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USACE / NAVFAC / AFCEC	**UFGS-40 05 13 (October 2007)** **Change 2 - 02/20**
Preparing Activity: USACE	**Superseding** **UFGS-40 05 13 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2024

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SECTION 40 05 13

PIPELINES, LIQUID PROCESS PIPING
10/07, CHG 2: 02/20

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NOTE: This guide specification covers the requirements for above and below grade liquid process piping located both inside and outside of treatment plants.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: Show the following information on the project drawings:

a. Location of pipelines indicating pipe designation, diameter and valves.

b. Pipe schedule relating pipe designation and service.

c. Valve schedule indicating valve designation and service.

d. Piping details.

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1.1 UNIT PRICES

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NOTE: This paragraph does not apply to invitation for bid (IFB) contracts. If it is determined that a lump sum contract may be more advisable, this paragraph will be deleted. If a unit price contract is to be used, the bid items for the unit price contract will be defined for each unit to be furnished and installed.

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Measurement and payment will be based on completed work performed in accordance with the drawings, specifications and the contract payment schedules. No payment will be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 31 00 00 EARTHWORK.

1.1.1 Measurement

Determine the length of pipelines, for which payment will be made, by measuring along the centerlines of the various piping systems and sizes as furnished and installed. Measure pipe from the center of fitting to center of fitting and from center of main header to end of pipe. Make no deduction for the space occupied by valves or fittings.

1.1.2 Payment

Payment will be made at the price per linear meter foot listed in the bid form for the various types and sizes of piping, and will be full compensation for all pipes, joints, fittings and specialties, complete in place. Payment for valves and other appurtenances will be made at the respective contract unit price for each item complete in place. Payment will include the furnishing of all testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown in contract documents.

1.1.2.1 Connections to Existing Piping

Connections to existing piping systems where new fittings in the existing line are required will be paid for according to the contract prices for such connection. The price will be considered as full compensation for material and labor required for the removal and replacement of the existing pipe as necessary.

1.1.2.2 Connections to Existing Equipment

Connections to existing equipment where new fittings for the existing equipment are required will be paid for according to the contract prices for such connection. The price will be considered as full compensation for material and labor required for the installation of new fittings or the removal and replacement of existing fittings, as necessary.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ANSI H35.2M	(2017) Dimensional Tolerances for Aluminum Mill Products

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B1.20.7	(1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and

Threaded

ASME B16.15 (2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250

ASME B16.18 (2021) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.20 (2023) Metallic Gaskets for Pipe Flanges

ASME B16.21 (2021) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.22 (2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26 (2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

ASME B16.34 (2021) Valves - Flanged, Threaded and Welding End

ASME B16.42 (2021) Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300

ASME B18.2.1 (2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

ASME B18.2.2 (2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B31.1 (2022) Power Piping

ASME B31.3 (2022; Errata 2023) Process Piping

ASME B36.10M (2022) Welded and Seamless Wrought Steel Pipe

ASME B36.19M (2022; Errata 2023) Welded and Seamless Wrought Stainless Steel Pipe

ASME B40.100 (2022) Pressure Gauges and Gauge Attachments

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001 (2021) Performance Requirements for Atmospheric Type Vacuum Breakers

ASSE 1012 (2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent

ASSE 1013 (2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies

ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

ANSI/AWWA C541	(2016; R 2021) Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
ANSI/AWWA C542	(2016; R 2021) Electric Motor Actuators for Valves and Slide Gates
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150/A21.50	(2021; R 2023) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C510	(2017; R 2021) Double Check Valve Backflow Prevention Assembly
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly

AWWA C550	(2017) Protective Interior Coatings for Valves and Hydrants
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C651	(2023) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS A5.3/A5.3M	(2023) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS A5.10/A5.10M	(2023) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS A5.11/A5.11M	(2018) Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding
AWS A5.14/A5.14M	(2024) Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2024) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A268/A268M	(2024) Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A334/A334M	(2004a; R 2021) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	(2021) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A395/A395M	(1999; R 2022) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A423/A423M	(2019) Standard Specification for Seamless and Electric-Welded Low-Alloy Steel Tubes
ASTM A436	(1984; R 2020) Standard Specification for Austenitic Gray Iron Castings
ASTM A479/A479M	(2024) Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A513/A513M	(2024) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A587	(2022) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM A632	(2004; R 2014) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service
ASTM A727/A727M	(2014; R2019) Standard Specification for Carbon Steel Forgings for Piping Components with Inherent Notch Toughness
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip

	Galvanized Coatings
ASTM A789/A789M	(2024) Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM A813/A813M	(2024) Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe
ASTM A814/A814M	(2015; R 2019) Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe
ASTM A815/A815M	(2024) Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
ASTM A858/A858M	(2024) Standard Specification for Heat-Treated Carbon Steel Fittings for Low-Temperature and Corrosive Service
ASTM A865/A865M	(2023) Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B124/B124M	(2020) Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B150/B150M	(2012; R 2017) Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B161	(2005; R 2014) Standard Specification for

	Nickel Seamless Pipe and Tube
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B165	(2019) Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
ASTM B167	(2023) Standard Specification for Nickel-Chromium-Aluminum Alloys, Nickel-Chromium-Iron Alloys, Nickel-Chromium-Cobalt-Molybdenum Alloy, Nickel-Iron-Chromium-Tungsten Alloy, and Nickel-Chromium-Molybdenum-Copper Alloy Seamless Pipe and Tube
ASTM B210/B210M	(2019a) Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211/B211M	(2023) Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B241/B241M	(2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B247	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B247M	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)
ASTM B302	(2017) Standard Specification for Threadless Copper Pipe, Standard Sizes
ASTM B345/B345M	(2011) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems
ASTM B361	(2016) Standard Specification for Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings
ASTM B366/B366M	(2023) Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings
ASTM B517	(2019) Standard Specification for Welded Nickel-Chromium-Iron-Alloy (UNS N06600, UNS N06603, UNS N06025, and UNS N06045) Pipe

ASTM B546	(2019; R 2024) Standard Specification for Electric Fusion-Welded Ni-Cr-Co-Mo Alloy (UNS N06617), Ni-Fe-Cr-Si Alloys (UNS N08330 and UNS N08332),Ni-Cr-Fe-Al Alloy (UNS N06603), Ni-Cr-Fe Alloy (UNS N06025), and Ni-Cr-Fe-Si Alloy (UNS N06045) Pipe
ASTM B564	(2022) Standard Specification for Nickel Alloy Forgings
ASTM B574	(2023) Standard Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Molybdenum-Chromium, Low-Carbon Nickel-Molybdenum-Chromium-Tantalum, Low-Carbon Nickel- Chromium-Molybdenum-Copper, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod
ASTM B619/B619M	(2019; R 2023) Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Pipe
ASTM B622	(2023) Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube
ASTM B725	(2022) Standard Specification for Welded Nickel and Nickel Copper Alloy Pipe
ASTM B775/B775M	(2022) Standard Specification for General Requirements for Nickel and Nickel Alloy Welded Pipe
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B829	(2019a) Standard Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C600	(1985; R 2010) Thermal Shock Test on Glass Pipe
ASTM D1418	(2010; R 2016) Standard Practice for Rubber and Rubber Lattices - Nomenclature
ASTM D1527	(1999; R 2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2235	(2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2239	(2012) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2609	(2015) Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2737	(2012a) Polyethylene (PE) Plastic Tubing
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2020) Standard Practice for the Two-Step

	(Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D2992	(2012) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3222	(2018a) Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3307	(2016) Standard Specification for Perfluoroalkoxy (PFA)-Fluorocarbon Resin Molding and Extrusion Materials
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3754	(2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D3839	(2014; R 2019) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3892	(2015) Standard Practice for Packaging/Packing of Plastics
ASTM D3965	(2016) Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings
ASTM D4024	(2015) Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene

	Injection and Extrusion Materials
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D5421	(2015) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D5685	(2019) Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
ASTM E438	(1992; R 2024) Standard Specification for Glasses in Laboratory Apparatus
ASTM E814	(2024) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM F336	(2002; R 2023) Standard Practice for Design and Construction of Nonmetallic Enveloped Gaskets for Corrosive Service
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	(2024) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	(2023) Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	(2024) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F442/F442M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

ASTM F656	(2021) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F876	(2024) Standard Specification for Crosslinked Polyethylene (PEX) Tubing
ASTM F1055	(2016; R 2022a) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX)Pipe and Tubing
ASTM F1056	(2018; R 2022) Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
ASTM F1199	(2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F1200	(2021a) Standard Specification for Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F (1Mpa and 65 degrees C))
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1545	(2015a; R 2021) Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings and Flanges

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2016) Thrust Restraint Design for Ductile Iron Pipe

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 228-1	(2000) Pipe Threads Where Pressure-Tight Joints Are Not Made on The Threads - Part 1: Dimensions, Tolerances and Designation

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	(2019) Wrought Stainless Steel Butt-Welding Fittings

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NACE INTERNATIONAL (NACE)

NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials for Emergency Response

PLASTICS PIPE INSTITUTE (PPI)

PPI Handbook	(2008) PPI Handbook Of PE Pipe

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-2	(2009) Hose Handbook; 8th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials and Equipment

Cable System

SD-03 Product Data

Qualifications

Welders

Waste Water Disposal

Manufacturer's Field Services

Delivery, Storage and Handling

Materials and Equipment

Installation

Pipe Schedule

Valve Schedule

Operator Schedule

SD-06 Test Reports

Double Containment Piping System

Pipe Leakage Tests

Hydrostatic Tests

Pneumatic Tests

Double Containment Piping Leak Detection System

Valve Testing

Disinfection

SD-07 Certificates

Fiberglass Reinforced Plastic (FRP) Piping System

Plastic Piping System

Plastic Pipe Installation

SD-10 Operation and Maintenance Data

Piping and Appurtenances; G, [_____]

1.4 QUALIFICATIONS

1.4.1 Experience

Submit a statement certifying that the Contractor has the specified experience. Ensure Contractor has successfully completed at least [three] [_____] projects of the same scope and size or larger within the last [six] [_____] years. Demonstrate specific experience in regard to the system installation to be performed.

1.4.2 Double Containment Piping System Manufacturer

****
NOTE: Delete the following paragraph when it is not required.
****

The double containment piping system manufacturer will have at least [ten] [_____] years of installation experience with leak detection/location sensor cable technology.

1.4.3 Welders

Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc. Weld pressure piping systems in accordance with qualifying procedures using performance qualified welders and operators. Use procedures and welders in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage must be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged must be replaced at the Contractor's expense. During installation, piping must be capped to keep out dirt and other foreign matter. A Safety Data Sheet in conformance with 29 CFR 1910 Section 1200(g) must accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling must be in accordance with ASTM F402. Storage facilities must be classified and marked in accordance with NFPA 704. Materials must be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings must be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe must be packed, packaged and marked in accordance with ASTM D3892.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Environmental Requirements

****

NOTE: HTRW sites are typically well studied and investigated. Site conditions found during these previous investigations (e.g., soil resistivity testing for corrosion control design) must be incorporated into the design. The next paragraph must be edited carefully to address existing site conditions.

****

Buried piping at the site may be subject to corrosion from the surrounding soil. Conduct testing and measurements in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Ensure piping system design, supply and installation addresses the external corrosion conditions so indicated.

1.6.2 Existing Conditions

****

NOTE: Connection locations and wet/dry connections must be clearly indicated to avoid confusion and claims.

****

Verify existing piping and penetrations. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.7 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, keep on site pertinent wall

pipes and sleeves before they are required for placement in concrete forms. Verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

1.8 MAINTENANCE

1.8.1 Service

****

NOTE: Selectively require manufacturer's service. Automatic valves in critical or hazardous systems require service assistance. Coordinate these services with specification sections that address instrumentation and control.

****

Provide services for [automatic valve] [double containment leak detection monitoring system] [double containment leak sensor cable] [_____] systems by a manufacturer's representative who is experienced in the installation, adjustment and operation of the equipment specified. Inspect the installation, and supervise the adjustment and testing of the equipment.

1.8.2 Extra Materials

****

NOTE: Include items needed for future maintenance and repair, items that might be difficult to obtain because of color or pattern match, or spare parts to ensure operation of critical systems.

****

Submit the manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation. Concurrent with delivery and installation of the specified piping systems and appurtenances, furnish spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to [3 years] [_____] of service. For each type and size of valve, provide the following extra materials: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve; [galvanized operating wrench, [1.2] [____]m [4.1] [_____] feet long, for T-handled operators;] [galvanized operating key for cross handled valves;] [_____]. Extra materials include [2] [_____] of the following spare parts for each type and size of valve: gaskets; [O-ring seals;] [diaphragms (molded);] all elastomer parts; stem packing; [seat rings [and seat ring pulling tool];] [_____].

PART 2 PRODUCTS

****

NOTE: All materials of construction specified will be retained except under conditions where they would not be suitable (see UFC 3-240-01); upon specific instructions of HQUSACE; as stipulated in specific project directives.; and as described within notes throughout the specification. A study of the process conditions will be made to determine the suitability of the materials. Where a material would be altogether unsuitable, every mention of the unsuitable material and referenced publications that

pertain only to the unsuitable material will be deleted. If a material would be suitable in a part of the system and unsuitable in other parts, the locations where the material may and may not be used will be stated in the contract specifications and shown on the contract drawings.

Soil conditions that may affect the corrosion rate of buried ferrous piping should be evaluated. The evaluation and corrosion control design will be performed in accordance with the directions provided in UFC 3-570-02A.

****

2.1 SYSTEM REQUIREMENTS

This specification covers the requirements for above and below grade liquid process pipe, pipe supports, fittings, equipment and accessories located both inside and outside of treatment plants.

2.1.1 Design Requirements

****

NOTE: Determine the design wind speed from ASCE 7-16 and/or UFC 3-301-01 STRUCTURAL ENGINEERING, although a minimum of 161 km/h (100 miles per hour) will be used. Similarly, use 1.2 kPa 25 psf snow load for most heavy snow climates. In some cases, local climates and topography will dictate that a larger value is required. This may be determined from ANSI A58.1, local codes or by research and analysis data of the effect of local climate and topography. Snow load requirements can be deleted for locations where the maximum snow is insignificant. Provide seismic requirements and show on the drawings. Delete the bracketed phrase if seismic details are not included. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Select and design support systems in accordance with MSS SP-58 within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility. The structural design, selection, fabrication and erection of piping support system components must satisfy the seismic requirements in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC [as indicated], accounting for a [_____] MPa psf soil bearing capacity, a maximum wind speed of [_____] km/h mph, a ground snow load of [_____] kPa psf, a maximum ambient air temperature of [_____] degrees Cdegrees F and a minimum ambient air temperature of [_____] degrees C degrees F.

