and program Sections (logic),
i. Animation table including list of variables, the values, data types and comments,
j. Operator Screen,
k. Cross-references including addresses, function block variables and instances, function block objects and subroutines.

D. Standard PLC/HMI Function Blocks
1. Refer to Document A-0102-AFRS-A001 for standard function blocks.

2.2 HMI APPLICATION SOFTWARE DESIGN REQUIREMENTS

A. HMI Software
1. Provide the following servers software as part each SCADA server package:
a. I/O Server
b. Report Server
c. Alarm Server
d. Trend Server
e. OPC Server
f. OPC Factory Server (OFS)
g. OFSOPC Driver
h. Modbus TCP/RTU Driver
i. DNP3 Driver
j. Ethernet IP Driver
k. Other I/O Drivers as required
2. Manufacturer and Model:
a. Schneider CitectSCADA - latest version

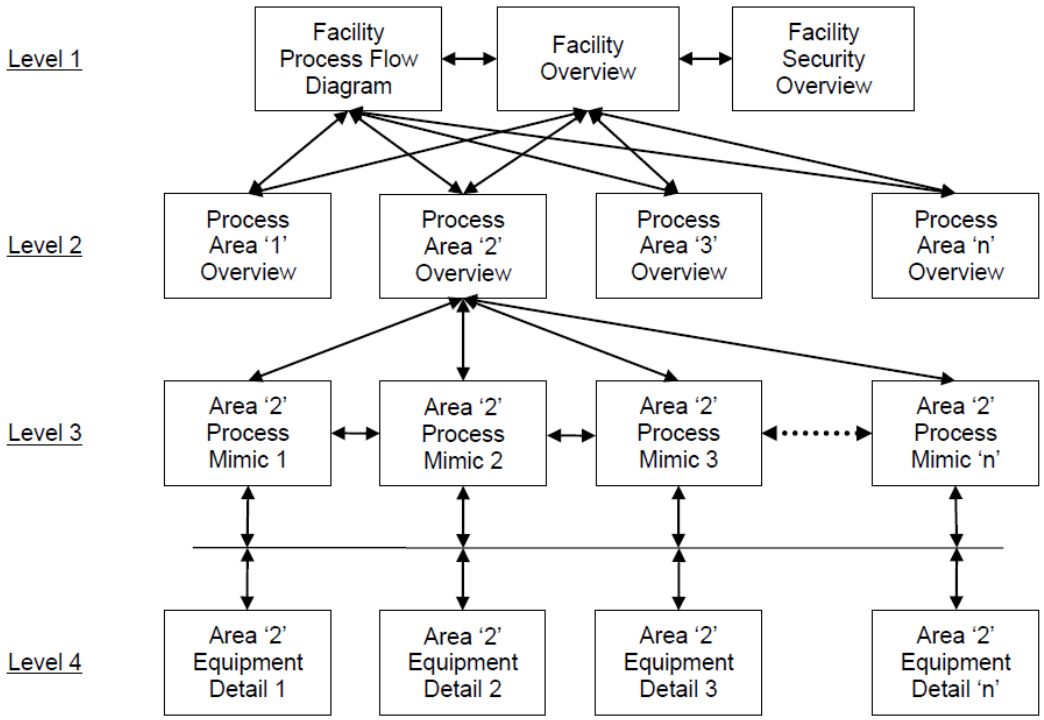
b. This product was standardized by the City via RFP 756-2013. No alternates or substitutes will be accepted.

B. General:
1. The Contractor shall develop the HMI design to convey accurate information to the plant operations staff so they can make informed process control decisions and provide the platform to execute the control decisions.
2. Contractor shall follow The City of Winnipeg, Water & Waste Department HMI Layout and Animation Plan for developing HMI design.
3. The following outlines key objectives in designing the HMI graphics displays:
   a. Easily navigated menus.
   b. Provide no more than 3 mouse actions to navigate to any control display.
   c. Maintain consistency in graphic display and controls design. (Consistency reduces the chances of misunderstanding, significantly reduces learning time, anxiety and stress.)
   d. Maintain consistent and predictable window operations.
   e. Accurate representation of the plant and its operations.
   f. Represent control options in an easily understood fashion.
   g. Modal windows are not acceptable.
   h. Develop help screens to provide additional information to help the operations staff understand the control options where complex operations are required.
   i. A pleasant and engaging interface that conforms to the operators “Mental Model”.
   j. Where possible, design overview displays similar to the physical layout of the facility. The perspective to the physical layout should be from the local main control room.
   k. Provide Operator Access to Process and Alarm Setpoints, including the following:
      1) Process Alarms (High-High, Hi, Low and Low-Low).
      2) Pump and Equipment Control Setpoints.
      3) Process timer setpoints.
      4) Sequence Setpoints for volume, level, time etc.
4. Where specified in the mechanical packaged system specification, fully replicate and integrate the package vendor graphic displays in the Plant HMI. The packaged systems include, but are not limited to, the following:
   a. Turboblower master controller
   b. Polymer mixing systems
   c. UV reactors
   d. RDT systems
   e. Biofilter

C. Graphic Display Types:
1. Displays are generally broken down in to the following categories (For details refer to HMI Layout and Animation Plan document):
   a. Header/footer Displays: For locating the elements that are common to all displays.

b. Navigation display: For display navigation and to open external application and documentation used by operators.
c. Overview displays: This display shows an overview of a facility, process area, or one or more process trains and appears like a dashboard or instrument panel.
d. Process mimic display: Shows a mimic of the process, similar to a P&ID but without unnecessary details.
e. Equipment detail display: This display shows a detailed full-screen display for complex equipment.
f. Sequencer detail display: when equipment is controlled via sequencing logic in PLC, the details of the sequence shall be provided.
g. Electrical single line display: This display shows the view of the operation of electrical system.
h. Equipment and controller Faceplates: Equipment faceplates are provided for individual instrument and equipment such as pumps, fans, and valves.
i. Trend displays: Trend displays are provided for operators to view real time and historical signals associated with an instrument or equipment. Trend displays may also be used to view setpoints, control limits and alarm limits.
j. Alarm summary displays: Alarm displays are full screen displays that show a listing of all active and historical alarms for the facility or process area.

D. Graphic Display Organization
1. Four display levels are defined within the display hierarchy for the facility as shown below:



E. Functions Common to all Loops and Equipment
   1. Unless otherwise indicated, reset and start running all strategies following a power interruption. Software signal selectors and mode memories which are toggled or advanced by momentary signals, are required to retain their last setting through power outages, except as indicated otherwise.
   2. Design and incorporate parameters into the software. Include parameters for limits, setpoints, tuning, scaling I/O values, timer settings, strategies, options, tables, etc. Duplicate or locate the parameters in a contiguous block of registers.
   3. Display all monitored values.
   4. All timer settings, set points, and miscellaneous adjustments will be determined during application software development or plant startup. All settings and adjustments shall be easily made through the programming software.
   5. Loss of Communication Sensing by the control system: Monitor the health of each PLC at the plant including vendor supplied PLCs which are on Supervisory or Control Network. Display their various status parameters such as low battery and communications (normal/fail) conditions.

F. Terminal Services
   1. Terminal Services Servers A & B
      a. Configure and program Terminal Servers A & B to provides RDP (Remote Desktop Protocol) for thin clients operator workstations trough out the plant.
      b. Provide centralized management for thin clients and terminal servers
      c. Provide thin client quick replacement features
      d. Thin client shall have automatic failover. If the primary terminal server fails the thin client shall automatically detect it and switch to the backup terminal server.
      e. Thin client shall connect to the terminal server with the lightest load
   2. Terminal Services Server C
      a. Configure and program Terminal Servers C to provides RDP (Remote Desktop Protocol) for HMI clients outside the plant.

2.3 SIMULATION SOFTWARE DESIGN REQUIREMENTS

A. Simulation Software
   1. Manufacturer and Model:
      a. Schneider Electric SimSci DynSim - latest version
      b. This product was standardized by the City via RFP 756-2013. No alternates or substitutes will be accepted.

B. Application Requirements:
   1. Provide full simulation of all I/O points and network connected device signals to the control system. Simulator shall integrate seamlessly with Schneider control system equipment.
   2. Simulator should easily allow simulated values to be changed by user. Provide a graphical user interface for the modification of simulated values, including automatic/manual simulation mode selection. The user interface shall be user-friendly and on a system basis consistent with the HMI display organization and P&IDs.

3. Provide the following simulation logic as required for control system testing:
   a. The simulator shall simulate the process and equipment by providing automated responses to all control system inputs, based on control system outputs. Simulate all inputs and outputs for both I/O and networked interfaces.
   b. Automatically adjust normal operating statuses for pieces of equipment (e.g. pumps, valves, packaged systems).
   c. Automatically adjust directly related process variables for each system output (a first order response). Detailed biological and mechanical modeling is not required. For example, on a pump feeding into a tank, when the pump run command is received, the flow in the pipe and level in the tank are simulated; additionally, the dissolved oxygen level in a Bioreactor tank will increase upon an increase in aeration rate.
   d. Automatically adjust process variables related to the operation of sequences to allow for complete run-through of sequence and allow for testing of failure modes. This includes, but is not limited to, the HRC system, Primary Clarifiers, and other complex sequences.
   e. Automatically adjust process variables related to complex control functions to allow for testing in normal operation and various failure modes. This includes, but is not limited to, the Wet Well level control, BNR dissolved oxygen control, and other complex control functions.
   f. Allow for manual override of all automatic simulation modes.
4. Submit a list to the Contract Administrator of all complex sequences and control functions to be tested during the SIFT for approval.
5. Incorporate the simulation software and logic into the operator training sessions.
6. All simulation logic and scenarios shall be turned over to the City on project completion.

No additional information beyond what is supplied in the contract documents will be provided by the Design Engineer. It is expected that the Contractor will determine all required process mechanical operational information from the contract documents.

2.4 REPORTS

A. General:
   1. Reports are to be generated on a daily and monthly basis and be automatically printed to a report PDF folder located in the file server each morning at 8:00 a.m. Each of the daily and monthly reports is to be screen accessible at all networked PCs. Each report is to be complete in all aspects of time, date, and description.
   2. Supply the following reports:
      a. Daily Flow Reports; all flows in MLD c/w 3 decimals.
      b. Monthly Flow Reports.
      c. Daily Analytical Reports.
      d. Monthly Analytical Reports.
   3. The reports shall be compiled from data stored by the historical data collection system. Automatically extract the required report data using the following data sample time base.
      a. Daily Reports: 60 minute samples.
      b. Monthly Reports: 1 hour samples.
   4. Provide a (soft) pushbutton command on the HMI to manually print each report. By default the report will print to PDF.

PART 3 EXECUTION

3.1 TESTING

A. Refer to Section 40 99 91 and 40 99 92 for FAT, SIFT, SAT and SIT procedures.

3.2 CITY TRAINING

A. General:
1. Provide an integrated training program for the City's personnel.
2. Perform training to meet specific needs of the City's personnel.
3. Provide a detailed training manual covering all aspects of the training provided.
4. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
5. Provide instruction on all working shift(s) as needed to accommodate the City's personnel schedule.
6. The City reserves the right to make and reuse recordings of all training sessions.

B. Management Seminar:
1. Length: 1 day.
2. Location: City's facility.
3. Objective: Provide an overview for non-operations and maintenance personnel for understanding the applications software.
4. Attended by management, engineering, and other non-operations and non-maintenance personnel.
5. Topics to include, but not be limited to:
   a. Applications software overview: How software is used for operation and control of facilities.
   b. Block Diagram Presentation of PLC and HMI: How and what information flows within system and what is done by each functional unit.
   c. Process/Operator Interface: Explanation and demonstration of how to use an operator's workstation to access displays, reports, and controls.
   d. Management-oriented explanation of data management displays and printouts.
   e. Walk-through of installed systems.

C. Operations:
1. Provide a minimum of 2 sessions of 8 day duration for training at the site indicated by the City for City’s personnel in the operation of the PLCs.
2. Training shall include, but not be limited to:
   a. Standard operational features of PLC equipment provided.
   b. Specific features provided for this project including:
      1) General Loop functions.
      2) Operation of each Loop: For example, AUTO/MANUAL control, control set point settings, control mode selection, alarm acknowledgment.
      3) Operation of each HMI display, dynamic objects, and controls on that display.
      4) Transition from the existing DCS to new HMI system.

c. Operations Startup Suggestions:
   1) Suggested unit operations startup suggestions shall be developed and presented to the operations staff. The suggested unit operation shall consist of two sections, field setup and Startup through the HMI.
      (1) The Field Set up shall list the field devices such as pumps, valves, chemical feeders, etc and the position of their local control switches to transfer control to the HMI.
      (2) The Start up Sequence through the HMI shall list each equipment control, its display where located and the control action to be taken and the expected response to be seen on the HMI.
d. Alarm Summary:
   1) Describe each HMI alarm, including HMI tag name, detailed description of the alarm, probable cause, suggested operator action(s).
   2) The Alarm summary shall be configured in Microsoft EXCEL.

D. Software Maintenance:
   1. Provide a minimum of 2 sessions of 5 day duration for training at the site indicated by the City for personnel in the maintenance of the PLCs and HMI software.
   2. Topics to include, but not be limited to:
      a. Programming Methodology
      b. Software Function Block Diagrams
      c. File naming convention
      d. HMI/PLC I/O Database

E. Simulator:
   1. Provide a minimum of 2 sessions of 2 day duration for training at the site indicated by the City for personnel in the operation and maintenance of the simulator software.
   2. Topics to include, but not be limited to:
      a. File structure and programming methodology
      b. User interface
      c. Control system interface

END OF SECTION

SECTION 40 99 90

PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

A. Comply with latest edition of the codes and standards referenced in Section 40 90 00, Instrumentation and Control for Process Systems 1.2 A, D and E and this section.

B. The following is a list of standards which may be applicable in this section:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
      c. ICS 2, Industrial Control Devices, Controllers and Assemblies.

1.2 DESIGN REQUIREMENTS

A. Provide a complete operating control system including the design, documentation, supply, delivery, tuning, testing, commissioning, and warranty.

