INDEX TO

SECTION 40 05 15 – PIPE HANGERS AND SUPPORTS

SECTION 40 05 15

PIPE HANGERS AND SUPPORTS

PART 1—GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. GENERAL: This section specifies hangers and supports for all exposed piping systems specified in Section 40 27 05. This section does not include pipe supports for fire sprinkler systems (if any)or seismic restraints.

2. SCOPE OF CONTRACTOR DESIGN: The Contractor shall provide the services of a "Design Professional" as specified in paragraph 40 27 05–1.01 A to conduct all necessary piping and support design for exposed piping.

   Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Construction Manager for resolution.

   The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.

   Additional requirements are specified in related sections.

3. SCOPE OF WORK BY DESIGN ENGINEER: Design Engineer has undertaken design details for supports and anchors for: selected discharge and intake manifolds; selected special installation requirements; and, selected piping 48–inches and larger. Contractor's Design Professional shall incorporate these features into the Contractor's design.

   Where shown, Design Engineer has also provided guidance in the form of general arrangements that may include specific types of supports or anchorage details. In addition, allowable anchor points and load capacities for potential support structures are shown or otherwise described herein.

B. OPERATING CONDITIONS:

The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:

1. Hot Systems
   A – 1. 120 degrees F to 450 degrees F
   A – 2. 451 degrees F to 750 degrees F
   A – 3. Over 750 degrees F

2. Ambient Systems
   B. 60 degrees F to 119 degrees F

3. Cold Systems
   C – 1. 33 degrees F to 59 degrees F
   C – 2. –20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A 2. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following:

1. The Contractor shall select pipe hangers and supports as needed to protect piping and equipment specified in the project manual. Selections shall be based upon the pipe support classifications specified in MSS–SP 69, the piping insulation thickness specified in Section 40 27 05.09, and any special requirements which may be specified by the Design Professional.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

3. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.

4. Where a particular pipe support design is shown, that design shall be used.

5. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1–inch.

6. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.

7. The pipe hanger and support system shall be coordinated with the seismic restraint system specified under Section 40 05 15.10.

8. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

   a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

   b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

   c. Reaction forces due to test and operational conditions.

d. Reaction forces due to the operation of safety, relief, or other valves.

e. Wind, snow or ice loadings on outdoor piping.

f. Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.

9. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

10. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

11. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

12. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

13. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

14. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper–plated, rubber, plastic or vinyl coated, or stainless-steel hanger and support components.

15. Stock hanger and support components shall be used wherever practical.

16. Fiberglass framing channel shall be provided where specified.

The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

3. Where critical support load requirements have been identified, limiting structural load requirements are shown.

4. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support

the pipe.

5. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.

6. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi–uniform. These quasi–uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.

7. For new construction, unless otherwise shown, pipe may be supported from nearest structural element (floor, ceiling, or wall). The Design Loads for mechanical equipment, as listed in the General Notes sheet of the Structural drawings shall not be exceeded.

8. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.

9. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

The following, project–specific criterion shall also be applied:

1. The spacing for pipe hangers shall not be less than 5 feet and shall not exceed 375 lbs of load for all existing pre–cast, Double Tee roof elements. For hangers off flanges of existing Tees, a washer shall be provided having minimum dimensions of 1/4 inch thick by 4-inch-long and 4 inch wide. The design and projection of those hangers above the roof shall be coordinated with the architectural roofing system.

2. For sodium hydroxide, or calcium hydroxide (lime) systems, pipe supports shall be 60 percent closer than the maximum spacing indicated for plastic piping for water service.

1.02 QUALITY ASSURANCE

A. REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in

effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design – 9th Ed.
FEDSPEC WW–H–171e–78	Hangers and Supports, Pipe
MFMA–2–91	Metal Framing Standards Publication
MSS SP–69–91	Pipe Hangers and Supports – Selection and Application
MSS SP–58–93	Pipe Hangers and Supports – Materials, Design and Manufacture

B. DESIGN:

The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Paragraph 40 27 05–1.01 A. The pipe system drawings specified in paragraph 40 27 05–2.04 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.

PART 2—PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe supports, and components shall be manufactured by B–Line, Carpenter & Patterson, Kin–Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP–69 and FEDSPEC WW–H–171e. Pipe support materials shall conform to the requirements of MSS SP–58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA–2.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be 304 stainless steel. Nuts, bolts and washers shall also be 304 stainless steel.

B. PIPE HANGERS AND SUPPORTS:

Pipe hangers and supports of dissimilar metals than pipe shall be insulated. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.

C. RACK AND TRAPEZE SUPPORTS:

Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

D. STRUCTURAL ATTACHMENTS:

1. TYPE A – MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. TYPE B – SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B–Line B3062, or equal.

3. TYPE C – MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron; tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B–Line B3054, or equal.

4. TYPE D – STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. TYPE E – FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B–Line B280, or equal. Double channel: Unistrut P2073A, B–Line B281, or equal.

6. TYPE F – WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B–Line B3083, Grinnell Fig. 66, or equal.

7. TYPE G – WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

8. TYPE H – CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.

9. TYPE J – ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B–Line B3082, or equal.

10. TYPE K – DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B–Line B297–12 through B297–36, or equal.

11. TYPE L – SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B–Line B198–6, B198–12, B196–18 and B196–24, or equal.

12. TYPE M – WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5.

13. TYPE N – PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2-inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

14. TYPE Q – CONTINUOUS CONCRETE INSERTS: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. ACCESSORIES:

1. HANGER RODS: Rods shall be stainless steel, threaded on both ends or continuous threaded and sized as specified.

2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B–Line B3200, or equal.

3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B–Line B3211, or equal.

4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B–Line B3202, or equal.

5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12–gage carbon steel. Channel shall have a continuous slot along one side with in–turned clamping ridges. Single channel: Unistrut P1000, B–Line B22, or equal. Double channel: Unistrut P1001, B–Line B22A, or equal. Triple channel: Unistrut P1004A, B–Line B22X, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in 40 27 05.09. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

A. STANDARD SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

B. VAPOR BARRIER SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 0133 00:

1. Hanger and support locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04.

2. Design Professional's reports as specified in paragraph 40 05 15–3.05.

PART 3—EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.
Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 ANCHOR BOLTS

Anchor bolts in new concrete shall be cast in place.

3.05 INSPECTION AND CERTIFICATION

The design professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15–1.02 B shall inspect the pipe hangers, support and restraint systems at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed pipe hanger, support and restraint system before the Owner assumes beneficial occupancy and provide written certification, without any qualification statements, that the installation conforms to the design professional's design and the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state.

SECTION 40 05 15

APPENDIX A

PIPE HANGERS AND SUPPORTS TABLES

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS						
NOMINAL PIPE SIZE (INCHES)	SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2		MAXIMUM SUPPORT SPACING (FEET)			
	ROD SIZE (INCHES)	MAX LOAD (POUNDS)	STEEL	COPPER	PLASTIC SEE NOTE 4	CAST IRON SEE NOTE 5
3/8 TO 3/4	3/8	610	5	5	CONTINUOUS	---
1	3/8	610	5	5	5	---
1-1/4	3/8	610	5	5	5	---
1-1/2	3/8	610	5	5	5	---
2	3/8	610	10	5	5	12 FEET FOR PRESSURE PIPE 10 FEET FOR SOIL PIPE
2-1/2	3/8	610	10	10	5	
3	3/8	610	10	20	5	
4	1/2	1130	10	20	5	
6	5/8	1810	15	20	5	
8	3/4	2710	15	20	5	
10	3/4	2710	20	---	5	
12	1	4960	20	---	10	
14	1	4960	20	---	---	
16	1	4960	20	---	---	
18	1	4960	20	---	---	
20	1-1/4	8000	20	---	---	
24	1-1/4	8000	20	---	---	
30	1-1/2	11630	20	---	---	

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.
2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.
3. PIPE SHALL NOT HAVE POCKETS FORMED IN THE SPAN DUE TO SAGGING OF THE PIPE BETWEEN SUPPORTS CAUSED BY THE WEIGHT OF THE PIPE, MEDIUM IN THE PIPE, INSULATION, VALVES AND FITTINGS.
4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. "CONTINUOUS" MEANS PIPE SHALL BE IN UNISTRUT OR SIMILAR CHANNEL.
5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.
6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION SECTION 15096.

TABLE B HANGER AND SUPPORT SELECTIONS

SYSTEM TEMP RANGE DEG F	INSULATION NOTE 1	PIPE ATTACHMENTS								BUILDING STRUCTURAL ATTACHMENTS			
		HORIZONTAL							VERTICAL	STEEL AND/OR MALL. IRON			
		STEEL STRAPS	STEEL BANDS	STEEL CLAMPS	CAST IRON HANGING ROLLS	CAST IRON SUPPORTING ROLLS	STEEL TRAPEZES AND RACKS	THERMAL HANGER SHIELDS	STEEL OR CAST IRON STANCHIONS	STEEL RISER CLAMPS	INSERTS	BEAM CLAMPS	WELDED AND BOLTED ATTACHMENTS	BRACKETS
HOT A-1 120 TO 450	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	10					
HOT A-2 451 TO 750	COVERED	13	1	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	NONE	3	NONE	NONE	20, 21	NONE	NONE					
HOT A-3 OVER 750	COVERED	13	1	3 (ALLOY)	4, 5	8	20, 21	SEE SPEC	10	11, 12	NONE	C, D	F, J, M	B, G, H, K, L
	BARE	13	NONE	3 (ALLOY)	NONE	NONE	20, 21	NONE	NONE					
AMBIENT B 60 TO 119	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	9,10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	9,10					
COLD C-1 33 TO 59	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2, 3	3	4, 5	8	20, 21	NONE	10					
COLD C-2 -2 TO 32	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	1, 2, 3	3	4, 5	8	20, 21	NONE	10					

TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

TABLE C
SEISMIC RESTRAINT SPACING

NOM. PIPE SIZE	MAXIMUM SPAN BETWEEN BRACES		BRACE TYPE	MAXIMUM BRACE LENGTH
	LATERAL BRACE (FEET)	LONGITUDINAL BRACE (FEET)		
2	40	80	A1	9'-4"
2-1/2	40	80	A1	9'-4"
3	40	80	A1	9'-4"
4	40	80	A1	9'-4"
6	40	80	A1	9'-4"
8	40	40	A1	9'-4"
10	40	40	A1	9'-4"
12	40	40	A2	10'-0"
14	30	30	A2	10'-0"
16	25	25	A2	10'-0"
18	20	20	A2	10'-0"
20	16	16	A2	10'-0"
24	10	10	A2	10'-0"

(S) - STANDARD WALL

END OF SECTION

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SECTION 40 05 15.10 – SEISMIC RESTRAINTS FOR PIPING

SECTION 40 05 15.10

SEISMIC RESTRAINTS FOR PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies seismic restraints for bracing all piping systems specified in Section 40 27 05. This section does not include seismic restraints for fire sprinkler systems.

B. DEFINITIONS:

1. Longitudinal direction—direction parallel to the pipe axis.
2. Lateral direction—direction perpendicular to the pipe axis.

C. OPERATING CONDITIONS:

The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.

All piping systems shall be provided with seismic restraints conforming to governing state and local codes. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

D. RESTRAINT SELECTION:

1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Paragraph 40 27 05–1.01 A, this work shall be the product of a Design Professional retained by the Contractor.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.

3. Seismic restraints may be omitted from the following installations:

   a. Gas piping less than 1–inch inside diameter.
   b. All other piping less than 2 1/2–inch inside diameter.

4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.

6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper–plated, rubber, plastic or vinyl coated, or stainless-steel restraint components.

7. Branch lines shall not be used to brace main lines.

8. Seismic bracing shall not limit the expansion and contraction of the piping system.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
MFMA–2	Metal Framing Standards Publication
MFMA–101	Guidelines for the Use of Metal Framing
MSS SP–58	Pipe Hangers and Supports – Materials, Design and Manufacture

Reference	Title
MSS SP–69	Pipe Hangers and Supports – Selection and Application
MSS–SP–89	Pipe Hangers and Supports – Fabrication and Installation Practices
SMACNA	Seismic Restraint Manual—Guidelines for Mechanical Systems

B. DESIGN:

The seismic restraint system shall be designed by the Design Professional retained under Paragraph 40 27 05–1.01 A. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in paragraph 40 27 05–2.04. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

PART 2 – PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B–Line, Kin–Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP–58, MSS–SP–69, MSS–SP–89, MFMA–1, and MFMA–101.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot–dip galvanized after fabrication. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc–coated except for those subject to moisture or corrosive atmosphere, which are listed in paragraph 26 05 00–1.05 B; those compounds shall be type 304 stainless steel. Also listed in paragraph 26 05 00–1.05 B are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe supports, anchor and seismic brace components (not just fittings and accessories) shall be made of fiberglass.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 40 05 15–2.03. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.04 PRODUCT DATA

The following information shall be submitted:

1. Seismic restraint system drawings and calculations as specified in paragraph 40 05 15.10–1.02 B.

2. Seismic restraint locations and legend as specified in paragraph 40 05 15.10–3.01.

3. The Design Professional's reports and certification of final installation as specified in paragraphs 40 27 05–1.01 A and 40 05 15.10–3.03.

PART 3—EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

Ductile and cast-iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

No–hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

Seismic restraint locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15.10–1.02 B.

3.02 INSTALLATION

Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.01 A and 40 05 15.10–1.02 B shall inspect the seismic restraint system at not less than bi-weekly intervals during construction and furnish the Engineer with monthly reports. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

INDEX TO

SECTION 40 05 15.15 – EXPANSION CONTROL FOR PIPING

SECTION 40 05 15.15

EXPANSION CONTROL FOR PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies expansion control for the piping systems specified in paragraph 40 05 15.15-1.01 C. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. DEFINITIONS:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis

C. OPERATING CONDITIONS:

Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.

Those piping systems listed in the following table shall be provided with expansion control conforming to good engineering practice.

Piping system	Minimum temperature, degrees F	Maximum temperature, degrees F
A, AA, BA, CA, IA, SA	17 (exterior –20)	300 (exterior 200)
CS, DS, LSG, MSG (and combinations)	30 (exterior –20)	120
EE	-20	1000
GRR/S	-20	200
HW, HRR/S	70	230
Unlisted Piping (exterior)	-20	120
Unlisted Piping (interior)	30	120

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
EJMA-93	Standards of the Expansion Joint Manufacturers Association, Inc., Sixth Edition, 1993
EJMA-85	A Practical Guide to Expansion Joints, Copyright 1985, Expansion Joint Manufacturers Association, Inc.

B. DESIGN:

The expansion control system shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05-1.01A. Expansion control details

shall be designed in conjunction with preparation of pipe system hangers and seismic restraint systems drawings specified in paragraph 40 27 05-2.04. The resulting drawings and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. DESIGN GUIDELINES:

The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 40 05 15.15-1.02 B:

1. The difference between the minimum and maximum temperatures listed in the table in paragraph 40 05 15.15-1.02 C shall be used for calculating pipe expansion.

2. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.

3. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.

4. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst-case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.

5. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

6. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Construction Manager shall be notified in the submittal required in paragraph 40 27 05-2.04. The requested loads shall be listed and the Construction Manager will redesign the structure as necessary at the Contractor's expense.

7. The test pressures listed in the PIPESPEC sheets shall be used when calculating pressure forces.

8. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Construction Manager.

9. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

10. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 15 and seismic restraints specified in Section 40 05 15.10.

11. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

12. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

13. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

14. Branch lines shall not be used to anchor main lines.

15. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.

1.03 SUBMITTALS

The following information shall be submitted for approval:

1. Expansion control schedules as specified in paragraph 40 05 15.15-3.01.

PART 2 - PRODUCTS

2.01 MATERIALS

Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support. Structural anchors may be fabricated from structural steel and coated. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in paragraphs 26 05 00-1.05 B and C, which shall be Type 304 stainless steel. Also listed in paragraph 26 05 00-1.05 C are corrosive areas specifically requiring fiberglass materials. In

those areas, all pipe support, anchor and brace components (not just fittings and accessories) shall be made of fiberglass.

2.02 PRODUCT DATA

The following product data shall be Submitted for Approval:

1. Anchor bolt calculations.

2. The Design Professional's reports and final certification, as specified under paragraph 40 05 15.15-3.03.

PART 3 - EXECUTION

3.01 EXPANSION CONTROL SCHEDULES

A. GENERAL:

Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by paragraphs 40 27 05-2.04 and 40 05 15.15-1.02 B. In addition, schedules shall be prepared as specified below.

B. ANCHORS:

The anchor schedule shall list as a minimum:

1. Anchor Point Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Forces
6. Load, pounds
7. Direction
8. Anchor Description
9. Remarks

C. GUIDES:

The guide schedule shall list as a minimum:

1. Guide Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Guide Description
6. Remarks

D. EXPANSION JOINTS:

The expansion joint schedule shall list as a minimum:

1. Expansion Joint Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Movement, inches
   a--Lateral movement
   b--Compression movement
   c--Extension movement
   d--Angular movement
6. Maximum Spring Force, pounds
7. Test Pressure, psig
8. Pressure Force, pounds
9. Total Forces
10. Load, pounds
11. Direction
12. Expansion Joint Description
13. Special Features
14. Remarks

3.02 INSTALLATION

The Contractor shall install the expansion control system in accordance with the drawings required in paragraph 40 05 15.15-1.02 B.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

Unless otherwise specified, embedded anchor bolts shall be used instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations. Anchors shall be directly connected to the pipe by welding or another acceptable, positive means.

Components in contact with plastic pipe shall be free of burrs and sharp edges.
Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05-1.01 A and 40 05 15.15-1.02 B shall inspect the completed expansion control system at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed expansion control

system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

INDEX TO

SECTION 40 27 01.02 – STEEL PIPE

SECTION 40 27 01.02

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket–Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot–Dipped, Zinc–Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

Reference	Title
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot–Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium–Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger— Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe—A Guide for Design and Installation
SSPC–SP10	Near–White Blast Cleaning

B. TESTING:

Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2 – PRODUCTS

2.01 PIPE MATERIALS

Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 27 05, Piping Systems.

Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

2.02 PIPE MANUFACTURE

Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 27 05. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

Connections shall be as specified in Section 40 27 05 and shall conform to Section 40 27 05.04. Coating for buried connections shall be as specified in paragraph 40 27 05.04–2.06.