2.1.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. Provide piping systems suitable for the

services specified and intended. Coordinate each piping system to function as a unit. Provide flanges, valves, fittings and appurtenances with a pressure rating no less than that required for the system in which they are installed.

2.1.2.1 Buried Piping Systems

Provide piping systems suitable for design conditions, considering the piping both with and without internal pressure. Give consideration to all operating and service conditions both internal and external to the piping systems. Ensure buried ferrous piping has cathodic protection in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

2.1.2.2 Above Grade Piping Systems

Provide piping systems suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Give consideration to all operating and service conditions both internal and external to the piping systems.

2.2 MATERIALS AND EQUIPMENT

****
NOTE: Verify that the pipe schedule is included in the contract drawings.
****

Submit manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream. Provide piping materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Ensure piping materials, appurtenances, and equipment supplied as part of this contract are of equal material and ratings as the connecting pipe, new and unused except for testing equipment. Ensure components that serve the same function and are the same size are identical products of the same manufacturer. Provide general materials to be used for the piping systems in accordance with TABLE I and indicate by service in the [Pipe Schedule] [contract drawings] [_____]. Submit a list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system. Provide pipe fittings compatible with the applicable pipe materials.

2.2.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least [2] [_____] years prior to bid opening. Submit the following: Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local

indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, revise the P&IDs found in the contract drawings to reflect the constructed process system, as directed by the Contracting Officer. Use nominal sizes for standardized products. Provide pipe, valves, fittings and appurtenances supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Identification and Tagging

Each piece of pipe must bear the ASTM designation and all other markings required for that designation. Mark valves in accordance with MSS SP-25 and securely attach an identification tag using [No. 12 AWG copper wire] [stainless steel wire] [chrome-plated beaded chain] [plastic straps designed for that purpose]. Identification tags must be [35 mm 1.375 inch] [[_____] mm inches] minimum diameter, made of [brass] [engraved laminated plastic] [engraved anodized aluminum] [stamped stainless steel] [_____]. [Use black indentations for reading clarity.] Display service, valve identification number shown on the [Operator Schedule] [Valve Schedule] in the contract drawings, the manufacturer's name, and the valve model number.

2.3 DUCTILE IRON PIPING SYSTEM

2.3.1 Ductile Iron Pipe

****
NOTE: Standard thicknesses of ductile iron pipe are governed by AWWA C150/A21.50 or AWWA C151/A21.51, except for integral flanged piping. The thickness of integral flanged pipe is regulated in AWWA C115/A21.15. If restrained joint pipe is used, thickness must conform to AWWA C151/A21.51.
****

Provide ductile iron pipe for pressure service with a design and wall thickness conforming to [AWWA C150/A21.50] [AWWA C151/A21.51] [AWWA C115/A21.15]. Provide ductile iron pipewith a [[standard] [double thickness] cement lining conforming to AWWA C104/A21.4] [standard asphaltic lining] [_____].

2.3.2 Ductile Iron Joints

****
NOTE: Flanged connections should not be used for buried service. Use joints for pipe and fittings installed underground (buried).
****

Provide joints with a working pressure rating for liquids equal to the pressure rating of the connected pipe. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.3.2.1 Mechanical Joints

Provide mechanical joints conforming to AWWA C110/A21.10 and AWWA C111/A21.11. [Furnish gaskets, glands, bolts and nuts in sufficient quantity for the complete assembly of each mechanical joint. Provide [ductile] [or] [gray] iron glands with an [asphaltic] [_____] coating. Provide gaskets consisting of [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____].] [For grooved shoulder piping, use self-centering gasketed couplings designed to mechanically engage piping and lock in a positive watertight couple.] [Compose housing of [malleable iron, ASTM A47/A47M] [or] [ductile iron, ASTM A536] and use gaskets of molded synthetic rubber, [halogenated isobutylene isoprene] [nitrile] [_____]. Bolts and nuts must be [heat treated carbon steel, ASTM A183, minimum tensile 760 MPa 110,000 psi] [_____].] [Mechanical joints must have bolt holes oriented [straddling the vertical centerline of the valves and fittings] [_____].]

2.3.2.2 Push-on Joints

Provide push-on type joints conforming to AWWA C111/A21.11. Supply each push-on joint complete with gasket and lubricant. Ensure gaskets are compatible with joint design and are comprised of [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____]. Provide lubricant that is specifically formulated for use with push-on joints, non-toxic, odorless, tasteless and does not support bacteria growth.

2.3.2.3 Restrained Joints

Provide restrained joints conforming to the requirements of AWWA C111/A21.11, and designed for a working pressure equal to connected pipe rating. When using ductile iron pipe with restrained joints, supply field cuts with a lock ring complete with retainer, retainer lock and roll-pin, as required by manufacturer's recommendations, procedures and/or installation instructions.

2.3.2.4 Flanged Joints

Provide flanged joints conforming to AWWA C110/A21.10. Provide gaskets, bolts and nuts with flanged joints in sufficient quantity for the complete assembly of each joint. Gaskets must be [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____].

2.3.3 Ductile Iron Fittings

****

NOTE: Fittings for ductile-iron or gray-iron piping involving 1.03 MPa 150 psi and 1.72 MPa 250 psi service are specified in AWWA C110/A21.10; for 2.41 MPa 350 psi service use AWWA 153. Typically, either gray or ductile iron fittings are acceptable. Specify the exact material if service conditions warrant.

Take special precaution with mating flanges specified in this paragraph; that is, mating flanges conforming to AWWA C110/A21.10 with flanges that are specified elsewhere using ASME B16.1 or B16.5 standards.

****

Fittings must be gray iron ASTM A48/A48M or ductile iron [AWWA C110/A21.10] [AWWA C153/A21.53]. Up to [300] [_____] mm [12] [_____] inches inclusive, the fittings must be [1.7] [_____]MPa [250] [_____] psig rated. Gray iron fittings must be cement mortar lined [standard] [double] thickness. Provide flanges and flanged fittings conforming to [AWWA C110/A21.10] [ASME B16.1] and rated for [1.03 MPa 150 psig] [1.72 MPa 250 psig] [[_____] MPa psig] service. Provide [ductile iron] [or] [gray iron] [_____] materials. For tie-in to existing flanges, field check existing flanges for nonstandard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolts and nuts must be [carbon steel conforming to ASTM A307, Grade [B] [_____]] [_____]. Provide bolts with washers of the same material as the bolts. Gaskets must be [rubber] [ring] [_____] [full face], maximum [3.2] [_____] mm [0.125] [_____] inch thick.

2.3.4 Corrosion Control

Ductile iron piping must be [coated with the manufacturer's standard asphaltic coating, approximately [0.025 mm 1 mil] [[_____] mm mil] thick, applied to the outside of pipe and fittings] [hot-dipped galvanized in accordance with ASTM A153/A153M] [_____]. Coat and wrap buried pipe, and provide with cathodic protection in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

2.4 CARBON STEEL PIPING SYSTEM

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NOTE: Consult the referenced standards for the proper carbon steel use and fittings. For example, ASTM A53/A53M carbon steel piping is a good general piping material and ASTM A106/A106M carbon steel is for high temperature applications. In addition, some of the types and grades may not be suitable for certain joining methods or cold bending; etc. Steel pipe meeting API Spec 5L is specified only with 50 mm 2 inch and smaller pipe that is subject to a low pressure application and the use of taper-threaded couplings.

****

2.4.1 Carbon Steel Pipe

2.4.1.1 General Service

Provide carbon steel pipe meeting the requirements of [ASTM A53/A53M [seamless] [butt welded] [electric-resistance welded], Grade [A] [B]] [API Spec 5L, Schedule [40] [80] [_____]] and [in accordance with Pipe Schedule] [, hot-dipped galvanized]. Provide Schedule [80] [_____] buried carbon steel piping and fittings.

2.4.1.2 High Temperature Service

Seamless carbon steel pipe for high temperature service must [conform to ASTM A106/A106M Grade [A] [B] [C], [hot-finished] [cold-drawn], Schedule [40] [80] [_____]] [be in accordance with Pipe Schedule] with dimensions conforming to ASME B36.10M.

2.4.1.3 Chemical Process Service

Provide electric-resistance welded low-carbon steel pipe conforming to ASTM A587 with a nominal wall thickness [of [_____] mm inch] [in accordance with Pipe Schedule].

2.4.2 Carbon Steel Tubing

Provide tubing meeting the requirements of [ASTM A334/A334M, [seamless] [welded], Grade [1] [_____] carbon steel] [ASTM A423/A423M, [seamless] [electric-resistance-welded], Grade [1] [2] low-alloy carbon steel] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.4.3 Carbon Steel Joints

Join carbon steel piping by [straight-threaded couplings] [taper-threaded couplings] [welding fittings] [flanges] [mechanical joints for grooved ends meeting the requirements of AWWA C606]. Join tubing using [compression] [_____] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.4.4 Carbon Steel Fittings

[Fittings must be [cast malleable iron] [carbon steel] [heat-treated low-carbon steel] [_____].] [Where cast fittings are not available, fabricate segmental welded steel fittings, ASTM A53/A53M, Grade B, meeting the requirements of manufacturer's recommended wall thicknesses.]

2.4.4.1 Threaded Fittings

Threaded fittings must be Class [150] [300] [_____], [malleable iron, ASTM A47/A47M, conforming to ASME B16.3, black, banded] [forged carbon steel ASTM A105/A105M, conforming to ASME B16.11] [low carbon steel, ASTM A858/A858M, conforming to ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1. Threaded, rigid couplings must be [welded] [seamless], [black] [Type I (hot-dipped galvanized)] [Type II (electrogalvanized)] carbon steel in accordance with [ASTM A865/A865M] [_____] and threaded in accordance with ASME B1.20.2MASME B1.20.1. [Use polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.4.4.2 Welding Fittings

Provide [butt-welding] [or] [socket-welding] welding fittings. Provide welding fittings consisting of forged [steel, ASTM A105/A105M Class [150] [300] [_____]] [low-carbon steel, ASTM A858/A858M [seamless] [or] [welded]] [_____] conforming to [ASME B16.9] [, or] [ASME B16.11].

2.4.4.3 Flanged Fittings

Ensure the internal diameter bores of flanges and flanged fittings are the same as that of the associated pipe. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Flanges and flanged fittings must be [forged steel, [ASTM A105/A105M] [ASTM A727/A727M] [_____]] [_____], faced and drilled to ASME B16.5 Class [150] [300] [_____] with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Drill cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, in conformance with [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing

flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Provide bolting consisting of [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 that are a maximum [3.2] [_____] mm [0.125] [_____] inch thick [chloroprene rubber, durometer hardness No.80,] [_____] 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.4.4.4 Compression Fittings for Tubing

Provide compression fittings consisting of [carbon steel [ASTM A108] [ASTM A576]] [_____] nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.4.5 Carbon Steel Coatings

****

NOTE: Carbon steel piping system components will be coated with corrosion resistant materials suitable for exposure to the environmental and process conditions of the site. For potential exposures to pressures less than 70 kPa 10 psi, temperatures less than 100 degrees C 212 degrees F and mild chemicals, prepare the surfaces in accordance with SSPC SP 6/NACE No.3.

For potential exposures to pressures and temperatures greater than those previously mentioned, and mild chemicals, intermediate options may be appropriate. For severe chemical exposures, the thermoplastic resin system should be used.

****

Coat carbon steel piping components with corrosion resistant materials. Ensure coatings and finishes are 100 percent holiday free.

2.4.5.1 Silicone Coating

Prepare carbon steel piping surfaces in accordance with SSPC SP 6/NACE No.3. Provide surfaces with an alkyd primer of [0.0625] [_____] mm [2.5] [_____] mils dry film thickness followed by two alkyd modified silicone final coats.

2.4.5.2 Zinc Coating

Galvanizing must be hot-dip applied and meet the requirements of ASTM A153/A153M; electroplated zinc or cadmium plating is unacceptable. Stainless steel components may be substituted where galvanizing is specified.

2.4.5.3 Thermoplastic Resin Coating System

[Carbon steel piping surfaces must have a minimum of [4] [_____] coats of phenolic type coatings applied at a minimum dry film thickness of [0.040] [_____] mm [1.6] [_____] mils per coat. Bake each coat at [149] [_____] degrees C [300] [_____] degrees F for [10] [_____] minutes. Cure the full coating system in an oven at [190] [_____] degrees C [375] [_____] degrees F for [30] [_____] minutes.] [Coat carbon steel piping system components with an adhesively mounted polyethylene coating system. Ensure the continuously extruded polyethylene and adhesive coating system materials conform to NACE SP0185 Type A.]

2.4.6 Carbon Steel Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.5 LINED STEEL PIPING SYSTEM

2.5.1 Outer Pipe Shell

****

NOTE: For the outer shell, carbon steel is most common; stainless steel will considerably limit suppliers. Flanged joining, Class 150 or 300, is commonly used. Most thermoplastic liners allow some vapors to permeate and become trapped between the liner and the shell. Therefore, venting via weep holes in the outer shell or venting flange collars (note that a single manufacturer has a patent on venting collars) are required to avoid gas accumulation. These are not required for nonpermeable liners such as PVDC. The use of thermoplastics with aggressive chemicals may result in a lower maximum operating temperature than that rated for an unlined pipe composed of the same material.

****

The outer shell of the lined piping system must be [carbon steel meeting the requirements of [ASTM A53/A53M [electric-resistance welded] [_____], Grade [B] [_____]] [_____], Schedule [40] [80] [in accordance with Pipe Schedule]] [TP304 stainless steel, [ASTM A312/A312M [seamless] [welded]] [_____], Schedule [10S] [40S] [80S] [5S] [in accordance with Pipe Schedule]] [_____]. Equip outer pipe with [3] [_____] mm [0.125] [_____] inch vent holes spaced axially at [_____] mm inches on center or locking and venting collars at each flange. If insulated, equip the vents of the lined piping system with the manufacturer's standard vent extensions to avoid blocking. [Coat carbon steel piping components externally with corrosion resistant materials. Ensure coatings and finishes are 100 percent holiday free.]

2.5.2 Lined Steel Joints

Join lined piping by [[cast steel] [forged steel] flanges] [_____].

2.5.3 Lined Steel Fittings

Fittings must be [cast gray iron, [ASTM A126 Grade B] [_____], conforming to ASME B16.1] [cast ductile iron, [ASTM A395/A395M] [_____], conforming

to ASME B16.42] [cast carbon steel, [ASTM A216/A216M Grade WCB] [_____], conforming to ASME B16.5] [cast, fabricated or forged carbon steel, [ASTM A587] [ASTM A106/A106M Grade B] [ASTM A53/A53M] [ASTM A105/A105M]] [stainless steel, [ASTM A312/A312M Grade 304L] [ASTM A276/A276M] [_____], conforming to ASME B16.5] [_____].