B. Assemble panels and install instruments and wiring in equipment manufacturer's factory.

C. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

1.3 SUBMITTALS

A. Where CD-ROM or other electronic media is submitted, insert in a carrier pouch in 3-ring binder.

B. Shop Drawings:
   1. Provide specifications, descriptive drawings, datasheets, catalog cuts, and descriptive literature, which shall include make and model of all components.
   2. Provide complete design documents including, but not limited to:
      a. Bill of materials
      b. Network interface drawings
      c. Electrical schematic and wiring diagrams
      d. Cause and Effect Diagram or Shutdown Key
      e. Electrical ladder diagrams
      f. Interconnection diagrams
      g. External Interface diagrams
      h. Control Panel Arrangement Drawings
      i. IO Lists
      j. Modbus TCP or DNP3 Address List
      k. ISA Style Instrument Datasheets
      l. Instrument Alarm, Range and Setpoint List

m. Configuration/parameter sheets including switch settings, parameter settings, and addresses. Show factory default settings and proposed settings
n. Diagram showing dip switches complete with proposed settings.
o. Control Narrative covering all logic and sequences of operation
p. PLC program documentation

3. Include in diagrams operator interface screens, control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters. The diagrams are to be fully comprehensive so that every circuit loop can be followed completely. Indicate types of loads, switches, transducers and power supplies such as motors, relays, lights, indicators, float switches, hand switches, isolators, signal selectors, dedicated 24VDC power supplies, etc.
4. Number and identify each component circuit and terminal according to the City of Winnipeg Identification Standard 510276-0000-40ER-0002. Show wiring, terminals and devices which are external to the panel including items supplied by others.
5. Identify all wires/cables, enclosures, terminals, and devices on the drawings according to the City of Winnipeg Identification Standard 510276-0000-40ER-0002.
6. Provide sample operator interface screens, if applicable.

C. Particular Shop Drawings for Programmable Equipment:
1. Provide a Bill of Materials to show documentation, software, hardware including communications gear and tools as follows:
   a. For software items include: Publisher, title, version, part number, serial number, media type and size, and information contained on label.
   b. For documentation include: Title and publisher for each item.
   c. For tools include: Documentation and appropriate hardware and software items.
2. Hardware:
   a. Physical, electrical and environmental requirements.
   b. Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.
   c. Show addresses for each hardware component including channel number, IP address.
   d. Network Communications wiring diagram showing all devices, ports, and cables. Identify locations of devices.
   e. I/O list including the following fields for each input/output point:
      1) I/O type (DI, DO, AI, AO)
      2) Internal point numbers. Format shall be similar to instrument tag number.
      3) A description of the I/O point (eg. Raw Sludge Pump 1).
      4) I/O point address including processor number, rack number, I/O module, slot, address, field interface terminal strip number and terminals.
      5) Field wire number.
3. Graphics: For Operator Interface Terminal (OIT), HMI, and/or computer application software submit a design document containing:
   a. Layouts of graphics and/or displays.
   b. Alarm priorities.
   c. Lists of monitored points and controlled points.
   d. Listings of templates; configuration listings, tables and descriptions.
   e. Set of user manuals.

f. Where applicable, provide all information required by the Systems Integrator to be able to fully replicate the HMI in the Plant HMI

4. For Application Software:
   a. English language machine functional description or control narrative. Describe in general and in detail all aspects of the devices controlled, the operations or actions performed by the controlled devices, the devices monitored, the sensors, and the logic performed. Include any assumptions made in developing the program.
   b. Initialization Considerations – A description of the impact of power fail or system failover type restarts upon the subsystem shall be described.
   c. Describe failure contingencies in detail.
   d. Listing of operator inputs/selections to the control strategy shall be illustrated.
5. For PLCs with present or future connection/communications to the Plant Control Network:
   a. Submit an Interface List that defines PLC register locations for all analog and discrete data transferred between the Package System PLC and the Plant Control Network.
   b. The Interface List submittal shall include memory address, description of what information is in the register and register format for all registers. For analog values, the memory map submittal shall also include the register units/span. For discrete values, the memory map submittal shall also define what each register state represents.
   c. The PLC registers location shall not be changed once the Interface List document has been reviewed and approved.
   d. See document A-0102-AELI-A020 for sample list.
6. For networks:
   a. Submit all network testing requirements to the Contract Administrator shortly following receipt of order defining required network testing of the Ethernet cabling. These tests will be performed by Contractor demonstrating to the Vendor and the Contract Administrator satisfactory communications connectivity.
7. Testing protocols and documentation

D. Submittals - Operations and Maintenance Manuals:
   1. As-constructed version of shop drawings.
   2. Particular O& M manuals for programmable equipment:
      a. For Hardware:
         1) Complete set of user manuals.
         2) Fully documented PLC program in pdf and in native format on CD-ROM.
         3) HMI/OI programs and databases on CD-ROM.
      b. For Commercial Software Products: Registration Forms or certificates showing City as the registered owner of the software licenses.

E. Information Submittals:
   1. Manufacturer’s Certificate of Proper Installation.
   2. Manufacturer’s list of proposed spares, expendables, and test equipment.
   3. Manufacturer’s standard troubleshooting procedures

1.4 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:
   1. Selector Switch, Pushbutton, and Pilot Light: one of each type used.
   2. Light Bulb: one of each type used.
   3. Fuse: two of each type and rating used.
   4. Surge Suppressors: one of each type used.

1.5 SIGNAL CHARACTERISTICS

A. Analog Signals:
   1. 4 to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
   2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
   3. Transmitters: Load resistance capability conforming to Class L.
   4. Fully isolate input and output signals of transmitters and receivers.

B. Discrete Output Signals (from vendor panel perspective):
   1. Two-state logic signals.
   2. Provide voltage free contacts for 24V DC signals to the PCS. Minimum switching current to be lower than the PLC input current consumption.
   3. Normal status signals shall be normally open, close to activate isolated contacts.
   4. Fault signals shall be normally closed, open to activate isolated contacts.

C. Discrete Input Signals (from vendor panel perspective):
   1. Two-state logic signals.
   2. Provide interface for 24V DC wet signals from the PCS.

PART 2 PRODUCTS

2.1 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with Canadian Electrical Code (CEC), provincial and local codes, and applicable sections of NEMA, ANSI, CSA 22.2 No. 14 ~ 95, Industrial Control Equipment, Industrial Products.

B. Panel to be constructed in a CSA inspected facility and shipped to site with a CSA sticker affixed to the panel.

C. Conform to NEMA ratings as specified in individual equipment sections.

D. All enclosure angles and cut-outs shall be free of dents, gouges or weld marks, and shall present a clean, smooth appearance.

E. No screws, fittings or other fastenings shall be used on external panel faces, which must be free of any marks, scratches or defaults.

F. Minimum Metal Thickness: 14 gauge.

G. The exterior of the control panel shall be painted ANSI 61 grey.

H. The interior of the control panel shall be painted gloss white.

I. Component mounting plates shall be three (3) mm thick steel and shall be painted with one (1) coat of primer and one (1) coat of white baked enamel.

J. NEMA 12 Panels: Carbon stainless steel construction unless otherwise specified.

K. Doors:
   1. Three-point latching mechanisms in accordance with NEMA 12 panels with doors higher than 450 mm (18 inches).
   2. For other doors, stainless steel quick release clamps.
   3. Width shall be 900 mm (36 inches) maximum

L. All floor-mounted control panels shall be equipped with lifting eyes that are attached to a structural member that is capable of bearing the control panel load.

M. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

N. Temperature Control:
   1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
   2. Furnish cooling fans with air filters if required to dissipate heat (provided that enclosure rating is maintained).
   3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 4 degrees C.

O. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

P. Lighting: Minimum of one internal LED or fluorescent light for panels 12 cubic feet and larger. Light to be controlled automatically via a door switch.

Q. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

R. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.
   1. Manufacturer and Product: Crouse-Hinds; Model ECD18.

S. Mount operator controls and indications on front access door.

T. Standard of Acceptance:
   1. Hoffman.
   2. Hammond
   3. Or approved equal in accordance with B8

2.2 CONTROL PANEL COMPONENTS

A. All components, terminals, wires, and enclosures shall be CSA or cUL listed

B. Control Panels supplied by Three-Phase Power:
   1. Provide disconnect for three-phase power mounted externally on cabinet
   2. Interlock main circuit breaker with panel door
   3. Circuit Breakers:
      a. In accordance with NEMA AB 1.
      b. 18,000-ampere RMS symmetrical rating, minimum at 600 volts, unless otherwise specified.
      c. Breakers Except Motor Branch Breakers: Molded case thermal magnetic.
      d. Motor Branch Circuit Breakers:
         1) 50 Horsepower and Less: Magnetic.
         2) Larger than 50 Horsepower: Thermal magnetic with adjustable magnetic trip units.
         3) Ratings: Recommended by manufacturer for maximum motor protection.
         4) Padlock Provisions: OFF position.
      e. Tripping: Indicate with operator handle position.
   4. Motor Starters and VFDs (If applicable)
      a. Furnish motor starters and VFDs for package unit systems for all motors, for a complete and working system.
      b. Package systems shall have all the require overcurrent and overload protection for motor loads supplied as part of the overall system.
      c. Locate to provide clear view of and access to breakers, contactors, overloads and VFDs when door is open. Interrupting rating and withstand rating shall be listed on the package equipment, and shall be suitable for a minimum of 50 kAIC (unless specifically noted on the drawings otherwise). In no case shall the interrupting rating be less than the maximum fault level available at the equipment.
      d. Motor starter minimum size: NEMA Size 1
      e. Manual reset type with reset button mounted on panel door.
      f. Provide electronic overloads
      g. Manufacturer:
         1) Schneider products only; no exceptions.
   5. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
      a. Power Control Transformer:
         1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
         2) Limit voltage variation to 15 percent during contact pickup.
         3) Fuse one side of secondary winding and ground the other.
         4) Furnish primary winding fuses in ungrounded conductors.
   6. Power Monitoring Relay (If Required):
      a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
      b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
      c. Transient Voltage Protection: 10,000 volts. Provide protection on 120 VAC control circuits where electronic equipment is connected.

d. Manufacturer and Product: Carlo Gavazzu DPB01, Crouzet FW Series or Siemens 3UG30-13 Series.

7. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
8. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full CSA, 75 degrees C ampacity.

C. Control Panels with both a Variable Frequency Drive and a PLC:
1. Separation:
   a. Furnish a solid metal barrier, approximately 90 percent of height and 90 percent of width of interior, to separate VFD from PLC components.
   b. Furnish interior circulation fans to aid overall heat dissipation.

D. Wiring:
1. All analog signal wiring shall be 18 AWG shielded twisted pair.
   a. Shield wires exiting the jacket must be covered with a black heat shrink, and the overall cable at the jacket end must also be covered with a heat shrink.
   b. Standard of Acceptance:
      1) Belden No. 8760.
2. All 24 VDC discrete signal panel wiring shall be 16 AWG TEW stranded conductor with 300V, 105 degrees C insulation.
3. All 120 VAC discrete signal panel wiring shall be 14 AWG TEW stranded conductor with 600V, 105 degrees C insulation.
4. All 24 VDC power and 120 VAC wiring shall be 12 AWG minimum.
5. The sizes and colours of wires shall be in accordance with the CSA and the Canadian Electrical Code, and Colour Coding.
6. Provide wire barrel ferules for all wiring.
7. Ethernet Patch Cords
   a. Requirements:
      1) Cat-6, shielded.
      2) Jacket colour: Blue.
8. Wiring Duct
   a. All wires shall be run in narrow slot wiring duct, unless shown otherwise
   b. Wiring Duct shall be installed on both sides of the panel and between the DIN rails.
   c. Wire or cable, connected to internal device or arriving from external device, shall be uncovered by Wiring Duct for a maximum of 10 cm.
   d. 120 VAC wires cannot share wiring duct with 10 VDC, 24 VDC or 4-20 mA wires, but can cross their path.
   e. All DC, AC, and thermocouple wiring shall be routed in separate wireways to prevent signal interference.
   f. Wire ties shall be non-metallic.
   g. Standard of Acceptance:
      1) Panduit
9. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Standard of Acceptance:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

10. Wire Colour Coding
    a. Utilize the following wire colours for the types of voltage/signals indicated:
        1) 120VAC Line: Black
        2) 120VAC Control: Red
        3) 120VAC Neutral: White
        4) 24VDC Supply: Blue
        5) 24VDC Control: Blue
        6) 24VDC Common: Brown
        7) 4-20mA Signal: White (+), Black (-)
        8) Protective Earth Green
        9) Signal Ground Green/Yellow

E. Wiring Interface:
    1. For analog and discrete signal, terminate at numbered terminal blocks.
    2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
    3. For panel, terminate at equipment on/with which it is mounted.

F. Terminals
    1. Quantity:
        a. Accommodate present and spare indicated needs.
        b. One wire per terminal for field wires entering/exiting enclosures.
        c. Maximum of 2 wires on each side of a terminal for internal enclosure wiring.
        d. Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.
    2. General:
        a. Connection Type: Screw compression clamp.
        b. Compression Clamp:
            1) Complies with DIN-VDE 0611.
            2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
            3) Guides strands of wire into terminal.
        c. Screws: Hardened steel, captive, and self-locking.
        d. Current Bar: Copper or treated brass.
        e. Insulation:
            1) Thermoplastic rated for minus 55 to plus 110 degrees C.
            2) Two funneled shaped inputs to facilitate wire entry.
        f. Mounting:
            1) Standard DIN rail.
            2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
            3) End Stops: Minimum of one at each end of rail.
        g. Jumpers: Allow jumper installation without loss of space on terminal or rail.
        h. Component and Wire Identification:
            1) Identification to conform to the City of Winnipeg's Identification Standard Document 510276-0000-40ER-0002
        i. Marking System:
            1) Terminal number shown on both sides of terminal block.

2) Allow use of preprinted and field marked tags.
3) Terminal strip numbers shown on end stops.
4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.

j. Terminal blocks shall be designed for the size of the wires to be connected to them. Terminal blocks used for analog, digital, and power cables shall be identified and physically separated from each other.

k. Drawings and templates supplied may not detail all hardware components such as labels, stoppers, rail lifters, end plates, separators, etc. The supplier must supply and install such components when required.