2.04 FITTINGS AND APPURTENANCES

Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. CEMENT MORTAR:

Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2–inch by 4–inch by 13–gage self–furring wire mesh reinforcement for hand–applied lining.

C. HIGH TEMPERATURE SERVICE EPOXY:

Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC–SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.

Glass lining shall be Ferrock MEH–32, Vitco SG–14, or equal.

2.06 PIPE COATING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

   The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. POLYETHYLENE TAPE:

Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

2.07 FUSION EPOXY COATING AND LINING

Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC–SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

Joint gaskets shall be as specified in Section 40 27 05.02.

2.09 PRODUCT DATA

The following information shall be submitted for approval:

1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.

2. Contractor's layout drawings as specified in paragraph 40 27 05–2.04.

PART 3—EXECUTION

3.01 INSTALLATION

A. GENERAL:

Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 27 05.04.

Sleeve–type mechanical pipe couplings shall be provided in accordance with AWWA M11 and paragraph 40 27 05.04–2.02 A.

Pipe lining and coatings at field joints shall be applied as specified in paragraphs 40 27 01.02–2.05 and 2.06.

Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in paragraph 40 27 05.04–2.06.

B. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.03 – PLASTIC PIPE

SECTION 40 27 01.03

PLASTIC PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 40 27 05 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket–Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat–Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2 – PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454–B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe—SDR 26; 200 psi pipe—SDR 21;

250 psi—SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 40 27 05. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push–on IPS–sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 33 05 01.03 as applicable.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454–B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 26. Neoprene gaskets with push–on joints shall conform to ASTM F477.

2. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454–B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447–B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PRODUCT DATA

The following information shall be provided:

1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent–cemented joints shall be made in strict compliance with the manufacturer's/supplier's instructions and recommended

procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push–on joints and steel or ductile iron push–on or mechanical joint fittings. Fittings shall be lined and coated as specified in Section 33 05 01.03. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt–fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt–fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.02 TESTING

Testing of plastic piping shall be as specified in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.04 – COPPER PIPING

SECTION 40 27 01.04

COPPER PIPING

PART 1–GENERAL

1.01 DESCRIPTION

This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

PART 2 – PRODUCTS

2.01 COPPER TUBING

Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

Unless otherwise specified, couplings and fittings for copper tubing 1/2 inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full

bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or equal.

Couplings and fittings for copper tubing larger than 1/2–inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

Solder to be used in copper piping shall be ASTM B32, Alloy Grade Sn95 or Silvabrite 100.

2.04 PRODUCT DATA

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of the copper piping shall be provided in accordance with contract submittal requirements.

PART 3 – EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS:

All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw union type and shall be provided in accordance with paragraph 40 27 05.04–3.03.

C. DIELECTRIC PROTECTION:

Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the Contractor shall provide dielectric protection in accordance with Section 40 27 05.04– 3.05.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

The installation, cleaning, disinfection, and testing of copper piping shall be as specified in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.05 – STAINLESS STEEL PIPING

SECTION 40 27 01.05

STAINLESS STEEL PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies stainless steel pipe and fittings.

B. TYPES OF SERVICE:

Stainless steel piping specified in this section shall be used for ALL Aeration piping.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11.80	Forged Steel Fittings, Socket Welding and Threaded.
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe

Reference	Title
ASME Section IX (1989)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A320/A320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

B. QUALIFICATIONS:

All shop fabricated stainless steel pipe and fittings shall be furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be furnished. The pipe and fittings shall be shop-fabricated and field-installed in accordance with common industry wide practices and methods and shall comply with these specifications.

Only weld procedures which have been qualified under ASME Section IX and only welders who have successfully completed performance qualification tests per ASME Section IX on these qualified procedures shall be utilized.

C. TESTING:

Factory testing shall conform to the requirements of ASTM A312, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 0133 00 Submittal:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.

3. Other data necessary to show conformance of the complete piping system to these specifications.

PART 2 – PRODUCTS

2.01 PIPE

Unless otherwise specified, stainless steel pipe 2-1/2 inches and smaller shall be Type 304L, seamless, threaded joints conforming to ASTM A312. The minimum wall thickness shall be Schedule 40S.

Unless otherwise specified, stainless steel piping 3 inches and larger shall be manufactured from ASTM A240 annealed and pickled sheets and plates, Type304L, in accordance with ASTM A778 or ASTM A409 HT-0. The minimum wall thickness shall be Schedule 5S. Only extra-low carbon (ELC) materials with 0.030 percent maximum carbon shall be used

2.02 FITTINGS

Unless otherwise specified, stainless steel fittings, 2-1/2-inches and smaller, shall be ASTM A403, of the same material and pressure rating as the pipe, threaded long radius with dimensions conforming to ANSI B16.11.

Unless otherwise specified, stainless steel fittings, 3-inch and larger, shall be butt-weld type manufactured in accordance with ASTM A774 of the same material and in the same

thicknesses as the pipe. Reducers shall be straight tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated from pipe.

2.03 JOINTS

Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-weld joints or flanges. Unless otherwise specified, flanged joints shall be Van Stone joints made up of stainless steel slip-on type rolled-angle face rings and ductile iron backup flanges drilled to ANSI B16.1, Class 125 standard. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded, and it shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes. For submerged joints, backup flanges shall be stainless steel plate flanges. The backup flanges shall be supplied with the following nominal thicknesses.

Nominal pipe size, inches	Flange thickness, inches
3	1/2
4	9/16
6-10	5/8

2.04 COUPLINGS

A. GENERAL:

Fabricated stainless steel piping shall be shop-prepared for pipe couplings where specified. Unless otherwise specified, couplings shall be arched-band or grooved type.

B. SLEEVE TYPE:

Sleeve type couplings, where specified, shall be of standard steel construction as specified in paragraph 40 27 05.04-2.02 A. Pipe shall be plain-end with external weld beads ground smooth to ensure proper gasket seating. For pressure pipe lines, sleeve coupling joints shall be restrained by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs shall be welded to the pipe to receive the harness rods.

C. ARCHED-BAND TYPE:

Arched-band type couplings shall be stainless steel of the same material and wall thickness as the pipe and shall be Depend-O-Lok type as manufactured by Brico or equal. Couplings shall be Fixed--FxF, Expansion--ExE, or Fixed by Expansion--FxE as specified or as required. The pipe shall be plain-end with external weld beads ground smooth and with S.S. restraining rings shop-welded to the piping for fixed type couplings.

D. GROOVED-END TYPE:

Grooved-end or split type couplings shall be malleable iron or ductile iron as specified in paragraph 40 27 05.04-2.02 C except that submerged couplings shall be the same material as the pipe. The pipe ends shall be roll-grooved to the coupling manufacturer's specifications. Where roll grooving is impractical, the pipe shall have heavy-wall machine-grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper-bored to the I.D. of the adjoining pipe to allow full-weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

E. EXPANSION TYPE:

Unless otherwise specified, expansion couplings shall be the flanged rubber arch type as specified in Section 40 27 05.06. Pipe flanges shall be provided for these couplings.

2.05 THREADED CONNECTIONS

Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276, shop welded to the pipe at the locations specified.

2.06 GASKETS

Unless otherwise specified, gaskets shall be as specified in the PIPESPECS and in paragraph 40 27 05.04-2.03. For air lines, gaskets shall be neoprene or EPDM suitable for use at temperatures to 240 degrees F.

2.07 BOLTS

Bolts, nuts, and washers for stainless steel flange assemblies and stainless-steel couplings shall be the same material, conforming to ASTM A320 for low-temperature service and ASTM A193 and ASTM A194 for high-temperature service. Bolts, nuts and washers for other couplings shall be as specified in referenced paragraphs for the couplings.

2.08 PIPE SUPPORT SYSTEMS

Unless otherwise specified, all hangers, rods, structural attachments, and other components of support systems for stainless steel pipe shall be of the same materials as the pipe and conform to Section 40 05 15.

2.09 FINISH

After all shop operations have been completed, pipe and fittings shall be pickled and passivated in manufacturer's plant and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed. The standard finish for 16-gage through 8-gage material shall be No. 1 or 2B per ASTM A480; 3/16-inch and heavier plate material shall be No. 1 mill finish or better per ASTM A480.

2.10 PRODUCT DATA

The following information and data shall be submitted for approval:

1. Certifications specified in the following documents:

   ASTM A403, paragraph 14.1
   ASTM A774, paragraph 14.1
   ASTM A778, paragraph 14.1
   ASTM A409, paragraph 17.1

2. Test results specified in paragraph 40 27 01.05-1.02 C.

3. Names and qualification records of proposed welders.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.02 WELDING

A. GENERAL:

Piping with wall thickness up to 11 gage (0.120 inch) shall be welded with the TIG (GTAW) process. Unless otherwise specified, heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

B. FIELD WELDING:

Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the but welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.

All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Eucleen," or equal, followed by complete removal of the agent.

C. PREPARATION OF SURFACES TO BE WELDED:

Surfaces of joints to be welded shall be free from mill scale, slag, grease, oil, paint, rust, and other foreign material. Joints to be welded shall be wire-brushed with stainless steel wire brushes and precisely fitted before welding.

D. WEATHER CONDITIONS:

Welding shall be done only when the surfaces are completely free of any moisture. Welding of the pipe shall not be done during periods of high winds or rain unless the areas being welded are properly shielded.

E. TACK WELDS, CLIPS, AND OTHER ATTACHMENTS:

Nicks, gouges, notches, and depressions in the base metal in the area of the joint shall be repaired before the joint weld is made. Tack welds, clips, and other attachments shall be removed and defects repaired, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed. Areas to be repaired shall be ground to clean metal and then repaired by building up with weld metal. The repaired areas shall be ground smooth to form a plane surface with the base metal.

F. DEFECTS AND REPAIRS:

Welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications shall be removed by chipping or grinding throughout their depth to clean base metal. Calking or peening of welds to correct defects shall not be done. Welds found deficient in dimension but not in quality shall be enlarged by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate. Weld deposits, slag, weld spatter, and projections into the interior of the pipe shall be removed by grinding.

3.03 MARKING, SHIPPING, AND STORAGE

All pipe, fittings, and fabrications shall be properly marked with type, gage, and heat number. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

3.04 FABRICATION/INSTALLATION REQUIREMENTS

The piping supplier during manufacturing, fabricating and handling stages, and the Contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless-steel piping. All saws, drills, files, wire

brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber-lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS, or equal, scrub with stainless steel brushes, and rinse clean.

3.05 COATINGS

After installation, the Contractor shall paint all steel or iron flanges, couplings, and appurtenances. Painting of the stainless-steel pipe is not required. However, the Contractor shall be responsible for supplying and installing the stainless-steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless-steel surface shall be washed with detergent and hot water and rinsed clean.

END OF SECTION

INDEX TO

SECTION 40 27 05 – PIPING SYSTEMS

SECTION 40 27 05

PIPING SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. General – This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 40 and 33. This section shall be used in conjunction with those sections.

   Most of the valves are provided on this project by Kubota as part of their equipment package. The valves listed in this specification are for valves that are not part of their package. The contractor shall coordinate with Kubota to confirm the pipe connections to the valves supplied in their package.

   Contractor shall provide all piping and ancillary devices as shown, specified and required to provide a fully functional system.

2. Contractor Design of Piping Systems – In addition to materials, labor, and plant required to construct piping systems, Contractor shall provide professional engineering services ("Design Professional") for the design and inspection of piping systems work.

   The Contractor shall provide the final design, inspection, and certification for the piping supports, seismic restraints, and provisions for control of dynamic forces and pipe expansion for buried and exposed piping on this project. Pipe supports are specified under Section 40 05 15. Seismic restraints are specified under Section 40 05 15.10. Pipe expansion control systems are specified under Section 40 05 15.15. The design of these systems shall be the product of a professional engineer currently licensed to practice in the State of South Carolina retained by the Contractor. The professional engineer (hereinafter and in all referenced sections the "Design Professional") shall obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate to be in effect for duration of this project plus one year. The Design Professional shall have not less than five years experience in the type of piping support, seismic restraint and expansion control design work required for this project. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. Documentation demonstrating qualifications and insurance shall be submitted.

B. Definitions:

Pressure terms used in Section 40 27 05 and elsewhere in Division 40 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc–Coated Welded and Seamless

Reference	Title
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A536	Ductile Iron Castings
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile–Iron Piping for Water and Other Liquids
AWWA C110	Ductile–Iron and Gray–Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber–Gasket Joints for Ductile–Iron and Gray–Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile–Iron and Gray–Iron Pipe with Threaded Flanges
AWWA C151	Ductile–Iron Pipe, Centrifugally Cast in Metal Molds or Sand–Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger—Shop Applied
AWWA C206	Field Welding of Steel Water Pipe

Reference	Title
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe—A Guide for Design and Installation
FEDSPEC L–C–530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL–H–13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL–STD–810C	Environmental Test Methods
UPC	Uniform Plumbing Code

B. Fittings and Coupling Compatibility – To assure uniformity and compatibility of piping components, fittings and couplings for grooved–end or shouldered–end piping systems shall be furnished by the same manufacturers.

C. Piping Supports, Seismic Restraints, and Expansion Control – Piping supports, seismic restraints, anchorage, and expansion control shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05–1.01A. There may be situations where the Owner wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be shown and shall be incorporated into the Design Professional's design.

Mandatory anchorage locations will be identified on the mechanical drawings, and maximum limitations, if any, for structure loads from the anchor will listed in kips, e.g. "X, 50", identifying location and 50,000 lb–force. Where structural load would be exceeded, piping flexibility or expansion joints shall be provided to achieve the maximum loading. If a support, anchor, seismic restraint or expansion element is detailed on the drawings, then those elements shall be incorporated into the

Contractor's design. Piping submittals by the Contractor shall include all elements, including those portions directed by the Owner, as well as complete piping runs. The structural reaction loads for all fixed supports shall be calculated and shown. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

D. Buried Piping – All buried piping shall be designed as fully–restrained systems. Where required, Design Professional shall size temporary and/or permanent thrust restraints. Restraint systems shall be designated to allow complete piping system disassembly without destructive measures.

Buried piping shall be provided as specified. Unless otherwise noted, materials specified in the PIPESPEC shall be used. Thicknesses specified in the PIPESPEC or referenced specifications shall be considered minimums. Excavation, installation and backfill shall be as specified.

Piping submittals by the Contractor shall include all elements, including those portions directed by the Owner, as well as complete piping runs. If a particular type of restraint or expansion element or approach is detailed on the drawings, then those elements shall be incorporated into the Contractor's design. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

1.03 SUBMITTALS

The following material shall be submitted for approval:

1. The qualifications of the Design Professional to be charged with design, inspection and certification of pipe supports, thrust and seismic restraints and pipe expansion control systems including education, proof of registration, proof of insurance, and previous experience in performing this type of work. The documentation shall be sufficient to demonstrate compliance with the requirements of paragraph 40 27 05–1.01 A. ***No further submittals under this or any related section will be considered until the qualifications of the Design Professional have been reviewed and accepted by the Construction Manager of Engineer of Record.***

2. A copy of this specification section, along with Sections 40 05 15, 40 05 15.10 and 40 05 15.15, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced

to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager and Engineer of Record shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. **Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.**

PART 2 – PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 40.

New and existing piping is designated by service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Contractor shall investigate and provide suitable connections, including electrical isolation, as necessary.

2.02 PIPING IDENTIFICATION

A. Plastic Coding Markers – Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, Marking Services Inc., or equal. Markers shall be the mechanically attached types that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL–STD–810C. Markers shall withstand a continuous operating temperature range of –40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside Pipe Diameter,[a] Inches	Letter height, inches
Less than 1–1/2	1/2
1–1/2 through 3	1–1/8
Greater than 3	2–1/4

[a] Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni- and bi-directional arrows, indicating flow direction, in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. Plastic Tracer Tape – Tracer tape shall be 6 inches wide, colored the same as the background colors as specified in Table A, paragraph 40 27 05-3.07, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

Two messages shall be printed on the tape. The first message shall read ***"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"*** with bold letters approximately two inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read "***CALL_____***" with letters approximately 3/4 inch high. Both messages shall be printed at maximum intervals of 2 feet.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W.H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal. Tape shall be acid and alkali-resistant, three inches wide, 0.005-inch thick, and have 1,500 psi strength and 140% elongation value. The tape shall be colored the same as the background colors as specified in paragraph 40 27 05-3.07 and shall be inscribed with the words **"CAUTION—PIPE BURIED BELOW"** and the name of the piping system.

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non-asbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111. Valve operators are specified in Section 40 29 01.

2.04 PRODUCT DATA

Product data on piping materials and layout shall be submitted for approval:

A. Pre-Construction Data – All information specified shall be transmitted to the Engineer a minimum of four weeks prior to construction.

1. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 15, 40 05 15.10, and 40 05 15.15. The drawings and calculations shall be sealed and submitted by the design professional specified in paragraph 40 27 05-1.02C through the Contractor. The Design Professional shall affirm that loads on structures are within the load limits noted on the contract documents.

2. Manufacturers' product literature on each bend, coupling, fitting, bolt, gasket, restraint or other item provided pursuant to this section.

3. A schedule showing the quantity provided and the piping system for each

item provided under this section.

4. Piping layout drawings, for both exposed and buried piping systems, depicting supports, locations of support, fittings and restraints, seismic restraint provisions, and other pertinent information, including wall and floor penetrations, where applicable. Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor and depicted on piping layout drawings. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

   Layout drawings and other Product Data shall be defined and depicted by system.

B. Post–Construction Data: - Inspection reports, authored, sealed and signed by the Design Professional retained under the provisions of paragraph 40 27 05–1.02 A. shall be submitted to the Construction Manager each week, as provided under paragraph 40 27 05–3.04. The Design Professional's final report shall be submitted to the Construction Manager and Engineer of Record before beneficial occupancy by the Owner, as provided under paragraph 40 27 05–3.04.

2.05 PIPE AND VALVE COMPATIBILITY

Selected pipe and pipe end connections for valves, or other equipment, shall be fully compatible within each piping system. Contractor shall coordinate the selection of pipe materials, linings and end connections so that valves operate properly over their entire range (e.g. sufficient disk clearance for butterfly valves). Selected end connections shall also be suitable for specified valve or equipment (e.g. wafer style valves or spectacle flanges shall be properly supported between flanges of equal inside diameter).

PART 3 – EXECUTION

3.01 INSTALLATION

A. Location – The Contract drawings are, in part, diagrammatic. Piping shall be provided as specified except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction. Adjustments to new piping shall be made to avoid interference and shown on the pipe layout drawings.

   Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

B. Piping Sizes – Where the size of piping is not specified, the Contractor shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than one inch in diameter) required for services not described by UPC shall be 1/2 inch.

C. Existing Piping Materials – Contractor shall pothole existing pipe at connections to new pipe to confirm material and joints prior to commencement of work.

D. Pipe Support, Anchorage, and Seismic Bracing:

1. General – Piping shall be supported by anchor brackets, guides, saddles or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the design professional retained under the provisions of paragraph 40 27 05–1.01 A. The details for the piping support, anchorage, seismic bracing, and expansion control systems shall be submitted with the Contractor's piping layout drawings as product data under the provisions of paragraph 40 27 05–2.04.

   Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support, expansion/contraction and for seismic bracing, as well as anchorage details, are referenced in Sections 40 05 15, 40 05 15.10 and 40 05 15.15 or shown on the drawings. Where a specific type of support or anchorage is indicated on the drawings, then only that type shall be used at that location.

   Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced as required to resist seismic loads. Supports shall be provided on each run at each change of direction. Piping supports manufactured of iron or steel shall be hot–dip or mechanically galvanized.

   Unless otherwise specified, existing pipes and supports shall not be used to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

2. Piping Connections to Machines – Piping at machine connections shall be aligned in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come–a–longs or other mechanical means to align field piping with the connections at the machines. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

E. Anchorage for Buried Piping – All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

F. Bedding and Backfill – Bedding and backfill for buried piping shall be as specified and as shown on the drawings.

G. Equipment Connection Fittings - Equipment connection fittings, as specified in Section 40 27 05.04, shall be provided between field piping systems and equipment inlet and outlet connections.

H. Buried Pipe at Structures – Unless otherwise specified, buried piping shall have two flexible fittings or couplings where pipe passes through structures per Section 40 27 05.04 and as shown on the drawings. Restraints across each joint shall be provided.

3.02 PIPING IDENTIFICATION

A. Pipe Coding – After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers as specified in paragraph 40 27 05–2.02 A. Legend markers and directional arrows shall be located at each side of walls, floors, and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. Plastic Tracer Tape – A single line of tape as specified in paragraph 40 27 05–2.02 B shall be provided 2.5 feet above the centerline of buried systems 4, 5, and 7 pipe. For systems 4, 5, and 7, pipelines buried eight feet or greater below finished grade, Contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermosetting resin pipe lines. For pipelines buried eight feet or greater below final grade, the Contractor shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4-inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves eight inches in diameter and larger shall have tags attached to the valve body by self-tapping corrosion resistant metal screws. Flangeless valves six inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

3.04 INSPECTION

The Contractor shall cause the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A to inspect the interior installation of the piping supports, anchorage, seismic restraints, and expansion control systems provided under this contract.

Upon completion of construction, but prior to beneficial occupancy of the piping systems by the Owner, the Design Professional shall conduct a detailed final inspection and furnish the Construction Manager with a final report in accordance with Section 40 05 15 requirements.

3.05 TESTING

A. General – Upon completion of piping, but prior to application of insulation on exposed piping, the Contractor shall test the piping systems. Pressures, media and test durations shall be as specified in the PIPESPEC. Equipment which may be

damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, the Contractor shall notify the Construction Manager 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. Gas, Air, and Vapor Systems: The Contractor shall test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.

Testing medium and procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D.

Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

Pipeline Size	Specified Test Pressure	Testing Medium
2 inch and smaller	75 psi or less	Air or water
2 inch and smaller	Greater than 75 psi	Water
Greater than 2 inch	3 psi or less	Air or water
Greater than 2 inch	Greater than 3 psi	Water

The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas, and natural gas systems.

The allowable leakage rate for other systems tested with air shall be based on a maximum pressure drop of five percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure.

C. Liquid Systems – Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Testing procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D. Testing procedures for hydraulic and lube oil systems are specified in paragraph 40 27 05–3.05 E. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

D. Hydraulic and Fluid Power Oil Systems – Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be

cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Drains – Drain systems, other than pumped drain systems, shall be tested in accordance with UPC.

3.06 CLEANING AND FLUSHING

A. General – Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, and regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Temporary Screens – Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 –1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

The Contractor shall maintain the screens during testing, initial start-up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. The Contractor shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Liquid systems handling solids shall have screens in place for clear water testing and operation. Initial operation on solids following clear water testing may be without screens.

C. Gas and Air Systems – Unless otherwise specified, gas and air system piping six inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than six inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an airstream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until

put in service. Chlorine and sulfur dioxide systems shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

D. Liquid Systems – After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens. Liquid chlorine and sulfur dioxide lines shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Potable Water Systems – Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

3.07 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS and on the drawings are alphabetically arranged by designated service symbols as shown in Table A. Table A also indicates the piping material system number, fluid category, and pipe marker background color of each service.

Table A: Process Piping Services

Pipe Designation	Pipe Service	Material	Interior Lining	Test Pressure, Psi
2W	Nonpotable City Water	ST	–	200
3W	Service Water (Filtered Effluent)	ST	–	200
CA	Compressed Air	SS	–	20
DR / TD	Drain	DI	CL	125
DSF	Diesel Fuel	ST	–	150
FE	Final Effluent	DI	CL	125
NaOH	Sodium Hydroxide	PVC	–	150
PA	Process Air	SS	–	20
PRMT (inside)	Permeate	PVC	–	125
RAS	Return Activated Sludge	ST /DI	EP	125
RS	Raw Sewage	ST /DI	EP	125
SHC	Sodium Hypochlorite	PVC*	–	150
SL	Sludge	DI	EP	100
WAS	Waste Activated Sludge	ST /DI	EP	125

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: CA—Compressed Air
PA – Process Air

Test Requirements:

Medium: Air; ref. spec paragraph 40 27 05–3.04 B.
Pressure: 20 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Mech Cpl: EPDM

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Stainless steel; ASTM A312, Schedule 40S. Ref. spec Section 40 27 01.05.
Conn; threaded, ANSI B1.20.1.
Ftgs; ASTM A403, material, ends and wall thickness to match pipe.

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Lift check; Crane 27TFE, Lunkenheimer 231, or equal.

(3" and larger)

Pipe: Stainless steel; ASTM A778. Ref. spec Section 40 27 01.05.
Conn; butt weld or flanged, couplings where specified.
Ftgs; ASTM A774, material, ends and wall thickness to match pipe.

Valves: Butterfly; ref. spec. Section 40 29 13. Line with 10 mils of epoxy per spec Section 40 27 01.02.

Remarks:

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: FE—Final Effluent

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig

Duration: 60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1. Flanged adapters for 2–1/2 inch, 3 inch valves.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

(2" and smaller)

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(4" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, with cement mortar lining. Ref. spec Section 40 27 01.02.
Conn; grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel, per spec Section 40 27 01.02; ends and lining to match pipe.

Or

Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

(2 1/2" thru 8")

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.
Swing check; spring loaded per spec Section 40 29 27.

(10" thru 24")

Pipe: Steel; same as 8 inch or AWWA C200, 3/16 inch thick, with cement mortar lining. Ref. spec Section 40 27 01.02.
Conn; same as 8 inch. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208. Lining and ends to match pipe.

Valves: Butterfly; ref. spec Section 40 29 13.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454-B, NSF certified, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2-1/2-inch lines.

(4" to 12")

Pipe: Ductile iron; AWWA C151 with cement mortar lining. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push-on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: 2W—No. 2 Water (nonpotable City Water)
3W—No. 3 Water (Filtered / Chlorinated Effluent)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05-3.04 C.
Pressure: 200 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push-on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1.

Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Ball; Jamesbury Fig. 351, Nibco T-580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(2 1/2" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2-1/2-inch lines.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Gate; ref. spec Section 15101, with extension stem and valve box. Coating.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push-on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08-3.03.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: TD–Tank Drain

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2 1/2" thru 4")

Pipe: Steel; ASTM A53 ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

(6" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

Buried and Encased Pipe:
(See drawings for pipe size. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.

Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: RAS—Return Activated Sludge
WAS—Waste Activated Sludge
RS– Raw Sewage Test Requirements:
Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)

Pipe: Steel; ASTM A53, galvanized. .
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSIB16.3, Class 150, galvanized.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Swing check; Lunkenheimer 230, Crane 137, or equal.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Epoxy Lined Ref. spec Section 33 05 01.03.
Conn; flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Check; per spec Section 40 29 27.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: SL—Sludge

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 100 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; flanged or mechanical.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 019. Install valve with seat upstream.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: DSF—Diesel Fuel

Test Requirements:

Medium: Fuel oil; ref. spec paragraph 40 27 05–3.04 E.
Pressure: 150 psig (pressure piping)
5 psig (nonpressure piping)
Duration: 60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–On/Mech Call: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A106, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.
Conn; threaded or socket weld with threaded adapters for valves.
Ftgs; forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled.

Valves: Lubricated plug; cast iron, PTFE coated plug, Nordstrom Fig. 142, Walworth Fig. 1796, or equal.
Lift check; Crane 27TF, Lunkenheimer 231, or equal.

(2 1/2" thru 12")

Pipe: Steel; ASTM A53, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.

Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, seamless, ANSI B16.9, pickled; ends shall match pipe.

Valves: Lubricated plug; cast iron with PTFE or molydisulfide coated plug, Nordstrom Fig. 143, Walworth Fig. 1797F, or equal, thru 5 inch; worm gear operator Rockwell Fig. 149, Walworth Fig. 1727F, or equal, 6 to 12 inches.

Swing check; cast iron, flanged, Jenkins 1025–B2, Walworth 5344F, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type.)

(2" and larger)

Pipe: Reinforced thermosetting resin (RTRP); Type 1, ref. spec Section 15058. Double containment unless otherwise specified. Provide magnetic tracer tape.
Conn; bonded bell and spigot or flanged.
Ftgs; RTRP to match pipe, ref. spec Section 15058.

Valves: Lubricated plug; same as exposed with extension stem and valve box.

Remarks:

1. The cleaning (pickling) solution used shall comply with Mil–H–13528B. Immediately following pickling and rinsing procedures, steel pipe and fittings shall be coated inside and outside with a rust and corrosion preventative system, and the ends sealed to prevent the entry of dirt.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: PRMT – Permeate
NaOH–Caustic Soda
SHC—Sodium Hypochlorite (See Remark 1)

Test Requirements:

Medium:	Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure:	150 psig
Duration:	120 minutes

Gasket Requirements:

Flange: PTFE bonded EPDM, full–face gaskets, ANSI B16.1.
Push–on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.
Conn; plain end, solvent weld, flanged for valves 3 inch and larger.
Ftgs; PVC, Sch. 80, solvent weld.

(4" and less)

Valves: Ball; PVC Chemtrol Tru Bloc TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and EPDM 0–rings.
Diaphragm; PVC body, Chemtrol Series PD, Posacon 677, Asahi/America, or equal with EPDM or PTFE diaphragm.
Ball check; PVC body, Chemtrol Series BC, Asahi/America, or equal with EPDM or PTFE seats/seals.

(5" and larger)

Valves: Diaphragm; ITT Dia–Flo 2558–2–M, Hills–McCanna 0649–1–38, or equal.
Swing or ball check; fully lined valve body; fully coated swing check flapper or ball check ball; lining and coating shall be Hypalon or fluorinated ethylene propylene. Valve and Primer Co. APCO Series 100R, Peabody Dore Model 770, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: PVC; same as exposed. Provide magnetic tracer tape.
Conn; same as exposed.
Ftgs; same as exposed.

(2" and less)

Valves: Ball; same as exposed with extension stem and valve box.

(2 1/2" and larger)

Valves: Diaphragm; same as exposed with extension stem and valve box.

Remarks:

1. For HOCL service, the following shall apply:

   a. Ball valves are not permitted on HOCL service.

b. Diaphragm valves 4 inches and smaller shall be provided with PTFE diaphragms; valves 5 inches and larger shall be provided with Hypalon or PDVF linings with PTFE diaphragms.

c. Sodium hypochlorite solvent weld shall be with adhesives developed specifically for NaOCL service.

2. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

END OF SECTION

INDEX TO

SECTION 40 27 05.02 – JOINT GASKETS

SECTION 40 27 05.02

JOINT GASKETS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D395	Rubber Property--Compression Set, Test for
ASTM D412	Rubber Properties in Tension, Test for
ASTM D471	Rubber Property--Effect of Liquids, Test for
ASTM D573	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240	Rubber Property--Durometer Hardness, Test for

B. Testing - Certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified in paragraph 40 27 05.02-2.02 shall be provided as product data.

PART 2 – PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50% by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. Tensile (ASTM D412) – The tensile strength shall be 1,500 psi minimum and the ultimate elongation shall be 350 percent minimum.

B. Hardness (ASTM D2240, Type A Durometer) – The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

C. Compression Set (ASTM D395) – The compression set shall not exceed 20% when compressed for 22 hours at 70 degrees C.

The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 ($\pm$ 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 $\pm$ 0.010 inches in diameter.

D. Aging (ASTM D573) – The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

E. Effect of Liquids (ASTM D471): The maximum volume change in oil and in water shall be as follows:

1. Oil: 100% in ASTM oil No. 3.

2. Water: 15%.

The test specimens shall have a thickness of 0.080 $\pm$0.005 inches and shall be circular discs cut from the gasket.

F. Ozone Cracking (ASTM D1149) – The test specimen shall be a gasket loop mounted to give at least 20% elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 °C.

2.03 PRODUCT DATA

Provide certified copies of test reports specified in paragraph 40 27 05.02-1.02 B.

PART 3 – EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 27 05.04 – PIPING CONNECTIONS

SECTION 40 27 05.04

PIPING CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME BI.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI BI.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials

Reference	Title
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

Provide catalog data demonstrating compliance with this specification and giving full description of the piping connections shall be provided in accordance with contract submittal requirements.

PART 2 – PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:

1. General – Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.

2. Flat Flanges – Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.

3. Convoluted Ring Flanges – Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products. The Construction Manager knows of no equal. The flange joints shall be rated for not less than 150% of the test pressures listed in Section 40 27 05 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

B. Gaskets:

1. Gasket material shall be as specified in paragraph 40 27 05.04-2.03.

2. Gaskets for plain faced flanges shall be the full-face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter, and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16-inch-thick for pipe 3-1/2 inches and less in diameter and 1/8-inch-thick for pipe 4 inches and larger.

C. Bolts:

1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI BI.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5. **All bolts shall be coated with an anti-seized product. No bolt treads shall be painted.**

2. Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.

2. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C111.

B. Plain End Couplings:

1. Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.

2. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C606.

C. Grooved End Couplings:

1. Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

2. Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C 606.

D. Dismantling Joints – Dismantling joints may be used as takedown couplings in accordance with paragraph 40 27 05.04-3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment

connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

E. Sleeve Band Couplings – Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 40 27 05.04-2.02 A.)

2.03 GASKETS

Gaskets designated in Section 40 27 05 shall be as follows:

A. EPDM: ethylene-propylene-diene-terpolymer.

B. Neoprene: neoprene.

C. Nitrile: nitrile (Buna N).

D. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).

E. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).

F. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).

G. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).

H. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

I. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

J. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI BI.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated.

2.07 PRODUCT DATA

The Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

A. Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 40 27 05. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 40 27 05.

B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within three feet of the wall, unless specified otherwise.

B. A union or flanged connection shall be provided within two feet of each threaded end valve.

3.04 FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within two feet of the structure for 2-inch through 6-inch diameter pipe; within three feet of the structure for 8-inch through 24-inch diameter pipe; and within 1.5 pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

Where a copper pipe is connected to steel or cast-iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 40 27 05.04-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

END OF SECTION

INDEX TO

SECTION 40 27 05.06 – EXPANSION JOINTS

SECTION 40 27 05.06

EXPANSION JOINTS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies piping expansion joints.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

B. Selection Criteria – The selection and installation of expansion joints shall be in conformance with the expansion control system designed by the Design Professional, retained under the requirements of paragraph 40 27 05–1.01 A, and the criteria specified herein. This requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. Design Criteria:

1. General – Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in the Piping System Specification Sheets (PIPESPEC) without crimping of corrugations.

2. Expansion Joints – Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

1.03 SUBMITTALS

The following submittals shall be submitted for approval:

A. Design and construction details of formed metal bellows type expansion joints.

B. Pressure thrust force and spring rate data for formed metal bellows expansion joints.

C. Details for installation of all expansion joints.

D. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.

PART 2 – PRODUCTS

2.01 EXPANSION JOINTS

A. Metal Construction:

1. Formed Bellows Type:

a. Formed bellows type expansion joints for temperatures up to 800 °F shall have 300 series stainless steel multi-ply bellows rated for the specified design temperature and pressure. Test pressures are specified in Section 40 27 05. Each expansion joint shall be factory tested at the test pressure. Ductwork expansion joints may be rated at less than 50 psig but must be rated equal to the design pressure and, in no case, less than 2 psig.

b. Expansion joint design shall be determined by the amount and kind of movement specified (axial, lateral, angular). Unless otherwise specified, end connections shall be flanged. Formed bellows type expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or equal.

2. Steel Expansion Compensator Type – Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Hyspan Series 8500, Keflex 7Q, or equal. Compensators shall have 2-ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.

3. Bronze Expansion Compensator Type – Bronze expansion compensator type expansion joints shall be Flexonics Model HB Expansion Compensator,

Hyspan Series 8500, Keflex 7Q, American BOA Inc., or equal. Compensators shall have multi–ply phosphor bronze or stainless-steel bellows and copper tube end fittings. Compensators shall be rated for 150 psi maximum working pressure and 400 °F.

B. Elastomer and Fabric Construction:

1. General:

a. Elastomer and fabric expansion joints shall be the standard spool arch type or the precision molded spherical design type as indicated or specified. Expansion joint connectors shall have control units (restraints) to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer. Unless otherwise specified, single arch and sphere type expansion joints shall have 6–inch face–to–face dimension for pipe up to eight inches and 8–inch face–to–face dimension for pipe 10 and 12 inches.

b. The cover elastomer shall be chlorobutyl, neoprene or EPDM. For temperatures between 180 and 240 °F, the tube elastomer shall be chlorobutyl or EPDM. Neoprene or Buna N liners are acceptable for temperatures to 180 °F.

c. Elastomer and fabric type expansion joints used for exterior service shall have ultra–violet light protection.

d. Elastomer and fabric type expansion joints shall not be used for pump discharge piping and where surge forces may be expected.