2.5.4 Lined Steel Flanged Fittings

Ensure the internal diameter bores of flanges and flanged fittings are the same as that of the associated pipe. [Cast steel, [ASTM A216/A216M Grade [WCB] [_____]] [_____],] [Forged steel, [ASTM A105/A105M] [_____],] [Stainless steel, [ASTM A312/A312M Grade 304L] [_____],] flanges and flanged fittings must be faced and drilled to ASME B16.5 Class [150] [300] [_____]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must be [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5 and nonmetallic conforming to ASME B16.21.

2.5.5 Lined Steel Spacers

For making connections between lined piping systems and other types of pipe or equipment, use spacers. Ensure spacers are composed of the same material as the liner with a bore identical to the internal diameter of the associated lined pipe. Unless otherwise specified for the liner systems, use a gasket between the spacer and the unlined piping system or equipment that conforms to the gaskets required for the unlined piping system or equipment nozzle. Spacers must be [standard ring] [standard full face] [lined steel ring] [as indicated on the contract drawings] [_____] for flanged connections. Provide spacers that are a minimum of [13] [_____] mm [1/2] [_____] inch thick for piping 200 mm 8 inches and smaller in diameter, and a minimum of [15] [_____] mm [5/8] [_____] inch thick for piping larger than 200 mm 8 inches in diameter. [Use] [Do not use] a tapered face spacer for piping directional changes less than [5] [_____] degrees, and do not use for piping directional changes larger than [5] [_____] degrees.

2.5.6 Glass Liner

****
NOTE: A pressure rating of 2 MPa 300 psi is available for the lining and piping system if Class 300 split flanges are used as joints.
****

Lock the liner to the shell. The liner must consist of [1.6] [_____] mm [1/16] [_____] inch of [chemical resistant, low-expansion, Type-I borosilicate glass, Glass A] [porcelain enamel] [_____] conforming to ASTM E438 rated to operate between -29 and plus 66 degrees C -20 and plus 450 degrees F at a nominal working pressure of [1.03] [_____] MPa [150] [_____] psig and full vacuum. [Test thermal shock resistance in accordance with ASTM C600.] [Use polytetrafluoroethylene (PTFE)] [_____] enveloped gaskets that conform to ASTM F336.

2.5.7 Perfluoroalkoxyl (PFA) Liner

****

NOTE: Liner thicknesses range from 1.5 to 3.8 mm 60 to 150 mil, depending on the size of the pipe. Nominal pipe diameters 25 mm 1 inch through 80 mm 3 inches are rated for full vacuum up to 230 degrees C 450 degrees F; 100 mm 4 inches diameter pipe is rated for full vacuum to 150 degrees C 300 degrees F; 150 mm 6 inches diameter pipe is rated for full vacuum at 120 degrees C 250 degrees F; and 200 mm 8 inches diameter pipe is rated for full vacuum at 65 degrees C 150 degrees F. Larger pipe diameters are available.

****

Lock the liner to the shell. The liner must consist of PFA, ASTM D3307 Type II, conforming to ASTM F1545, and rated to operate between -29 and plus 260 degrees C -20 and plus 500 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide liner for fittings with a minimum wall thickness and minimum uniform face thickness of [_____] mmmil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.8 Polypropylene (PP) Liner

****

NOTE: Liner thicknesses range from 3.8 to 8.6 mm 150 to 340 mil), depending on size of pipe. Nominal pipe diameters 25 mm 1 inch through 300 mm 12 inch are rated for full vacuum up to 107 degrees C 225 degrees F, if the liner is of swaged construction. For interference fit type liners, pipe diameters 25 mm 1 inch through 200 mm 8 inch are rated for full vacuum to 107 degrees C 225 degrees F; 250 mm 10 inch and 300 mm 12 inch diameter pipe is rated for full vacuum to 38 degrees C 100 degrees F.

****

Lock the liner to the shell. The liner must consist of PP, ASTM D4101, must conform to ASTM F1545, and rated to operate between -18 and plus 107 degrees C 0 and 225 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide liner for fittings with a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.9 Polytetrafluoroethylene (PTFE) Liner

****

NOTE: Liner thicknesses range from 1.5 to 3.8 mm 60 to 150 mil, depending on pipe dimensions. Nominal pipe diameters 25 mm 1 inch through 300 mm 12 inch are rated for full vacuum up to 107 degrees C 225 degrees F, if the liner is of swaged construction.

For interference fit type liners, pipe diameters 25 mm 1 inch through 100 mm 4 inch are rated for full vacuum to 230 degrees C 450 degrees F; 150 mm 6 inch and 200 mm 8 inch diameter pipe is rated for full vacuum at 180 degrees C 350 degrees F. For swaged fit type liners, pipe diameters 25 mm 1 inch through 200 mm 8 inch are rated for full vacuum to 230 degrees C 450 degrees F. For slip fit type liners, pipe diameters 25 mm 1 inch through 100 mm 4 inch are rated for full vacuum to 230 degrees C 450 degrees F.

****

Lock the liner to the shell. The liner must consist of PTFE, must conform to [_____], and rated to operate between -29 and plus 260 degrees C -20 and plus 500 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a minimum uniform face thickness of [_____] mm mil.

2.5.10 Polyvinylidene Fluoride (PVDF) Liner

****

NOTE: Liner thicknesses range from 3.81 to 5.33 mm 150 to 218 mil depending on the pipe dimensions. Proper liner thickness assures a non-permeable lining. Nominal pipe diameters 25 mm 1 inch through 200 mm 8 inch are rated for full vacuum up to 135 degrees C 275 degrees F, if the liner is of swaged or interference fit construction. For loose fit type liners, nominal pipe diameters 25 mm 1 inch through 100 mm 4 inch are rated for full vacuum to 135 degrees C 275 degrees F, and 150 mm 6 inch and 200 mm 8 inch diameter pipe is rated for 64.2 kPa 19 inch of mercury of vacuum to 135 degrees C 275 degrees F.

****

Lock the liner to the shell. The liner must consist of PVDF, ASTM D3222, and must be rated to operate between -18 and plus 135 degrees C 0 and 275 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide liner for fittings with a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.11 Rubber Liner

****

NOTE: Liner thicknesses range from 3.2 mm 0.125 inch to 12.7 mm 0.5 inch. Rubber lined pipe is not rated for vacuum service. Use a standard gasket for hard rubber lining. For soft rubber use a coating or sheet of polyethylene or similar material consistent with the application as a gasket. Operating temperature ranges are as follows:

natural rubber	-54 to plus 82 degrees C -65 to plus 180 degrees F
chloroprene	-54 to plus 107 degrees C -65 to plus 225 degrees F
isobutylene isoprene	-54 to plus 149 degrees C -65 to plus 300 degrees F
nitrile	-54 to plus 107 degrees C -65 to plus 225 degrees F
EPDM	-54 to plus 149 degrees C -65 to plus 300 degrees F
chlorosulfonated polyethylene	-54 to plus 121 degrees C -65 to plus 250 degrees F

****

Lock the liner to the shell. The liner must consist of [_____] mm inch of elastomeric material, ASTM D1418 Class [_____], with a hardness of [_____]. Terminate lining inside of the bolt holes. Fill remaining space from the liner to the flange edge with a [_____] mm inch [polytetrafluoroethylene (PTFE)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [_____] spacer. Provide flange gaskets that are [a maximum [3] [_____] mm [1/8] [_____] inches thick [polyethylene (PE)] [_____] [sheet] [or] [coating]] [[_____] gasket].

2.5.12 Polyvinylidene Chloride (PVDC) Liner

****

NOTE: No vents are needed in the outer pipe for PVDC. Liner thicknesses range from 3.8 to 5.5 mm 150 to 218 mil depending on the pipe dimensions.

****

Lock the liner to the shell. The liner must consist of PVDC conforming to ASTM F1545 and rated to operate between -18 and plus 79 degrees C 0 and 175 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide fittings liner with a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.13 Lined Steel Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.6 STAINLESS STEEL PIPING SYSTEM

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NOTE: The following paragraphs specify general liquid service use of stainless steel piping. To

specify the material, review the application. For example, of the austenitic steels, TP316 or TP316L have better resistance to pitting corrosion than TP304 or TP304L where brines, sulphur-bearing waters or halogen salts, such as chlorides, are present.

The option for crimped couplings and fittings requires a low pressure application - less than 1.03 MPa 150 psig, service where the stainless steel piping materials (TP304, TP304L, TP316 and TP316L) are compatible to the fluid and thin wall (schedule 5S) pipe or tubing. A limited number of manufacturers are available so include other joint/fitting option(s).

****

2.6.1 Austenitic Piping

2.6.1.1 Stainless Steel Pipe

Stainless steel pipe intended for general corrosive service must meet the requirements of [ASTM A312/A312M, [seamless] [welded]] [ASTM A813/A813M for fit-up and alignment quality, Class [SW] [DW]] [ASTM A814/A814M for flanged and cold-bending quality, Class [SW] [DW]] [_____], Grade [TP304] [TP304L] [TP316] [TP316L] [_____], Schedule [10S] [40S] [80S] [5S] [in accordance with Pipe Schedule] [_____] with dimensions conforming to ASME B36.19M.

2.6.1.2 Stainless Steel Tubing

Provide stainless steel tubing meeting the requirements of [[ASTM A269/A269M] [ASTM A632], [seamless] [welded], Grade [TP304] [TP304L] [TP316] [TP316L] [_____]] [ASTM A789/A789M, [seamless] [welded], Grade [S32760] [_____]] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.6.1.3 Stainless Steel Joints

Join stainless steel piping by [threaded couplings] [welded fittings] [flanges] [crimping couplings]. Join tubing using [crimping couplings] [compression] [_____] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.6.1.4 Stainless Steel Threaded Fittings

Provide threaded fittings consisting of [austenitic stainless steel, [ASTM A182/A182M Grade [TP304] [TP304L] [TP316] [TP316L] [_____], conforming to [ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1.]] Use [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.6.1.5 Stainless Steel Welding Fittings

Provide [butt-welding] [or] [socket-welding] welding fittings. Provide welding fittings consisting of forged austenitic stainless steel, [ASTM A403/A403M Grade [TP304] [TP304L] [TP316] [TP316L] [_____], [butt-welding fittings, Class [CR], conforming to ASME B16.9] [socket-welding fittings, Class [WP-S] [WP-W] [WP-WX] [WP-WU], conforming to ASME B16.11].] [_____].

2.6.1.6 Stainless Steel Flanged Fittings

Provide internal diameter bores of flanges and flanged fittings that are the same as that of the associated pipe. Ensure flanges are [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Provide flanges and flanged fittings consisting of [forged austenitic stainless steel, ASTM A182/A182M Grade [TP304] [TP304L] [TP316] [TP316L] [_____]] [_____], Class [150] [300] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Drill cast austenitic stainless steel backing flanges, ASTM A351/A351M Grade [_____], Van Stone type, to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must be [alloy-steel ASTM A193/A193M Grade [B8] [B8C] [_____] hex head bolts and ASTM A194/A194M Grade [8] [8C] [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 and that are a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.6.1.7 Stainless Steel Crimping Fittings

Crimping fittings must be cold drawn, [TP304] [TP304L] [TP316] [TP316L] austenitic stainless steel. O-ring seals must be [butadiene acrylonitrile] [ethylene propylene diene monomer (EPDM)] [fluoro-elastomeric] [_____].

2.6.1.8 Compression Fittings for Tubing

Provide compression fittings consisting of [ASTM A479/A479M] [_____] stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.6.1.9 Stainless Steel Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.6.2 Ferritic and Martensitic Piping

2.6.2.1 Pipe

Provide stainless steel pipe meeting the requirements of [ASTM A268/A268M, [seamless] [welded], Grade [S44627] [S43035TP430] [_____], Schedule [5S] [10S] [40S] [80S] [in accordance with Pipe Schedule]] [_____] with dimensions conforming to ASME B36.19M.

2.6.2.2 Tubing

Provide stainless steel tubing meeting the requirements of [ASTM A268/A268M, [seamless] [welded], Grade [TP410] [_____]] [ASTM A789/A789M, [seamless]

[welded], Grade [S31500] [_____]] [ASTM A268/A268M, welded, unannealed Grade [S44627] [_____]] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.6.2.3 Joints

Join stainless steel piping by [threaded couplings] [welding fittings] [flanges]. Join tubing using [compression] [_____] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.6.2.4 Threaded Fittings

Provide threaded fittings consisting of [stainless steel, ASTM A182/A182M Grade [TP430] [6a Class 1] [_____], conforming to [ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1.] [Use polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.6.2.5 Welding Fittings

Provide [butt-welding] [or] [socket-welding] welding fittings. Provide welding fittings consisting of forged stainless steel, [ASTM A815/A815M Grade [TP430] [TP410] [_____], [butt-welding fittings, Class CR, conforming to ASME B16.9] [socket-welding fittings, Class [WP-S] [WP-W] [WP-WX], conforming to ASME B16.11].] [_____].

2.6.2.6 Flanged Fittings

Provide internal diameter bores of flanges and flanged fittings that are the same as that of the associated pipe. Ensure flanges are [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Provide flanges and flanged fittings consistig of [forged stainless steel, ASTM A182/A182M Grade [TP430] [6a Class 1] [_____]] [_____], Class [150] [300] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Drill cast stainless steel backing flanges, ASTM A352/A352M Grade [_____], Van Stone type, to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must be [alloy-steel ASTM A193/A193M Grade [L7] [L7A] [_____] hex head bolts and ASTM A194/A194M Grade [7] [7A] [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 and a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.6.2.7 Compression Fittings for Tubing

Provide compression fittings consisting of [ASTM A479/A479M] [_____] stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.6.2.8 Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.7 NICKEL AND NICKEL ALLOYS PIPING SYSTEMS

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NOTE: The preferred method for joining nickel and nickel alloy pipe is welding due to cost of flanges. In all cases, only Schedules 40S and 80S can be threaded due to wall thickness. Flanges should be used when attaching nickel pipe to pumps, process vessels, and other equipment that requires removal periodically. Generally, for temperatures up to 115 degrees C 240 degrees F, and normal pressures encountered, the chloroprene gasket specified is appropriate for most "dilute" process liquids, water and sludge services. However, other liquids may require other, more suitable gasket materials.

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2.7.1 Nickel

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NOTE: Alloy N02200 and alloy N02201 are the 2 basic compositions of nickel pipe. Alloy N02200 is limited to a maximum operating temperature of 315 degrees C 600 degrees F.

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2.7.1.1 Nickel Pipe

[Alloy N02200] [Alloy N02201] nickel pipe must be [seamless conforming to ASTM B161 and ASTM B829] [welded conforming to ASTM B725 and ASTM B775/B775M], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule in the contract drawings].