3. Terminal Block Types:
   a. Control wiring
      1) General:
         a) Connection type: Screw connection.
         b) Mounting: NS 35 mm DIN rail.
         c) Approval: CSA.
      2) Manufacturer and Series:
         a) Phoenix Contact UT 4 and UTTB 4 series
         b) or approved equal in accordance with B8
      3) Standard of Acceptance
         a) Terminal Block, Feed-through:
            (1) Rated Voltage: 600V ac.
            (2) Rated Current: 30 amp.
            (3) Wire Size: 26 to 10 AWG.
            (4) Color: Gray body.
            (5) Width: 6.2 mm.
            (6) Bridging: Plug-in bridge.
            (7) Standard of acceptance: Phoenix Contact 3046184.
         b) Terminal Block, Ground:
            (1) Wire Size: 26 to 10 AWG.
            (2) Color: Green and yellow body.
            (3) Width: 6.2mm.
            (4) Grounding: Electrically grounded to mounting rail.
            (5) Standard of acceptance: Phoenix Contact 3046207
         c) Terminal Block, Knife Disconnect:
            (1) Rated Voltage: 600V ac.
            (2) Rated Current: 16 amp.
            (3) Wire Size: 26 to 10 AWG.
            (4) Color: Gray body, orange switch.
            (5) Width: 6.2 mm.
            (6) Bridging: Plug-in bridge.
            (7) Standard of acceptance: Phoenix Contact 3046139.
         d) Terminal Block, Fused:
            (1) Rated Voltage: 600V ac.
            (2) Rated Current: 6.3 amp.
            (3) Wire Size: 26 to 10 AWG.
            (4) Color: Gray body.
            (5) Width: 6.2 mm.

(6) Bridging: Plug-in bridge.
(7) Fuse: 5 mm x 20 mm.
(8) Standard of acceptance: Phoenix Contact 3046142, 3036806.

e) Terminal Block, Double Level, Fused:
(1) Rated Voltage: 500V ac.
(2) Rated Current: 6.3A.
(3) Wire Size: 26 to 10 AWG.
(4) Color: Gray.
(5) Width: 6.2mm.
(6) Bridging: Insertion bridge.
(7) Fuse: 5 mm x 20mm.
(8) Standard of acceptance: Phoenix Contact 3044720, 3036806.

G. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

H. General Purpose Miniature Industrial Relays:
1. General
a. Relays suitable for an industrial setting.
b. Relay Mounting: Plug-in type socket.
c. Relay Enclosure: Provide dust cover.
d. Socket Type: Screw terminal interface with wiring.
e. Socket Mounting: Rail.
f. Furnish holddown clips.
2. Control Circuit Switching Relay:
a. Type: Compact general purpose plug-in.
b. Contact Arrangement: 3 Form C contacts.
c. Contact Rating: 10A at 28V dc or 240V ac.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As noted or shown.
f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Push-to-test button.
3. Control Circuit Switching Relay, Time Delay:
a. Type: Adjustable time delay relay.
b. Contact Arrangement: 2 Form C contacts.
c. Contact Rating: 10A at 240V ac.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As specified or shown.
f. Operating Temperature: Minus 10 to 55 degrees C.
g. Repeatability: Plus or minus 2 percent.
h. Delay Time Range: Select range such that time delay set point fall between 20 to 80 percent or range.
i. Time Delay Set Point: As specified or shown.
j. Mode of Operation: As specified or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.

4. Standard of Acceptance:
    a. Finder
    b. Omron

I. Relays for Plant Control System I/O Interface
1. General:
    a. Approvals: CSA
    b. Relay Mounting: plug-in type socket.
    c. Socket type: Screw terminal.
    d. Socket mounting: 35mm DIN rail.
2. Control Circuit Switching Relay:
    a. Type: Compact general purpose plug-in.
    b. Coil operating voltage display: LED.
    c. Operation temperature: -40 to 55 degrees C.
    d. Expected mechanical life: 20,000,000 cycles.
3. Manufacturer and Series:
    a. Phoenix Contact PLC-RSC Series.
    b. or approved equal in accordance with B8.
4. Standard of Acceptance
    a. Relay interface for PLC Discrete Inputs, 1PDT:
        1) Coil rating: 3.5 mA at 120VAC.
        2) Contact material: Gold-plated silver tin oxide alloy
        3) Contact switching voltage: 36 V dc max.
        4) Contact minimum switching current: 1 mA
        5) Contact maximum inrush current: 50 mA
        6) Wire Size: 26 to 14 AWG for both input and output side.
        7) Color: Gray body.
        8) Width: 6.2 mm.
        9) Bridging: Plug-in bridge.
        10) Approvals: cULus
        11) Standard of acceptance: Phoenix Contact 2966281
    b. Relay interface for PLC Discrete Outputs, 1PDT:
        1) Coil rating: 9 mA at 24V dc.
        2) Contact material: Silver tin oxide alloy
        3) Contact switching voltage: 5V ac min, 250 V ac max.
        4) Contact limiting continuous current: 6A.
        5) Wire Size: 26 to 14 AWG for both input and output side.
        6) Color: Gray body.
        7) Width: 6.2 mm.
        8) Bridging: Plug-in bridge.
        9) Approvals: cULus
        10) Standard of acceptance: Phoenix Contact 2966171
    c. Relay interface between PLCs, 1PDT:
        1) Coil rating: 11 mA at 24V AC/DC.
        2) Contact material: Gold-plated silver tin oxide alloy.
        3) Contact switching voltage: 36 V dc max.
        4) Contact minimum switching current: 1 mA
        5) Contact maximum inrush current: 50 mA

6) Wire Size: 26 to 14 AWG for both input and output side.
7) Color: Gray body.
8) Width: 6.2 mm.
9) Bridging: Plug-in bridge.
10) Approvals: cULus
11) Standard of acceptance: Phoenix Contact 2966278

J. Control Power Transformer
1. Function: Provide required secondary voltage level with high degree of stability.
2. Type: Single phase, indoor, industrial.
3. Mounting: Directly to enclosure back panel with mounting feet made of heavy steal and welded or bolted to the core.
4. Standard secondary and optional primary fuse kits.
5. Standard of Acceptance:
   a. Hammond HPS Imperator.

K. 24 VDC Power Supplies and Redundancy Modules
1. Approvals: CSA.
2. Type: Regulated switch mode.
3. Mounting: NS 35 DIN rail.
4. Utilize two separate power supplies in a redundant configuration
5. Redundancy module:
   a. As required
6. Performance:
   a. Load regulation: < 2 percent.
   b. Temperature derating: 2.5 percent/ degrees C from 60 degrees C.
   c. Output ripple: < 30 mV peak-to-peak.
   d. Efficiency: 93 percent or greater.
7. Features:
   a. Capable of parallel operation.
   b. Power boost: 130 percent handle start up loads and temperature derating effect.
   c. Input transient surge protection.
   d. Input overcurrent protection
   e. Output overcurrent protection.
8. Status lights:
   a. DC OK LED: active, green;
   b. Alarm LED: red.
9. Status contacts:
   a. Power supply failure, qty 1 normally open (Form A), contact closed during normal operation.
10. Environmental:
   a. Temperature, operating: -25 to 60 degrees C.
   b. Humidity, operating: max 95 percent, non-condensing.
11. Standard of Acceptance:
   a. Phoenix Contact, Quint Series.

L. Intrinsic Safety Barriers:
1. Monitor discrete signals that originate in hazardous area and are used in a safe area.

2. Interface analog signals as they pass from hazardous area to safe area.
3. Standard of Acceptance:
   a. Pepperl+Fuchs
   b. MTL, Inc.

M. Front-of-Panel Devices:
1. Type: 30 mm
2. Contact Block:
   a. Type: Silver-coated butting, unless otherwise noted.
   b. Rating: 10 amps continuous at 120VAC or as noted.
   c. Sequence: Break-before-make, unless otherwise shown.
   d. Arrangement: Normally open or normally closed as shown, or perform functions noted.
   e. Electrical design life: 1,000,000 cycles.
   f. Terminals: Screw with strap clamp, unless otherwise noted.
3. Pilot Device Colours
   a. The following pilot device colour shall be used:

1) Running Status Light:	Green
2) Stopped Status Light:	Blue
3) Position Open Status Light:	Green
4) Position Closed Status Light:	Blue
5) Alarm Status Light – Major or Safety:	Red
6) Warning or Minor Alarm Status Light:	Amber
7) Ready Status Light:	Blue
8) Operating Mode – Normal Mode:	Blue
9) Operating Mode – Alternate Mode:	Amber
10) Start Pushbutton:	Green or Black
11) Stop Pushbutton:	Red or Black
12) Test Pushbutton:	Black
13) Reset Pushbutton:	Black
14) E-Stop Pushbutton:	Red push-pull with mushroom
15) Overload Reset Pushbutton:	Blue with White “R”
16) Selector Switch:	Black with White Insert

4. Standard of Acceptance:
   a. Schneider K or SK

N. Programmable Controllers:
1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
3. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.
4. Program using conventional relay ladder diagram or function block notation.

5. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions.
    a. Manufacturer and model: As defined in the applicable packaged equipment specification
6. Data Exchange with Plant Control System:
    a. The Package Control System PLC shall be configured to allow remote monitoring of the packaged equipment from the Plant Control System via Ethernet.
    b. Provide MODBUS/TCP communication module on PLC rack for connection to the Plant Control Network. When defined in the mechanical packaged system specification, provide redundant communications from the Package Control System to the Plant Control Network using two Ethernet connections with different subnets.
    c. OIT Tag Names must conform to the client standards for easy cross reference between OIT Tag Names and those in the Plant HMI.
    d. As a minimum, data exchange shall include:
        1) Equipment status (running, off, local/remote mode, PLC AUTO/PLC MANUAL mode, of machine).
        2) Alarm/Fail condition of machine.
        3) Operating modes.
        4) Operating status values; discrete and analog.
    e. Develop a data exchange table/map. Data table shall include:
        1) For each data point, its name, register location, and tag number.
        2) Group data by type; e.g., discrete inputs, discrete outputs, analog inputs, analog outputs.
    f. When defined in the mechanical packaged system specification. Coordinate with the Systems Integrator to provide full replication of the OIT on the Plant HMI. Provide a means for operators to select either the local OIT or the Plant HMI as the active system.
7. PLC Programming Software: Perform PLC programming using Schneider Unity Pro or other as applicable. Confirm with the Contract Administrator, via submittal, about the version to be used before starting the program. The Vendor should use his own software package (or a rented copy) for the programming.

O. Operator Interface Terminals:
1. Requirements:
    a. Power: 24V dc.
    b. Graphics: Color.
    c. Minimum Size: 10”
    d. Interface: Keypad and touch-screen.
    e. Control strategies: Not permitted in PCs, OITs, or HMIs
    f. Provide Run Time license, where applicable.
    g. Communication: Ethernet.
    h. Manufacturer and Product:
        1) As defined in the applicable packaged equipment specification

P. Managed Ethernet Switches:
1. Full compliance with IEEE 802.3.
2. Supports 10 MBit/s Ethernet, 100 MBit/s Fast Ethernet, and 1,000 MBit/s Gigabit Ethernet.

3. Mounting: DIN-rail.
4. Power: 24V dc.
5. Operating Temperature: 0 degrees C to 60 degrees C.
6. Provide one spare port dedicated as a maintenance connection.
7. Standard of Acceptance:
   a. Moxa EDS-G512E-4GSFP

Q. Network Cabling
1. Provide interconnection cabling of all Ethernet devices internal to the panel. Provide CAT6 shielded patch cables: factory made, ruggedized with a protective connector boot.
2. Interconnectivity cabling for the Ethernet network external to the panel will be provided by the installing Contractor.

2.3 SPARE COMPONENTS

A. Supply two spares of each fuse type and rating. Supply one spare of each type of door mounted component. Place in a clear plastic bag and attach to the panel door interior.

2.4 INSTRUMENTATION

A. Instrumentation supplied as part of a pre-manufactured system shall be the manufacturer's standard equipment. Instruments shall be industrial grade and suitable for the conditions in which they will be installed.

B. Instrumentation shipped loose shall meet the requirements specified in Section 40_91_01 Instrumentation and Control Components.

2.5 EQUIPMENT IDENTIFICATION

A. Identify electrical and automation equipment with nameplates.

B. Nameplates:
1. Lamacoid 3 mm thick plastic lamacoid nameplates, white face, black lettering, mechanically attached with self tapping stainless steel screws.

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters
Size 8	35 x 100 mm	3 lines	5 mm high letters

C. Wording on nameplates to be approved by Contract Administrator prior to manufacture.

D. Allow for average of twenty-five (25) letters per nameplate.

E. Identification to be English.

2.6 PROGRAMMING TOOLS & ACCESSORIES

A. Provide the following as minimum:
   1. Programming tools for each different type of programmable equipment:
      a. Software program complete with interconnecting cable, signal converter, instruction manual and equipment documentation; or
      b. Programming keypad and accessories. For example handheld programming unit for Milltronics Multiranger 100/200.
   2. Backup Copies of Application Software:
      a. One copy for each unique version of software program or data.
      b. Machine-readable backup software copy in the form of USB Memory Stick or CD-ROM.

2.7 CONTROL PANELS FED FROM CENTRAL UPS:

A. Where the PLC and remote I/O rack in the package panel are powered from a centralized UPS panel make provisions to accept two different 120 VAC power supplies, one 120 VAC power from central UPS for critical loads and one normal 120 VAC power from separate feed or control power transformer, as applicable, for non-critical loads.

B. Critical loads must include the following as minimum:
   1. CPUs and I/O racks
   2. Network components
   3. Digital input source voltage

C. Centralized UPS and distribution panelboard will be provided under another section in the installation contract.

PART 3 EXECUTION

3.1 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C. Use manufacturer’s recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

E. All wires and cables inside the control panels shall be identified on both ends.

F. Route power cabling separate and spaced out (so that there is no derating factors applied to the cabling). Cable shall be routed to allow for maintenance of systems, and shall not impede access in the room or present obstructions.