2. Spool Type:

a. Spool type expansion joints shall be of the resilient arch type and shall be standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.

b. Spool type expansion joints shall be constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body. Standard arch type expansion joints suitable for the specified temperature and pressure shall be provided with retaining rings or backup rings. Retaining rings shall be 3/8–inch thick steel, split, either galvanized or zinc shield coated. Expansion joints, single, multiple, or filled arch, shall be Mason Style EJBN, Garlock Style 204, Mercer Style 500, Goodall Style E–1462, General Style 1025, or equal.

c. Filled arch type shall be used on all piping systems carrying fluids containing solids. High pressure couplings suitable for 240 °F operating temperatures shall be Mason Style EJBN–HD, Mercer Style 510, Garlock Style 204–HP, Goodall Style E–1489, General Style 1015, or equal.

3. Spherical Molded Type – Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid. Single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E–611, General Type 1010, Garlock Style 8100, or equal. Double sphere or triple sphere connectors shall be provided where required to provide for the specified movement.

C. Polyvinylchloride Construction - Polyvinylchloride expansion joints shall be Celanese "Chemtrol" CPVC slip type with Teflon impregnated seal rings, Certain–teed Fluid Tite PVC, Johns–Manville PVC double bell expansion joint, or equal.

D. Teflon Construction – Teflon expansion joints shall be molded TFE bellows and shall be Metraflex T–2, Garlock Style 215, Resistoflex R–6905, EGC Style M–150, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Expansion joints and anchors shall be located as specified. Location and number of guides shall be determined from EJMA Standards.

B. Expansion joints shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

C. Unless otherwise specified, expansion joints four inches and larger shall be furnished with control rods.

3.02 ALIGNMENT

Piping systems shall be aligned prior to installation of expansion joints. Expansion joints shall not be used to correct piping misalignment during installations. Expansion joints normally preset at the factory for rated axial compression and expansion shall be installed in this preset condition.

3.03 EXPANSION JOINT AND CONNECTOR SCHEDULE

Expansion joints provided for specific equipment items or piping systems are specified on the following schedule. The location of piping system expansion joints and design criteria, including temperature, pressure and movement for each joint, are specified and/or shown on the drawings.

Expansion Joint and Connector Schedule

Type of Expansion Joint/Connector	Type of Service/Use
Formed metal bellows; medium temperature (2.01 A.1.a.)	Boiler exhaust, hot water, high pressure air, and gas and steel lines subjected to ambient temperature differentials sufficient to require expansion joints.
Steel expansion compensator (2.01 A.2.)	Same type service/use as for "formed metal bellows type expansion joint" except size of piping is limited to 3-inch diameter or less.
Bronze expansion compensator (2.01 A.3.)	Copper piping.
Elastomer spool arch (2.01 B.2.)	Blower connectors and expansion joints for piping 14-inch diameter and larger.
Elastomer spherical molded (2.01 B.3.)	Blower connectors and expansion joints for piping 12-inch diameter and less.
PVC (2.01 C.)	PVC piping.
Teflon (2.01 D.)	RTRP (FRP) piping.
Teflon flexible connector (2.03)	Connection of PVC piping to chemical storage tanks.

[a] Excludes steam and chemical services.

END OF SECTION

INDEX TO

SECTION 40 27 05.08 – PIPING APPURTENANCES

SECTION 40 27 05.08

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE

1. This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents, and drains.

B. EXCLUSIONS:

1. Temperature, pressure and flow measuring devices used for instrumentation are specified in Other Sections.

PART 2 – PRODUCTS

2.01 PIPELINE THERMOMETERS

A. GENERAL:

1. Pipeline thermometers shall be suitable for the 50 – 150 degrees Fahrenheit. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus two percent of thermometer full scale.

2. Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

B. BIMETALLIC THERMOMETERS:

1. Unless otherwise specified, bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing. Bimetallic thermometers shall have type 304 stainless steel case. Thermometer dials shall be a minimum of five inches in diameter and shall be equipped with an external adjustment mechanism for zero reset. Bimetallic thermometers shall be Ashcroft Type EH, Marsh Mastertherm, or equal.

C. FILLED THERMOMETERS:

Unless otherwise specified, filled type thermometers shall have minimum scale length of nine inches and shall be of the adjustable angle type mounted for convenient viewing. Filled thermometers shall consist of a type 304 stainless steel frame and a mercury-filled pyrex tube. The thermometer tube shall be recessed into the frame. Filled thermometers shall be Weksler, Taylor, or equal.

2.02 FLOW AND LEVEL GAGES

A. ROTAMETERS:

1. Unless otherwise specified, rotameters for purges and other low capacity services shall be Brooks Sho-Rate "50," Wallace & Tiernan three-inch purge meter, Schutte & Koerting, or equal, with integral needle valve and flow controller. Meter tubes shall be glass, floats shall be stainless steel, and cases shall be aluminum or stainless steel. Unless otherwise specified, meter sizes shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale. Units shall have a 3-inch minimum scale direct reading in the units of flow.

2. Rotameters for high capacity service shall be glass tube-type with a 5-inch scale and stainless steel frame. Flow range shall be as specified and scales shall indicate the units of flow. Rotameters shall be as manufactured by Brooks, Wallace & Tiernan, Schutte & Koerting, or equal.

B. SIGHT GAGES:

1. Sight gages shall be 3/4-inch Penberthy 205 Series, Lunkenheimer Fig. 589, or equal, automatic water gage complete with pyrex gage glass and gage glass protector. Overall length of gages, type of mounting, and orientation of set shall be as specified.

C. FLOW INDICATORS:

1. Flow indicators shall be provided where specified. Each indicator shall consist of a bronze body with threaded ends and a sight glass with rotary wheel. Pressure ratings for flow indicators shall match pipe pressure ratings. Indicators shall be as manufactured by Jacoby-Tarbox, Schutte & Koerting, Eugene Ernst Products, or equal.

2.03 PRESSURE DEVICES

A. GAGE COCKS:

1. Unless otherwise specified, gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. PRESSURE GAGES:

1. Unless otherwise specified, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale, shall be 4 1/2-inch, 270-degree movement, 1/2-percent accuracy, full-scale, and suitable for bottom stem mounting. Gages shall have a 316-SS bourdon tube. All gages shall have a 300 series stainless steel case, shatterproof glass, and a 1/2-inch NPT bottom connection.

2. Pressure gages for air, gas, and low-pressure services (0-10 feet) shall be premium grade, heavy-duty bourdon-tube units (bellow type for vacuum) with Delrin bushings and pinion, and stainless steel sector.

3. Gages on liquid service shall be as noted above, except they shall be provided with an internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill. Snubbers or orifices shall not be utilized. Gages shall be Ashcroft Duragauge Fig. 1279, Ametek 1981L, or equal.

C. DIAPHRAGM SEALS:

1. Unless otherwise specified, seals shall be diaphragm type with 1/4-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

D. PRESSURE SENSORS

1. Unless otherwise specified, pressure sensors (tubular chemical seals) shall be the in-line full stream captive sensing liquid type. Wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated for 200 psi with five-inch SC hysteresis. Seals shall be Ronningen-Petter, Red Valve, or equal.

2. Fill fluid shall be rated for a temperature range of -20 degrees Fahrenheit to 200 degrees Fahrenheit. Capillary tubing shall be armored stainless steel. Fittings shall be provided for vacuum filling of system. Systems that are not factory filled shall be vacuum filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.04 STRAINERS

A. AIR AND GAS STRAINERS:

1. Unless otherwise specified, air and gas line strainers shall be Y-pattern, cast iron body, with 40 mesh Monel screens packed with Everdur wool. Bronze bodies shall be provided with copper piping. Air line strainers shall be fitted with a brass blow off cock. Strainers shall be Mueller, Armstrong, or equal.

B. STEAM AND WATER STRAINERS:

1. Steam and water strainers shall be of Y-pattern, unless otherwise specified. Steam strainers shall have carbon steel body; water strainers shall have cast iron body. Bronze bodies shall be provided with copper piping. Strainers shall have 304 stainless steel screens and tapped and plugged blow off connections. Screen perforations shall be 0.020 inch for steam service and 0.045 inch for water service. Strainers shall be Mueller, Armstrong, or equal.

C. FUEL OIL STRAINERS:

1. Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens. Screen perforation shall be 3/64 inch. Strainers shall be Bailey No. 1, Mueller, or equal.

2.05 PRODUCT DATA

A. Manufacturer's product data shall be submitted for approval.

PART 3 – EXECUTION

3.01 PIPELINE THERMOMETERS

A. Unless otherwise specified, filled thermometers shall be used on all water based services, and bimetallic thermometers shall be used for high temperature (300 degrees F or above) steam or gaseous services. Filled thermometers shall be installed where vibration or unstable mounting conditions exist. Thermometers shall be provided for all water and process stream inlets and outlets at each heat exchanger, heat extractor, and chiller; where shown, and adjacent to process taps for temperature sensing or transmitting instrumentation.

3.02 GAGE TAPS

A. Gage taps shall be provided on the suction and discharge of all pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.03 VENTS AND DRAINS

A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted four feet above the floor. Vents in piping systems for fluids containing solids shall be one-inch non-lubricated eccentric plug valves fitted with quick couplers.

B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted four feet above the floor. Drain valves shall be threaded end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

INDEX TO

SECTION 40 27 05.09 – INSULATION FOR EXPOSED PIPING AND EQUIPMENT

SECTION 40 27 05.09

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

2. All above ground lines require insulation (One-inch minimum. See table in 3.02 for specifics).

B. TEMPERATURE CLASSES:

Insulation for exposed piping and equipment is classified for the following temperature ranges: low, medium, high, and very high.

Low temperature class insulation shall be suitable for an operating temperature range of minus 100 to 100 degrees Fahrenheit.

Medium temperature class insulation shall be suitable for an operating temperature range of 100 to 800 degrees Fahrenheit.

High temperature class insulation shall be suitable for an operating temperature range of 800 to 1,200 degrees Fahrenheit.

Very high temperature class insulation shall be suitable for an operating temperature range of 1,200 to 1,800 degrees Fahrenheit.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or

replaced.

Reference	Title
ASTM B209	Aluminum and Aluminum–Alloy Sheet and Plate
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C552	Cellular Glass Thermal Insulation
ASTM E96	Water Vapor Transmission of Materials
FEDSPEC L–P–535E	Plastic Sheet (Sheeting) "Plastic Strip" Poly (Vinyl Chloride) and Poly (Vinyl Chloride–Vinyl Acetate), Rigid
ASTM C547	Mineral Fiber Pipe Insulation

PART 2 –PRODUCTS

2.01 GENERAL

A. Piping insulation shall be tubular type or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.02 INSULATION

A. GENERAL:

1. Low temperature class insulation shall be of the unicellular elastomeric thermal, cellular glass, or fiberglass type.

2. Medium temperature class insulation shall be of the cellular glass or fiberglass type.

3. High temperature class and very high temperature class insulation shall be of the calcium silicate type or the flexible blanket type. Piping and equipment subjected to vibration (such as engine exhaust) shall be insulated with flexible blanket type.

B. UNICELLULAR ELASTOMERIC THERMAL TYPE:

1. Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.

C. CELLULAR GLASS TYPE:

1. Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.

D. FIBERGLASS TYPE:

1. Fiberglass type insulation shall conform to the requirements of ASTM C547, Type I, Grade A.

E. CALCIUM SILICATE TYPE:

1. Calcium silicate type insulation shall conform to the requirements of ASTM C533, Type II, Class C.

F. FLEXIBLE BLANKET TYPE:

1. HIGH TEMPERATURE CLASS: High temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,200 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, SEI Temp–Set 1200, or equal.

2. VERY HIGH TEMPERATURE CLASS: Very high temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,800 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom–fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and high purity alumina and silica nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, or equal.

2.03 INSULATION JACKETS

A. LAMINATED JACKETS:

1. Laminated jackets shall consist of aluminum and white kraft paper. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with procedure A of ASTM E96.

B. ALUMINUM JACKETS:

1. Aluminum jackets shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Jackets shall be 0.016 inch thick.

2. Sheet metal screws shall be aluminum or stainless steel.

3. Jackets shall be secured with 0.020 by 3/4 inch type 304 stainless steel expansion bands.

2.04 INSULATION COVERS

A. POLYVINYLCHLORIDE (PVC) COVERS:

1. Polyvinylchloride covers shall be one piece, premolded polyvinylchloride.

B. ALUMINUM COVERS:

1. Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Covers shall be 0.016 inch thick.

C. SOFT COVERS:

1. Soft covers shall be of the reusable type with TFE–coated fiberglass covers and liner.

2.05 SHIELDS

A. Unless otherwise specified, thermal pipe hanger shields shall be provided at pipe supports. Thermal hanger shields shall be as specified in Section 40 05 15.

2.06 FLASHING

A. Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.

B. Reinforcement in flashing heated up to 370 degrees Fahrenheit shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

2.07 PRODUCT DATA

A. The following information shall be submitted:

1. Manufacturer and manufacturer's type designation.

2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.

3. Descriptive literature and catalog data for materials to be used showing methods of installation.

4. Certification of ratings for water vapor transmission and puncture and stiffness as specified in paragraph 40 27 05.09–2.03 A.

PART 3 – EXECUTION

3.01 INSTALLATION

A. GENERAL:

1. Insulation shall be applied over clean, dry surfaces. Double layer insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.

B. PIPE SUPPORTS AND SHIELDS:

1. Unless otherwise specified, thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, apply the following to all butt joints:

   a. On hot pipe systems, the Contractor shall apply three–inch wide vapor barrier tape or band over the butt joints.

   b. On cold water, chilled water, or refrigerant piping, the Contractor shall apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3–inch wide vapor barrier tape or band.

C. PROTECTION:

1. Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. PIPING INSULATION:

1. GENERAL:

   a. PIPE: Piping shall be continuously insulated along its entire length including all in–line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Unless otherwise specified, piping insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the underside of pipe.

      1. PVC covers specified in paragraph 40 27 05.09–2.04 A shall not be used with medium– or high–temperature class insulation. Removable flexible blanket–type insulation need not be jacketed.

   b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Fitting, connection, flange and valve insulation shall be provided with covers specified in

paragraph 40 27 05.09–2.04. Insulation shall be secured in place with 20–gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Covers shall be provided with their seams located on the underside of fittings and valves.

2. LOW TEMPERATURE CLASS:

a. PIPE: Insulation shall have ends sealed off with a vapor barrier coating.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, insulation for pipe sizes two inches and less, shall be provided with rigid PVC covers specified in paragraph 40 27 05.09–2.04 A. Covers shall be sealed at edges with vapor barrier adhesive. The ends of covers shall be secured with vinyl tape. The tape shall overlap the jacket and the cover at least one inch. Vapor barrier shall not be penetrated.

1. Except where soft covers are specified, insulation for pipes two and a half inches and larger shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

3. MEDIUM, HIGH, AND VERY HIGH TEMPERATURE CLASS:

a. PIPE: Except for flexible blanket type, insulation shall have ends sealed with end joint strips and held in place by waterproof adhesive.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

4. OUTDOOR PIPING:

a. PIPE: Rigid insulation shall be provided with aluminum jackets specified in paragraph 40 27 05.09–2.03 B. Flexible blanket–type insulation shall be designed for outdoor, weather–exposed service.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Flexible blanket type insulation shall be designed for outdoor, weather–exposed service.

E. MECHANICAL EQUIPMENT INSULATION:

1. GENERAL: Unless otherwise specified, insulation shall fit the contours of equipment and shall be secured with 1/2 by 0.015 inch galvanized steel bands. Weld pins or stick clips with washers may be used for flat surfaces

and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Unless otherwise specified, insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A.

a. Unless specifically specified to be uninsulated, equipment connected to insulated piping shall be insulated.

2. OUTDOOR EQUIPMENT: Insulation shall be provided with a coat of weatherproof mastic and a layer of open–weave glass cloth embedded into a wet tack coat. Seams shall overlap at least two inches. A finish coat of weatherproof mastic shall be provided. The total coating thickness shall be a minimum of 1/8-inch.

3. LOW TEMPERATURE CLASS: Insulation shall have joints, breaks, and punctures sealed in facing with fire–retardant vapor barrier adhesive reinforced with four–inch tape.

Insulation shall be provided with a layer of open–weave glass cloth embedded into a wet coat of fire–retardant adhesive. Seams shall overlap at least two inches. A finish coat of fire–retardant adhesive shall be provided.

4. MEDIUM TEMPERATURE CLASS: Joints shall be covered and cemented in place with four–inch–wide strips of the same material as the laminated jackets specified in paragraph 40 27 05.09–2.03 A.

5. HIGH AND VERY HIGH TEMPERATURE CLASS: High and very high temperature equipment shall be covered with custom–fitted removable blanket–type insulation. Blanket–type insulation shall be secured with stainless steel wire lacing and hooks. Ends of blanket segments shall overlap to prevent gaps and voids when the piping and equipment is heated. Blankets shall be snugly secured under nuts and bolt heads to assure complete coverage during operation and to prevent vibration–induced gaps or voids. Blankets shall be secured in strict accordance with the manufacturer's instructions.

F. FLASHING:

1. Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and piping supports.

2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe or protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall then be troweled over the reinforcement to a minimum thickness of 1/8-inch.

3. Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

3.02 INSULATION THICKNESS SCHEDULE

A. The insulation dimensional tolerances shall comply with the specified standards. Equipment insulation shall match thickness of attached piping. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Piping service	Fluid temperature range, degrees F	Insulation thickness in inches for nominal pipe sizes					
		Runouts up to 2 inches	1 inch and less	1.25 to 2 inches	2.50 to 4 inches	5 and 6 inches	8 inches and larger
Cooling:							
Refrigerant	25–40	1.0	1.0	1.0	1.0	–	–
Process:							
Water & similar	60-100	1.0	1.0	1.5	1.5	1.5	2.0
PA, CA[f]	150–250	1.0	1.0	1.5	1.5	1.5	–
NaOH	60 – 100	1.0	1.0	1.0	–	–	–

a. See specification Section 40 27 05.
b. Runouts to individual terminal units (not exceeding 12 feet in length).
c. Refrigerant insulation by air conditioning equipment supplier.
d. Insulate piping for personnel protection between compressor and after cooler only. Include drip legs.
e. For condensation control, see specification Section 40 27 05. Unless otherwise specified, connected equipment shall be uninsulated.
f. All above ground lines require a 1-inch minimum thick insulation.