2.7.1.2 Nickel Joints

Joining must use [welded] [or] [threaded] [_____] methods, except that connections to equipment or spool pieces that may be periodically removed must be [flanged] [_____]. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.1.3 Nickel Fittings

Fittings including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43 must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Provide fittings for alloy N02200 that are [corrosion resistant, Grade CRN] [Class [150] [_____], Grade WPN] and for alloy N02201, provide fittings that are [corrosion resistant, Grade CRNL] [Class [150] [_____], Grade WPNL].

2.7.1.3.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.1.3.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.1.3.3 Flanged Fittings

Provide flanges and flanged fittings consisting of [ASTM B564 forged nickel alloy [N02200] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. Ensure flanges are [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Use cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [nickel-copper alloy, ASTM B164 alloy [N04400] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Nonmetallic gaskets must conform to ASME B16.21 and be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.7.2 Nickel-Molybdenum-Chromium (NMC) Alloy

2.7.2.1 NMC Pipe

[Alloy N06022] [Alloy N06455] [Alloy N10276] [Hastelloy] [_____] NMC alloy pipe must be [seamless conforming to ASTM B622 and ASTM B829] [welded conforming to ASTM B619/B619M and ASTM B775/B775M], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule].

2.7.2.2 NMC Tubing

Provide seamless tubing conforming to ASTM B622 NMC alloy [N06022] [N06455] [Hastelloy] [_____] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.7.2.3 NMC Joints

Use [welded] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.2.4 NMC Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Provide fittings for alloy N06022 that are [corrosion resistant, Grade CRHC22] [Class [150] [_____], Grade WPHC22]; for alloy N06455, provide fittings that are [corrosion resistant, Grade CRHC4] [Class [150] [_____], Grade WPHC4]; and for alloy N10276, provide fittings that are [corrosion resistant, Grade CRHC276] [Class [150] [_____], Grade WPHC276] [_____].

2.7.2.4.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.2.4.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.2.4.3 Flanged Fittings

Provide flanges and flanged fittings consisting of [ASTM B564 forged NMC alloy [N06022] [N10276] [Hastelloy] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system, Class [150] [300] [600] and drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face]] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Use cast steel backing flanges, [ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1 Class [150]] [_____]]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [low carbon NMC alloy, ASTM B574 alloy [N06022] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 and a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.7.2.5 NMC Compression Fittings for Tubing

Compression fittings must be of ASTM B574 [low carbon NMC alloy] [Hastelloy], nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.7.3 Nickel-Copper Alloy

2.7.3.1 Nickel-Copper Pipe

Alloy [N04400] [_____] nickel-copper alloy pipe must be [seamless conforming to ASTM B165, [annealed] [stress-relieved] condition, and ASTM B829] [welded conforming to ASTM B725 and ASTM B775/B775M], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule].

2.7.3.2 Nickel-Copper Tubing

Provide seamless tubing conforming to ASTM B165 nickel-copper alloy N04400, [annealed] [stress-relieved] condition, with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.7.3.3 Nickel-Copper Joints

Use [welded] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.3.4 Nickel-Copper Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Fittings for alloy [N04400] [_____] must be [corrosion resistant, Grade CRNC] [Class [150] [_____], Grade WPNC] [_____].

2.7.3.4.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.3.4.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.3.4.3 Flanged Fittings

Flanges and flanged fittings must be [ASTM B564 forged nickel-copper alloy [N04400] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], and drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. [Use cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [nickel-copper alloy, ASTM B164 alloy [N04400] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M

Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 that are a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.7.3.5 Nickel-Copper Compression Fittings for Tubing

Compression fittings must be of ASTM B164 nickel-copper alloy [N04400] [N04405] nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads must be straight, conforming to [ISO 228-1] [ASME B1.1].

2.7.4 Nickel-Chromium-Iron (NCI) Alloy

2.7.4.1 NCI Pipe

Alloy [N06600] [N06025] [N06045] [_____] NCI alloy pipe must be [seamless conforming to ASTM B167 and ASTM B829] [welded conforming to ASTM B517 and ASTM B775/B775M] [electric fusion-welded conforming to ASTM B546, and dimensioned Schedule [5S,] [10S,] [40S,] [80S]] [in accordance with the Pipe Schedule in the contract drawings].

2.7.4.2 NCI Joints

Use [welded] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.4.3 NCI Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Fittings for alloy N06600 must be [corrosion resistant, Grade CRNCl] [Class [150] [_____], Grade WPNCl]; for alloy N06025, fittings must be [corrosion resistant, Grade CRV602] [Class [150] [_____], Grade WPV602]; and for alloy N06045, fittings must be [corrosion resistant, Grade CRV45TM] [Class [150] [_____], Grade WPV45TM] [_____].

2.7.4.3.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.4.3.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.4.3.3 Flanged Fittings

Provide flanges and flanged fittings consisting of [ASTM B564 forged NCI

alloy [N06600] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. [Use cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [NCI alloy, ASTM B164 alloy [N06600] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 that are a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and be constructed of [_____].]

2.8 ALUMINUM PIPING SYSTEM

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NOTE: Alloys 1060, 3003, 5052, 6061 and 6063 are the most common compositions of aluminum pipe. Alloy 6063 is most widely used due to economical cost, good corrosion resistance and mechanical properties.

The preferred method for joining aluminum pipe to handle corrosives is welding. Be aware that welding reduces tensile strength. Threading is not recommended for aluminum piping systems that handle corrosives. Flanges are usually limited to connecting aluminum pipe to pumps, process vessels, etc.

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2.8.1 Aluminum Pipe

Aluminum and aluminum alloy pipe must be seamless alloy [6063] [6061] [5052] [3003] [1060], Temper [TL] [_____], Schedule [5S] [10S] [40S] [80S] [in accordance with the Pipe Schedule], with AA ANSI H35.2M standard dimensions, and conforming to [ASTM B241/B241M with [ASME B1.20.2M ASME B1.20.1 threaded] [standard] ends] [ASTM B345/B345M with [ASME B1.20.2MASME B1.20.1ASME B1.20.2M threaded] [grooved] [beveled] [standard] [_____] ends].

2.8.2 Aluminum Tubing

Tubing must be drawn seamless and conform to ASTM B210/B210M alloy [6061, temper T6,] [_____] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.8.3 Aluminum Joints

Use [welded] [mechanical coupling] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.8.4 Aluminum Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, must be [butt][or][socket] welding and meet the requirements of ASTM B361. Provide Grade [WP1060] [WP3003] [WP Alclad 3003] [WP6061] [or] [WP6063] fittings.

2.8.4.1 Aluminum Welding Fittings

Welding fittings must be [butt-welding] [or] [socket-welding] and factory made, wrought alloy [WP6063] [_____] in accordance with ASTM B361. [Provide butt-welding fittings conforming to ASME B16.9.] [Provide socket-welding fittings conforming to ASME B16.11.] Conduct welding in accordance with AWS A5.3/A5.3M and AWS A5.10/A5.10M.

2.8.4.2 Aluminum Threaded Fittings

Provide threaded fittings consisting of forged aluminum alloy [3003] [6061] [_____], Temper [_____], in accordance with ASTM B247M ASTM B247 and conforming to ASME B16.11. Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.8.4.3 Aluminum Flanged Fittings

Design flanges and flanged fittings in accordance with ASME B31.3. Flanges must be forged aluminum alloy [3003] [6061] [_____] Temper [_____], conforming to ASTM B247M ASTM B247, Class [150] [300] [600] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [aluminum bolting material, conforming to ASTM B211/B211M and ASME B16.5, dimensioned to ASME B18.2.1 and ASME B18.2.2 and with ASME B1.1 coarse threads] [_____]. Provide bolts with washers of the same material as the bolts. [Gaskets listed in ASME B16.5, Annex E, Fig. E1, Group 1a may be used with any flange rating class and bolting.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.]

2.8.4.4 Aluminum Compression Fittings for Tubing

Provide compression fittings consisting of ASTM B211/B211M aluminum alloy [2014], temper [T4] [T6], nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.8.5 Aluminum Piping Supports

****

NOTE: Galvanic corrosion must be prevented from

occurring on piping support systems. Conventional steel hangers should not be used. Galvanized steel is acceptable only as long as the galvanizing is intact; therefore, a galvanized system should not be used where expansion/contraction or other piping movement is likely.

****

Support piping system using [aluminum] [[galvanized] [alloy] [_____] steel units, integrally padded with [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____],] [_____] piping supports conforming to MSS SP-58. Do not use conventional steel and galvanized pipe hangers for aluminum piping systems.

2.9 COPPER PIPING SYSTEM

****

NOTE: This paragraph covers copper pipe that may be used for corrosive services, and tubing used for noncorrosive water; refrigerant, and sample lines, etc. Copper is rapidly corroded by oxidizing acids such as chromic and nitric acids. The most common copper alloy is alloy 122 (C12200); however, other alloys may also be suitable for use. These include C10200, C10300, C10800 and C12000.

Thin walled piping systems (ASTM B302) can only be assembled using brazed joint pipe fittings. However, for high pressure and Class 'M' fluid services soldered or brazed joints and fittings are not permitted pursuant to ASME B31.3.

****

2.9.1 Copper Pipe

Seamless [C12200] [_____] copper alloy pipe, must be a [[O61 (annealed] [H55 (light-drawn)] [or] [H80 (hard-drawn)] Temper with [regular] [extra strong] standard dimensions conforming to ASTM B42] [H (drawn) Temper with standard dimensions conforming to ASTM B302].

2.9.2 Copper Tubing

Provide seamless copper alloy tubing conforming to [ASTM B88M ASTM B88 alloy C12200, Type [K] [L] [or] [M], with a [O60 (annealed)] [H (drawn)] temper] [ASTM B75/B75M alloy [C12200] [_____] with a [O60 (soft-annealed)] [_____] temper]. Specifications for applications include: [refrigerant tubing - Type L, hard drawn] [P-trap priming connection - Type L, soft Temper] [sample lines - Type L, hard drawn] [_____].

2.9.3 Copper Joints

Join pipe using [threaded] [soldered] [or] [brazed] fittings and [flanged] [_____] connections to equipment. Join tubing using [solder] [flared] [or] [press] [compression] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.9.4 Copper Fittings

Provide component castings of flanges and fittings consisting of copper

alloy [C92200, Temper [_____] conforming to ASTM B61] [C83600 (also known as alloy 85-5-5-5), Temper [_____] in accordance with ASTM B62]. Provide solder joint fittings conforming to ASME B16.22 and ASME B16.18. Provide fittings for flared copper tube conforming to ASME B16.26. Provide cast bronze threaded fittings conforming to ASME B16.15 and are threaded in accordance with ASME B1.20.2MASME B1.20.1. Ensure flanges and flanged fittings are faced and drilled Class [150] [300] [_____] in accordance with ASME B16.26. Provide copper and bronze press fittings conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements must be of EPDM and factory installed or an alternative supplied by fitting manufacturer. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Tubing compression fittings must be [forged brass alloy C37700, conforming to ASTM B124/B124M] [_____], nuts, ferrules and bodies rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.9.4.1 Bolting For Copper Piping

Provide bolting materials that meet the requirements of ASME B31.1 and consist of [ASTM B98/B98M alloy [C65100] [C66100]] [ASTM B150/B150M alloy [C63000] [C64200]] [ASTM B164 alloy [N04400] [N04405]] [_____] materials. Provide bolts with washers of the same material as the bolts.

2.9.4.2 Gaskets For Copper Piping

[Gaskets listed in ASME B16.5, Annex E, Group [1a] [1b] may be used with any flange rating class and bolting.] [Provide nonmetallic, full faced gaskets used with low strength or non-ferrous bolting with a seating pressure less than 11.0 MPa 1,600 psi.] Ensure gasket dimensions conform to [ASME B16.21] [ASME B16.20].

2.9.5 Solder For Copper Piping

****
NOTE: Solder compositions can be selected from Table 5 contained in ASTM B32. Common solder types are Sb5 and SN95. Selection should be made based on suitability to the application considering temperature and corrosivity.
****

Use solder [and flux] conforming to ASTM B32 [and AWS A5.8/A5.8M]. The solder alloy must [be [_____]] [contain less than 0.2 percent lead]. [Ensure the flux type is [R] [RMA] [RA] [OA] [OS] [IS] and conforms to ASTM B813.]

2.9.6 Copper Piping Supports

****
NOTE: Galvanic corrosion must be prevented from occurring to piping support systems; conventional and galvanized steel hangers should not be used.
****

Support piping system using [copper] [brass] [padded steel] [_____] piping supports that conform to MSS SP-58. Do not use conventional steel and galvanized pipe hangers for copper piping systems. Ensure all valves,

instruments and other equipment attached to the piping system are individually supported.

2.10 PLASTIC PIPING SYSTEM

****

NOTE: Plastic Piping Systems - Many of the thermoplastic piping systems are available in both a nominal pipe schedule dimension or in a standard dimension rating (SDR). Schedule based piping has the same dimensions, outer diameter and wall thickness, as steel pipe but the pressure rating decreases with increasing pipe diameter. For SDR pipe, the pressure rating is kept uniform for all nominal pipe sizes of a given material and SDR value by increasing wall thickness. Refer to ASTM D2241 and ASTM D1785 for PVC SDR piping.

Backing flanges for plastic piping systems can be stainless steel, ductile iron, steel (galvanized and plain), or aluminum, depending on the application. Change the flange subparagraphs accordingly. Similarly, change the gasket material selections as required by the liquid application.

Use PVC for selected chemical services, where pipelines may be subjected to exterior corrosion, and liquid processes of 60 degrees C 140 degrees F or below.

Schedule 40 pipe should not be threaded at all. Schedule 80 pipe should not be threaded in sizes larger than 100 mm 4 inch. Schedule 80 threaded joints larger than 50 mm 2 inch must be back-welded to achieve fully rated maximum operating pressures.

****

Submit documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

2.10.1 PVC Pipe

PVC, ASTM D1784, minimum cell classification [12545-C] [_____], pipe must be [Schedule [40] [80] [_____] conforming to ASTM D1785] [manufactured to an SDR rating in accordance with ASTM D2241, so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [_____].

2.10.2 PVC Tubing

Provide flexible and clear tubing with nominal size and wall thickness [in accordance with Pipe Schedule] [_____] [and reinforcement].

2.10.3 PVC Joints

Join piping system by [socket-weld] [flanged] [or] [mechanical] connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Ensure connections at those points are threaded and back-welded. Tubing connections must use compression fittings.

2.10.4 PVC Fittings

****

NOTE: Specify ASTM D2464 for Schedule 80 threaded type; ASTM D2466 for Schedule 40 socket type; ASTM D2467 for Schedule 80 socket type.