END OF SECTION

SECTION 40 99 91

FAT AND SIFT PROCEDURES

PART 1 GENERAL

1.1 SCOPE

A. This Section provides requirements for the FAT and SIFT procedures for Plant Control System.

B. For SAT and SIT detailed procedures refer to Commissioning Procedure (CP) document for control system.

1.2 REFERENCES

A. Comply with latest edition of the standard referenced in this section:
   1. International Society of Automation (ISA)
      a. ISA-62381 (IEC 62381 Modified), Automation Systems in the Process Industry, Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT)

1.3 ACRONYMS AND ABBREVIATIONS:

A. FAT Factory Acceptance Test

B. SIFT System Integration Function Test

C. SAT Site Acceptance Test

D. SIT Site Integration Test

E. RIO Remote Input Output

F. FRS Functional Requirement Specification

G. PLC Programmable Logic Controller

H. P&ID Piping and Instrumentation Diagram

I. HMI Human Machine Interface

J. CPU Central Processing Unit

K. VFD Variable Frequency Drive

L. UPS Uninterruptible Power Supply

1.4 DEFINITIONS

A. Factory Acceptance Test: The inspection and testing of control system components, before shipping to site, which is conducted at the Contractor's facility to demonstrate that the Plant Control System satisfies the requirements outlined in the project documentation.

B. System Integration Function Test: The testing of Control System, before shipping to site, which is conducted at Contractor's facility to demonstrate the integration of all components of the Plant Control System including, but not limited to, automation system components (e.g. instruments, actuators, etc.), electrical system components (e.g. VFDs, motor starters, power meters, UPS), vendor packaged control systems (e.g. polymer mixing panels, rotary drum thickeners), and other subsystems (e.g. fire alarm system).

C. Site Acceptance Test: Inspection and testing which is conducted at construction site to demonstrate that Control System installation satisfies the project installation requirements and applicable codes and standards.

D. Site Integration Test: Inspection and testing which is conducted at construction site to demonstrate that integration of all control system components and subsystems is completed and that all components work together as specified in project documentation.

1.5 SUBMITTALS

A. Submit test plans and schedule a minimum of two months prior to tests.

B. FAT Test Plan
   1. Contractor shall submit the FAT Test Plan for Contract Administrator approval.
   2. The FAT Test Plan provided by Contractor shall include, but not be limited to:
      a. Scope of the test, including hardware, software, programming, configuration, documentation etc.,
      b. Hardware, including construction, visual inspection, wiring, labeling, agreement with shop drawing, requirements and acceptance criteria,
      c. Performance of application related and system related functions, operator interface, I/O test, Bus device and acceptance criteria,
      d. Bus segment tests,
      e. Review of programming, graphic displays and database completeness,
      f. Action plan for all tests that are excluded from FAT,
      g. Review of software revisions, updates or modifications to date from the time the software loaded to the system,
      h. Review of pre-FAT tests performed by Contractor.

C. SIFT Test Plan
   1. Contractor shall submit the SIFT Test Plan for Contract Administrator approval.
   2. The SIFT Test Plan provided by Contractor shall include:
      a. Scope of the tests, including hardware, software, programming,
      b. configuration, documentation etc.,
      c. Testing of interface to other systems.
      d. Contractor facility and infrastructure to perform the test.

D. Submit the FAT and SIFT procedures a minimum of 2 weeks prior to the respective test date.

E. Procedures shall be submitted in accordance with requirements outlined in referenced standards and this Section.

F. Contractor shall conduct a full in-house test before FAT and submit test report to Contract Administrator.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 FAT

A. Required Documentation
   1. Following documents shall be available at the test facility:
      a. FRS documents,
      b. Process Control Narratives,
      c. P&IDs,
      d. HMI layout and animation plan,
      e. I/O list,
      f. Instrument Index and Specifications,
      g. Control System architecture,
      h. HMI architecture,
      i. As- built shop drawings,
      j. Contractor pre-FAT test reports,
      k. Operation & Maintenance manuals,
      l. PLC Program documentation,
      m. HMI Program documentation,
      n. Software licenses with release information and tag capacity,
      o. CPU loading calculations, Network and Servers loading reports,
      p. Hardware and Software Configuration parameters.

B. Test Procedures
   1. The test procedures shall include, but not be limited to, the following items:
      a. Control Panels inspection:
         1) Visual inspection,
         2) Verification of cabinet layout according to as-built Shop drawings,
         3) Warning labels, nameplates,
         4) Verification of component tags and labels according to as-built drawings,
         5) Cabinet internal grounding,
         6) Verification of component part numbers,
         7) Cabinet lighting and fan,
         8) Spare capacity.
      b. Wiring inspection:
         1) Wire tags,
         2) Fusing ,circuit breakers,

3) Segregation of different wirings according to shop drawings,
4) Wire duct loading,
5) Random wire crimp inspection and random manual wire pull test,
6) Power supply and distribution.

c. Start-up testing and general Control System function testing:
1) Cold start up,
2) On-line change to configuration/program,
3) Controller cycle time,
4) Display call-up time,
5) Value update time,
6) System load,
7) Time synchronization check,
8) User log-on security and security levels,
9) Back-up power supply operation,
10) Firewall operation,
11) Remote access operation.

d. System alarm testing:
1) Alarm philosophy and acknowledgment,
2) Power supply failure alarm,
3) Priority levels of alarms,
4) System diagnostic alarms,
5) Network alarms,
6) Wire break, short circuit, out of range, earth fault,
7) Watchdog,
8) Electrical fault and status alarms.

e. Hardware redundancy testing:
1) PLC redundancy,
2) Power supply redundancy,
3) Server redundancy,
4) Terminal server redundancy,
5) Control network redundancy.

f. Programming/Maintenance workstation functionality testing:
1) FDT/DTM function,
2) Data editor,
3) Debugging tool,
4) PLC simulator,
5) Trending tool,
6) Documentation editor,
7) Cross-reference function,
8) Modifying the program in Run mode,
9) Import/Export function,
10) Operating system update utility,
11) Report generation.

g. HMI testing:
1) Symbols for process equipment,
2) Colors,
3) Process flow direction,
4) Hierarchies and linking displays,

5) Dynamic changes of colors, sub-pictures and data entry points,
6) Density of information,
7) Static text and dynamic changes.

h. Device interface HMI testing:
1) The Device faceplate shall be checked as follows to confirm required appearance and functionality:
a) Functionality, service text, range,units,etc.,
b) Link to physical or communications I/O point/address,
c) Related process group display,
d) Related trends.
2) Color changes for dynamic objects, for example, valves, motors bar graphs, etc shall be checked.
3) Location of tag targets on the graphics shall be checked to be in correct location.
4) Alarm assignments: Type, value, priority, etc shall be checked.
5) Alarm E-mail notification shall be checked (if practicable).

i. Hardwired I/O function testing:
1) Full functionality of I/Os shall be tested by simulation device or simulation software.
2) The most complete I/O testing method is to connect simulation devices to field terminals.
3) If the above method is not possible, then simulation devices may be connected to I/O modules, or I/O modules software simulation may be used.
4) I/O simulation software shall provide I/O simulation for Schneider M580 PLCs.

j. Bus device function testing:
1) Full functionality of bus devices shall be tested by simulation device or simulation software.
2) The most complete bus device testing method is to connect simulation devices to fieldbus network.
3) If the above method is not possible, then simulation software may be used.

k. Bus interface link testing:
1) Selected bus segments which are agreed upon, should be built up and tested with all segment devices.
2) This test should cover interoperability of the Control System and the device.
3) Signals related to segments not built up should be simulated.
4) All relevant segment documents should be reviewed.
5) Functionality of bus protection devices shall be tested.

C. Punch List
1. During the FAT, any defect, non-compliance or incomplete work shall be recorded on punch list.
2. Punch list shall include description of the issue, resolution and date completed.
3. All rectification activities should be done during the FAT. If this is not possible, problem correction to be completed after the FAT upon mutual agreement.

D. FAT Documentation
1. Documentation of FAT shall include:
a. Signed copies of test plan and any other documents generated during the FAT,

b. FAT punch list,
c. List of all software and hardware configurable parameters used,
d. List of hardware and software tested,
e. Backup copies of application software,
f. Color copies of applicable graphic displays,
g. System loading during the test and spare capacity.

E. FAT Completion
1. The FAT shall be considered complete when all required functions have been tested and verified according to FAT plan with the exception of mutually agreed remaining punch list items.
2. The tests that could not be completed during the FAT shall be completed at Site Acceptance Test (SAT) during pre-commissioning activities.

3.2 SIFT

A. Required Documentation
1. Following documents shall be available at test facility:
a. FRS documents,
b. Process Control Narratives,
c. P&IDs,
d. HMI layout and animation plan,
e. I/O list,
f. Control System architecture,
g. HMI architecture,
h. PLC Program documentation,
i. HMI Program documentation,
j. Vendor documentation.

B. Test Procedure
1. Communication links to subsystems (vendor package control system, Electrical systems and other subsystems) shall be tested.
2. If actual connection to all Electrical systems is not possible, one typical connection to the electrical equipment (VFD, MCC, Power meter, etc.) shall be tested.
3. If actual connection to subsystem is not possible, subsystem simulation device or software shall be used.
4. Full functionality of link shall be tested as far as practicable.
5. Link failure effects and redundancy functions shall be tested.
6. Control System HMI functionality shall be tested for vendor package control systems, electrical systems and other subsystems.
7. Interlocks and complex function testing:
a. Complex functions, interlocks and operating modes shall be tested after the I/O tests to satisfy requirements of FRS documentation.
8. Process simulation:
a. Test and validate the process plant operation by using process and equipment models created with process simulation software.

C. Punch List
   1. During the SIFT, any defect, non-compliance or incomplete work shall be recorded on punch list.
   2. Punch list shall include description of the issue, resolution and date completed.
   3. All rectification activities should be done during the SIFT. If this is not possible, problem correction to be completed after the SIFT upon mutual agreement.

D. SIFT Documentation
   1. Documentation of SIFT shall include:
      a. Signed copies of test plan and any other documents generated during the SIFT,
      b. SIFT punch list.

E. SIFT Completion
   1. The SIFT shall be considered complete when all required functions have been tested and verified according to SIFT plan with the exception of mutually agreed remaining punch list items.
   2. The tests that could not be completed during the SIFT shall be completed at Site Acceptance Test (SAT) during pre-commissioning activities.

END OF SECTION

SECTION 40 99 92

AUTOMATION TESTING AND COMMISSIONING

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. This section provides requirements for the testing and commissioning of all process instrumentation and control systems necessary to confirm the functional performance for the equipment and systems.

1.2 ACRONYMS AND ABBREVIATIONS

A.	FAT	Factory Acceptance Test
B.	SIFT	System Integration Function Test
C.	SAT	Site Acceptance Test
D.	SIT	Site Integration Test
E.	RIO	Remote Input Output
F.	FRS	Functional Requirement Specification
G.	PLC	Programmable Logic Controller
H.	P&ID	Piping and Instrumentation Diagram
I.	HMI	Human Machine Interface
J.	CPU	Central Processing Unit
K.	VFD	Variable Frequency Drive
L.	UPS	Uninterruptible Power Supply

1.3 DEFINITIONS

A. Factory Acceptance Test: The inspection and testing of control system components, before shipping to site, which is conducted at the Contractor’s facility to demonstrate that the Plant Control System satisfies the requirements outlined in the project documentation.

B. System Integration Function Test: The testing of Control System, before shipping to site, which is conducted at Contractor’s facility to demonstrate the integration of all components of the Plant Control System including, but not limited to, automation system components (e.g. instruments, actuators, etc.), electrical system components (e.g. VFDs, motor starters, power

meters, UPS), vendor packaged control systems (e.g. polymer mixing panels, rotary drum thickeners), and other subsystems (e.g. fire alarm system).

C. Site Acceptance Test: Inspection and testing which is conducted at construction site to demonstrate that Control System installation satisfies the project installation requirements and applicable codes and standards.

D. Site Integration Test: Inspection and testing which is conducted at construction site to demonstrate that integration of all control system components and subsystems is completed and that all components work together as specified in project documentation.

1.4 SUBMITTALS

A. Submit all required data and documentation described herein in accordance with Section 01 33 00, Submittal Procedures

B. Refer to the attached CSO and CP documents for specific submittal requirements and furnish all documentation in accordance with project schedule requirements and timelines defined.

C. Submit test plans and schedule a minimum of two months prior to tests.

D. SAT TEST PLAN
1. Contractor shall submit the SAT plan for Contract Administrator approval.
2. The SAT plan provided by Contractor shall include:
   a. Scope of the test, including hardware, software, programming, configuration, documentation etc.,
   b. Hardware, including construction, visual inspection, wiring, labeling, agreement with shop drawing requirements and acceptance criteria,
   c. Software, including the loaded application and HMI software and the configuration,
   d. Hardware and software configurations shall comply with the FAT and SIFT results,
   e. FAT and SIFT functional tests to be re-performed after installation,
   f. Tests that were not completed during the FAT/SIFT and any open FAT/SIFT punch list item,
   g. Tests to be performed after loop checks such as interlock, logic and sequence check,
   h. Security of Control System network (fire wall rules and network segmentation).

E. SIT TEST PLAN
1. Contractor shall submit the SIT plan for Contract Administrator approval.
2. The SIT plan provided by Contractor shall include:
   a. Scope of the test, including hardware, software, programming, configuration, documentation etc.,
   b. Tests to confirm interoperability of systems involved,
   c. Any functional test to be re-performed after interface to package control system.

F. Supplement submittal documentation as needed to provide adequate records of testing and commissioning activities in accordance with accepted industry practice.

G. Issue submittals for Contract Administrator review and acceptance in accordance with the project schedule as defined herein and in a timely manner to ensure that all required

documentation is in place prior to the commencement of any testing or commissioning activities.

H. Coordinate the submittals detailed in other sections of the specifications with the requirements defined in this section to achieve a complete set of documentation without overlap or gaps.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. The testing and commissioning activities described herein applies to all components and systems that make up the entire process instrumentation and control system for the SEWPCC Upgrading and Expansion Project.

B. See Appendix A for the CSO document. The CSO document defines the overall objectives of the commissioning task as it relates to each area of the project. It also defines the various aspects required to successfully complete the commissioning of the process instrumentation and control systems.

C. See Appendix B for the CP document. The CP document describes the specific testing and verification procedures required during the pre-commissioning and commissioning phases of the work. The document also describes the required documentation that is to be prepared by the Contractor for review and acceptance by the Contract Administrator. After the acceptance, this documentation will be used by the Contractor to record commissioning activity execution and successful completion.