END OF SECTION

INDEX TO

SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48-inch NPS, for Water and Sewage Systems

PART 2 – PRODUCTS

2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

2.02 OPERATORS

A. GENERAL:

1. Manual operators shall have operating torques less than 80 foot–pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. WRENCH NUTS:

1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. CHAIN WHEELS:

1. Chain wheels shall be ductile iron. Operating chains shall be **stainless steel.**

2.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay–put covers.

B. FLOOR BOXES:

1. Floor boxes shall be hot–dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. ADJUSTABLE SHAFT VALVE BOXES:

1. Adjustable shaft valve boxes shall be concrete or cast-iron Brooks No. 3RT, Christie G5, Empire 7–1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design, and material requirements shall be provided.

PART 3—EXECUTION

3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. GENERAL:

1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. WRENCH NUTS:

1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within six inches of the valve box cover.

C. CHAIN WHEELS:

1. Unless otherwise specified, valves with centerlines more than seven feet, six inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within four feet of the specified operating level below the valve. For plug-type valves eight inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

3.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. FLOOR BOXES:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

INDEX TO

SECTION 40 29 13 – BUTTERFLY VALVES

SECTION 40 29 13

BUTTERFLY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies butterfly valves for air, gas, steam, and water service.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold–Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber–Seated Butterfly Valves

PART 2 – PRODUCTS

2.01 MATERIALS

A. Valves specified for use in Water shall be considered TYPE A and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A276, Type 304 Carbon steel, ASTM A108, with stainless steel journals
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A436, type 1 (Ni–Resist); or ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 304, mounted in body or on disc edge; or Ni–Chrome on the disc edge
Seat sealing surface	Neoprene, EPDM or Buna N
Body	Cast iron, ASTM A126, Class B

B. Valves specified for use in Air shall be considered TYPE B and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A582, Type 416
Disc	Cast iron, ASTM A126, Class B
Seat sealing surface	Neoprene or Buna N—air and gas services Nordel—(high temp water)
Body	Cast iron, ASTM A126, Class B
Disc edge	Nickel

2.02 MANUFACTURE

A. GENERAL:

1. Valves shall be the stub or through shaft design. Wafer type valves are not acceptable for buried service. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125.

B. TYPE A:

1. Type A valves shall be designed in accordance with AWWA C504. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure specified in Section 40 27 05 and Class B as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

2. Type A valves, size 3 through 72 inches, shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.

C. TYPE B:

1. Valves shall be rated at 175 psig and provide drip tight shutoff up to the full valve rating on dead–end or isolation service. Seat shall be mechanically held in place and shall be field replaceable. Valve ends shall be as specified in Section 40 27 05.

2. Type B valves, size 2 through 20 inches, shall have seats that are bonded to a rigid reinforcing ring.

2.03 MANUAL OPERATORS

A. GENERAL:

1. Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.

B. TYPE A:

1. Manual operators for Type A valves shall be of the traveling nut, rack, and pinion, or worm gear type. Operators shall be equipped with adjustable mechanical stop–limiting devices to prevent over travel of the disc in the open and closed positions and shall be self–locking and designed to hold the valve in any intermediate position between full open and full closed. Valve operator components shall withstand an input torque of 300 ft.–lbs. at the extreme operator positions without damage.

2. Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig. Operators for exposed service shall include a hand wheel and be gasketed for weatherproof service.

C. TYPES B:

1. Operators for Type B valves six inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

2.04 PRODUCT DATA

A. Affidavits of compliance with AWWA C504 for Type A valves shall be provided.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 29 19 – ECCENTRIC PLUG VALVES

SECTION 40 29 19

ECCENTRIC PLUG VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies eccentric plug valves.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber Seated Butterfly Valves

B. Proof of Design Tests – The Contractor shall furnish the Construction Manager and Engineer of Record three certified copies of a report from an independent testing laboratory certifying successful completion of proof–of–design testing conducted in accordance with AWWA C517–05, except that where the word "disc" appears in the standard, it is understood to mean "plug." In lieu of testing the valves at an independent testing laboratory, proof–of–design testing may be performed at the valve manufacturer's laboratory but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports must be certified by

the laboratory representative. Proof–of–design testing shall have been performed on not less than three 6–inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2 – PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B, or cast-iron ASTM A436 (Ni–resist), or ductile iron, ASTM A536
Plug facing	Neoprene or Buna–N
Body seats	
Less than 3 inches	Cast iron, ASTM A126, Class B
3 inches and larger	Stainless steel, ASTM A276, Type 304 or nickel
Packing	Buna V–flex or TFE

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.02 MANUFACTURER

A. General – Valves shall be straight–flow, non–lubricated, resilient plug type suitable for drip-tight, bi–directional shutoff at the specified valve design pressure. Port areas for the valve shall be at least 80% of the adjacent full pipe area. Valve body seats consisting of nickel for valves three inches and larger shall be constructed of a welded–in overlay of not less than 90% pure nickel. Upper and lower journal bearings shall be replaceable, sleeve–type, corrosion resistant, and permanently lubricated. Packing shall be self–adjusting, chevron-type, replaceable without disassembling the valve. ***The valve shall be manufactured by Dezurik.*** No other valves are acceptable.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Design pressure, psig
12 and smaller	175
14 through 36	150
42 through 54	125

B. End Connections – Valves three inches and smaller shall have threaded ends. Valve flange drilling for valves larger than three inches shall be per ANSI B16.1, Class 125. Grooved–end valves may be provided with grooved–end piping systems.

C. Manual Operators – Unless otherwise specified, valves four inches and smaller shall be provided with a lever type manual operator. Valves larger than four inches shall be provided with totally enclosed worm gear operators. Where specified, manual operators shall have an adjustable stop. All operator components shall be sized for the valve design pressure in accordance with AWWA C504, Section 4.5. Operators shall comply with applicable portions of Section 40 29 01.

2.03 MOTORIZED ACTUATOR FOR ATTACHED TO PLUG VALVES (14", 24" and 30" Plug Valves & 30" Knife Gate Valve)

See Specification Section 40 29 50 (Specialty Valves) for all the actuators specification.

2.04 PRODUCT DATA

The following information shall be provided:

A. Manufacturer's product data.

B. Proof–of–design test reports specified in paragraph 40 29 19–1.02 B.

PART 3 – EXECUTION

Unless otherwise specified, valves shall be provided with the seat downstream away from flow. Valves at tank connections shall be installed with seat away from tank. Valves on pump discharge lines shall be installed with seat adjacent to the pump.

END OF SECTION

INDEX TO

SECTION 40 29 27 – NONCLOG BALL CHECK VALVE

SECTION 40 29 27

NONCLOG BALL CHECK VALVE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies nonclog ball check valves.

B. TYPE:

1. The nonclog check valves shall consist of three components: body, cover, and ball—one moving part. The design of the valve shall keep solids, stringy material, grit, rags, etc., moving without the need for backflushing. The ball shall clear the waterway providing "full flow" equal to the nominal size. There shall be no outside levers, weights, springs, dashpots, or other accessories.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Flygt and Golden Anderson, or equal.

2.02 COMPONENTS

A. BODY AND COVER:

1. Valve body and cover shall be of gray cast iron or ductile iron. Flange drilling shall be according to ANSI B16.1, Class 125.

B. BALL:

1. The valve ball shall be hollow steel with an exterior of nitrile rubber. It shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 4 to 10), tearing, and abrasion.

2.03 PRODUCT DATA

A. Submit product information and applicable operation and maintenance information for review.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 29 50 – SPECIALTY VALVES & MOTORIZED ACTUATORS

SECTION 40 29 50

SPECIALTY VALVES & MOTORIZED ACTUATORS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME SEC VIII D2	Boiler and Pressure Vessel Code, Pressure Relief Devices
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

PART 2 – PRODUCTS

2.01 MUD VALVES

A. Mud valves shall be of the heavy-duty flange type with rising or non-rising stems as shown on the plans. Frame, cover, yoke and stem extension connection shall be stainless steel. Stems shall be stainless steel. Lift nuts shall be bronze. On non-rising stem models the stem is to be protected by a stainless-steel shroud with drain hole. Valve shall be operated by a tee handle, hand wheel, or with stainless (mild steel) stem extension to the height required. On rising stem valves, stem guides shall be provided such that the L/R ratio of the unsupported part of the stem shall not exceed 200. Pedestal lifts, stem guides, and wall brackets shall be furnished by mud

valve manufacturer to make a complete and operable unit. Mud valves shall be Waterman MV–11, Trumbull 367-1351 or equal.

2.02 PRESSURE RELIEF VALVES

A. Pressure relief valves for air shall be ASME certified, Watts Fig 41A, Lonergan L14/L40 Series, or equal. Size and pressure settings shall be as specified or as required for the service intended. Pressure relief valves for cold and hot water shall be McDonnell and Miller 230, Watts 174A, Cash Acme F–82, Lonergan L14/L40 Series, or equal.

2.03 HOSE VALVES

A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, Crane 17, Lunkenheimer 214, Powell 151, or equal with threaded nipple adapter for hose connection.

2.04 FLUSHING COCKS

A. Flushing cocks shall consist of a DeZurik 159/118–S, Keystone Fig 541, or equal, neoprene–faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1 inch in diameter.

2.05 KNIFE GATE VALVES (AT GRIT SYSTEM)

A. Design features and materials of construction for service condition at wastewater application.

i. Fully lugged body design providing uni-directional shutoff.

ii. Working Pressure Rating: 150 psi for valves 2" to 24"; 100 psi for 30" and 36".

iii. Body: Round port, single piece cast stainless steel body (316SS) and shall be equipped with a minimum of 3 flush ports valves (at 3, 6, and 9 O'clock positions) to allow for cleaning of solids trapped within the body cavities that can be flushed with plant reuse water (holes drilled and tapped, pipping by the G.C).

iv. Gate: Stainless steel (fully machined) gate, material to be same as body with 60-degree V-port

v. Stem: 303/430 stainless steel, single start trapezoidal thread.

vi. Seats: Shall be made of EPDM material, and mechanically held in place by means of a stainless-steel seat retainer ring, no adhesives or O-ring style seats shall be permitted.

vii. Packing: Shall be PTFE impregnated synthetic fibre (ST) with EPDM O-ring, retained by a one-piece cast stainless steel (same as body material) packing gland which shall be fully accessible for maintenance purposes.

viii. Ends: Flange connection shall be per ANSI B16.5 Class 150.

ix. Yoke: One-piece formed 316 S.S.

x. Operator: non-Rising stem manual hand wheel, one-piece upper stem protector shall be included. (Non-rising stem, stem extensions, automation requirements as specified per project requirements.)

xi. Factory pressure and leak test per MSS-SP 81.
Non-Bonneted (standard) and Bonneted (fabricated) models available, please specify with pressure rating required.

xii. Acceptable manufacturers:

The knife gate valve shall be **Orbinox** – Model series 20 or **Dezurik**

2.06 MOTORIZED ACTUATOR FOR 30" KNIEF GATE VALVE (2 Each)

The motorized actuator shall be **Limitorque-MXa**-40/MOD for attachment to a knife gate valves with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 225 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA14 MSS MOUNTING BASE
- 1.82" MAXIMUM BORE w/1/2 x 1/2 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 104 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE V-3 BEVEL GEARBOX
- 5:1RATIO
- FA16 MSS MOUNTING BASE
- 2.83" MAX STEM ACCEPTANCE
- 1844 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

Adaption Specifications:
MOUNTING TO KNIFE GATE VALVE INCLUDES
- ADAPTION TO VALVE
- MACHINING ACTUATOR TORQUE NUT
- MACHINING GEARBOX STEM NUT

2.07 MOTORIZED ACTUATOR FOR 14" PLUG VALVES (1 Each)

The motorized actuator shall be **Limitorque-MXa**-20/MOD electric actuator 18 RPM NEMA 4X enclosure for attachment to a 14" Plug valve at RAS pump station coupled to a WG-04-B Gearbox with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 125 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA10 MSS MOUNTING BASE
- 1.25" MAXIMUM BORE w/1/4 x 1/4 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 49.5 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE WG-06-1SD-B GEARBOX
- 252:1 RATIO
- FA25 MSS MOUNTING BASE
- 3.25" MAX STEM ACCEPTANCE
- 767 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

2.08 MOTORIZED ACTUATOR FOR 24" PLUG VALVES (6 Each)

The motorized actuator shall be **Limitorque-MXa**-20/MOD B4 77 RPM for attachment to a 24" Plug valves (2 at RAS pump station, and 4 at influent lines to screens) coupled to a WG-04-1SD-B Gearbox with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 125 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA10 MSS MOUNTING BASE
- 1.25" MAXIMUM BORE w/1/4 x 1/4 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 49.5 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE WG-06-1SD-B GEARBOX
- 252:1 RATIO
- FA25 MSS MOUNTING BASE
- 3.25" MAX STEM ACCEPTANCE
- 767 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

2.09 MOTORIZED ACTUATOR FOR 30" PLUG VALVES in Manhole (2 Each)

The motorized actuator shall be **Limitorque-MXa**-10/STD B4 for attachment to a 30" Plug valves in manhole (actuators and electrical components & wiring shall be rated for submergence in 10ft. of water) coupled to a WG-06-1SD-B Gearbox with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 125 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA10 MSS MOUNTING BASE
- 1.25" MAXIMUM BORE w/1/4 x 1/4 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 94.5 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE WG-06-1SD-B GEARBOX
- 768:1 RATIO
- FA10 MSS MOUNTING BASE
- 2.83" MAX STEM ACCEPTANCE
- 24190 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

2.10 TELESCOPING VALVES

A. Contractor to furnish and install four (4) 24" tube diameter telescoping valves to fit onto a 24" RAS piping as shown on the plans. The valve body shall be 316 stainless steel. The lifting straps shall be the same material as tube with flared tube tops. The wiper gasket shall be Neoprene to provide a friction seal around the sliding tube. The stem and operator shall also be 316 S.S.

The lift and stems shall be handwheel type, with UHMW polyethylene thrust bearings along with a stub acme threaded type 316 stainless steel stem to provide automatic self-locking, infinite valve positioning. If needed, a vee keyed shaft, with torque plate, shall be used to prevent valve tube rotation. Handwheels shall be a minimum of 12" in diameter and shall include a clear plastic Butyrate stem cover with a mylar strip type position indicator, calibrated in ¼ inch increments to illustrate valve

position. The mylar strip, provided by the manufacturer, will be affixed by the contractor after installation to provide a true and accurate indication of the tube elevation by comparing it to the top of the rising stem. Stainless steel anchor bolts shall be provided for all pedestals.

The telescoping valves shall be manufactured by **Waterman** or approved equivalent.

2.11 QUICK DISCONNECTS

B. Quick disconnects shall not be disconnectable under pressure. Quick disconnects for air service shall be Swagelok, Tomco, or equal, and shall be 1/2 inch, unless otherwise specified. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1 inch, unless specified otherwise.

2.12 PRODUCT DATA

A. Provide product data for approval.

PART 3 – EXECUTION

3.01 EXECUTION

A. Specialty valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 31 00

FABRICATED STAINLESS STEEL SLIDE & WEIR GATES

SECTION 40 31 00

FABRICATED STAINLESS-STEEL SLIDE & WEIR GATES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies heavy-duty, self–contained Stainless Steel Downward Opening Weir Gates and gate operators and upward opening slide gates for MBR tanks and the splitter box.

B. TYPE:

Slide gates shall be of fabricated stainless-steel heavy-duty construction, with gates, guides, and operators provided by one manufacturer. Gates shall meet the leakage requirements of AWWA C561.

The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of water control gates.

C. DESIGN CONDITIONS:

Self–contained slide gates shall be designed for continuous exposure to raw municipal wastewater. Fluid temperature is expected to range from 60 degrees F to 80 degrees F. The gates will be installed outdoors in a municipal wastewater treatment plant near the ocean.

D. OPERATING REQUIREMENTS:

Equipment number	Gate size, inch (a)	Gate type (b)	Opening direction (c)	Bottom seating (d)	Design head, feet		Operator type (e)
					Seating	Unseating	
WG–101 (MBR 1)	60 x 24	W	D	SA [1]	1	0	HW [2]
WG–102 (MBR 2)	60 x 24	W	D	SA [1]	1	0	HW [2]
WG–103 (MBR 3)	60x 24	W	D	SA [1]	1	0	HW [2]
WG–104 (MBR 4)	60 x 24	W	D	SA [1]	1	0	HW [2]
SG – 201-Splitter	60 X 18	W	U	SA [1]	1	0	HW [2]

Equipment number	Gate size, inch (a)	Gate type (b)	Opening direction (c)	Bottom seating (d)	Design head, feet		Operator type (e)
					Seating	Unseating	
SG – 202- Splitter	60 X18	W	U	SA [1]	1	0	HW [2]

Notes:

SA [1] =Self-adjusting UHMW seal along the invert
HW [2] = hand wheel-operated gearbox type

[a] Width by height.
[b] C = channel–mounted, W = wall–mounted
[c] U = upward, D – downward
[d] FB = flush bottom, J = J–seal on invert
[e] GC = geared crank type, HW = hand wheel type

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Notice Inviting Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME	American Society of Mechanical Engineers
ASTM 240	Heat–Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable
ASTM D2000	Rubber Products in Automotive Applications
ASTM D4020	Ultra–High–Molecular–Weight Polyethylene Molding and Extrusion Materials
AWWA C561	Open–Channel, Fabricated Metal Slide Gates

B. SUBMITTALS:

The following information shall be submitted for approval:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked–up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Fabrication drawings with full dimensions.

3. Plan, cross section, and details showing proposed mounting for each size and typical application of gate.

C. MANUFACTURING:

Manufacturer's welders shall be certified per ASME, Section 1X or American Welding Society.

D. EXPERIENCE:

Manufacturer shall have a minimum of ten years' experience with the fabrication of the model of gate provided. Submit installation list of the model of gate provided to confirm this requirement.