****

Ensure the schedule rating for the fittings is not less than that for the associated pipe. Fittings must be ASTM D1784, minimum cell classification [_____], PVC conforming to the requirements of [ASTM D2464, threaded in accordance with ASME B1.20.2MASME B1.20.1] [ASTM D2466, socket type] [ASTM D2467, socket type]. [[No] [_____] thread lubricant is required.]

2.10.4.1 Push-on Joints

Seal push-on type joints with [ethylene propylene rubber (EPR)] [_____] gaskets in accordance with ASTM F477.

2.10.4.2 Flanged Fittings

Provide flanges and flanged fittings that are Class [125] [_____], [one piece, molded hub type, flat faced, and conform to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded PVC stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the PVC flange from bolting moment.

2.10.4.3 Tubing Fittings

Provide compression type fittings comprised of [forged brass alloy C37700, conforming to [ASTM B124/B124M] [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.10.5 PVC Solvent Cement

Join socket connections with PVC solvent cement conforming to ASTM D2564. Ensure manufacture and viscosity is as recommended by the pipe and fitting manufacturer to assure compatibility. [Prepare joints with primers

conforming to ASTM F656 prior to cementing and assembly.]

2.11 CHLORINATED POLYVINYL CHLORIDE (CPVC)

****
NOTE: Use CPVC for chemical or corrosive services that are between 60 degrees C 140 degrees F and 99 degrees C 210 degrees F.

Like PVC, CPVC Schedule 40 pipe should not be threaded at all. Schedule 80 pipe should not be threaded in sizes larger than 100 mm 4 inch. Schedule 80 threaded joints larger than 50 mm 2 inch must be back-welded to achieve fully rated maximum operating pressures.
****

2.11.1 CPVC Pipe

CPVC, ASTM D1784, minimum cell classification [23447] [_____], pipe must be [Schedule [40] [80] conforming to ASTM F441/F441M] [manufactured to an SDR rating in accordance with ASTM F442/F442M, so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [_____].

2.11.2 CPVC Joints

Join piping system by [socket-weld] [flanged] [or] [mechanical] connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Ensure connections at those points are threaded and back-welded.

2.11.3 CPVC Fittings

****
NOTE: Specify ASTM F437 for Schedule 80 threaded type; ASTM F438 for Schedule 40 socket type; ASTM F439 for Schedule 80 socket type.
****

Ensure the schedule rating for the fittings is not less than that for the associated pipe. Fittings must be ASTM D1784, cell classification [23447] [_____], CPVC conforming to the requirements of [ASTM F437, threaded in accordance with ASME B1.20.2MASME B1.20.1] [ASTM F438, socket type] [ASTM F439, socket type]. [[No] [_____] thread lubricant is required.]

2.11.3.1 Push-on Joints

Seal push-on type joints with [ethylene propylene rubber (EPR)] [_____] gaskets in accordance with ASTM F477.

2.11.3.2 Flanged Fittings

Provide flanges and flanged fittings that are Class [125] [_____], [one piece, molded hub type, flat faced, and conforming to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded CPVC stub ends]. Ensure flanged connections have

the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the CPVC flange from the bolting moment.

2.11.4 Solvent Cement

Join socket connections with PVC solvent cement conforming to ASTM F493. Ensure manufacture and viscosity is as recommended by the pipe and fitting manufacturer to assure compatibility.

2.12 POLYVINYLIDENE FLUORIDE (PVDF)

****
NOTE: PVDF pipe is chemically resistant to most acids, bases and organics, and can transport liquid halogen solutions of chlorine or bromine. PVDF should not be used with strong alkalis, fuming acids, polar solvents, amines, ketones or esters. PVDF does not degrade in sunlight; therefore, PVDF does not require UV stabilizers or antioxidants. Use on liquids above 49 degrees C 120 degrees F require continuous support. Care must be used in using PVDF piping under suction.
****

2.12.1 PVDF Pipe

[High Purity] PVDF, conforming to ASTM D3222, pipe must be [Schedule [40] [80]] [manufactured to a SDR rating so that the pressure rating of the pipe is consistent for all pipe sizes. The pipe must be SDR with a pressure rating of [1.03 MPa 150 psig at 23 degrees C 73.4 degrees F] [1.6 MPa 232 psig at 23 degrees C 73.4 degrees F]] [_____].

2.12.2 PVDF Tubing

Provide flexible tubing with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.12.3 PVDF Joints

****
NOTE: Fusion welding is the preferred method for joining PVDF pipe. Threading can only be accomplished on Schedule 80 pipe.
****

Join PVDF pipe by [thermal butt-fusion] [socket heat fusion] [or] [socket electric-resistance fusion], except where connecting to valves and equipment that may require future disassembly, provide [threaded] [or] [flanged] joints. Tubing connections must use compression fittings.

2.12.4 PVDF Fittings

Provide molded PVDF fittings. Provide fittings with the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. Provide flanges and flanged fittings that are Class [125] [_____], [one piece, molded hub type, flat faced, and conforming to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded PVDF stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the PVDF flange from bolting moment. Provide compression type tubing fittings comprised of [forged brass alloy C37700, conforming to ASTM B124/B124M [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.13 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) Piping

****

NOTE: ABS piping is resistant to many chemicals, however, for mixed waste systems chemical analyses and corrosion testing may be necessary to properly select the piping system. The recommended maximum temperature for continuous liquid applications is 82 degrees C 180 degrees F.

Verify acceptance and installation of ABS piping systems with local code enforcement authorities having jurisdiction.

****

2.13.1 ABS Pipe

****

NOTE: While ASTM D1527 has been withdrawn by ASTM without replacement, the standard remains a valid reference.

****

ABS, ASTM D3965, minimum cell classification [42222][_____], pipe must be Schedule [40][80] conforming to ASTM D1527, so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F. Where ABS pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. Accomplish this with the use of expansion joints and offset piping arrangements.

2.13.2 ABS Joints

Join pipe by solvent cementing, except where connecting to valves and equipment that may require future disassembly, then provide [flanged] [_____] joints.

2.13.3 ABS Fittings

Provide molded ABS fittings. Ensure fittings have the same or higher pressure rating as the pipe when installed in accordance with the specifications. Provide flanges and flanged fittings that are Class [125][_____], [one piece, molded hub type, flat faced, and conform to [ASME B16.1][ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1][ASME B16.5] drilling. Provide flanges complete with one-piece, molded ABS stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8][B8M][_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, aupplya flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the ABS flange from bolting moment.

2.13.4 ABS Solvent Cement

Join socket connections with ABS solvent cement conforming to ASTM D2235. Use viscosity as recommended by the pipe and fitting manufacturer to assure compatibility.

2.14 POLYETHYLENE (PE)

****

NOTE: The requirements listed below are for normal pressure applications, and where operating temperatures will not exceed 38 degrees C 100 degrees F. For more difficult installations and/or higher temperatures, the ASTM D3350 cell classification should be carefully chosen. In addition, use the cell classification to specify UV stabilizers and color additives.

****

2.14.1 PE Pipe

Ensure pipe is extruded from PE, ASTM D3350 with a minimum cell classification of [324433-C] [_____]. The PE pipe must be [Schedule [40] [80]] [[manufactured to an SDR rating in accordance with ASTM D3035 for piping systems less than 100 mm 4 inch in diameter, or in accordance with ASTM F714 for piping systems with a diameter equal to or greater than 100 mm 4 inch] [manufactured to an SDR rating in accordance with ASTM D2239 for use with insert fittings], so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [Schedule 40 conforming to ASTM D2239 for use with insert fittings] [_____].

2.14.2 PE Tubing

Tubing must be flexible [low-density PE conforming to ASTM D3350, minimum cell classification [_____], and dimensioned in accordance with ASTM D2737] [crosslinked PE conforming to ASTM D3350, minimum cell classification [35400] [_____], and dimensioned in accordance with ASTM F876] with nominal size [in accordance with Pipe Schedule] [_____].

2.14.3 PE Joints

Join PE pipe by [thermal butt-fusion] [socket heat fusion] [and/or] [socket electrofusion], except where connecting to valves and equipment that may require future disassembly, use [threaded [polystyrene] [_____] fittings] [or] [flanged] joints.

2.14.4 PE Fittings

Provide PE fittings with the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. Provide molded PE fittings. Provide butt-fusion fittings conforming to ASTM D3261. Provide socket-fusion fittings conforming to ASTM D2683 with tools meeting the requirements of ASTM F1056. Provide insert fittings conforming to ASTM D2609.

2.14.4.1 Couplings

Join couplings and saddle joints by electrofusion in accordance with ASTM F1055.

2.14.4.2 Flanged Fittings

Provide flanges and flanged fittings that are [Class [125] [_____]], [ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded PE stub ends. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21.

2.14.4.3 Tubing Fittings

Provide compression type fittings comprised of [forged brass alloy C37700, conforming to ASTM B124/B124M [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.15 RUBBER/ELASTOMER PIPING SYSTEM

****

NOTE: Rubber/elastomer piping systems are generally useful in applications requiring unusual flexing, resilience and abrasion service.

****

2.15.1 Elastomeric Hose

Provide elastomeric hose consisting of an elastomeric tube, [reinforced] [not reinforced], and [with] [without] an external cover. Provide hose conforming to RMA IP-2 Class [212-A] [_____], rated for [1.03 MPa 150 psig] [[_____] MPa psig] with a minimum burst pressure of [4] [_____] times the rated working pressure. Provide hose with a nominal diameter [of [_____] mm inch] [as indicated in the Pipe Schedule in the contract drawings] with tolerances conforming to RMA IP-2. Use a minimum bend radius of [6] [_____] times the hose internal diameter.

2.15.1.1 Elastomeric Tube

Provide hose tube composed of [fluoro-elastomer] [isobutylene isoprene] [butadiene acrylonitrile] [chloroprene] [natural polyisoprene] [_____], [ASTM D2000 Grade [_____], Type [_____], Class [_____] base requirements] [_____] materials.

2.15.1.2 Tube Reinforcement

[Strengthen the tube with [[one] [_____] wire-braid] [two spiral wire and one wire-braid] [two rayon-braid] [one textile-braid and one wire-braid] [synthetic-fiber] [[four] [six] -ply, [light] [heavy] spiral-wire] [_____] reinforcement.] [Do not reinforce the tube.]

2.15.1.3 Hose Cover

[Protect the hose with a [synthetic rubber] [thin, nonskive] [textile-braid] [thermoplastic] [_____] cover.] [The hose must not have a cover.]

2.15.2 Hose Joints

[Hose must be continuous, without joints] [Hose must be supplied cut to length with integral end connections] [Join hose using [swaged] [crimped] [insert] [internally expanded - full flow] [_____] fittings]. [_____].

2.15.3 Fittings For Elastomeric System

Ensure all fittings are supplied by the same manufacturer. Join fittings to the hose assembly as specified. Ensure fittings are [supplied in accordance with the Pipe Schedule in the contract drawings and] constructed of [aluminum] [TP304 stainless steel] [TP316 stainless steel] [_____]. Accomplish interconnections through integral couplers configured as [ASME B1.20.7 threaded] [quick connect interlocking] [compression ring] [_____] couplings.

2.16 FIBERGLASS REINFORCED PLASTIC (FRP) PIPING SYSTEM

****
NOTE: Consult a reputable manufacturer to determine the FRP type for given application and temperature. Temperature is ambient if unlisted.
****

Submit the name and qualifications of the manufacturer's representative and written certification from the manufacturer stating that the representative is technically qualified to supply and install FRP piping

systems. Provide all FRP pipe, fittings, and flanges for each system complete by one manufacturer and with a design internal pressure rating [in accordance with the Pipe Schedule in the contract drawings] [of 0.69 MPa 100 psig] [of [_____] MPa psig], as specified in ASTM D2310 and ASTM D2992.

2.16.1 FRP Pipe

Provide FRP pressure pipe conforming to ASTM D3754 Type [1] [2] [3] [4], liner designation [_____], surface layer grade [_____], pressure Class [_____], pipe stiffness [_____]. Provide size [in accordance with the Pipe Schedule in the contract drawings] [[_____] mm inches] [_____]. Ensure the inside diameter of the pipe is consistent with the inside diameter of the fittings.

2.16.2 FRP Joints

Join the pipe using [axially unrestrained bell and spigot gasket joints, conforming to ASTM D4161, with elastomeric gaskets meeting the requirements of ASTM F477] [butt-joints with laminated overlays in accordance with ASTM D3754] [bell and spigot joints with laminated overlays in accordance with ASTM D3754] [adhesive bonded bell and spigot joints in accordance with ASTM D3754] [flanged] [_____].

2.16.3 FRP Fittings

Provide fittings, other than flanges, conforming to [ASTM D5685] [_____]. Provide filament wound fittings of the same thickness specified for adjoining pipe or duct. Provide other fitting types of the minimum pipe wall thickness required for the specified pressure class. Provide contact molded flanges and flanged fittings conforming to ASTM D5421 Type [A] [B], Grade [_____], Class [I] [II], pressure rating [_____]. All other flange types must conform to ASTM D4024 Type [_____], Grade [_____], Class [_____], pressure rating [_____]. Flanges mating with flanges on thermoplastic-lined steel pipe must be ductile iron castings, ASTM A395/A395M or cast steel, ASTM A216/A216M Grade WCB, Van Stone type, conforming to [ASME B16.1] [ASME B16.5] Class [150] [_____].

2.16.3.1 FRP Bolting

With flat ring gaskets, the bolting must be stainless steel, ASTM A193/A193M Grade [B8] [B8M] [_____], hex head bolts and, ASTM A194/A194M Grade [8] [8M] [_____], hex head nuts. Provide bolts with washers of the same material as the bolts.

2.16.3.2 FRP Gaskets

Gaskets must be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____]. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between the outer diameter of the raised face and the flange outer diameter in order to protect the FRP flange from the bolting moment. When mating a FRP flange, Van Stone type, to a thermoplastic-lined steel pipe, use a [polytetrafluoroethylene (PTFE)] [_____] enveloped, flat ring type gasket in accordance with ASTM F336.

2.17 DOUBLE CONTAINMENT PIPING SYSTEM

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NOTE: Due to the difficulty of proper installation of double containment pipe, double containment piping should only be specified when it is absolutely required. Refer to the Handbook of Double Containment Piping Systems, Christopher G. Ziu, McGraw-Hill, NY, 1995, for the design and selection of a double containment piping system. According to Ziu, page 71, many pre-engineered double containment piping systems have only been conceptualized and not engineered.

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Submit manufacturer's engineering end load calculations for anchors in double containment piping systems. Provide double containment piping systems conforming to the requirements of ASME B31.3.