D. The calibration checkout, testing and commission activities specified in the other sections of the overall specification are to be considered as supplemental to the requirements described herein. Those requirements are to be completed for each particular part of the work described prior to the execution of these overall requirements. Where any duplication in requirements may exist, the most stringent requirement will take precedence.

E. Sample commissioning forms are included in Appendix C. The Contractor is responsible for providing all required testing and commissioning forms. Microsoft Word versions of the sample commissioning forms can be provided after contract award.

3.2 PRE-COMMISSIONING

A. Carry out all testing and pre-commissioning activities as required herein.

B. Coordinate all pre-commissioning schedules with the Contract Administrator.

C. Keep accurate records of all works completed and submit final documentation for each pre-commissioning activity as and when completed for each portion of the project. Certify all final submissions as accurate and true.

3.3 COMMISSIONING

A. Carry out all testing and commissioning activities as required herein.

B. Coordinate all commissioning schedules with the Contract Administrator.

C. Keep accurate records of all works completed and submit final documentation for each commissioning activity as and when completed for each portion of the project. Certify all final submissions as accurate and true.

3.4 CONTRACTOR REPRESENTATIVE

A. Designate and furnish one or more Contactor personnel to coordinate and expedite all testing and commissioning activities and documentation functions.

B. Contractor representative(s) to coordinate all testing and commissioning works carried out by specific equipment vendors in accordance with the commissioning planning and schedules submitted by the Contractor.

C. Representative(s) to attend all meetings concerning the commissioning function as may be requested by the Contract Administrator. Representative(s) to be available at all times during the testing, pre-commissioning, commissioning and performance evaluation phases of the project.

END OF SECTION

Appendix A

Commissioning Specifications and Objectives (CSO)

COMMISSIONING SPECIFICATION AND OBJECTIVES (CSO)
PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS)

1.0 GENERAL SCOPE

This document defines pre-commissioning and commissioning tests and activities required for the Process Instrumentation and Control System (PICS). The tests are required to verify proper operation of the PICS in accordance with manufacturer's instructions, project design documents and applicable codes and standards. Instrumentation system consists of field instruments with a hardwired or digital communication interface to the control system, instrument accessories, required utilities for field instruments such as power/air, and instrument process tubing/piping. The Process Control System (PCS) is a PLC/HMI based control system consisting of remote and local I/Os, ring device network, redundant PLCs, redundant control network, redundant HMI servers, redundant Terminal servers with Thin clients, Historian server, , server network, supervisory network and programming/maintenance workstations.

Detailed procedures and activities for conducting the tests are covered in the Commissioning Procedures (CP) document.

Control system migration activities are not included in this document. See the DCS migration plan S0926-01CA-PLA-0001 for details.

Refer to Annex 1.0 for definition of project milestones and phases in the commissioning of instrumentation and control systems, according to ISA- 62381 standard.

2.0 REFERENCES

.1 IEC 62337, Edition 2.0-2012, Commissioning of electrical, instrumentation and control systems in the process industry-Specific phases and milestones

.2 ANSI/ISA-62381-2011 (IEC 62381 Modified), Automation Systems in the Process Industry-Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT)

.3 ANSI/ISA-62382-2012 (IEC 62382 Modified), Automation Systems in the Process Industry- Electrical and Instrumentation Loop Check

.4 ANSI/NETA ECS-2015, Standard for Electrical Commissioning Specifications for Electrical Power Equipment and Systems

3.0 COMMISSIONING OBJECTIVES

.1 Verifying the PICS operation in accordance with design requirements, manufacturer's instructions and applicable codes and standards;

.2 Contributing to the safe and reliable operation of the plant;

.3 Providing baseline results for routine maintenance of the system and related components.

4.0 PRE-COMMISSIONING PHASE ACTIVITIES/TESTS

Following activities and tests are required during the pre-commissioning phase:

.1 Reviewing Factory Acceptance Test (FAT) and the end of construction documentation to verify acceptable condition and suitability for pre-commissioning phase;

.2 Reviewing Commissioning plan;

.3 Planning for automation system manufacturer assistance;

.4 Providing a manufacturer instruction file which is readily accessible throughout the pre-

commissioning and commissioning phases;

.5 Site Acceptance Tests (SAT) as described in section 4.1;

.6 Site Integration Tests (SIT) as described in section 4.2;

.7 Process Instrumentation system tests as described in section 4.3;

.8 Loop checks as described in section 4.4;

.9 Function checks as described in section 4.5;

.10 Obtaining local inspectors approval, where required;

.11 Providing the record of corresponding test/check certificates;

.12 Providing a punch list during all inspections and tests;

.13 Test reports and close-out.

Refer to Annex 1.0 for typical sequence of FAT, SAT, SIT, loop and function check activities with respect to project milestones, according to ISA- 62381 standard.

4.1 Site Acceptance Test (SAT)

The SAT shall be performed after installation of the system at site. The SAT is performed to demonstrate the proper functionality of the system after delivery and installation. The SAT includes but is not limited to:

.1 Checking of Hardware/Software inventory;

.2 Mechanical inspection;

.3 Wiring and termination inspection;

.4 System energization;

.5 Checking hardware redundancy and diagnostic;

.6 Checking operator interface;

.7 I/O test;

.8 Verification of the Profibus and Modbus interfaces;

.9 Function check (cannot be completed until after loop checks);

.10 Performing the tests which could not be completed during the FAT;

.11 Developing SAT punch list;

.12 SAT close-out.

4.2 Site Integration Test (SIT)

The SIT shall ensure that interconnected systems function together in order to achieve the results based on design requirements. The SIT consists of testing the communication and interaction between the PCS sub-systems or with other systems, such as mechanical package control systems, to ensure desired functional performance. The SIT shall be performed after the SAT for each system/sub-system has been successfully completed. The following typical tasks should be considered:

.1 Mechanical inspection;

.2 Testing communication links;

.3 Checking operator interface;

.4 Testing Hardwired I/O;

.5 Functional tests;

.6 Developing SIT punch list;

.7 SIT close-out.

4.3 Process Instrumentation System tests/activities

The following tasks should be performed after completion of construction and during pre-commissioning phase to insure that instrumentation system is ready for the loop checking activities:

- **.1** Visual inspection;
- **.2** Verification of correct installation and grounding;
- **.3** Verification of instrument operability;
- **.4** Bench or field calibration;
- **.5** Cleaning the air and process tubing/piping;
- **.6** Leak test of pneumatic and impulse (process) lines;
- **.7** Checking the wiring;
- **.8** Providing punch lists and test report.

4.4 Loop check

Loop checks are performed to verify the proper operation of all loops prior to the commissioning of the plant. They follow the installation of all the loop components and the functionality checks of the control system after SAT. The loop checks will ideally occur in the pre-commissioning phase of the schedule shown in Annex 1.0, Figure 1.0. However the loop check may begin when any specific loop is completed even if it is during the “construction” phase. Loop checks are the last systematic check of a control system before mechanical completion to ensure that all loop documents are available, all instrumentation and equipment has been installed in accordance with engineering documents, and all loops function as required. Refer to Annex 1.0, Figure 1.0 for the “loop check” sequence. Loop check shall be performed in three steps:

- **.1** Documentation check;
- **.2** Visual inspection;
- **.3** Loop functional check.

After the loop checks, the punch list and marked or “red line” drawings shall be provided.

4.5 Function check

Function checks include interlock checks, complex function checks and sequence logic checks. These checks are part of the SAT but cannot be completed until after loop checks. Verification of complex control schemes is typically done at commissioning phase. Refer to Annex 1.0, Figure 1.0 for the “function check” sequence.

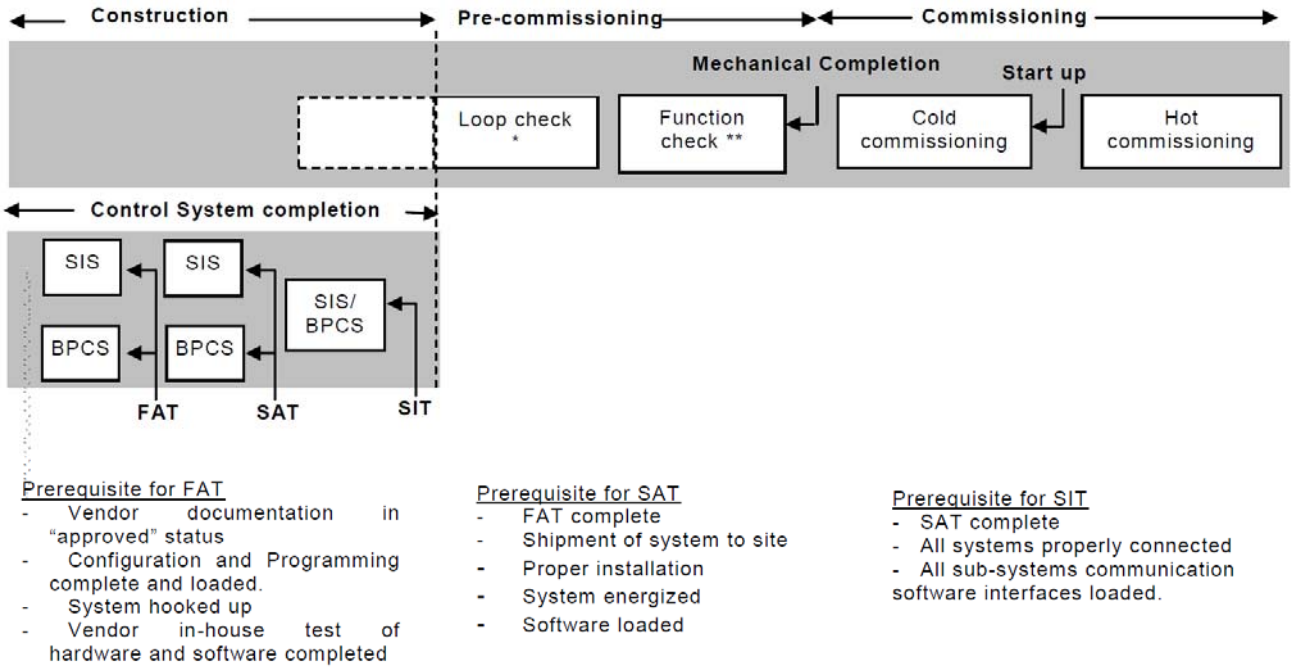
5.0 COMMISSIONING PHASE ACTIVITIES/TESTS

Following activities and tests are required during the commissioning phase:

- **.1** Reviewing commissioning plan;
- **.2** Reviewing pre-commissioning reports to verify acceptable condition for commissioning phase;
- **.3** Final alarm and control set point adjustments as necessary;
- **.4** Adjustments of controller’s PID value (Loop Tuning) as necessary;
- **.5** Verification of complex control schemes;
- **.6** Monitoring the PCS diagnostic alarms;
- **.7** Monitoring the control system performance;
- **.8** Commissioning of analyzers, sample handling systems and other special instruments;
- **.9** Commissioning report.

ANNEX 1.0

Sequence of FAT, SAT, SIT, Loop and Function Check Activities



* NOTES: * The loop check can be started during the construction phase once the required infrastructure has been installed.

** Function checks include interlock checks, complex function checks, and sequence or batch logic checks. These tests are part of the SAT but cannot be conducted until after loop checks.

Figure 1 – Diagram depicting typical sequence of events for FAT, SAT and SIT with respect to the project milestones

NOTES:

.1 The term "BPCS", on the sheet, stands for Basic Process Control System. It is the terminology used by the ISA standard for process control systems which does not perform any Safety Integrity Level (SIL) rated function. It is equivalent to the SEWPCC Process Control System (PCS).

.2 The term "SIS", on the sheet, stands for Safety Instrumented System. It is used by the ISA standard for process control systems which perform SIL rated functions. The SIS is not applicable to the SEWPCC project.

mechanical completion
milestone, which is achieved when the plant, or any part thereof, has been erected and tested in accordance with drawings, specifications, instructions, and applicable codes and regulations to the extent necessary to permit cold commissioning

NOTE This includes completion of all necessary electrical and instrumentation work. This is a milestone marking the end of the precommissioning activities.

cold commissioning
phase, during which the activities associated with the testing and operation of equipment or facilities using test media such as water or inert substances prior to introducing any chemical in the system take place

hot commissioning
phase during which the activities associated with the testing and operation of equipment or facilities using the actual chemical process prior to making an actual production run take place

start-up
milestone marking the end of cold commissioning

NOTE At this stage, the operating range of every instrument loop is already adjusted to reflect the actual working condition.

Appendix B
Commissioning Procedure (CP)

COMMISSIONING PROCEDURES (CP)
PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS)

1.0 GENERAL SCOPE

This document provides detailed information to support completion of activities and tests described in the Commissioning Specification and Objective (CSO) document for PICS at pre-commissioning and commissioning phases. The Instrumentation System consists of field instruments with Profibus or 4-20 mA output, instrument accessories, required utilities for field instruments such as power/air and instrument process tubing/piping. The Process Control System (PCS) is a PLC/HMI based control system consisting of remote and local I/Os, ring device network, redundant PLCs, redundant control network, redundant HMI servers, redundant Terminal servers with Thin clients, Historian server, , server network, supervisory network and programming/maintenance workstations.

Factory Acceptance Test (FAT), System Integration Function Test (SIFT) and DCS migration plan are not included in this document. See Section 40 99 91 and S0926-01CA-PLA-0001 for details.

Refer to Commissioning Specification and Objectives (CSO) document for definition of phases, milestones and tests that are used in this document.