PART 2—PRODUCTS

2.01 PRODUCTS

Fabricated stainless-steel weir gates shall be RW Gate Company, Golden Harvest, Hydro Gate, Rodney Hunt, Fontaine, Waterman, or equal, modified as necessary to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Materials for components shall be as follows:

Component	Material
Frames, slides, rails, and yokes	ASTM A276 or ASTM A240, Type 316L Stainless Steel
Fasteners and anchor bolts	ASTM A276, Type 316 Stainless Steel
Stems	ASTM A276, Stainless Steel, Type 316
Stem Guides	ASTM A276, Stainless Steel, Type 316L, with bronze or UHMW Polyethylene bushing
Seals	ASTM D2000, Grade AA625, Buna–N or neoprene rubber, or ASTM D4020 UHMW Polyethylene

2.03 EQUIPMENT FEATURES

A. GENERAL DESIGN. Weir gates shall be self–contained, and of the rising stem or non–rising stem configuration. Design stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the materials at maximum load conditions. Minimum thickness of slide, its reinforcing members, and all structural components of the guide and frame shall be 0.25 inches.

B. FRAME. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one–piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

C. SLIDE. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head. The gate frame shall be a rigid, welded unit, composed of the guide rails, cross bars, and deadrails, with a clear opening the same size as the waterway, unless otherwise specified. They shall be integral flange back or embedded type. The guides will be of sufficient length to support two–thirds (2/3) the height of the slide, when the gate is fully open. On wall mounted gates, compressible gaskets or grout shall be provided between frame and wall as needed to ensure full mating of surfaces and no leakage.

Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. The yoke to support the operating device shall be formed by members welded or bolted at the top of the guides. The arrangement of the yoke shall be such that the slide and stem can be removed without disconnecting the yoke. When the slide is too long to allow this,

the yoke shall be bolted for easy removal.

D. GUIDES AND SEALS. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self–adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.

Seals shall maintain the specified leakage rate in both seating and unseating conditions.

E. OPERATOR STEM AND COUPLINGS. The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the crank or hand wheel.

The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.

For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1 ¾ inches, shall be pinned to an extension tube.

The couplings shall be grooved and keyed and shall be of greater strength than the stem.

Gates having width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

F. STEM GUIDES. Stem guides shall be fabricated from type 316L stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

G. STEM COVER. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

H. LIFTING MECHANISM. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.

Operators shall be hand wheel type. Operators shall meet AWWA C501 specifications, except as otherwise specified. Gears, and bearings shall be enclosed in a weatherproof housing, and pressure type fittings shall be provided for grease lubrication of the bearings and gears. A maximum effort of 40 pounds pull of the crank or hand wheel shall operate the gate under the specified

operating conditions.

The operator shall be either pedestal or bench mounted as specified. Pedestal type floor standards shall be the offset type or the standard type with wall mounting bracket. Pedestal or bench stands shall be cast iron. The head of the pedestal or bench stand operator shall have a solid bronze, internally threaded operating nut. The operator shall be mounted on anti friction roller bearings. Cranks and handwheels shall be removable from the operator. Hand crank operators shall be provided with a 2–inch AWWA operating nut in horizontal appropriate for use with portable electric operators.

I. YOKE. Self–contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span. The yoke shall be sufficiently strong to support the lift forces when subjected to a load of 100 pounds pull on the operator. The yoke shall be designed so that its deflection under full operating load will not exceed 1/360 of the gate width.

J. MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A–240 type 316L
Guides, side and bottom seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D–4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Threaded stem	Stainless steel ASTM A–276 type 303 MX or 316
Fasteners	ASTM F593 and F594 and GR2 for type 316
Pedestal, hand wheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D–3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS–C86500

In addition to the above, the gates shall meet the followings;

1. All wall mounted frames shall have a minimum guide weight of 13 pounds per foot. The portion of the frame, where the anchor penetrates, shall have a minimum thickness of 1/2-inch.
2. The guide extensions shall have a minimum weight of 6 pounds per foot and shall be constructed of formed plate. Angles are not acceptable for guide extensions.
3. The yoke members shall be C-channel structural members. Angles are not acceptable for yoke members.

4. The portion of the slide, that engages the frame, shall have a minimum thickness of 1/2-inch.
5. The stem shall have a minimum diameter of 1-1/2 inches.

2.04 PRODUCT DATA

The following information shall be submitted for approval:

1. Product information, charts, or graphs to verify that the product provided meets the requirements set forth in the specification.

2. Affidavits of compliance in accordance with AWWA C561.

3. Applicable operation and maintenance.

PART 3—EXECUTION

3.01 INSTALLATION

Unless otherwise specified, self–contained slide gates shall be installed in accordance with manufacturer's instructions.

3.02 TESTING

For purpose of this specification, field leakage tests shall be performed as specified in Section 6.3 of AWWA C513.field leakage tests shall be conducted with no head on one side of the gate being tested.

Gate shall be operated through a minimum of two cycles, to confirm operation. Limit switches and other stops shall be adjusted per the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 31 05 – FRP WEIRS

SECTION 40 31 05

FRP WEIRS

PART 1 – GENERAL

1.01 DESCRIPTION

SCOPE:

This section provides detailed specifications for weirs fabricated from fiber reinforced thermoset plastic (FRP).

1.02 QUALITY ASSURANCE

A. REFERENCE:

1. The FRP items to be provided under this section shall meet the applicable requirements of AWWA F102–96, Type II.

B. SERVICE CONDITIONS:

1. The weirs to be furnished under this specification will be installed in a membrane bioreactor tank in a municipal wastewater treatment plant. The wastewater is expected to contain finely divided organic solids, dilute industrial solvents and petroleum products, animal fats and greases, vegetable oils, trace quantities of chlorine, dissolved hydrogen sulfide gas in concentrations up to 20 milligrams per liter, and oxygen may be either present or absent. During the normal life of these laminants, they will be exposed to the weather, including sunlight, both with and without liquid in the tank, and may be left in the dry condition for protracted periods. It is possible that dilute sulfuric acid may be present and may collect on any surface. Wastewater temperatures are expected to vary between 55 and 70 degrees Fahrenheit. The surface temperature of the weirs are expected to reach 120 degrees Fahrenheit when the tank is drained.

1.03 SUBMITTALS

A. The following shall be submitted for approval:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked–

up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Shop drawings showing equipment dimensions and materials of construction.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials used shall be per AWWA F102–96.

2.02 MANUFACTURE

A. DIMENSIONS:

1. The two weir plates shall be 72 inches wide by 12 inches high.

B. FABRICATION:

1. FRP weirs shall be fabricated by the matched–die molding process per AWWA F102–96. The final weir plate thickness shall be at least 1/4 inch. Slotted bolting holes shall be provided as shown to allow adjustment and leveling. Mounting shall permit expansion and contraction through the range of temperatures specified.

PART 3 – EXECUTION

3.01 EXECUTION

A. Field cutting of weir notches shall not be permitted. All field cuts required for installation shall receive two sealing coats.

B. Weirs shall be mounted, with gasket material, and leveled to a tolerance of plus or minus 0.01 foot during freshwater testing when the tank contains water to the normal operating level. Provisions shall be made to accommodate thermal expansion and contraction through the use of expansion joints at each weir plate joint.

END OF SECTION

INDEX TO

SECTION 40 40 01 – EQ. TANK JET MIXING EQUIPMENT

SECTION 40 40 01

EQ. JET MIXING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. The work includes providing equipment and field services, complete with accessories and appurtenances required for a Jet Mixing System that shall be installed within the flow equalization tank. A total of one (1) complete jet mixing system shall be provided in the tank measuring 114 ft diameter with a maximum SWD of 25'. Jet mixing system shall consist of all in–basin submerged liquid piping, in–basin submerged supports and externally mounted jet mixing pump with accessories. Control panel including motor starter shall be provided by others.

B. The Contractor shall coordinate the work specified in this section with the work of other sections in order that all necessary items shall be provided as required for satisfactory operation and that the various items of equipment will properly fit and operate in the spaces allotted to them.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 25 50 00 – Plant SCADA System

B. Division 26 – Electrical

1.3 SERVICE CONDITIONS

A. Service Conditions:

1.	Liquid Pumped:	Screened wastewater
2.	Temperature of water	15 degrees to 30 degrees C
3.	pH:	6 to 8
4.	Specific Gravity:	1.0

B. The Jet mixing equipment shall operate at constant speed and the control system shall be operated automatically through a PLC or timer–based control panel as well as manually through selection switches on the control panel face.

1.4 SUBMITTALS

A. Shop drawings and product data as described in Division 1.

B. Operation and maintenance data as described in Division 1.

C. In addition, submit the following:

Full equipment layout dimensional drawings and bill of materials, including:

1. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and NPSH (required) over entire operating range of pump, from shutoff to maximum capacity.

2. Provide complete motor nameplate data, as defined by NEMA, motor manufacturer; and any motor modifications.

3. Detailed mixing calculations showing tank turnover, tank pumpage, mixing energy in BHP/MG of volume, mean velocity gradient, required water velocities and turn time.

4. Motor wiring diagram for the pump.

5. Complete operation and maintenance instructions for all equipment shall be submitted after the Shop Drawings are approved, but no more than thirty days after shipment of all equipment.

1.5 QUALITY ASSURANCE

A. Manufacturer: Fluidyne Corporation of Cedar Falls, IA or approved equal. The jet mixing system shall be a standard product of a manufacturer who has been actively providing jet mixing equipment including stainless steel mixing manifolds and pumps for a minimum of ten (10) years. The manufacturer shall have twenty (20) operating installations for a minimum of five (5) years utilizing stainless steel jet mixing manifolds with mixing pumps. References on mixing installations with details on the manufactured equipment shall be provided if requested.

1.6 WARRANTY

A. The system supplier shall provide a one (1) year warranty from the date of Substantial Project Completion in accordance with Division 1, not to exceed 18 months from date of complete shipment.

PART 2 PRODUCTS

2.1 JET MIXING SYSTEM:

A. The equipment furnished shall be a jet type mixing system. A total of two (2) jet mixing manifolds shall be provided in the basin. Each jet manifold shall include a minimum of twenty–two (22) jet mixing nozzles, configured in a uni–directional layout. The orifice size of each liquid nozzle shall be no less than 1.58 inches in diameter to avoid plugging problems. Layout of the jet mixing manifolds shall be as shown on the drawings. All nozzles shall be leveled and at same elevation (+/–) 1/4" by the contractor during installation. The mixing manifold shall be manufactured of 304 stainless steel for prolonged life. All materials must be resistant to a complete range of operating temperature, salinity, hardness, corrosiveness, and abrasives experienced in domestic wastewater treatment. The equipment must further be capable of continuous operation over extended periods. The mixing system shall be designed to provide mixing such that when operated under design conditions, it shall suspend materials found in equalization basin.

2.2 JET MIXING LIQUID MANIFOLD:

A. Jet mixing manifold shall be comprised of a liquid duct, mixing nozzles, mixing chambers with induction ports comprising one self–contained integrally formed

unit. Sections shall ship in up to 20' length for field installation. The liquid duct shall be a circular, cylindrical tube having a plurality of liquid nozzles which are longitudinally spaced units, and which are aligned on a common plane. The liquid ducts shall be fabricated of corrosion resistant structurally sound material. Each multiple jet mixing assembly shall form a structural unit. All components of the manifold shall be constructed of 304 stainless steel.

2.3 JET NOZZLES

A. Nozzles shall have both an inner and outer assembly to facilitate mixing and increase tank turnover. All nozzles shall be fabricated out of 304 stainless steel. Nozzles shall come pre–welded to the jet manifold as shown in the Drawings.

2.4 JET MIXING PIPING:

A. All in basin submerged liquid piping shall be provided by the System Supplier as part of the system to the extent shown on the plans. All piping shall be 304 stainless steel schedule-10. Liquid piping shall be minimum 12" diameter and shall reduce down and terminate if and as necessary to terminate with a flange connection to mate to the discharge flange on the pump discharge elbow assembly. All interconnecting hardware and gaskets are to be included.

2.5 JET MIXING MANIFOLD HEADER SUPPORTS:

A. All necessary supports for the jet manifold shall be supplied as part of the system. The supports shall be manufactured of 304 stainless steel.

B. The supports shall be manufactured of 304 stainless steel. The supports shall consist of dual leg angle welded to a supporting base. The base shall be leveled and grouted in place if required. The support angles shall be field welded directly to the jet manifold by the contractor during installation with instructions to be supplied by the manufacturer.

2.6 PASSIVATION

A. All shop welded assemblies and components of the stainless-steel jet aeration manifold including manifold sections, piping and supports shall be completely passivated. Passivation of stainless-steel fabricated parts, piping, supports and assemblies shall conform to ASTM A380. Prior to passivation, all parts must be cleaned of any contaminants and generally must undergo a validating test to prove that the surface is clean. Once cleaned, the parts are then placed in an acidic passivating bath that meets the temperature and chemistry requirements of the Method and Type specified. Following the acidic passivating bath, the parts must then be neutralized using a bath of aqueous sodium hydroxide and then rinsed with clean water, dried, and the passive surface is validated using exposure to humidity, elevated temperature, a rusting agent, or some combination of the three.

2.7 MIXING PUMPS

A. Furnish one (1) installed vertical, closed coupled single stage jet mixing pump

for each jet mixing manifold as an integral part of the jet mixing system. Pump shall be equipped with a **40 HP** premium efficient electric motor, connected for operation on 460 volts, 3 phase, 60 hertz electrical service. Pump motor shall be maximum 1200 RPM. The pump shall meet the following:

Service:	**Jet Aeration**
Model	12"– B5741CT
No. Of pumps:	**2**
Liquid:	Wastewater
Maximum Temperature (degree F):	80
Maximum speed (rpm):	885
Minimum shut–off head at max speed (ft):	41
Design capacity (gpm):	4400
Design total head (TH) (ft):	21
Minimum sphere solid size (in):	3.50
Minimum capacity at run out	4700 gpm
Minimum head at run out (ft):	18
Minimum efficiency at run out capacity:	72%
NPSHR at run out capacity (ft):	18
2nd design point capacity (gpm):	2500
2nd design point head (ft):	31
2nd design point efficiency (%);	73%
Motor HP	40
Minimum pump suction diameter (in):	14"
Minimum pump casing discharge diameter	12"

B. Major pump components shall be of grey cast iron, ASTM A–48. The pump shall have the base cast integrally with the front head. Suction flanges shall be 125 lb. ANSI drilled. Shall be provided with a combination base elbow of the Turbo free version, providing a low–profile setting. Conventional base elbows are not acceptable. Backhead shall be provided with an integrally cast sealing box.

Shaft Assembly

Minimum shaft diameter	**All Pumps**
1. At impeller	2.375"
2. At sleeve	2.625"
3. At thrust bearing	2.953"
4. At radial bearing	3.740"
5. Between bearings	4.00"
6. At Coupling	2.375"
7. Center to Center of bearings	14.125"

The pump shaft shall be high–strength alloy steel, A668 AISI 4140 HT; with a minimum 100,000 PSI tensile strength and 75,000 PSI yield strength of sufficient diameter to carry the maximum loads imposed and to prevent vibration and fatigue. The shaft shall be accurately machined along its entire length and precision ground at bearing locations. Keyways shall be provided at both ends.

Radial (inboard) bearings shall be grease lubricated double row spherical roller bearings designed to carry the hydraulic radial loads encountered in the service

conditions. Thrust (outboard) bearings shall be an angular contact ball bearing designed to carry the pump hydraulic axial and dead load thrust. Bearing shall be designed for a nominal L10 life of 100,000 hrs. Per AFBMA at best efficiency point.

2.8 MECHANICAL SEALS

A. Each pump shall be provided with double mechanical seals with carbon vs. ceramic faces. The mechanical seals must be commercially available and manufactured by a major seal manufacturer, John Crane or equal.

2.9 PUMP SHAFT

A. The shaft shall be made from high quality steel, of sufficient diameter to carry the maximum load imposed and to prevent vibration and fatigue. Shaft is to be accurately machined along its entire length. A renewable shaft sleeve, positive adhesive sealed, shall protect the shat through the sealing box area.

2.10 IMPELLER

A. The impeller shall be a non–clogging type made of close–grained cast iron conforming to ASTM A48 Class 30. The impeller shall be of one–piece, single suction, enclosed two–vane, radial flow design with well–rounded leading vanes and then tapered toward the trailing edge for a circular flow pattern. The impeller is to be statically balanced and secured to a straight fit on the shaft by means of a bolt, washer and key.

2.11 VOLUTE/CASING

A. The volute is to be one–piece cast iron with side flanged tangential discharge. Discharge flange shall be 125 lb. ANSI drilling. Volute design to permit front or back impeller removal and be capable of radiation in increments to accommodate piping orientation independent of the base location. Casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff, whichever is greater.

2.12 MOTOR PROTECTION

A. Thermal overloads shall be installed in adjacent phases of the motor winding to provide overheat protection. These motor windings thermostats must be connected to an electric controller per local and state codes and the National Electric Code.

2.13 DESIGN CHARACTERISTICS

A. Design Characteristics

1.	Fluid:	Screened wastewater(2mm)–Max.0.5% solids
2.	Temperature:	15 –32 degrees C
3.	S.G.:	1.0
4.	Pump Speed:	900 RPM maximum
5.	HP Max:	40
6.	Discharge:	12"

7. Solids Handling: 3"

2.14 CONTROL PANELS

A. To be provided by the General Contractor. (See Electrical Division)

2.15 INSTRUMENTATION

A. All instrumentation, wiring, cabling and conduit for all instrumentation and electrical motors shall be provided by the Contractor.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine stainless steel mixing headers and components to be sure that these are free from defects or damage.

B. Examine the pump to be sure all passages are clean and clear of obstruction and that the impeller rotates freely. Examine the pump mounting surface and make certain that bolts are properly located. Correct any irregularities prior to installation.

3.2 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the drawings. Installation shall include furnishing the required oil and grease for initial operation. See Section 01 77 00– Contract Closeout.

B. The Contractor shall submit a certification from the equipment manufacturer stating that the installation of the equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit

3.3 SUPPLIERS / MANUFACTURERS' SERVICES

A. Field Service and Training: The Contractor shall provide the services of a factory–trained technician, employed by the jet mixing system supplier, with at least three years factory experience in jet mixing equipment. The factory technician shall be qualified to inspect installation, test for proper installation, conduct start–up, and train operators in the operation of the equipment and the process. A minimum of two (2) man days on the job site in a minimum of one (1) trip shall be provided.