2.17.1 Primary (Carrier) Pipe

The primary, or carrier, pipe of the double containment piping system must be [[PVC][CPVC][PVDF][PE][_____], [Schedule [40] [80] [_____]] [SDR [_____]]][TP304 stainless steel, Schedule [10] [40] [_____]][[FRP], pressure class [_____]] [_____], as specified elsewhere in this Section. Ensure the primary piping is rated at a working pressure of at least [_____] MPa psig at a maximum operating temperature of [_____] degrees C degrees F. Provide piping that is free of flanges and other joints that are not compatible with the secondary piping installation. Equip piping with expansion loops, offsets, or direction changes as necessary to counter thermal expansion and contraction, which must be coordinated with the secondary piping.

2.17.2 Secondary (Containment) Pipe

The secondary, or containment, pipe of the double containment piping system must be [[PVC][CPVC][PVDF][PE][_____], [Schedule [40] [80] [_____]] [SDR [_____]]][carbon steel, Schedule [40] [80] [_____]] [TP304 stainless steel, Schedule [10] [40] [_____]] [_____], as specified elsewhere in this Section. Provide secondary piping that is resistant to weathering, impacts, and ambient temperature variations, and rated at a working pressure of at least [_____] MPa psig at a maximum operating temperature of [_____] degrees C degrees F. Equip piping with expansion joints, expansion loops, offsets, or direction changes as necessary to counter thermal expansion and contraction. Coordinate equipment for addressing thermal movement with the primary piping. Ensure secondary piping is drainable and dryable [, and capable of being tested using air pressure]. The secondary piping system must be [compartmentalized] [continuous] and equipped with drains at all low points and vents at all high points. Equip pressurized secondary piping systems with pressure relief devices. Provide drains, vents and pressure relief devices as specified elsewhere in this Section. Design piping to allow pulling of the leak detection cable into the containment pipe both during and after piping installation. Minimum annular clearance must be [19] [_____] mm [0.75] [_____] inch. Locate containment pull ports a maximum of [150] [_____] m [492] [_____] feet apart for straight runs and reduced by [45] [_____] m [148] [_____] feet for every 90 degree change in direction.

2.17.3 Cathodic Protection For Double Containment System

Buried ferrous piping must have cathodic protection.

2.17.4 Connections and Fittings For Double Containment System

All fittings must be factory manufactured of material compatible with the process fluids and associated piping. [All secondary contained fittings must be of unitized construction with the carrier and containment integrally anchored together to prevent the movement of the carrier relative to the containment within the fitting.] Provide anchors of sufficient thickness to withstand the maximum possible end loads that will be generated by the carrier pipe during the life of the system. [Elbows must be anchored on both ends.] [Tees must be anchored on both the run and the branch.]

2.17.4.1 Fitting Pressure Rating

Ensure pressure rating of connections and fittings is greater than or equal to the design pressure of the system with a minimum safety factor of [five] [_____].

2.17.4.2 End Seals

Provide dnd seals and other subassemblies which are designed and factory prefabricated to prevent the ingress of moisture into the system. Design subassemblies to allow for complete draining of the secondary containment.

2.17.5 Leak Detection

Provide a [cable detection] [sensing probe] [visual detection] leak detection system. [Equip the leak detection system with an electronic monitoring and control unit.]

2.17.5.1 Leak Detection Monitoring Unit

Provide a microprocessor based monitoring unit. The monitoring unit must indicate when any liquid leaks into the secondary containment piping by sounding an alarm, actuating output relays, displaying a message that a leak has been detected and the location of that leak. Ensure the unit is capable of monitoring [sensor cables] [probe sensors] [and] [switch sensors]. The monitoring unit power requirements must be [120] [240] [_____] VAC, [60] [_____] Hz, [single] [_____] phase. Equip monitoring units with [an RS-232 communication port] [and] [one common and one SPDT output relay per cable, rated for 250 VAC, 10 amp]. [Furnish a complete cable-type leak detection and location system consisting of a microprocessor based monitoring unit, sensor cable, probes, system layout map and auxiliary equipment required to provide continuous monitoring of the sensing strings for leaks, shorts, breaks and probe activation. If any of these conditions should occur at any point along the cable, sound an alarm, clearly identify type of condition and clearly display the location. Monitor the interstitial space of double contained piping.]

2.17.5.1.1 Enclosure

Enclose monitoring unit in a NEMA 250 Type [12] [_____] enclosure. [The unit must be Underwriters Laboratory (UL) listed and Factory Mutual approved to provide connections for intrinsically safe sensor circuits for use in Class [1] [_____], Division [I] [_____], Groups [C and D] [_____]

hazardous locations.] Ability to locate a leak must not depend on battery backed up functions. In the event of power failure, ensure system conditions and parameters are stored in nonvolatile memory allowing the unit to automatically resume monitoring, without resetting, upon restoration of power. Provide an on-off switch in the panel for servicing. [Furnish a NEMA 250 Type 4X outer enclosure with a viewing window for mounting outdoors] [Furnish a NEMA 250 Type 7 explosion proof outer enclosure] [_____].

2.17.5.1.2 Relay Outputs

Provide relays for remote indication of an alarm condition. The relays must provide indication that no alarm conditions exist, an alarm condition exists but has not yet been acknowledged, and an alarm condition exists and has been acknowledged. [Ensure communications are available via RS-232 and ASCII communication protocols to allow central point monitoring and control via a remote computer.]

2.17.5.1.3 Storage Memory

Record significant events in permanent memory. Store a minimum of [_____] events. When the memory becomes full, delete the recorded events from memory in sequential order beginning with the oldest event. Include the time and date that the event occurred for each recorded event. [Ensure archives are retrievable through RS-232 and ASCII communication protocols.]

2.17.5.1.4 Status Indication

The system must continuously provide positive indication that it is monitoring the sensing string and the status of the sensing string.

2.17.5.1.5 Security

The system must have assignable password security.[Ensure the system has multilevel security passwords for access to operating functions with recording of all password entries to nonvolatile memory.] Do not allow the system to permit unauthorized modifications to the sensing string without causing an alarm condition.

2.17.5.2 Cable System

Submit an as-built location map for the cable leak detection system in double containment piping systems indicating the as installed system configuration and sensing string layout. Provide marks in meters feet along the length of the cable as references to locate leaks. [Ensure sensor cable, connectors, [probes] and jumpers are supplied by the manufacturer of the monitoring unit.]The cable sensing principle must provide for continuous monitoring while short lengths of the cable are in contact with liquids, without altering the system's sensitivity and/or accuracy. The cable system must be a [conductance][or][impedance] type system.

2.17.5.2.1 Requirements

Locate the point of origin of the first liquid leak within [0.1] [_____] percent of the sensor string length. Identify the type of alarm as well as the location. Ensure system is able to monitor (detect and locate) with up to [30 m 98.4 feet] [[_____] m feet] of wetted cable without significant inaccuracy in location. Ensure system is capable of

monitoring up to [600 m 1,970 feet] [[_____] m feet] of cable per sensor string from a single monitoring unit. [The system must be capable of monitoring (detecting and locating) for multiple leaks or additional liquid on the sensor cable.]

2.17.5.2.2 Detection Capabilities

[The system must be capable of detecting all liquids, including, but not limited to aqueous, hydrocarbon, and conductive and nonconductive liquids.] [Furnish two cables to detect and differentiate between hydrocarbons/solvents and aqueous liquids.] [Only hydrocarbons are to be detected.] [Only acids are to be detected.] Provide system with field adjustable sensitivity to increase or decrease the amount of wetted cable needed to cause an alarm from several mm to m inches to feet. Ensure system is capable of identifying the location of breaks and shorts on the cable. When either of these faults occur, an alarm must sound and a display visible on the front of the monitoring unit must clearly indicate the type of fault and display the location of the fault.

2.17.5.2.3 Materials

Provide sensor cables suitable for use with the monitoring unit. Provide sensor cables of coaxial construction consisting of an insulated [copper] [_____] center conductor, a suitable spacer material, and an outer braid. Provide center conductors that are no less than [twenty AWG] [_____] for mechanical strength. Cables must be capable of field installation of connectors by trained technicians. Ensure cable is available in bulk spools. All cables must be field repairable by trained technicians.

2.17.5.3 Sensing Probes

Sensing probes for the leak detection system must be [pH probes] [conductivity probes] [liquid level switches] [specific ion probes] [or] [pressure transducers].

2.17.5.4 Visual Leak Detection System

Equip all low points of the secondary piping system with sample valves meeting the requirements specified in paragraph [SAMPLE PORTS] [_____] of this Section.

2.17.6 Supports

Design and supply supports for the conveyance and containment piping to prevent distortion of the pipes and strain on joints and fittings. Design supports by the double containment piping system manufacturer. No field fabricated supports will be allowed. Design and fabricate the system taking into account pressure and temperature requirements when placing the pipe supports. [Double supports are required throughout the system to minimize stresses due to point loading.] [Support clips are not allowed.]

2.18 ISOLATION JOINTS AND COUPLINGS

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NOTE: Isolation joints and couplings require gaskets for isolating and/or sealing. The gaskets are typically shaped to meet each particular manufacturer's coupling requirements and may not be interchangeable. Refer to manufacturers' catalogs

for material compatibility and selection.
****

2.18.1 Dielectric Fittings

Provide dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves. Provide dielectric fittings, suitable for the required working pressure, temperature and corrosive application, to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.18.2 Isolation Joints

Provide isolation joints between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Provide isolation joints consisting of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Provide full faced isolation gaskets with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves must be full length. Units must be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.18.3 Metallic Piping Couplings

Provide thrust ties where shown on the contract drawings and where required to restrain the force developed by [1.5] [_____] times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, attach thrust ties with fabricated lugs. For ductile iron pipe, attach thrust ties with socket clamps against a grooved joint coupling or flange. For exposed installations, use zinc-plated nuts and bolts. However, high-strength, low-alloy steel, in accordance with AWWA C111/A21.11, may be substituted for use on cast iron and ductile iron couplings. For buried and submerged installations, provide [TP304] [_____] stainless steel bolts and nuts. Use steel middle rings and followers that are [fusion bonded epoxy-lined and coated in accordance with Section 09 90 00 PAINTS AND COATINGS and] pressure tested beyond yield point.

2.18.3.1 Sleeve-Type Couplings

Use sleeve-type couplings for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe. A coupling consists of one [steel] [ductile iron] middle ring, two [steel] [ductile iron] followers, two elastomeric [wedge] [_____] section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. For pipe sizes between 13 through 40 mm 0.5 through 1.5 inch, ensure the followers are [ductile iron] [malleable iron], and the middle ring is in accordance with [ASTM A513/A513M] [ASTM A395/A395M] with AWWA C111/A21.11 bolting, [light pattern coupling]. For pipe sizes 50 mm 2 inch and larger, ensure the followers are [ASTM A395/A395M] [_____], and the middle ring is [ASTM A513/A513M] [ASTM A395/A395M] [_____] with AWWA C111/A21.11 bolting, [light pattern coupling]. Gaskets must be [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____]. [Split sleeve-type couplings may be used in aboveground installations under special situations and when approved in advance by the Contracting Officer.]

2.18.3.2 Transition Couplings

Transitional couplings may be used to connect two pipes of the same

material that have small differences in outside diameter. Size a fully assembled transitional coupling to properly fit pipe diameters. The coupling must consist of one [steel] [ductile iron] [_____] middle ring, two [steel] [ductile iron] [malleable iron] [_____] followers, two elastomeric [wedge] [_____] section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. The coupling must use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. Size the coupling to match the associated piping.

2.18.3.3 Flanged Coupling Adapters

Provide flanged coupling adapters consisting of fully assembled units manufactured to meet [ASTM A126 Class [B] [_____], cast iron]. The flanges must mate with [ASME B16.1] [ASME B16.5] [AWWA C207] Class [_____] flanges of the same nominal size. [Apply a factory applied corrosion resistant coating.] The coupling must use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. Where pipe movement out of the adaptor may occur, provide proper anchorage of the pipe [and furnish couplings with lock pins]. Size the coupling to match the associated piping.

2.18.4 Couplings for Nonmetallic Piping

2.18.4.1 Bellows Coupling

Provide a bellows coupling with a minimum of two [polytetrafluoroethylene (PTFE)] [_____] convolutions unless otherwise shown, with [[ductile iron] [_____] flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [125] [150] [300] [_____]], [_____] end connections, and metal reinforcing bands. The maximum allowable working pressure is [960 kPa 140 psig] [_____] at [49] [_____] degrees C [120] [_____] degrees F. Limit bolting to restrain the force developed by [1.5] [_____] times the specified maximum allowable operating pressure. Size the coupling to match the associated piping.

2.18.4.2 Compression Coupling

A compression coupling consists of one [steel] [_____] middle section, two [steel] [_____] mechanical nuts, two elastomeric gaskets and two machined steel lock rings. The coupling must use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. The maximum allowable working pressure is [1.03 MPa 150 psig] [_____] at [49] [_____] degrees C [120] [_____] degrees F. Size the coupling to match the associated piping.

2.19 VALVE BOXES[, SERVICE BOXES][, VALVE MANHOLES][AND VALVE PITS]

****

NOTE: Construction of valve manholes is to be avoided where feasible because of problems with dewatering/drainage and frostproofing. Use manually operated gate and butterfly valves suitable for direct burial and fitted with valve boxes in lieu of valves in manholes whenever possible. Review

project-specific valve box requirements. Select and modify as required or refer to Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

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The box length must adapt [to the length required for the depth of the line] [to the depth of cover required over the pipe at the valve location] without full extension. Boxes must be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Provide boxes with housings of sufficient size to completely cover the valve or service stop and complete with covers.

2.19.1 Valve Boxes

Provide cast-iron valve boxes with minimum metal thickness of 5 mm 3/16 inch and of the extension type with slide-type adjustment and flared base. Provide concrete boxes that are the standard product of a manufacturer of precast concrete equipment.

2.19.2 Service Boxes

Provide extension service boxes with either screw or slide-type adjustment.

2.19.3 Valve [Manholes] [or Pits]

Construct valve [manholes] [or pits] for automatic valves and meters installed below grade in accordance with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

2.20 VALVES

****

NOTE: This paragraph will be coordinated with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES. Material selection based on piping materials and liquid characteristics is also provided. For critical or hazardous applications, insert specific material requirements, grades and alloys, and standards rather than a general material name.

Valves are grouped together by type. If a valve is required for your application that is not listed, insert the valve specification and notify the Contracting Officer. Check manufacturer's catalogs to make sure valves selected are current. Operator options vary by both manufacturer and valve size.

****

2.20.1 General Requirements For Valves

Valves include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. Ensure valves are suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. [Provide valves that are the same size as adjoining pipe]. Ensure valve ends are compatible with adjacent piping system. Size an operator to operate the associated valve for the full range of pressures and velocities. Valves will open by turning

[counterclockwise] [_____]. Provide factory mounted operators, actuators, and accessories.