2.0 REFERENCES

- IEC 62337, Edition 2.0-2012, Commissioning of electrical, instrumentation and control systems in the process industry-Specific phases and milestones
- ANSI/ISA-62381-2011 (IEC 62381 Modified), Automation Systems in the Process Industry-Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT)
- ANSI/ISA-62382-2012 (IEC 62382 Modified), Automation Systems in the Process Industry-Electrical and Instrumentation Loop Check
- ANSI/NETA ECS-2015, Standard for Electrical Commissioning Specifications for Electrical Power Equipment and Systems
- ANSI/NETA ATS-2013, Standard for Acceptance Testing Specification for Electrical Power Equipment and Systems
- CSA-Z462-15, Workplace electrical safety

3.0 DOCUMENTATION

3.1 Pre-Commissioning Phase

3.1.1 Site Acceptance Test (SAT)

A. Following reference documents shall be available for the SAT:
   1. Commissioning plan;
   2. Commissioning procedure (this document);
   3. Factory acceptance test report;
   4. Design basis;
   5. Functional Requirement Specifications (FRS);
   6. Instrumentation and process control system specifications;
   7. Manufacturer instruction/operating manuals;

8. Manufacturer data sheets;
9. Manufacturer instruction files;
10. Licensing information;
11. Purchased/installed software/firmware version information;
12. Hardware and software configuration version used at the FAT;
13. Design documents including, but not limited to:
    a) Cabinet layout drawings;
    b) Cabinet wiring diagrams;
    c) Equipment layout drawings;
    d) Power distribution schematics;
    e) Network diagram;
    f) Control system architecture diagrams;
    g) Profibus segment diagrams;
    h) Loop diagrams;
    i) Instrument list;
    j) I/O list;
    k) Instrument location plan;
    l) Control room layout;
    m) Instrument installation details;
    n) Electrical schematics;
    o) P&IDs.

14. SAT plan, which shall be reviewed and accepted by Contract Administrator (CA), shall include but not be limited to:
    a) Overall scope of test including hardware, software configuration/programming, etc and division of responsibility for each test;
    b) FAT functional tests to be re-performed after installation;
    c) FAT tests that were not completed during the FAT;
    d) Security of plant control network (firewall rules and proper network segmentation);
    e) Tests to be performed after loop checks, such as interlock checks, complex functionality checks and sequence logic checks;
    f) Plan schedule.

B. Following documents shall be available after the SAT completion:
1. SAT report which shall include the following:
    a) Attendees;
    b) Tests performed;
    c) Open issues and agreement for their solution;
    d) Contract Administrator acceptance of the system.

2. SAT documentation which shall include the following:
    a) Signed copies of all documents generated during the SAT;

b) SAT punch list which shall include the following:
   - Description of issue;
   - Person(s) responsible for resolution;
   - Description of the resolution and date completed;
   - Sign-off area for the Contract Administrator.

c) The actual hardware and software tested (including versions);
d) All software and hardware configurable parameters used;
e) Backup copies of the final complete system and application software;
f) System loading observed during the test and spare capacity;
g) A list and color copies of any graphic displays modified or added since the FAT.

3.1.2 Site Integration Test (SIT)

A. Following documents shall be available for the SIT:
   1. Commissioning plan;
   2. Commissioning procedure (this document);
   3. SAT report;
   4. IP Address lists;
   5. Manufacturer documentation for each system or sub-system to be checked;
   6. SIT plan which shall be approved by the Contract Administrator and address the following areas:
      a) Overall scope of test including hardware, software, configuration/programming, etc, and division of responsibility for each test;
      b) Tests to confirm interoperability of systems involved;
      c) FAT or SAT functional tests of systems to be re-performed after interface to other system(s);
      d) Plan schedule.

B. Following documents shall be available after the SIT completion:
   1. SIT report which shall include the following:
      a) Attendees;
      b) Tests performed;
      c) Open issues and agreement for their solution;
      d) Contract Administrator acceptance of the system.
   2. SIT documentation which shall include the following:
      a) Signed copies of all documents generated during the SAT;
      b) SIT punch list which shall include the following:
         - Description of issue;
         - Person(s) responsible for resolution;
         - Description of the resolution and date completed;
         - Sign-off area for the Contract Administrator.
      c) The actual hardware and software tested (including versions);
      d) All software and hardware configurable parameters used;
      e) Backup copies of the final complete system and application software;
      f) System loading observed during the test and spare capacity;

g) A list and color copies of any graphic displays modified or added since the FAT.

3.1.3 Loop Check

A. Following documents shall be available for the loop check:
   1. P&IDs;
   2. Instrument list;
   3. Loop diagrams;
   4. Profibus segment diagrams;
   5. Instrument calibration document;
   6. Instrument and equipment location drawings;
   7. Specification sheet for each device in the loop;
   8. Loop check sheet;
   9. Electrical schematics and single line diagrams;
   10. Functional Requirement Specifications (FRS).

B. Following documents shall be available after the loop checks:
   1. Signed copy of loop check sheets;
   2. Marked or “red line” drawings or other loop-related documents reflecting final as-installed state of the loop components;
   3. Punch list including all the deficiencies found and tracking their final resolution.

3.1.4 Process Instrumentation Tests

A. Following documents shall be available for the Process Instrumentation System tests:
   1. Instrument list;
   2. P&ID diagrams;
   3. Instrument specification;
   4. Instrument data sheets;
   5. Instrument location layout;
   6. Instrument factory calibration document;
   7. Manufacturers’ manuals;
   8. Instrument installation details.

B. Following documents shall be available after Process Instrumentation tests:
   1. Signed copy of check sheets;
   2. Signed copy of Instrument configuration/calibration sheets;
   3. Punch list including all of the deficiencies found and tracking their final resolution.

3.2 Commissioning Phase

Following documents shall be available at the commissioning phase:
1. Commissioning plan and schedule;
2. Commissioning procedure (this document);
3. Pre-commissioning report.

4.0 TESTING EQUIPMENT

Typical test equipment to perform test, configuration, calibration and loop checks include but are not limited to:

1. Digital multimeter;
2. Portable pressure calibrator;
3. Dead weight tester;
4. Precision pressure gauge;
5. Temperature calibrator;
6. Temperature calibration bath;
7. Standard temperature sensor and meter;
8. Loop calibrator;
9. Hand-held oscilloscope;
10. Ethernet fiber and copper network tester;
11. Profibus PA and DP segment tester;
12. Profibus PA hand-held field communicator;
13. HART hand-held field communicator if applicable;
14. Two way radio.

4.1 Testing Equipment Calibration

1. Contractor shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The firm providing calibration services shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a) Field instruments analog and digital: 12 months maximum;
   b) Laboratory instruments: 12 months maximum;
   c) Leased specialty instruments: 12 month maximum.
4. Dated calibration labels shall be visible on all test equipment.
5. Calibrating standard shall be of better accuracy than that of the instrument tested.

5.0 QUALIFICATION OF PERSONNEL

.1 The personnel performing the field tests and commissioning shall be experienced and thoroughly familiar with the apparatus and systems being tested and commissioned. They shall be capable of conducting the tests and commissioning activities in a safe manner, analyze the test data and make a decision on operability of specific equipment and system.

6.0 DIVISION OF RESPONSIBILITY

6.1 Pre-Commissioning Phase

Contract Administrator shall provide the testing organization (Contractor) with the following:

1. Commissioning Procedure (this document);
2. Applicable design documents;
3. Contract Administrator’s project requirements;

The testing organization (Contractor) shall provide the following:

1. Commissioning plan;
2. Factory acceptance test report;
3. Manufacturer instruction manuals and data sheets.
4. Review of factory acceptance, end of construction documents and punch lists to identify any remaining work which has to be completed before the pre-commissioning phase;
5. Review the commissioning plan document and provide a test plan for the SAT and SIT as described in sections 3.1.1(A-14) and 3.1.2 (A-5);
6. Provide a test plan for the loop and instrumentation system check including overall scope of test and schedule;
7. Planning for manufacturer assistance based on test schedule;
8. All field technical services, tooling, equipment, instrumentation, and technical supervision to perform the required tests and inspections;
9. Timely notification to the Contract Administrator prior to commencement of any testing;
10. A timely notification of any system, material, or workmanship that is found deficient based on the results of the acceptance tests
11. The SAT and SIT documentation as described in sections 3.1.1(B-2) and 3.1.2(B-2);
12. The loop and instrumentation system documentation as described in sections 3.1.3(B) and 3.1.4(B);
13. The SAT and SIT reports as described in sections 3.1.1(B-1) and 3.1.2(B-1);
14. Pre-commissioning report which shall include the following:
    a) The SAT, SIT, instrumentation system test and loop check plans;
    b) The loop and instrumentation system check documentation;
    c) The SAT and SIT reports and documentation.

6.2 Commissioning Phase

The Contract Administrator shall provide the commissioning organization (Contractor) with the following:

1. Commissioning schedule (based on the Contractor's previous submittals);
2. Contract Administrator's project requirements;
3. Designated representative(s) for the project commissioning activities.

The commissioning organization (Contractor) shall provide the following:

1. Commissioning plan;
2. Manufacturer instruction manuals and data sheets.
3. Review of outstanding deficiencies from pre-commissioning phase and verifying the acceptable condition for commissioning phase;
4. Commissioning report which shall include:
    a) Summary of project;
    b) A complete copy of the test reports;
    c) Identification of systems or assemblies that do not meet the Contract Administrator's project requirements where applicable;
    d) Analysis and recommendations;
    e) Resolution plan for incomplete tasks.

7.0 HAZARD AND SAFETY

All parties involved in pre-commissioning and commissioning activities must be familiar with standard safety practices and shall have complete knowledge of the hazards involved. Safety representative shall be designated to supervise operations with respect to safety.
Safety practices shall include but not limited to the following requirements:

a) The Contract Administrator's safety practices;
b) CSA-Z462-15, Workplace electrical safety.

8.0 PRE-COMMISSIONING PHASE TESTS/ACTIVITIES

8.1 Site Acceptance Test (SAT)

The following sections describe activities required for typical equipment on this project. The list of equipment and description of activities are not exhaustive and the Contractor is responsible for all tests and activities required for completion of the Site Acceptance Tests.

8.1.1 Power Supply Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and required area clearances.
4. Inspect isolating and equipment grounds.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Verify connection of UPS and normal power supplies.
7. Inspect field wiring installation, cable entry, routing, support, and terminations.
8. Inspect cable duct loading.
9. Verify correct labeling, cable and wire tagging in accordance with power distribution schematics.
10. Verify segregation of wires in accordance with cabinet layout drawings.
11. Perform manual wire pull test (random), and wire crimp inspection, (random).
12. Perform point-to-point test to determine the resistance between the main grounding system and power supply cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
13. Check that there is no load on power supply cabinet when it is energized.
14. Verify the voltage values of 24 VDC and 24 VAC.
15. Verify functionality of the Redundancy Module.
16. Check the power supply module status alarm in accordance with manufacturer's published data.
17. Connect the loads, one at a time, and check power supply loading at full load, with both normal and UPS power supply inputs.
18. Restrict access to cabinet after energization.

8.1.2 Remote I/O (RIO) Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and required area clearances.
4. Inspect isolating and equipment grounds.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Verify connection of power supply.
7. Inspect field wiring installation, cable entry, routing, support, and terminations.

8. Inspect cable duct loading.
9. Verify correct labeling, cable and wire tagging in accordance with power distribution schematics.
10. Verify segregation of wires in accordance with cabinet layout drawings.
11. Perform manual wire pull test (random), and wire crimp inspection, (random).
12. Verify RIO address by checking rotary switch setting on CRA (Ethernet drop) module.
13. Perform point-to-point test to determine the resistance between the main grounding system and RIO cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
14. With I/O modules signaling power fuses disconnected, energize the main and expansion racks in accordance with manufacturer's published data. Check status of diagnostic LEDs and displays on all rack modules.
15. Test and verify I/O prior to checking the loops involving that I/O.This I/O test is performed to verify the RIO cabinet internal wiring to I/O modules and it should be conducted for I/Os that could not be tested during the FAT.
16. Check the power supply module status alarm in accordance with manufacturer's published data.
17. Restrict access to cabinet after energization.

8.1.3 Field Junction Boxes and Miscellaneous Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect, alignment, and required clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside junction box have been removed.
6. Inspect field wiring installation, cable entry, routing, support, and terminations.
7. Inspect cable duct loading where applicable.
8. Verify correct labeling, cable and wire tagging in accordance with wiring diagrams.
9. Perform point-to-point test to determine the resistance between the main grounding system and Junction box ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
10. Energize the panel where applicable.
11. Check functionality of relays, push buttons, lights and control circuits, where applicable.
12. Restrict access to cabinet after energization.

8.1.4 Network and Profibus Device Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect, alignment, and required clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Inspect field wiring installation, cable entry, routing, support, and terminations.
7. Inspect cable duct loading where applicable.
8. Verify correct labeling and cable tagging in accordance with wiring diagrams.
9. Perform point-to-point test to determine the resistance between the main grounding system and cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
10. Verify DIP switch settings on Profibus network devices.
11. With circuit breakers of the Profibus devices and Ethernet switches in open position or fuses removed, energize the cabinet.

12. Energize the Profibus network devices, network switches and Modbus Gateway (where applicable), one at a time, and check status of diagnostic LEDs on devices.
13. Run diagnostics in accordance with test equipment (Profibus tester) manufacturer's published data, to confirm proper installation of the Profibus segment.
14. Check settings and performance of the Ethernet copper/fiber network with network tester in accordance with test equipment manufacturer's published data.
15. Check functionality of Modbus Gateway, where applicable.
16. Restrict access to panel after energization.

8.1.5 Profibus Equipment (Repeater) Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect, alignment, and required clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Inspect field wiring installation, cable entry, routing, support, and terminations.
7. Inspect cable duct loading where applicable.
8. Verify correct labeling and cable tagging in accordance with wiring diagrams.
9. Perform point-to-point test to determine the resistance between the main grounding system and cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
10. Verify DIP switch settings on Repeaters.
11. With circuit breakers of the Profibus Repeaters in open position, energize the cabinet.
12. Energize the Profibus Repeaters, one at a time, and check status of diagnostic LEDs on devices.
13. Run diagnostics in accordance with test equipment (Profibus tester) manufacturer's published data, to confirm proper installation of the Profibus segment.
14. Restrict access to panel after energization.

8.1.6 Network Protection Device Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect, alignment, and required clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Inspect field wiring installation, cable entry, routing, support, and terminations.
7. Inspect cable duct loading where applicable.
8. Verify correct labeling and cable tagging in accordance with wiring diagrams.
9. Perform point-to-point test to determine the resistance between the main grounding system and cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.

8.1.7 Local Control Panel, Field Relay Panel

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect, alignment, and required clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside panel have been removed.
6. Inspect field wiring installation, cable entry, routing, support, and terminations.

7. Inspect cable duct loading where applicable.
8. Verify correct labeling and cable tagging in accordance with wiring diagrams.
9. Perform point-to-point test to determine the resistance between the main grounding system and panel ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
10. Energize the panel in a safe manner and check functionality of associated control and monitoring schemes.
11. Where applicable, perform functional test of local control panel during the loop check activity.
12. Restrict access to panel after energization.