END OF SECTION

INDEX TO

SECTION 40 80 01 – PROCESS PIPING LEAKAGE TESTING

SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING

PART 1 – GENERAL

1.01 SUBMITTALS

A. Information 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).

2. Certifications of Calibration: Testing equipment.

3. Certified test report.

1.02 QUALITY ASSUERNCE

A. Testing shall be by a testing laboratory which operates in accordance to ASTM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regular scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

B. Infiltration, line and grade of sewer, pump performance; hydrostatic test on force mains and water mains and all other tests shall be made by the Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing five days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Wait seven 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 three days.

3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping Connected to Existing Piping:

a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that so not require testing include tank overflows, and tank atmospheric vents.

6. Test Pressure: As indicated on in each section, and other sections (min. 150 psi)

C. Test section may be filled with water and allowed to stand under low pressure prior to testing. Contractor shall pretest prior to requesting an official test.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TESTING FOR PRESSURE PIPING

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

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.

2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

4. Maintain hydrostatic test pressure continuously for 120 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 fill.

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 two 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.

D. Hydrostatic and Leakage Tests – Ductile iron pipe shall be tested in accordance with AWWA Standard C 600, Section 5.2 – Hydrostatic Testing. Allowable leakage shall not exceed the formula $L = SDP^{1/2}/148{,}000$, in which L is allowable leakage in gallons per hour; S is length of pipe in feet tested; D is nominal diameter of pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

E. P.V.C. pipe shall be tested in accordance with AWWA Standard C 605, Section 7.3 – Hydrostatic Testing. Allowable leakage shall not exceed formula $Q = LDP^{1/2}/148{,}000$, in which Q is allowable leakage in gallons per hour; L is length of pipe in feet tested; D is nominal diameter of the pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

1. Should any test of pipe laid disclose leakage greater than the above specified, Contractor shall, at its own expense, locate and repair defective joints until leakage is within specified allowance. Contractor is responsible for notifying the Engineer 48 hours (minimum) prior to applying pressure for testing. Pressure test will be witnessed by Engineer or Project

Representative. All visible leaks shall be repaired regardless of the leakage amount.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.

2. Piping larger than 18 inches.

3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.

2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase 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 ten 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 visible evidence of leakage.

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

3.04 DEFLECTION FOR GRAVITY PIPING

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than five percent. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30–days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95 percent of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a

density greater than 1.0 as related to water at 39.2 degrees Fahrenheit, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0 percent of diameter of pipe being measured and shall be accurate to 1.0 percent of indicated dimension. Installed pipe showing deflections greater than five percent of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner. 100 percent of the pipe shall be tested.

3.05 LEAKAGE FOR GRAVITY PIPING

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a two-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

100 percent of the pipe shall be tested.

3.06 DISINFECTION FOR WATER MAIN

A. After hydrostatic and leakage tests have been completed, water pipes shall be disinfected in accordance with AWWA C 651 and Regulations of the local Health Department.

B. All new mains shall be thoroughly flushed then chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or 70 percent high–test calcium hypochlorite can be used. Water from existing distribution system or other source of supply should be controlled to flow slowly into the newly laid pipeline during application of chlorine. The solution shall be retained in pipeline for not less than 24 hours and a chlorine residual of 25 ppm shall be available at this time. Then system shall be flushed with potable water and the sampling program started. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non–detectable in those systems not chlorinating. Normal system residual should be between 0.2 and 0.8 ppm. The chlorine residual shall be measured and reported. If the membrane filter method of analysis is used for coliform analysis, non–coliform growth must also be reported. If non–coliform growth is greater than eighty colonies per one hundred milliliters, the sample result is invalid and must be repeated.

C. A minimum of two samples from each sampling site shall be collected for total coliform analysis. The number of sites depends on amount of new construction, but must include all dead-end lines, be representative of water in newly constructed mains, and shall be collected a minimum of every 1,200 linear feet. Each set of samples shall be taken at least 24 hours apart after disinfection and tested by a State approved lab and shall indicate bacteriological satisfactory water. Contractor shall submit results to the Engineer.

3.07 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.

3. Test fluid.

4. Test pressure.

5. Remarks, including:

   a. Leaks (type, location).

   b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Contractor and Engineer to represent that test has been satisfactory completed.

END OF SECTION

INDEX TO

SECTION 40 91 00 – PROCESS INSTRUMENTATION

SECTION 40 91 00

PROCESS INSTRUMENTATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
25 50 00	Plant SCADA System

1.02 SCOPE

A. The Contractor shall furnish and install all instrumentation and instrumentation installation hardware, conduit, and wiring necessary to provide for the complete installation of all instrumentation described in this specification. At a minimum the Contractor shall be responsible for:
1. Purchasing of all instrumentation tagged on the P&ID drawings, instrumentation schedule, or others listed in these specifications.
2. Installation and termination of all instrument and power wiring.
3. Installation and connection of all instrument pneumatic tubing and related controls.
4. Performance of instrument calibration and loop checks.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports, or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

1.03 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:
   1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.
   2. A complete set of submittal information in PDF format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.04 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting & installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 – PRODUCTS

2.01 DISSOLVED OXYGEN SENSOR/TRANSMITTER

A. Sensor
   1. The sensor shall be a continuous-reading probe that utilizes luminescent sensor technology.
   2. All parts of the probe shall be corrosion resistant and fully-immersible.
   3. The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.
   4. The operation of the analyzer shall not be affected by H2S, pH, K+1, Na+1, Mg+2, Ca+2, NH4+1, Al+3, Pb+2, Cd+2, Zn+2, Cr (total), Fe+2, Fe+3, Mn+2, Cu+2, Ni+2, Co+2, CN-1, NO3-1, SO4-2, S-2, PO4+3, Cl-1, anion active tensides, crude oils, or Cl2-1.
   5. The probe shall provide electrolyte-free operation without the requirements of sample conditioning.
   6. The sensor cap shall be warranted for one full year against defects in material and workmanship.

7. The probe shall be warranted for three full years against defects in material and workmanship.
8. Sensor shall be self-calibrating with a response time to 90% in less than 430 seconds or to 95% in less than 60 seconds at 20 degrees C.
9. Measurement accuracy shall be approximately.1ppm below 1 ppm and approximately .2 ppm above 1 ppm.
10. The sensor shall be approved for operation from 32 to 122 degrees F.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach LDO sensor with **SC200 controller.**
2. Approved equal.

2.02 TURBIDITY SENSOR/TRANSMITTER

A. Sensor
1. The turbidimeter shall be a microprocessor-based, continuous reading, on-line nephelometric instrument
2. The turbidimeter shall measure turbidity in the range of 0.001-100 NTU
3. Accuracy shall be approximately 2% of reading or approximately 0.015 NTU (whichever is greater) from 0 to 40 NTU; approximately 5% of reading from 40 to 100 NTU
4. Displayed resolution shall be 0.0001 NTU from 0 to 9.999 NTU and 0.001 NTU from 10.000 to 9.999 NTU.
5. Repeatability shall be better than approximately 1.0% of reading or approximately 0.002 NTU (whichever is greater).
6. The turbidimeter shall meet all design and performance criteria specified by USEPA method 180.1.
7. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells.
8. Optical components shall be mounted in a sealed head assembly that can be removed for calibration/ service without disturbing sample flow.
9. The turbidimeter body shall be corrosion-resistant.
10. An internal bubble removal system shall be included to vent entrained air from the sample stream.

11. Calibration of the turbidimeter shall be either formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.
12. User selectable signal averaging, bubble removal, alarm and recorder output hold, and self-test diagnostics shall be provided.
13. Connections between the turbidimeter(s) and the controller shall be "plug and play."
14. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
15. The interface unit shall include two analog outputs and 3 unpowered SPDT alarm contacts.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach 1720E with SC200 controller.
2. Approved equal.

2.03 MIXED LIQUOR SUSPENDED SOLIDS (MLSS) SENSOR/TRANSMITTER

A. Sensor
1. The sensor shall use dual-beam infrared/scattered light photometer for measuring suspended solids. The LED shall transmit light at 45 degrees to the sensor face and the back-scatter photoreceptors shall detect scattered light at 140 degrees to the transmitted beam.
2. The sensor shall provide color-independent measurement.
3. The sensor shall be equipped with self-cleaning device to prevent erroneous values and maintenance problems.
4. The signal averaging time shall be user selectable ranging from 1 to 300 seconds.
5. The sensor shall be capable to measure from 0.001 mg/l to 50,000 mg/L.
6. Measurement accuracy shall be less than 5% of reading.
7. Measurement repeatability shall be less than 3% of reading.
8. The sensor shall be approved for operation from 32 F and 104 F.
9. The sensor shall be warranted for one full year.
10. The sensor shall be enclosed in stainless steel or PVC and shall include a silicon wiper blade and integral cable.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH SOLITAX with SC200 controller.
2. Approved Equal.

2.04 pH SENSOR/TRANSMITTER

A. Sensor
1. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.
2. The pH sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 meters (328 feet) with standard cabling and up to 1000 meters (3280 feet) with a termination box.
3. The pH sensor shall have NTC 300 ohm thermistor for automatic temperature compensation and shall have a analyzer temperature readout.
4. The measurement range shall be -2 to 14 pH.
5. The measurement sensitivity shall be approximately 0.01pH.
6. The sensor shall be suitable for operation from 23 F to 158 F.
7. The sensor material shall be PEEK®, salt bridge of matching material with Kynar® junction, glass process electrode, titanium ground electrode, and Viton® O-ring seals.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH Differential pH with SC200 controller.
2. Approved equal.

2.05 HYDROSTATIC LEVEL TRANSMITTER

A. The level transmitter shall be a hydrostatic pressure sensor with an integral baffle plate to protect the sensing element from debris.

B. The level transmitter shall measure up to 23 feet of water head.

C. The level transmitter shall have a static accuracy of 0.5% FSO BFSL and one-year stability of 0.20% FSO.

D. The response time shall be less than 5 ms.

E. The signal output shall be 4-20 mA DC two wire twisted pair grounded shield cable at 0.042 ohm per foot.

F. The transmitter shall be approved for operation from -20 F to 190 F.

G. The transmitter and sensor shall be made of 316 stainless steel. The cable shall be polyurethane-jacketed cable with 40 feet of length.

H. The transmitter shall require 10-30 VDC unregulated power.

I. Manufacturers
1. Blue Ribbon Bird Cage Level Transmitter.
2. Endress and Hauser FMX Level Transmitter.
3. Approved equal.

2.06 ULTRASONIC LEVEL TRANMITTER

A. The transmitter shall use the Sonic Intelligence® echo processing technology.

B. The measuring range shall be 0.8 feet to 26 feet.

C. The accuracy shall be 0.25% of measuring range (in air).

D. The transmitter shall be suitable for operation under ambient temperature conditions from -40 F to 140 F and shall include built-in temperature compensation.

E. The Power supply required for the transmitter shall be 12 to 28 V DC, max 0.1 A. The max power consumption shall be 0.75 W (25 mA at 24 V DC).

F. The output signal shall be 4-20mA and max load shall be 600Ω in the loop at 24 V DC.

G. The transmitter shall have CE, CSA $_{NRTL/C}$, FM and 3A certificates, and approvals.

H. The transmitter electronics enclosure shall be made of PVC and transducer shall be made of PVDF copolymer.

I. Manufacturers
   1. Siemens Milltronics Level Transmitter.
   2. Approved equal.

2.07 LEVEL SWITCH

A. The level switch shall be an enclosed, narrow angle, mechanical float switch designed for use in sewage environments.

B. The level switch shall utilize mechanically-activate microswitches for indication of specific water levels. Level switches containing mercury shall not be acceptable.

C. The switches shall be a single-pole, double throw (SPDT) type and have an electrical rating of 10 amps at 120 VAC.

D. The power cord shall be chlorinated polyethylene type SJ00W-300 volt on 16/3.

E. The float shall be ABS or polypropylene material and shall be leak proof, shock proof, and impact resistant.

F. The level switches shall be supplied with an anchor to which the float shall be tethered. The anchor shall allow for adjustment of the actuation level and be of sufficient weight as to hold the floats secure in a well-mixed tank. The anchor shall be constructed of corrosion-resistant material suitable for continuous submergence in mixed liquor.

G. Manufacturers
   1. Conery 2902 Series Mechanical Angle float switches.
   2. Kobold NAE Series float switches.

2.08 TEMPERATURE SWITCH

A. The enclosure material shall be Die cast aluminum, epoxy powder coated, gasketed, and with captive cover screws.

B. The enclosure shall meet NEMA 4X requirements.

C. The set point repeatability shall be within approximately1% of adjustable temperature range.

D. The output shall be SPDT snap action switch.

E. The switch shall be electrically rated for 20A 125/250/480 VAC resistive.

F. The temperature dead band shall be within 2% of range under laboratory conditions (70 F ambient circulating bath at rate of ½ F per minute change).

G. The immersion stem shall be made of nickel-plated brass.

H. Manufacturers
1. United Electric.
2. Approved equal.

2.09 TEMPERATURE GAUGE

A. The temperature gauge shall be hermetically sealed to prevent moisture entry into the casing.

B. The temperature gauge shall be tamperproof with Maxivision dial for accurate temperature readings.

C. The temperature gauge shall be suitable for use in ambient temperature between -40 F and 200 F.

D. The temperature gauge shall measure temperature from 50 F to 400 F.

E. The temperature gauge accuracy shall be 1% full span to ASME B40.3 (Grade A).

F. The bimetal coils used are heat treated for optimum stability and over temperature capability.

G. The temperature gauge case and stem material shall be 304 SS.

H. Manufacturers
1. Ashcroft Bimetal Thermometers.
2. Approved equal.

2.10 FLOW SENSOR/TRANSMITTER FOR PERMEATE AND MIXED LIQUOR SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be ± 0.5% of rate ± 0.02% of full scale (33 feet per sec.) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from ½-inch to 78 inches.

E. The tube shall be lined with polyurethane and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges

shall be ANSI B16.1 Class 150 for 12 inches and smaller and AWWA Class D for 14 inches and larger.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of 316SS material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16-character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
1. Siemens Danfoss
2. Endress Hauser Model 50P
3. Approved equal.

2.11 FLOW SENSOR/TRANSMITTER FOR CLEAN-IN-PLACE CHEMICAL SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be ± 0.5% of rate ± 0.02% of full scale (33 feet per see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 1 inch -12 inches.

E. The tube shall be lined with PTFE and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12 inches.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of Alloy C-22 material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The transmitter shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16-character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units. The display shall be used in conjunction with integral push buttons for configuration and diagnostic messages.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
1. Siemens Danfoss

2. Approved equal

2.12 ROTAMETER (LIQUID SERVICE)

A. The liquid rotameter shall be a variable-area style flow meter.

B. The rotameter shall be rated for service up to 145 psig and temperatures up to 140-degree F with an accuracy of +/- 4% of full scale.

C. The rotameter shall have a polysulfone measuring tube with a direct reading scale which is calibrated for measurement in gallons per minute.

D. The rotameter shall be supplied with PVC socket x half union connections.

E. The float shall be PVDF.

F. The rotameter shall be supplied with EPDM o-rings.

G. Manufacturers
1. Kobold KSM series
2. Approved equal.

2.13 FLOW SENSOR/TRANSMITTER FOR AIR SERVICE

A. The flow meters shall be an insertion-style with an integrally-mounted transmitter.

B. The voltage shall be linearly proportional to flow velocity from 0.65 to 275 feet per second. Standard accuracy of the pulse output between .65 and 275 feet per second shall be +/- 1.5% of reading +/- 0.5% of full scale (275 Feet Per Second) for all meters. The installation location shall meet the manufactures installation guidelines for straight run requirements with and without using a flow conditioner.

C. The air flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 3 inches to 60 inches.

D. The metering mechanism shall be manufactured of 316 Stainless steel sensors shall be of the proper sizes to measure the design flow rate of the piping and shall be noted in the instrument schedule.

E. Repeatability 0.5% for velocities above 0.65 feet per second.

F. The transmitter shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC, 45 to 65 Hertz. or 20 to 55 V AC, 45 to 65 Hertz, or 16 to 62 V DC transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

G. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient

protection. Power consumption shall be no more than 16 VA, independent of meter size.

H. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

I. Each meter shall be provided with a certificate of a 3-point calibration report exceeding stated accuracy of 1.5% of reading for 100% to 20% of full scale at reference conditions, 0.3% of full scale for 20% to 1% of full scale at reference conditions.

J. Manufacturer
1. Endress Hauser Model 65I.
2. Sierra Model 640S.
3. Approved equal.

2.14 ROTAMETER (AIR SERVICE)

A. The air flow rotameter shall be a glass tube variable-area style flow meter.

B. The rotameter shall be rated for service up to 100 psig and temperatures up to 212-degree F with an accuracy of +/- 1% of full scale.

C. The air flow rotameter shall have a tempered glass measuring tube with a direct reading scale which is calibrated for measurement of air in SCFH.

D. The rotameter shall be supplied with 316 stainless steel 150 lb ANSI flanges.

E. The float shall be 316 stainless steel

F. The rotameter shall be supplied with EPDM O-rings.

G. Manufacturers
1. Kobold KDV series.
2. Approved equal.

2.15 PRESSURE SENSOR/TRANSMITTER FOR LIQUID SERVICE

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero-point adjustment with no on-site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum

deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be +/- 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4...+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
1. Endress+Hauser PMC131.
2. Approved equal.

2.16 PRESSURE SENSOR/TRANMITTER (AIR SERVICE)

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero-point adjustment with no on-site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001-inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be +/- 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4...+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
1. Endress+Hauser PMC131.
2. Approved equal.

2.17 PRESSURE SWITCH

A. The pressure switch shall feature diaphragm sensing technology, a 20-amp snap-acting switch, and adjustable pressure ranges up to 475 psi.

B. The pressure switch should be able to operate in 0 to 160 F (17 to 71 C). Set point shifts less than 1% of range for a 50 F (28 C) ambient temperature change.

C. The pressure switch shall use an EPDM sensor material and should handle a maximum temperature of 250 degrees F.

D. The pressure switch shall be enclosed in Type 1 Enclosure and shall be made of Zinc plated steel with bright chromate finish.

E. The pressure switch should be surface mounted with two screws through clearance holes or mounted by pressure connection.

F. The pressure switch shall have electrical rating of 20 A at 480 VAC

G. Manufacturers
   1. United electric 25 Series Model 25A1F4A pressure switch.
   2. Approved equal.

2.18 PRESSURE GAUGE

A. The pressure shall be solid front and hinged blow-out back style with elastomer compensating diaphragm on the inside of the hinged blow-out back.