2.20.2 Valve Schedule

****
NOTE: Verify that the schedules are included in the contract drawings. Delete this subparagraph if the valve schedule is not used.
****

Submit a list of valve materials, pressure ratings, valve operator's materials, air supply pressure, electrical service, location, source of supply, and reference identification as indicated in the contract drawings. Provide a list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly. Requirements relative to this paragraph are shown on the [Valve Schedule] [and Operator Schedule] located [in the contract drawings] [_____].

2.20.3 Factory Finishing

[Provide valves with an epoxy [lining and] coating in accordance with AWWA C550 unless otherwise specified. Ensure the epoxy is either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material applies if a valve coating is specified as "fusion" or "fusion bonded" epoxy. Provide epoxy [lining and] coating with a minimum [0.180 mm 7.0 mils] [[_____] mm mils] dry film thickness except where it is limited by valve operating tolerances.] Finish exposed valves in accordance with Section 09 90 00 PAINTS AND COATINGS. [Paint safety isolation valves and lockout valves with handles, handwheels, or chain wheels "safety yellow."]

2.20.4 Check Valves

****
NOTE: "Check valves" are generally service oriented. Specific types of check valves should be specified for the specific applications; for example, the ball check valve is capable of passing solids. Rated operating pressures vary based on body and seat materials, size and other parameters such as wafer class. Consult manufacturer's information to select the appropriate rating for the application.

Piping plane and valve orientation may affect check valve performance. Certain types of check valves will only operate under specific conditions; for example, lift check valves can only operate in horizontal lines, and swing check valves can operate in either horizontal or vertical (flow up) positions.
****

2.20.4.1 Swing Check Valves

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NOTE: The requirements on subpart c. below are based on general water service and AWWA ratings.

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Provide swing check valves conforming to the following:

a. Provide swing check valves, 50 mm 2 inches and smaller, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] ends. Provide valves with a swing type, replaceable [butadiene acrylonitrile] [polytetrafluoroethylene (PTFE)] [_____] disc. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service.

b. Provide swing check valves, 65 mm 2.5 inches through 300 mm 12 inch, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [_____] ends. Provide valves with a bronze-mounted swing type, [bronze] [ductile iron] [cast iron] [_____] disc, [solid bronze] [ductile iron] [_____] hinges, and stainless steel hinge shaft [with outside lever and [weight] [spring]]. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service.

c. Provide swing check valves, 50 mm 2 inch through 900 mm 36 inch, conforming to AWWA C508, and have [ASME B16.1 Class [_____] flanged], [welding], [mechanical joint] [grooved] [_____] end connections. Provide valves with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [_____] -mounted disc, solid [bronze] [ductile iron] [_____] hinges, and a stainless steel hinge shaft. Provide valves 50 mm 2 inch through 300 mm 12 inch rated for [1.2 MPa 175 psig] [[_____] MPa psig] service and valves 350 through 900 mm 14 through 36 inch rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Fit valves with an [adjustable outside lever and spring] [adjustable outside lever and weight]. An increasing-pattern body valve may be used where increased outlet piping size is shown.

2.20.4.2 Thermoplastic Check Valve

Provide thermoplastic check valves, 8 mm 0.25 inch through 400 mm 16 inch, of a [Y-check] [ball-check] design, manufactured of [polyvinyl chloride (PVC)] [chlorinated polyvinyl chloride (CPVC)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF)] [_____] with [flanged] [socket] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] end connections. Use valves that are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service. Provide valves with [fluoro-elastomeric O-ring] [_____] seals and seats. [Fit discs with a polyvinyl chloride (PVC) coil guide.] [Caps must be of hex design.]

2.20.4.3 Double Disc Swing Check Valve

Double disc swing check valves, 50 mm 2 inch through 1300 mm 52 inch, must be wafer style, spring loaded swing check valve, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, a [aluminum-bronze] [ductile iron] [stainless steel] [bronze] [carbon steel] [_____] disc, resilient seats, stainless steel hinge pin, and a stainless steel stop pin spring. Ensure valves 50 mm 2 inch through 300 mm 12 inch are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F and valves 350 mm 14 inch through 1300 mm 52

inch are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.20.4.4 Slanting Disc Check Valve

Slanting disc check valves, 50 mm 2 inch through 1500 mm 60 inch, must be of a slanting or tilting disc design, with off-center pivot. Provide valve bodies consisting of [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____], and of a [two-piece] [wafer-style] design. Seats must be [bronze] [stainless steel] [_____] set on a [55] [_____] -degree angle. Discs must be [bronze] [ductile iron] [cast iron] [stainless steel] with pivot pin and bushing constructed of [TP304 stainless steel] [aluminum bronze] [_____], [butadiene acrylonitrile] [_____] disc seal, [TP316 stainless steel] [Monel] [_____] spring, [bottom mounted buffer cylinder for cushion closing] [and] [valve disc position indicator]. Use valves that are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service [and have [ASME B16.5] [ASME B16.1] Class [_____] flanged end connections].

2.20.4.5 Silent Check Valve

Provide silent check valves conforming to the following:

a. Silent check valves, 50 through 250 mm 2 through 10 inch, must be wafer style, center guided valve with a [cast iron] [cast steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [stainless steel] [_____] trim, [butadiene acrylonitrile] [_____] seat, and [bronze] [stainless steel] [_____] springs. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

b. Silent check valves, 65 through 1050 mm 2.5 through 42 inch, must be globe style, center guided valve with [ASME B16.1] [ASME B16.5] Class [125] [250] [_____] flanged end connections, a [cast iron] [ductile iron] [cast steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [stainless steel] [_____] trim, [butadiene acrylonitrile] [_____] seat, and [bronze] [stainless steel] [_____] spring. Ensure valves are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service.

2.20.4.6 Ball Check Valve

Provide ball check valves, 25 mm 1 inch and larger, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] ends, and [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [polyvinyl chloride (PVC)] [_____] bodies with a cleanout and [floating] [sinking] type [hollow steel] [phenolic] [butadiene acrylonitrile covered metal] ball. [Flanges must be ASME B16.1 Class [125] [_____].] Ensure valves are rated for [690 kPa 100 psig] [[_____] MPa psig] service and are suitable for vertical or horizontal flow.

2.20.5 Ball Valves

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NOTE: Top or bottom entry bronze ball valves are not readily available. An end entry valve requires additional unions or ability to spring pipe clear in order to service valve. Flanged and wafer style valves can be readily removed.

****

2.20.5.1 General Purpose Ball Valves

Provide general purpose ball valves conforming to the following:

a. Ball valves, 50 mm 2 inch and smaller, must be end entry type with [bronze] [brass] [_____] bodies and [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [soldered] [_____], [full bore] [regular] ports. Provide valves with [polytetrafluoroethylene (PTFE)] [_____] seats and packing, [chrome plated] [brass] [stainless steel] [_____] balls and [hand lever] [tee-handle] [hand wheel] [pneumatically actuated] [electrically actuated] [_____] operators. Ensure valves are rated for [2.76 MPa 400 psig] [[_____] MPa psig] service at 66 degrees C 150 degrees F and conform to ASME B16.34 Class [_____]. [Install a union adjacent to the valves to provide access to the seat.]

b. Ball valves, 65 mm 2.5 inch and larger, must be end entry type with [bronze] [cast iron] [_____] bodies and [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] ends. Provide valves with [polytetrafluoroethylene (PTFE)] [_____] packing and seats, a [chrome plated] [brass] [stainless steel] [_____] ball, [regular] [full bore] ports, and [hand lever] [tee-handle] [hand wheel] [pneumatically actuated] [electrically actuated] [_____] operators. Ensure valves are rated for [2.76 MPa 400 psig] [[_____] MPa psig] service at 66 degrees C 150 degrees F and conform to ASME B16.34 Class [_____].

c. Provide ball valves, 50 to 300 mm 2 to 12 inch, conforming to ASME B16.34 Class [_____], and with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, stainless steel ball and stem, polytetrafluoroethylene (PTFE) packing and gasket, and [flanged] [welding] [_____] ends, full port. Ensure valves are rated for [1.38 MPa 200 psig] [[_____] MPa psig] service, and have [hand lever] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.5.2 Multiple Piece Body Ball Valves

Provide multiple piece body ball valves, 40 to 150 mm 1.5 to 6 inch, with [three] [_____] piece bodies constructed of [stainless steel ASTM A276/A276M Grade [TP316] [_____]] [cast steel ASTM A351/A351M Grade [CF8M] [_____]] [ASTM A216/A216M] [_____] stainless steel. Valves must have a [TP316] [_____] stainless steel ball, and [ASME B16.11 threaded] [ASME B16.5 flanged] [_____] end connections. Ensure valves are rated for [6.89 MPa 1000 psig] [_____] service and conform to ASME B16.34 Class [_____]. Provide valves with [reinforced polytetrafluoroethylene (PTFE)] [_____] seats and stem packing, that are [full] [standard] bore, andequipped with [handwheel] [hand lever] [tee-handle] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.5.3 Thermoplastic Ball Valve

Provide thermoplastic ball valves, 150 mm 6 inch and smaller, rated for [1.03 MPa 150 psig] [1.55 MPa 225 psig] [[_____] MPa psig] service at 49 degrees C 120 degrees F, and have ASTM D1784, minimum cell classification [_____], [polyvinyl chloride (PVC)] [chlorinated polyvinyl chloride (CPVC)] [ASTM D3222 polyvinylidene fluoride (PVDF)] [_____] bodies, balls, and stems. Provide valves of end entry, double union design, with [solvent-weld socket] [threaded, in accordance with ASME B1.20.2M

ASME B1.20.1,] [flanged] [butt] [_____] ends connections, a [ethylene propylene diene monomer (EPDM)] [fluoro-elastomer] [_____] seat, and [fluoro-elastomer] [polytetrafluoroethylene (PTFE)] [ethylene propylene diene monomer (EPDM)] [_____] O-ring stem seals. Provide valves with [hand lever] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.6 Gate Valves

2.20.6.1 General Service Gate Valves

****
NOTE: The requirements on subpart b. below are based on general water service and AWWA ratings.
****

Provide general service gate valvesconforming to the following:

a. Provide gate valves, 50 mm 2 inch and smaller, with [bronze] [_____] bodies and stems, [screwed] [union] [bolted] [yoke] bronze [_____] bonnets, single [solid] [split] wedge bronze discs, and [rising] [non-rising] stems. Provide valves rated for [1.2 MPa 175 psig] [[_____] MPa psig] service and conforming to ASME B16.34 Class [_____]. End connections must be [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [_____]. Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

b. Provide gate valves, 65 mm 2.5 inch and larger, with [Ni-resistant] [3 percent nickel-iron] [cast-iron] [_____] bodies with [iron] [bronze] [Ni-resistant stainless steel] [_____] trim. Provide valves meeting the requirements of [AWWA C500] [AWWA C509] and have Class [125] [250] [_____] [flanged] [welding] [threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [mechanical joint] [push-on] [_____] end connections. Provide a [clamp] [OS&Y Bolted] [NRS Bolted] type bonnet. Discs must be [wedge] [double] type of [iron] [bronze] [ductile iron] [bronze faced iron] [rubber coated ductile iron] [_____] construction, and have [nonrising] [rising] stems [with backseats]. Include a by-pass of the same materials as the gate valve for each gate valve, 400 mm 16 inch and larger. Provide bypass meeting the requirements of AWWA C500. Use valves rated for [1.4 MPa 200 psig] [[_____] MPa psig] service. Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.6.2 Thermoplastic Gate Valve

Provide thermoplastic gate valves, 13 mm1/2 inch and larger, with [ASTM D1784 polyvinyl chloride (PVC), minimum cell classification [_____],] [ASTM D1784 chlorinated polyvinyl chloride (CPVC), minimum cell classification [_____],] [_____] bodies, [bolted] [_____] bonnets, single [styrene butadiene rubber] [polypropylene] [_____] wedge discs, [non-rising] [rising] stems, and [flanged] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [_____] end connections. Provide valves rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Equip valves with [handwheel] [_____] [pneumatically actuated] [electrically actuated] operators.

2.20.7 Globe Valves

2.20.7.1 General Requirements For Globe Valves

Provide globe valves, 80 mm 3 inch and smaller, that are [angle pattern] [globe style] valve with [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] bodies, with [bronze] [brass] [stainless steel] [_____] trim, and [bronze] [brass] [_____] bonnets. Provide valves conforming to ASME B16.34 Class [_____], and with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] end connections. Include [union] [threaded] [OS&Y] bonnets, inside screws, rising stems, [plug] [needle] [conventional] discs constructed of [polytetrafluoroethylene (PTFE)] [butadiene acrylonitrile] [bronze] [stainless steel] [_____], and [bronze] [brass] [stainless steel] [_____] rings. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service. Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.7.2 Needle Valve

Needle valves, 25 mm 1 inch and smaller, must be of a [straight] [angle] [cross] pattern and must have [brass] [TP316 stainless steel] [_____] bodies and trim. Provide valves [conforming to ASME B16.34 Class [_____] with ASME B16.11 [male] [female] threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [have tubing compression fittings, that match associated tubing fittings,] [_____] end connections. Ensure valves include [threaded] [integral] [union] [_____] bonnets, [TP316 stainless steel] [_____] stems, [plug] [soft tip] [non-rotating ball] [_____] stem tips constructed of [polytetrafluoroethylene (PTFE)] [butadiene acrylonitrile] [bronze] [stainless steel] [_____], [fluoro-elastomer] [polytetrafluoroethylene (PTFE)] [ethylene propylene diene monomer (EPDM)] [_____] packing [and O-ring stem seals]. Ensure valves are rated for [2.07 MPa 300 psig] [[_____] MPa psig] service. Equip valves with [toggle-handle] [handwheel] [tee-handle] [pneumatically actuated] [_____] operators.

2.20.7.3 Hose Valve

Hose valves, 20 through 80 mm 0.75 through 3 inch, must be [globe style] [angle pattern] hose valves with [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] bodies, [bronze] [stainless steel] [_____] trim, inside screws, rising stems, and [polytetrafluoroethylene (PTFE)] [rubber] [_____] disc. The outlet ports must be [cast brass] [_____] in accordance with [ASME B1.20.2MASME B1.20.1 pipe threads, male by male, nipple adapter with hexagonal wrench feature [and brass cap with chain]] [_____]. Provide valves rated for [860 kPa 125 psig] [[_____] MPa psig] service.