8.1.8 PLC and Device Network Equipment Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and required area clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Verify connection of power supply.
7. Verify connections of “Device Network”.
8. Inspect field wiring installation, cable entry, routing, support, and terminations.
9. Inspect cable duct loading.
10. Verify correct labeling and cable tagging in accordance with power distribution schematics.
11. Verify segregation of wires in accordance with cabinet layout drawings.
12. Perform manual wire pull test (random), and wire crimp inspection, (random).
13. Perform point-to-point test to determine the resistance between the main grounding system and PLC cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
14. Verify DIP switch settings on Profibus network devices.
15. With circuit breakers of the Profibus network devices and Ethernet switches in open position or fuses removed:
    a) Energize the main rack of redundant PLCs in accordance with manufacturer’s published data;
    b) Energize the supplement power supply of the cabinet where applicable.
16. Check the power supply module status alarm in accordance with manufacturer’s published data.
17. Check the Ethernet switch status alarm in accordance with manufacturer’s published data.
18. Check status of diagnostic LEDs and displays on processor module and all other rack modules.
19. Energize the Profibus network devices and network switches, one at a time, and check status of diagnostic LEDs on devices and switches.
20. Run diagnostics in accordance with test equipment (Profibus tester) manufacturer’s published data, to confirm proper installation of the Profibus segments. Connect each bus segment, one at a time, and verify the I/O and required functionality. After all segments connected, confirm bus loading and bus performance before performing any loop-based tests involving that I/O.
21. Check settings and performance of the Ethernet copper/fiber network with network tester in accordance with test equipment manufacturer’s published data.
22. Download the latest version of application software to the processor (if it is not loaded during the FAT) in accordance with manufacturer’s published data.
23. Check processor loading when loops and other functions running.
24. Check redundant operation of PLCs in accordance with manufacturer’s published data.

25. Restrict access to cabinet after energization.

8.1.9 PLC Cabinets for HVAC & Miscellaneous

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and required area clearances.
4. Verify the correct equipment and isolating ground connections.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Verify connection of power supply.
7. Verify connections of “Device Network”.
8. Inspect field wiring installation, cable entry, routing, support, and terminations.
9. Inspect cable duct loading.
10. Verify correct labeling and cable tagging in accordance with power distribution schematics.
11. Verify segregation of wires in accordance with cabinet layout drawings.
12. Perform manual wire pull test (random), and wire crimp inspection, (random).
13. Perform point-to-point test to determine the resistance between the main grounding system and PLC cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
14. With I/O modules signaling power fuses disconnected, energize the main and expansion racks in accordance with manufacturer’s published data. Check status of diagnostic LEDs and displays on all rack modules.
15. Check the power supply module status alarm in accordance with manufacturer’s published data.
16. Test and verify I/O prior to checking the loops involving that I/O. This I/O test is performed to verify the cabinet internal wiring to I/O modules and it should be conducted for I/Os that could not be tested during the FAT.
17. Download the latest version of application software to the processor (if it is not loaded during the FAT) in accordance with manufacturer’s published data.
18. Check processor loading when loops and other functions running.
19. Restrict access to cabinet after energization.

8.1.10 Network Cabinets

1. Compare equipment nameplate data with panel layout drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and required area clearances.
4. Verify the correct ground connection.
5. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
6. Verify connection of power supplies.
7. Verify connections of “Device Network”, “Control Network”, “Server Network”, “Supervisory Network” and “DMZ Network” where applicable.
8. Inspect field wiring installation, cable entry, routing, support, and terminations.
9. Inspect cable duct loading.
10. Verify correct labeling and cable tagging in accordance with power distribution schematics.
11. Verify segregation of wires in accordance with cabinet layout drawings.
12. Perform manual wire pull test (random), and wire crimp inspection, (random).
13. Perform point-to-point test to determine the resistance between the main grounding system and network cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
14. Energize the Ethernet switches, one at a time, and check status of diagnostic LEDs.

15. Energize Router (where applicable) and check status of diagnostic LEDs.
16. Check the Ethernet switch status alarm in accordance with manufacturer's published data.
17. Check settings and performance of the Ethernet copper/fiber network with network tester in accordance with test equipment manufacturer's published data.
18. Restrict access to cabinet after energization.

8.1.11 Server Cabinets

1. Compare equipment nameplate data with design documents.
2. Inspect physical and mechanical condition.
3. Verify the correct ground connection.
4. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cabinet have been removed.
5. Verify connection of power supplies.
6. Verify connections of "Control Network", "Server Network", "Supervisory Network" and "DMZ Network" where applicable.
7. Verify correct labeling and cable tagging in accordance with design documents
8. Verify segregation of wires in accordance with cabinet layout drawings.
9. Perform point-to-point test to determine the resistance between the main grounding system and server cabinet ground, and investigate point-to-point resistance values that exceed 0.5 ohm.
10. Energize the server cabinet.
11. Check settings and performance of the Ethernet copper/fiber network with network tester in accordance with test equipment manufacturer's published data.
12. Verify functionality of Terminal (Remote Desktop), Historian server in accordance with manufacturer's instructions.
13. Restrict access to cabinet after energization.

8.1.12 Operator Interface (HMI)

1. Inspect physical and mechanical condition of workstations.
2. Verify connection of power supply and network cables.
3. Check that the latest version of all graphic displays is present.
4. Check the static and dynamic functionality of operator interface (HMI) displays if it could not be tested at FAT. Test each I/O to the operator interface (HMI) in accordance with the following:
   a) Check the faceplate for the I/O point to confirm that appearance and functionality meet the design requirements:
      - Functionality, service text, range, units, state text, etc.;
      - Link to proper physical I/O point/address;
      - Correct linking of split range control schemes where applicable;
      - Related group display and process group display;
      - Related trends.
   b) Verify that the tag target on the graphic(s) is(are) in the correct location and that the color changes for dynamic targets, for example, valves, motors, bar graphs, etc. are in accordance with design requirements;
   c) Check of alarm assignments- Type, value, priority.
5. Verify Alarm E-mail notification functionality if applicable.

8.2 Site Integration Test (SIT)

The SIT shall ensure that interconnected systems functions together in order to achieve the results based on project requirements. The SIT shall be performed after the SAT for each system/sub-system involved has been completed. Mechanical package control system shall be tested in accordance with the same procedures as the PCS and instrumentation system.

The SIT consists of testing the communication and interaction between the PCS and sub-systems. This includes but is not limited to:

1. Gas Detection Controllers;
2. Power meters;
3. 125 VDC Battery Chargers;
4. UPSs;
5. Electrical Real Time Automatic Controllers and associated 15kV protection system;
6. Generator Controllers;
7. Fire Alarm System;
8. Polymer Mixing systems;
9. Grit blowers;
10. Mechanical Screens ;
11. Washer/Compactors;
12. Raw sewage pump vibration and temperature monitoring system;
13. UV package systems;
14. High speed turbo blower systems;
15. BioFilter system;
16. Rotary Drum Thickeners.
17. HVAC Systems;
18. Chemical Feed Systems;
19. MCC's and VFD's;
20. Fieldbus Networks;

Tests to include but not limited to:

1. Inspection:
   a) Verify that network connection between systems properly installed (serial connection, Ethernet, fiber optics, etc.);
   b) Verify that Baud rate and handshake protocols for communication properly set (dip switches on hardware, software setting, etc).
2. Communications:
   a) Test all communication links between the systems. Test shall be performed as with hardwired I/O, with consideration of transmission times;
   b) Verify communication between systems;
   c) Verify that I/O signals between systems function properly;
   d) Review and update communication settings, IP addressing, network port allocations etc.
3. Operator Interface (HMI):
   a) Verify visualization of subsystems and mechanical packaged systems within the PCS operator interface (HMI) according to the design requirements;
   b) Test functionality against project documents;
   c) Performance check.
4. Hardwired I/O: Test all hardwired I/O between the systems.
5. Functionality: Check functionality in detail with all related alarms, messages, trends, signal updating on graphics and face plates.

8.3 Process Instrumentation Tests

8.3.1 Visual Inspection

1. Compare instrument nameplate data with instrument specification.
2. Inspect instrument, accessories and tubing (air and process) for any damage.
3. Verify that instrument has been installed in accordance with installation details and manufacturer's published data.
4. Verify instrument correct grounding where applicable.
5. Check and verify instrument and instrument cable tagging.
6. Verify that instrument is clean and shipping restraints, stops, and plugs have been removed.
7. Compare process tubing and fitting material and thickness with design documents.
8. Verify slope of process tubing in accordance with installation details or standard practice.
9. Verify correct flow instrument and control valve installation with respect to flow direction.
10. Check accessibility and operability of the control and on/off valves.
11. Verify straight length requirements for flow instruments.
12. Verify insertion length of thermowells.
13. Verify that temperature instruments can be physically installed and removed.
14. Verify that temperature sensors are in contact with bottom of thermowell.
15. Verify installations are in accordance with manufacturer's published data and installation details.

8.3.2 Process Tubing/Fitting Leak Test

1. Instrument process tubing/fitting is typically tested to the pressure limit of the instrument or to a pressure of 1.5 times of the process design pressure, whichever is lower. Instrument air or demineralised water should be used for pressure testing.
2. The leak is typically checked by soaping (snooping) applied to fittings and instrument isolation valve.
3. After the test, the instrument and process tubing shall be drained and blown out.

8.3.3 Air Tubing Tests

1. Air tubing to instruments and analyzers shall be leak tested in accordance with section 8.3.2.
2. Air tubing shall be blown down and tested using instrument air that is filtered and dry.

8.3.4 Analyzer Leak Tests

After completing the installation, the sample line, calibrated gas line and utility lines shall be blown clean and leak tested for the analyzers which are supplied with the sampling and calibration lines.

8.3.5 Instrument Calibration And Configuration

1. Verify configuration of Profibus instruments with Profibus hand-held communicator, Asset Management system (if applicable) or PCS programming/configuration software.
2. Calibrate 4-20 mA instruments in accordance with manufacturer's published data, instrument data sheets and common calibration practices.
3. Calibrate Analyzers in accordance with manufacturer's published data.
4. Gas detectors shall be calibrated in accordance with manufacturer's published data.
5. Record the results on calibration and configuration check sheets.

8.4 Loop Check

Loop checks involve three steps:

1. Documentation check;

2. Installation check;
3. Loop functional check.

Refer to Annex 1.0 for an example of a loop check sheet.

8.4.1 Documentation Check

Documentation check should establish that all documentation necessary for each loop, as listed in Section 3.1.3 of this document, are available and consistent.

8.4.2 Installation Check

The installation of each loop component should be visually checked against the documents to ensure the correct instruments were installed and the installation is in accordance with the hardware specification and installation details. Visual inspection of field instruments should be performed in accordance with section 8.3.1 of this document for field instruments. Visual inspection of other components of the loop should be performed in accordance with section 8.1 of this document.

8.4.3 Loop Functional Check

The purpose of the functional check is to exercise all components of a loop during one test and verify individual and combined proper operation. The functional check of the loops should be performed by process area. The functional check shall include the following:

1. Checking the functionality and interoperability of hardware components of the loop, such as field instruments, segment protectors, input/output cards, Profibus interface cards, processor units, network devices, servers, workstations and connection of the loop to other systems;
2. Checking the configuration and functionality of software components:
   a) Faceplates and graphics;
   b) Alarms settings;
   c) Control (control algorithm, direct/reverse setting);
   d) Interlocking (verification of interlocks typically takes place after the completion of loop checks);
3. Checking of loop reaction during a failure or malfunction;
4. Checking the “fail-safe” action of the loop.

8.4.3.1 Loop Functional Check Method

- **Measurements**
  1. For analog signals use 4-20 mA sources to simulate the transmitter signal. For Profibus instruments, use a handheld communicator connected at the transmitter to simulate the signal. For discrete signals, simulation includes the use of a jumper or lifting a wire/opening a fuse in the circuit.
  2. Simulate values at multiple points (in both increasing and decreasing directions) of transmitter span (0, 25, 50, 75 and 100%) to confirm the sensor/transmitter, HMI and any other indicators all agree.
  3. Simulate values above and below range to confirm failure reaction in PCS.
  4. Simulate a sensor/transmitter failure and/or disconnection to verify the failure reaction in PCS.
  5. Reconnect the transmitter to verify the device is automatically and correctly communicating with PCS.

6. Simulate process variable alarm conditions and check indication, settings and priority level in operator interface (HMI).
7. Simulate process variables increasing or decreasing values over the control set point and verify PCS controller direction (reverse/direct).
8. Alternative method for measurement is to force the sensing element to induce loop functions. Examples would be applying pressure to a pressure transmitter or heat to a thermocouple. It should be done in a manner as close to the way the process will be applied as practical. Forcing a sensor/transmitter usually requires disconnection and reconnection of the sensor, fittings, etc.

- **Actuators/Valves**
  1. Actuate the valve from local and HMI and check for :
     a) On/Off stroke- reaching the fully open and fully closed position in an acceptable time;
     b) Position indication- proper indication at the valve and HMI via limit switch(es), if applicable;
     c) Control stroke- reaching the fully open and fully closed position in an acceptable time. It is also checked at intermediate points such as 25%, 50%, and 75% open in both the increasing and decreasing directions;
     d) Position indication- proper indication at the valve and HMI via limit switch(es) or positioner feedback, if applicable.
  2. Simulate the actuator failure (loss of air supply or electric signal) to verify the correct failure reaction of PCS.
  3. Simulate the limit switch or positioner failure to verify the correct failure reaction of PCS.
  4. Disconnect the actuator; check for the failsafe position and the failure reaction in PCS.
  5. Reconnect the actuator; verify the device is automatically and correctly communicating with PCS.
- **Motor Loops**
  1. Motor loop checks typically occur prior to cold/hot commissioning and should be completed in a manner that process equipment (pumps, agitator, etc.) are not damaged while running dry.
  2. Cycle On/Off: Actuate the motor starter from HMI and local and check for :
     a) Proper operation of the starter and running indication (PCS/local);
     b) Proper operation of the motor.
  3. Cycle VFD: Actuate VFD from HMI and local and check for:
     a) Full speed range-motor speed varying from minimum to maximum;
     b) Intermediate points such as 25%, 50%, and 75%, in both increasing and decreasing directions;
     c) Speed feedback-proper indication of motor speed at VFD and in HMI;
     d) Other signals, such as motor current, motor torque;
     e) Configuration settings are proper and documented.
  4. Confirm the proper size and settings of the motor protection device.