B. The pressure gauge accuracy shall be 0.5% full scale to ASME B40.1 standard (Grade 2A)

C. The pressure gauge case and blow-out back shall be made of molded fiberglass reinforced thermoplastic and should be fire retardant and impact resistant

D. The pressure gauge lens shall be 4 mm thick laminated safety glass with lens rind made of molded fiberglass reinforced thermoplastic.

E. The fillable liquid used for the pressure gauge shall be glycerin.

F. The Stem and socket connections shall be made of 316 Stainless steel.

G. Manufacturers
   1. McDaniel MPB-S Pressure gauge.
   2. Approved equal.

PART 3 – EXECUTION

3.01 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner's Representative changes required to resolve interferences.

3.02 IDENTIFICATION PLATES AND CODING

A. All components provided under this section, both field and rack mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Rack mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

B. The Contractor shall attach nametags to control devices with screws, bolts, or wire leader to create a permanent bond.

3.03 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.04 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.05 INSTRUMENT PROCESS CONNECTIONS

A. The Contractor shall complete all necessary connections to process equipment, control panels, and instruments as required to meet the intent of the drawings. All vents and drains from instrument process piping shall be routed to the proper vent headers or sewers as required for environmental reasons or as provided for in the job specifications and drawings.

B. Over range limit, maximum working pressure and static pressure limits shall not be exceeded to prevent damage to the transmitter. The Manufacturer shall specify all transmitters and measuring elements to be compatible with the pressure and temperature ranges of process parameters.

C. Process temperature limit, ambient temperature limit and storage temperature limit shall not be exceeded in any installation. The Manufacturer shall ensure the installation provides affordable protection to the instrument devices.

3.06 INSTRUMENT SETUP/PROGRAMMING

A. The contractor shall setup and program all instrumentation. As necessary, the Contractor shall have the Manufacturer's Representative on-site to program or setup any instrumentation and ensure that no warranties are voided.

B. Copies of all software, programs, or equipment setup logs shall be given to the Owner prior to completion of the project. This information shall be made available to the Owner or Owner's Representative upon request at any time during construction or check-out of equipment.

3.07 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.08 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.09 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 40 91 16.29 – MAGNETIC FLOW METERS

SECTION 40 91 16.29

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all hardware, conduit, wiring, spare parts, accessories, and appurtenances as herein specified, as recommended by the manufacturers and as shown on the Drawings necessary to complete installation.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

G. Coordinate signal requirements with MBR System Supplier.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 91 00 Process Instrumentation

B. Section 45 50 00 Membrane Bioreactor (MBR) System

1.3 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:

1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.

2. A complete set of submittal information in PDF and MSWord format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.4 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting and installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a stainless-steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65□C. Meter

and transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.5 percent of rate over the flow velocity range of 1.0 to 30.0 feet per second. Repeatability shall be 0.1 percent of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than five uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°Celcius. Power supply shall be 115 VAC, 60 Hertzz.

M. Flow tubes shall be 150-pound flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or two-inch pipe mounted as shown in the Drawings or as specified.

N. Magnetic flow meter systems shall be as manufactured by **Siemens**.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to the specifications for further requirements.

3.2 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner and Engineer changes required to resolve interferences.

3.3 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.4 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.5 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.6 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies.

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.7 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 40 95 13 – MBR CONTROL PANEL

SECTION 40 95 13

MBR CONTROL PANEL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following.

Section	Description
45 50 00	Membrane Bioreactor
40 95 20	MBR SCADA Hardware and Software

1.02 REFERENCES

A. Standards referenced in this section are listed below:

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

2. National Electrical Manufacturer's Association (NEMA):

   a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volt Maximum).

   b. NEMA ICS 6 - Enclosures for Industrial Control and Systems.

3. Underwriters Laboratories Inc. (UL):

   a. UL 50 - Enclosures for Electrical Equipment.

   b. UL 508 - Industrial Control Equipment.

   c. UL 508A - Standard for Industrial Control Panels.

1.03 SCOPE

A. This Section specifies the hardware requirements for the MBR control panel.

B. The control panel, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 20 MBR SCADA Software and Hardware.

C. The control panel provider shall be responsible for the following:

   A. Design of the MBR system control panel.

B. Development of the MBR system control panel submittal documentation and drawing set.

C. Fabrication of the MBR system control panel.

D. Delivery of the MBR system control panel in packaging designed to prevent physical damage.

1.04 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. All components and equipment shall comply with requirements to meet UL508 listing.

2. All control panels shall be UL 508A labeled unless otherwise allowed for in the Contract Documents.

1.05 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

B. Submit the following control panel shop drawings in a single package:

1. Layout diagrams for all control panels and enclosures. Include panel elevations (front, side, interior), and sizing. Panel front elevations shall be of sufficient scale to allow all engraved nameplates and inscriptions to be legible without the use of schedules.

2. Wiring diagrams for all control panels. Diagrams shall be complete electrical wiring diagrams showing all components and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc. All wires and terminals shall be numbered on the diagrams, and line cross references shall be labeled. Include wiring interface to the SCADA controllers where applicable. Include on these drawings, a tag number to identify each component, referenced to a component identification list.

3. Power requirements and heat dissipation summary for all control panels. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in Btu/hr. Summary shall be supplemented with calculations.

1.06 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the RFP and the Contract Documents. The warranty duration shall be 12 months beyond Final Acceptance. All hardware components that are part of the completed system shall be covered by the warranty. The control panel supplier shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 CABINET

A. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common keyed locks.

B. Cabinets and panels located outdoors or in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction. Cabinets located in chlorine storage/feed areas shall be of nonmetallic, FRP construction, rated NEMA 4X.

C. Cabinets and panels located indoors within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

D. Cabinets and panels shall have doors on the front and shall be designed for front access. All cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.

E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

F. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman, Rittal, Saginaw, or approved equal.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Control and data acquisition associated with site equipment shall be performed by a Programmable Logic Controller (PLC).

B. Each PLC and I/O rack shall be equipped with its own regulated power supply module energized from a standard, commercial 120 VAC 60 Hz, single phase source provided by the Uninterruptible Power Supply. Any power transformation, rectification, regulation, or other conditioning necessary shall be provided as part of the unit's power supply package. The module shall have sufficient capability to handle the power requirements for all the PLC components and I/O points, including the required, installed spare I/O capacity.

C. The PLC shall be Allen-Bradley CompactLogix 1769-L32E or 1769-L35E. A minimum of 768 KB of user memory shall be installed. The actual amount of memory supplied shall be sufficient to provide 20% unused capacity when the entire PLC program, as provided, is loaded and running. Provide industrial Compact Flash module to maintain memory integrity of the PLC program and eliminate the need for downloading system programs from a host computer following temporary (short-term) power failures. PLC shall be capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic.

D. All I/O modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminals shall be provided with unique identification. All I/O modules shall be Allen-Bradley 1769 series.

E. The PLC shall communicate with the MBR SCADA system over an Ethernet Modbus TCP/IP network.

F. I/O count shall be as required to implement the functional requirements of the system.

1. Size the I/O chassis for the required I/O cards plus the greater of 1 spare module or 10% additional spare I/O of each type.

2. If necessary, use expansion chassis to accommodate these requirements.

2.03 NETWORK SWITCHES AND MODEMS

A. As required to provide Owner with a complete and fully functional system.

2.04 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration.

B. Provide ten percent (rounded up) spare fuses (minimum of 10) of each type and rating supplied.

PART 3 - EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment, and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top.

2. Thermostatically controlled, low noise internal air blowers (initial set point 75 °F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

E. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the specifications.

F. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.

G. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

H. A copper 120 VAC ground bus shall be installed in each cabinet and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.

I. All interior panel wiring shall be labeled and uniquely identified.

J. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit within and distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

K. The power entrance to the panel shall be provided with a surge protection device.

L. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:

1. Solenoid valves

2. Electrically actuated valves

3. Instruments connected to the control panel.

M. Door mounted HOA switches shall be provided for all solenoid and non-modulating valves.

N. Fuse holders shall be indicating type.

O. A panel mounted UPS shall be included in each PLC cabinet. The UPS shall be sized to provide at least 30 minutes of run time for the PLC. The UPS shall also power any door mounted operator interface if included.

P. Intrinsic safety barriers shall be provided for all equipment signals originating in a hazardous area.

Q. Enclosures with any dimension larger than 36 inches shall be provided with fluorescent service lights and 120 VAC duplex receptacles for service equipment. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

END OF SECTION

INDEX TO

SECTION 40 95 20 – MBR SCADA HARDWARE AND SOFTWARE

SECTION 40 95 20

MBR SCADA HARDWARE AND SOFTWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
40 95 13	MBR Control Panel

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. Underwriters Laboratories Inc. (UL)

1.03 DEFINITIONS

A. Operator Interface Terminal – A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.

B. Operator Workstation – A terminal that runs a commercially available operating system such as Windows. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels.

C. SCADA – Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.

D. SCADA System Provider – A company that takes a commercially available SCADA software package, and then develops a project specific application. This company will typically supply hardware for the SCADA software and application to operate on.

1.04 SCOPE

A. This Section specifies the SCADA software and hardware for control of the MBR system.

B. The SCADA system, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 13 MBR Control Panel.

C. The SCADA System Provider shall be responsible for the following:

1. Supply of the MBR system SCADA and Operator Workstation (the plant workstation).

2. Coordination with all panel suppliers to insure proper data transfer between the MBR operator station and control panels.

3. Delivery of Operator Workstation and SCADA software in packaging designed to prevent damage from static electricity and physical damage.

1.05 QUALITY ASSURANCE

A. All electrical components, devices, and accessories shall be UL listed.

1.06 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals shall include, but not be limited to the following:

1. Hardware Product Information Submittal

2. Software Product Information Submittal

a. Software License information shall be submitted for each software or program in the system, indicating the number of licenses provided for each type of program or software.

1.07 OPERATION AND MAINTENANCE MANUALS

A. The SCADA System Provider shall supply O&M manuals for all equipment and software provided. The manuals shall be developed for an electronic technician audience. A manual, or manuals, shall be furnished for all deliverable hardware, including OEM equipment. Manuals for OEM equipment shall contain original printed materials, not copies, and may be in the manufacturer's original format.

B. The SCADA System Provider shall supply a Graphical Interface Users' Manual. The manual shall be developed for an operations technician audience.

1. The Graphical Interface Users' Manual shall describe the configuration and functions of the provided Human Machine Interface. The manual shall describe in detail the operator interface operator interaction sequences. The following shall be provided, as a minimum:

a. Summary description of all major functions.

b. Presentation of data on displays.

c. Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.

d. Description of every message and alarm that the system is capable of outputting, and an explanation of what the message indicates.

C. O&M support materials shall include:

1. Program Media:

a. The SCADA System Provider shall furnish complete sets of program media documentation. These documents shall include source of all programs written by the SCADA System Provider specifically for the proposed system. This includes, SCADA applications, HMI scripting, and objects of all programs necessary for the operation and maintenance of the systems programs. If any changes are made to programs during commissioning, the SCADA System Provider shall provide, within 10 days, corrected copies of source, object, and system media.

2. Program Listings:

a. Each program listing shall include revision information. Each time a change is made in the listing, its revision level shall be documented by the party making the change. Program listings will include all in-program comments and documentation and must be clearly understandable by programmers familiar with the language used. Undocumented code is not acceptable.

3. Software Licenses:

a. Each software package shall be provided with documented serial numbers and verification of licenses in Owner's name.

4. Remote Access Procedure:

a. The Remote Access Procedure documentation shall describe configuration of remote access software including all applicable phone numbers, IP Addresses, usernames and passwords.

D. Final manuals and documentation shall be provided in an electronic format on media compatible with the optical drives supplied with system. Electronic documents shall be provided in both the native application used for creating the documents (MS Word, AutoCAD, etc.) and the Adobe PDF format.

1.08 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the Agreement and this product manual. The warranty duration shall be 12 months beyond Final Acceptance. All software and hardware components that are part of the completed system shall be covered by the warranty. The SCADA System Provider shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 OPERATOR WORKSTATION

A. The requirements defined in this subsection apply to the computer-based components of the SCADA System Provider's proposed system.

1. All workstations shall be from a single manufacturer and be from the same "family" or product line. All computer equipment shall be from the equipment manufacturer's standard offering and shall not be specifically built nor require major modifications in order to meet the requirements set forth in this Specification.

2. The MBR SCADA system shall use an Ethernet network as the preferred peer-to-peer network.

B. Minimum Hardware Requirements:

1. Workstations shall be Dell Precision or equivalent with equal or higher quality. The minimum workstation hardware requirements are as follows:

a. 3.00 Ghz Intel® Xeon 4 processors w/2 MB Cache.

b. 2GB DDR3 SDRAM, ECC.

c. Dell 19-inch flat panel monitor.

d. 250 GB Hard Drive, SATA, 7200 RPM.

e. 16X DVD+/-RW Optical Drive.

f. Graphics card suitable to handle the graphics of the SCADA application.

g. Dell QuietKey keyboard.

h. Dell USB Optical Mouse.

2.02 UNINTERRUPTIBLE POWER SUPPLIES

A. Uninterruptible Power Supplies (UPS) will be provided for all workstations and network switches in the project. As a general rule, provide a dedicated UPS for each workstation. The UPS system shall be able to run on Utility or generator power without any disruption in service. The UPS shall also be able to absorb the transients generated by ATS changeover.

2.03 SCADA SOFTWARE

A. The requirements defined in this subsection apply to SCADA software and configuration of the proposed control system.

B. The SCADA software shall be capable of communicating to PLCs connected to the network, remote PLCs, I/O servers, and other devices on the network. The SCADA software shall have the following communications capabilities:

1. Diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.

2. A package of communication drivers that shall include the following as a minimum:

   a. Ethernet Modbus (TCP/IP).

   b. Ethernet IP.

C. Security features shall be fully integrated to allow only users with appropriate security levels access to individual parts of the system. The SCADA software shall have the following:

1. Passwords hidden in both the configuration and runtime environments to ensure that other personnel cannot access another account.

2. Monitoring and logging of each control action of each user. This shall include all operator control actions, including system log-in and log-out. The sequence of actions shall be viewable within the SCADA package and also exported to an external open file format (e.g. txt, csv) for later analysis.

3. Automatically log out a user after an adjustable time period. Logging out a user will only cause the system shall revert to a view-only security status. Logging out will not shutdown the system.

4. A minimum of four privilege levels. The software shall ensure that a user has access to all tasks for his privilege level. If the user does not have the correct privilege for a task, a message will indicate insufficient privilege.

5. Assign each graphic object to a plant area, define the privilege level, define whether operator input is enabled or disabled, and if the object will be interactive or not based on the operator's current privilege levels within the plant area.

D. The SCADA software shall have the following graphical display features:

1. Capable of displaying images from 3rd party packages for use within the SCADA displays.

2. Capable of pop-up windows for trends, loops, device status, and device control by clicking on hot spots or objects on the main graphics page.

3. Ability to allow the user to navigate around the graphics system utilizing a variety of navigation methods.

4. Hot Key links to specific graphics pages from the keyboard.

5. Navigation menus allowing access to system set-points, trends, logs, and performance summary pages from any page.

6. Configured with "hot spots," where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

E. The SCADA software shall monitor and display all analog, discrete, and calculated process values.

1. Historical data logging functionality shall be provided:

a. All analog and calculated values shall be logged to a local database with value, time and date labels.

b. Data logged to disk shall be viewable while the system is online or offline without interrupting data collection.

c. Ability to export historical data logs to an external open file format (e.g. txt, csv) for later analysis shall be provided.

F. The SCADA software shall monitor and display all process alarm conditions.

1. Alarm display shall have the following:

a. Alarms shall be configurable in multiple levels. The color of the text of the alarm message shall indicate priority. Text color shall be configurable by engineers.

b. Provided with a standard alarm display page. The alarm page shall allow for scrolling of alarms, and acknowledgment of individual alarms or all alarms on the page.

c. Possibility to display the following information for each alarm as it appears on an alarm display page:

i. Alarm Tag Name.

ii. Alarm Description.

iii. Value of the Variable.

iv. Trip point.

v. Alarm Status: Disabled, Acknowledged, Unacknowledged.

vi. Alarm Category or Priority.

vii. Time & Date.

viii. Category.

d. A mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date /time range, state or type.

2. Alarm logging functionality shall be provided:

a. The alarms shall be able to be logged to a local database with alarm text, time and date labels.

b. Alarms that are logged to disk shall be viewable while the system is online or offline without interrupting data collection.

c. Ability to export alarm logs to an external open file format (e.g. txt, csv) for later analysis shall be provided.

G. The software shall provide the following trending functionality.

1. The software shall be capable of displaying historical trend information over a user configurable time period.

2. Every analog tag defined in the system configuration shall be available for trending.

3. The software shall have the following in its native functionality:

a. Line graphs with time on a linear, continuous horizontal or vertical axis and the trended variable on the vertical or horizontal axis.

b. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in a different color.

c. Each trend graph shall be capable of displaying a minimum of eight trend pens.

d. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent to each other pen displayed on a page.

e. Include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable, by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired.

f. The trend display shall be dynamic, scrolling through time, with the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history.

g. The trend display shall have a minimum of two slide wires that can be moved over the page. The slide wires will provide indication of the date, time, and value at the intersection of the slide wire and the trend point.

h. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range.

i. The software shall make available trending data from the historical database for export to disk files or external databases. Data shall be exported to csv or txt formatted files.

H. SCADA software shall be Wonderware Intouch.

2.04 OPERATOR WORKSTATION SOFTWARE

A. The MBR Operator Workstation software package shall support dual core and multi-processor CPU's.

B. As a minimum, the SCADA software shall run development and runtime implementations on the following Microsoft operating systems:

1. Windows 7 Professional.

C. The specified SCADA functionality shall have communications drivers, graphics capabilities, data reporting, historical storage, trend and alarm displays, and the development environment offered as a single integrated software package or suite of packages. Additionally, software will be supplied to enhance functionality of the software package:

1. Word Processing and Spreadsheets: Microsoft Office 2007 Basic.

2.05 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration. All acquired hardware and software shall be registered to "The Owner," as user, and "Owner's Company's Name," as the organization.

B. Provide "mock-up" of screen views to Engineer for approval.

END OF SECTION