5. Check temperature and vibration monitoring when applicable
6. Simulate motor protection device failure and check correct indication in HMI.
7. Check correct operation of motor protection device in test mode and removed motor fuses.

8.4.3.2 Special Loops

Loops that contain analyzers where special procedures are needed for startup or verification should be checked in accordance with manufacturer's published data in addition to the standard loop check procedure in this document.

8.5 Function Check

8.5.1 Interlock Verification

Verification of interlocks implemented in the PCS typically takes place after the completion of loop checks. A PCS interlock check should not be performed until after all loops involved in the interlock have successfully completed their loop check. The interlock is verified to perform as described in the FRS documentation. The interlock check consists of either forcing or simulating each interlock initiator, one at a time, and confirming that all interlock actions occur at the proper trip points in accordance with FRS.

8.5.2 Sequence Logic Check

Verification of sequence logic implemented in PCS typically takes place after the completion of loop checks. A PCS sequence logic check should not be performed until after all loops involved in the logic have successfully completed their loop check. The sequence logic is verified to perform as described in the FRS documentation. The check consists of either forcing or simulating each sequence logic initiator, one at a time, and confirming that all logic actions occur properly in accordance with FRS.

9.0 Commissioning Phase Tests/Activities

1. Make final adjustments to control point settings which are not set in pre-commissioning.
2. Put field instruments in service.
3. Make final adjustments to alarm settings as required.
4. Perform complex logic function tests which are not completed at pre-commissioning phase.
5. Commission analyzer system with sampling lines in accordance with manufacturer's published data.
6. Monitor the controller and network loading and performance.
7. Perform PID loop tuning as necessary. Document the resulting parameters including a trend screen shot capture.
8. Monitor diagnostic alarms for the PCS including controllers, I/O modules, network modules, Profibus devices, Ethernet switches, power supply modules, Profibus segments and Ethernet network.

Annex 1.0

Example of a loop check sheet

Project No.	Sub-System	Priority	Loop No.

Loop Check Group	Check Method to be used	Loop Service

1. Documentation Available				*Loop documentation complete &available?*	
☐	Instrument specifications	☐	Smart Device Configuration Info	**Results Satisfactory**	
☐	Loop Drawing	☐		Date:	
☐	Alarm list	☐		Name:	
☐	Loop functional requirements	☐		Signature:	

2. Visual Inspection of Installation		*Physical installation correct and complete?*	
☐	All loop components installed and tagged per drawings/specs? Flow direction correct?	**Results Satisfactory**	
☐	Electrical connections tight, covers in place?	Date:	
☐	All IO wiring complete, cards, modules, resistors, supporting infrastructure installed?	Name:	
☐		Signature:	
☐			

3. Functional Check of Loop		*PCT Loop function correct?*
☐	Transfer of Responsibility Form received from Installer?	Notes:
☐	Have any hydrostatic checks that could affect loop components been completed?	
☐	Correct type/size fuses placed in system?	
☐	All components operational?	
☐	Setup/configuration of all components complete, correct, and documented?	
☐	For any loop Fieldbus Devices, are Fieldbus segment checks complete?	

Transmitter								Tag:
	Test Method:	☐ Forced	☐ Fuse	☐ Simulated using:				Notes:
	Span:	Min (LRV):		(URV):		Eng. Units:		
	Indications:	0%	25%	50%	75%	100%	Units	
	Transmitter	increasing / decreasing						
	BPCS	increasing / decreasing						
	SIS	increasing / decreasing						
	Panel/Other	increasing / decreasing						
	☐	Span and units on all readouts (including BPCS) match transmitter?						
	☐	BPCS Graphic and faceplate indications OK?						
	For Temperature: Sensor Burnout			☐Upscale	☐Downscale			
	Transmitter Failure Action:			☐Upscale	☐Downscale		☐Other	
	For AMS-supported loop checks							
	☐	DCS calibration blocks match transmitter?						
	☐	Device self test passed?						

Switch						Tag:
	Test Method:	☐ Forced	☐ Fuse	☐ Simulated using:		Notes:
	Trip setting:			☐ Increasing	☐ Decreasing	
	Reset point:			☐ Increasing	☐ Decreasing	
	Indications:			Off/Contact Open	On/Contact Closed	
		Switch				
		BPCS				
		SIS				
		Panel/Other				
	☐	BPCS graphic and faceplate indications OK?				

BPCS							Point Tag:
☐	BPCS Alarm Settings Correct?	Settings:	HH:	H:	Units:		Notes:
☐	BPCS Alarms Enabled?		L:	LL:			
☐	BPCS Controller Direction Correct? ☐ Direct ☐ Reverse ☐ N/A						

Valve (attach additional sheets if mutliple valves in the loop)							Tag:
Air supply regulator: ☐ set to: PSIG ☐ not required							Notes:
Fail positions: ☐ correct?			Air Off / Electric On		Air On / Electric Off		
☐	Valve strokes properly, no visible signs of problems?						
Throttling Valves	Output	0%	50%	100%	50%	0%	
	Valve Position						
	BPCS Indication						
	BPCS indication setting:		☐ Increasing Open		☐ Increasing Closed		
	☐ Positioner properly set up and stroked? ☐ Not applicable						
ON/Off Valves	Signal to Valve		Off	On	Limit switches		
	Valve Position				☐ open ☐ closed		
	BPCS Indication				☐ none		
	Travel time		Closed to Open				
			Open to Closed				
BPCS Control OK? ☐ fail and not re-open on signal loss/restore? ☐ Auto reset?							

Motor							Tag:
☐ Motor Check Sheet (rotation, meggar, etc.) completed/signed? (Practice 6.5.2)							Notes:
On/Off Motor - Indication/Control			Indication		Control		
Check all control modes (e.g. H/O/A) at all applicable locations.		BPCS	☐ OK	☐ N/A	☐ OK	☐ N/A	
		MCC	☐ OK	☐ N/A	☐ OK	☐ N/A	
		Local	☐ OK	☐ N/A	☐ OK	☐ N/A	
		Panel	☐ OK	☐ N/A	☐ OK	☐ N/A	
Variable Speed Motor - Indication/Control							
Indications:		Drive Local Setpoint			Drive Remote Setpoint		
	Signal	0%	50%	100%	0%	50%	100%
At Drive	increasing / decreasing						
BPCS	increasing / decreasing						
Other	increasing / decreasing						
Control OK? At Drive: ☐ OK ☐ N/A; At BPCS: ☐ OK ☐ N/A; Other: ☐ OK ☐ N/A							
BPCS Control OK? ☐ fail and not re-start on signal loss/restore? ☐ Auto reset?							

Notes/Settings/Conversion Factors/Test Equipment Used

Problems Found & Resolution

Note any discrepancies. Each discrepancy is to be initialed by the person making the correction and by the Project PCTrepresentative witnessing it.

Loop check complete. Loop returned to ready for Commissioning state.	Date:
Project PCT Eng. Representative	**Owner Representative**

Notes:

1- This loop sheet provides guidance for the Contractor to develop loop sheets in mutual agreement

with the Contract Administrator.

2- The term “BPCS”, on the sheet, stands for Basic Process Control System. It is the terminology used by ISA standard for process control system which does not perform any Safety Integrity Level (SIL) rated function. It is equivalent to SEWPCC Process Control System (PCS).

3- The term “SIS”, on the sheet, stands for Safety Instrumented System. It is used by ISA standard for process control system which performs SIL rated functions. The SIS is not applicable to SEWPCC project.

Appendix C

Sample Commissioning Documents

Winnipeg / SNC·LAVALIN	INSTRUMENTATION SWITCH CHECKLIST	Page 1 of 1

Project	
Facility:	Project Name:
Area :	Bid Opportunity:

Instrument		
Tag:	Description:	
Manufacturer:	Model:	Serial Number:

Inspection Checklist

No.	Item to be Inspected	Comments	Pass (P/F)
1.	Instrument type and class per P&ID and specification		
2.	Instrument tag(s) installed and correct		
3.	Installation of sensor complete and correct		
4.	Block and drain valves		
5.	Pneumatic / hydraulic tubing leak tested		
6.	Heat tracing / insulation / instrument housing		
7.	Wiring correct		
8.	Drawings marked up as-built		
9.	HMI Graphic symbol and tag correct		

State Checklist

State	State Desc	PLC Input	Local HMI	SCADA	Alarm	Pass (P/F)
0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
1		☐	☐	☐	☐ On ☐ Off	

Calibration

Transition	Setpoint Trip Point (incl. units)	Actual Trip Point (incl. units)	Setpoint Time Delay	Actual Time Delay	Pass (P/F)
0 → 1					
1 → 0					

Comments:

	Company	Name	Signature	Date (yyyy/mm/dd)
Tested By				
Witnessed By				

Winnipeg / SNC·LAVALIN	INSTRUMENTATION TRANSMITTER LOOP CHECKLIST	Page 1 of 2

Project	
Facility:	Project Name:
Area :	Bid Opportunity:

Instrument (Sensor / Element)		
Tag:	Description:	
Manufacturer:	Model:	Serial Number:

Transmitter		
Tag:	Description:	
Manufacturer:	Model:	Serial Number:
Units:	Design Range: -	
Output	☐ 4-20 mA ☐ 0-10 V ☐ Modbus ☐ Ethernet IP ☐ Other:	

Inspection Checklist			
No.	**Item to be Inspected**	**Comments**	**Pass (P/F)**
1.	Instrument type and class per P&ID and specification		
2.	Instrument tag(s) installed and correct		
3.	Installation of sensor complete and correct		
4.	Block and drain valves		
5.	Pneumatic / hydraulic tubing leak tested		
6.	Heat tracing / insulation / instrument housing		
7.	Impulse lines pressure tested		
8.	Wiring correct		
9.	Drawings marked up as-built		
10.	HMI Graphic symbol, tag and units correct		

Signal Validation					
Input Signal	**Location**	**Design Value**	**Actual Value**	**Error (%)**	**Pass (P/F)**
	Transmitter Display				
	Transmitter Output				
	Process Display				
	PLC				
	HMI				
	Transmitter Display				
	Transmitter Output				
	Process Display				
	PLC				
	HMI				
	Transmitter Display				
	Transmitter Output				
	Process Display				
	PLC				
	HMI				

Notes:

1. Attach factory calbration forms for all instruments where provided and/or specified.
2. Provide instrument parameters for each parameter changed from the factory default.

Comments:

	Company	**Name**	**Signature**	**Date** (yyyy/mm/dd)
Tested By				
Witnessed By				

Winnipeg / SNC·LAVALIN	MODULATING CONTROL DEVICE CHECKLIST	Page 1 of 1

Project	
Facility:	Project Name:
Area :	Bid Opportunity:

Control Device		
Tag:	Description:	
Manufacturer:	Model:	Serial Number:

Inspection Checklist			
No.	**Item to be Inspected**	**Comments**	**Pass (P/F)**
1.	Actuator type and class per P&ID and specification		
2.	Instrument tag(s) installed and correct		
3.	Installation of actuator complete and correct		
4.	Wiring correct		
5.	Drawings marked up as-built		
6.	HMI graphic symbol, tag and units correct		

Control Validation					
Control Output	**Location**	**Design Value**	**Actual Value**	**Error (%)**	**Pass (P/F)**
0%	**PLC Output**				
	Field Device				
50%	**PLC Output**				
	Field Device				
100%	**PLC Output**				
	Field Device				

Notes:
1. Attach factory calbration forms for all instruments where provided and/or specified.
2. Provide instrument parameters for each parameter changed from the factory default.

Comments:

	Company	**Name**	**Signature**	**Date** (yyyy/mm/dd)
Tested By				
Witnessed By				

Winnipeg / SNC·LAVALIN	PID CONTROLLER CHECKLIST	Page 1 of 1

Project	
Facility:	Project Name:
Area :	Bid Opportunity:

Controller Loop	
Tag:	Description:

Test Checklist

No.	Item to be Inspected	Comments	Pass (P/F)
1.	Startup Test		
2.	Input signal positive bump test		
3.	Input signal negative bump test		
4.	Bumpless auto-manual control transition		
4.	Manual output capability		
5.	Bumpless manual-auto control transition		
6.	HMI graphic symbols, tag and units correct		
7.	HMI equipment faceplate correct		

Final PID Tuning Values		
P :	**I :**	**D :**

Notes:

1. Attach printouts of trends for varous tests, with final PID tuning values.

Comments:

	Company	Name	Signature	Date (yyyy/mm/dd)
Tested By				
Witnessed By				

Winnipeg / SNC·LAVALIN	PLC DISCRETE INPUT CHECKLIST	Page 1 of 2

Project	
Facility:	Project Name:
Area :	Bid Opportunity:

PLC	
PLC ID:	Description:
Rack:	Slot:

Pt	Tag	Description	State	State Desc.	PLC Input	Local HMI	SCADA	Alarm	Pass (P/F)
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off ☐ N/A	
			1		☐	☐	☐	☐ On ☐ Off	

			0		☐	☐	☐	☐ On ☐ Off	☐ N/A
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off	☐ N/A
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off	☐ N/A
			1		☐	☐	☐	☐ On ☐ Off	
			0		☐	☐	☐	☐ On ☐ Off	☐ N/A
			1		☐	☐	☐	☐ On ☐ Off	

Comments:

	Company	**Name**	**Signature**	**Date** (yyyy/mm/dd)
Tested By				
Witnessed By				

Winnipeg / SNC·LAVALIN	PLC DISCRETE OUTPUT CHECKLIST	Page 1 of 2

Project	
Facility:	Project Name:
Area :	Bid Opportunity:

PLC	
PLC ID:	Description:
Rack:	Slot:

Pt	Tag	Description	State	State Desc.	PLC Output	Field Device	Pass (P/F)
			0		☐	☐	
			1		☐	☐	
			0		☐	☐	
			1		☐	☐	
			0		☐	☐	
			1		☐	☐	
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Comments:

	Company	**Name**	**Signature**	**Date** (yyyy/mm/dd)
Tested By				
Witnessed By				