2.20.8 Plug Valves

2.20.8.1 Eccentric Valve

Provide nonlubricated type eccentric valves, 80 mm 3 inch and smaller, rated for [1.2 MPa 175 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Valves must have drip-tight shutoff with pressure from either direction, and [cast iron] [bronze] [Ni-resistant] [acid resistant bronze] [aluminum] [carbon steel] [stainless steel] [nickel] [_____] bodies, in accordance with [ASME B16.5 flanged] [ASME B16.1 flanged] [

ASME B16.11 threaded] [AWWA C606 grooved] [_____] end connections, [all metal, matching body] [rubber lined] [_____] plugs with [round] [rectangular] ports, [stainless steel] [nickel] [_____] seats, self-lubricating [stainless steel] [Monel] [nickel] [_____] stem bearings, and [butadiene acrylonitrile] [polytetrafluoroethylene (PTFE)] [filled polytetrafluoroethylene (PTFE)] [fluoro-elastomer filled polytetrafluoroethylene (PTFE)] [_____] [U-cup] [_____] seals. [Provide valves conforming to ASME B16.34 Class [_____].] Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.8.2 Lined Eccentric Valve

Provide nonlubricated type eccentric valves, 80 through 1350 mm 3 through 54 inch, rated for [1.2 MPa 175 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Provide valves with drip-tight shutoff with pressure from either direction, and [cast iron] [bronze] [Ni-resistant] [aluminum] [carbon steel] [stainless steel] [nickel] [_____] bodies in accordance with [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [AWWA C606 grooved] [AWWA C111/A21.11 mechanical joint] [_____] end connections. Provide cast iron plugs with [round] [or] [rectangular] ports of no less than [80] [_____] percent of the connecting pipe area [and coated with] [butadiene acrylonitrile] [chloroprene] [fluoro-elastomer] [hard natural rubber] [_____]. Provide valves with [stainless steel] [nickel] [_____] seats, self-lubricating [stainless steel] [reinforced polytetrafluoroethylene (PTFE)] [_____] stem bearings, and [multiple [V-rings] [U-cups] [O-rings] stem seals] [[nitrile rubber] grit seals on the stems]. [Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.] [Provide valves 150 mm 6 inch and smaller with a wrench lever manual operator and valves 200 mm 8 inch and larger with a totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel.] [Ensure valves conform to ASME B16.34 Class [_____].]

2.20.9 Butterfly Valves

****

NOTE: Refer to AWWA C504 and manufacturers' data for valve selection and torque calculation data. Only valves with high velocities, heavy grit loads, or severe throttling service should be specified with a seat in the body.

****

2.20.9.1 Standard Service Butterfly Valve

Provide butterfly valves, 50 mm 2 inch and larger, with [ASTM A126 cast iron] [ductile iron] [carbon steel] [stainless steel] [_____] bodies, [[wafer] [lugged] styled] [with [ASME B16.5 flanged] [ASME B16.1 flanged] [AWWA C111/A21.11 mechanical joint] [_____] end connections]. Provide valves conforming to [AWWA C504 Class [125] [150] [_____]] [ASME B16.34 Class [_____]]. Discs must be contoured [ASTM A436 Type 1 Ni-resist cast iron with maximum lead content of 0.003 percent] [ASTM A536 Grade 65-45-12 ductile iron] [stainless steel] [polyvinylidene fluoride (PVDF) coated ductile iron] [bronze] [_____]. Provide [carbon steel] [stainless steel] [_____] valve shafts with self-lubricating, corrosion-resistant sleeve type bearings. Provide valve seats, constructed of [chloroprene] [_____], for [600 mm 24 inch] [_____] and smaller valves and attach to either the valve body or the disc. Provide valve seats for valves larger than [750 mm

30 inch] [[_____] mm inch] which are field replaceable in accordance with AWWA C504. Provide valves with [manual, locking hand lever] [hand wheel] [crank] [chain wheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.9.2 Thermoplastic Butterfly Valves

Provide thermoplastic butterfly valves, 40 mm 1.5 inch and larger, with [wafer] [lugged] style bodies constructed of [polyvinyl chloride (PVC)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF) coated ductile iron] [_____]. Provide valves with [polyvinyl chloride (PVC)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [polytetrafluoroethylene (PTFE)] [_____] discs, [ethylene propylene diene monomer (EPDM)] [fluoro-elastomeric] [butadiene acrylonitrile] [natural rubber] [ethylene propylene diene monomer (EPDM) backed] [_____] seats, [ethylene propylene diene monomer (EPDM)] [polytetrafluoroethylene (PTFE)] [same material as seats] [_____] seals, and [lever] [gear] [_____] [pneumatically actuated] [electrically actuated] operators. Ensure valves are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.20.10 Pinch Valves

****

NOTE: Pinch valves are commercially available in sizes ranging from 50 mm 2 inch to 1500 mm 60 inch. Consider using an enclosed bevel gear operator for valves 150 mm 6 inch and larger and above 500 kPa 72.6 psig. The pinch valve included is illustrative, consult manufacturers' catalogs for other styles, pressure ratings, and operators.

****

Provide pinch valves with [aluminum] [stainless steel] [carbon steel] [ductile iron] [cast iron] [_____] bodies, in accordance with [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] flanged end connections, [natural rubber] [chloroprene] [chlorobutyl] [butadiene acrylonitrile] [fluoro-elastomeric] [ethylene propylene diene monomer (EPDM)] [_____] seats, [full port] [double wall] [reduced port] [cone] [variable orifice] sleeves, and [manual] [pneumatically actuated] [electrically actuated] [upper] [and] [lower] pinch bars.

2.20.11 Diaphragm Valves

****

NOTE: Diaphragm valves are commercially available in sizes ranging from 15 mm 0.5 inch to 250 mm 10 inch depending upon the materials of construction. Contact manufacturers to confirm availability based upon size and material.

****

2.20.11.1 Standard Service Diaphragm Valve

Provide diaphragm valves, 13 mm 1/2 inch and larger, with [aluminum] [stainless steel] [carbon steel] [ductile iron] [cast iron] [_____] bodies, [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] [flanged] [_____] end connections and [natural rubber] [chloroprene] [chlorobutyl] [butadiene acrylonitrile] [fluoro-elastomeric] [ethylene propylene diene

monomer (EPDM)] [_____] seals, and are [manually] [pneumatically] [_____] actuated. Provide position indicators to indicate diaphragm position. Valves must be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.20.11.2 Thermoplastic Diaphragm Valve

Provide thermoplastic diaphragm valves, 13 mm 1/2 inch and larger, with [polyvinyl chloride (PVC)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF)] [_____] bodies, [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] [flanged] [union socket] [butt-fusion] [_____] end connections and [ethylene propylene diene monomer (EPDM)] [polytetrafluoroethylene (PTFE)] [_____] seals, and that are [manually] [pneumatically] [_____] actuated. [Pneumatically operated valves must be [fail-closed] [fail-open] [double acting].] Provide position indicators to indicate diaphragm position. Valves must be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 20 degrees C 68 degrees F.

2.20.12 Self-Contained Automatic Valves

2.20.12.1 Pressure-Reducing Valve

****

NOTE: Verify that the valve schedule is included in the contract drawings.

****

Pressure-reducing valves, 13 mm 1/2 inch and larger, must be [direct] [hydraulically] operated, diaphragm actuated, [pilot] [spring] controlled [angle] [globe] valves with [cast iron] [ductile iron] [steel] [aluminum] [stainless steel] [bronze] [_____] bodies. End connections must be [ASME B16.1] [ASME B16.5 Class [150] [_____] flanged] [ASME B16.11 [threaded] [socket-welded]]. Provide [stainless steel] [_____] trim and stem. Valves must be normally [open] [closed] to maintain a constant downstream pressure regardless of fluctuations in flow or upstream pressure [, and prevents backflow,] [and have externally mounted strainers with cocks]. Use valves sizes and ratings as [shown in the Valve Schedule on the contract drawings.] [as follows.] PCV [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig.

2.20.12.2 Pump Control Valve

Provide pump control valve which is [hydraulically operated, diaphragm actuated, pilot controlled globe valve with [cast iron] [ductile iron] [cast steel] [_____] bodies, [ASME B16.1] [ASME B16.5] Class [_____] flanged end connections, [bronze] [stainless steel] [_____] trim, stainless steel stems, and externally mounted strainers with cocks] [_____]. Design valves to eliminate pipeline surge caused by pump startup and shutdown, and include automatic check features.

2.20.13 Operators

2.20.13.1 Operator Schedule

****

NOTE: Verify that the operator schedule is included in the contract drawings. Delete this subparagraph if an operator schedule is not used.

****

Requirements relative to this paragraph are shown on the Operator Schedule located [in the contract drawings] [_____].

2.20.13.2 Manual Operator

The force in a manual operator is not allowed to exceed [175 N 39.3 pound] [[_____] N pound] under any operating condition, including initial breakaway. Equip the operator with gear reduction when force exceeds [175 N 39.3 pound] [[_____] N pound]. Provide a self-locking type manual operator or equip with a self-locking device. Supply a position indicator on quarter-turn valves. Provide worm and gear operators consisting of a one-piece design with worm-gears of gear bronze material. Worm must be hardened alloy steel with the thread ground and polished. Provide traveling nut type operators with threader steel reach rods with an internally threaded bronze or ductile iron nut.

2.20.13.2.1 Exposed Operators

Provide exposed operators with galvanized and painted handwheels. Lever operators are allowed on quarter-turn valves [200 mm 8 inch] [[_____] mm inch] and smaller. Supply cranks on gear type operators. If located off of the operator floor, provide chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level. Ensure valve handles are capable of padlocking, and provide wheels that are lockable with a chain and padlock.

2.20.13.2.2 Underground Operators

Buried service operators on valves larger than [65 mm 2.5 inch] [[_____] mm inch] must have a [50 mm 2 inch] [[_____] mm inch] operating nut. Buried operators on valves [50 mm 2 inch] [[_____] mm inch] and smaller must have a cross handle for operation by a forked key. Enclose the moving parts of valve and operator in housing to prevent contact with the soil. Design buried service operators for quarter-turn valves to withstand an input torque of [^610 N-m (450 foot-pound) 450 foot-pound] [[_____] N-m foot-pound] of input torque at the fully open or fully closed positions, and grease pack and gasket to withstand a submersion in water to [70 kPa 10.2 psig] [[_____] MPa psig]. Provide buried valves with extension stems, bonnets, and valve boxes.

2.20.13.3 Pneumatic Operator

****

NOTE: Associated transducers must pneumatically provide the same pressure range as used by the actuator. Do not use piston actuators at less than 275 kPa 40 psig supply pressure. Include a safety vented isolation valve in the operator paragraph for use on air sets.

****

Provide pneumatic operators complete with actuators, air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories. Ensure pneumatic operators are suitable for full operation range of valve at air supply pressure indicated. Use actuators to return the valve to the closed position upon loss of signal unless otherwise indicated. [Use springs to return valve to this failed

position.] Furnish pneumatic operators with features noted on the [Operator Schedule] [Valve Schedule] in the contract drawings. [Provide limit switches on all actuators.]

2.20.13.3.1 Cylinder Actuators

Provide cylinder actuators conforming to ANSI/AWWA C541 and ANSI/AWWA C542, and operate with an air supply pressure of [550 kPa 80 psig] [[_____] MPa psig]. Totally enclose the nonswivel type with travel stops and position indicator, and factory lubricate and seal, requiring no additional lubrication. The double acting type must be nonmetallic for operation on nonlubricated air and must have a [manual] [handwheel] override independent of the cylinder. Locate the manual override [_____].

2.20.13.3.2 Diaphragm Actuators

Provide diaphragm actuators with a spring return with a [steel or aluminum] [_____] diaphragm case and spring barrel, steel spring and actuator stem, and [fabric-reinforced chloroprene] [_____] diaphragm. Use actuators on quarter-turn valves which include a totally enclosed valve actuating mechanism with adjustable travel stops and valve position indicator with manual override if indicated. The actuating mechanism must factory lubricated and sealed. Size and configure diaphragm actuators for the service indicated and an air supply pressure of [240 kPa 35 psig] [[_____] MPa psig].

2.20.13.3.3 Air Sets

Include a pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by the valve actuator. The air set must have an aluminum body and handwheel, safety vented lockout isolation valve, and gauge range [1.33 to 2] [_____] times maximum operating pressure.

2.20.13.3.4 Limit Switches

Provide single-pole, double-throw (SPDT) type limit switches, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type [4] [_____] enclosure, and adjustable for open and closed valve positions.

2.20.13.3.5 Positioners

The positioners for modulating actuators must be pneumatic force balance instruments to control valve positions as a function of the input signals. The positioners must accomplish positive positioning of valve by a mechanical feedback connection from the valve actuating mechanism. Provide position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Provide positioner suitable for either a double acting or spring return actuator. Provide positioner with zero and span adjustment and field reversible for direct or reverse action. Include gauges for supply and output pressure and for input signal pressure. Operate modulating valve positioners on a [21 to 103 kPa 3 to 15 psig pneumatic] [or] [[4 to 20 mA] [1 to 5 v dc] electric] input signal unless otherwise indicated. [A positioner for dc input signal with transducers must convert the electrical signal to the appropriate pneumatic signal. Ensure transducer is [integral with the positioner] [or] [a separate component]. If separate, factory mount the transducer on the pneumatic operator. Line electric power is not required for transducer operation.] Corrosion-resistant enclosures for positioners

and transducers must be splash- and moisture-proof with gasketed covers.

2.20.13.3.6 Solenoid Valve

Use a solenoid valve to pilot the control actuator in the appropriate configuration for the type of actuator being controlled. Provide a pilot operated diaphragm type solenoid valve consisting of a [brass] [_____] body and resilient seat and operate with minimum operating pressure differential no greater than [70 kPa 10.2 psi] [[_____] kPa psi] and maximum operating pressure differential no less than [1.03 MPa 150 psi] [[_____] MPa psi]. Provide corrosion-resistant internal parts. Provide solenoid valve with Class F molded coils for operation on 120 volts, 60-Hz, ac, unless otherwise indicated. Provide solenoid enclosure conforming to NEMA 250 Type [4] [_____]. Solenoids on double acting cylinders for open-close and throttling valves must be four-way with dual coils. Solenoids on spring return cylinders for open-close and throttling valves must be three-way, spring return. Furnish an air exhaust muffler in the exhaust port of all actuator pilot solenoid valves.

2.20.13.4 Electric Operator

Provide electric operators complete with actuators, speed controls and accessories. Operate actuators on [120 VAC, 60 Hz] [_____] with a [75] [_____] percent duty cycle and equip with an AC thermal overload protector with automatic rest, reversing (bi-directional) operation for use with quarter-turn valves, or rotating equipment to full rotation. Gearing must be a two-stage planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output staff. Use start-up torque of [163 N-m 120 foot-pound] [[_____] N-m foot-pound]. Use stall torque of [203 N-m 150 foot-pound] [[_____] N-m foot-pound]. Mount [two] [_____] travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams, on the drive shaft. Provide a side mounted hand turn wheel for a manual override. Ensure actuators have a NEMA 250 Type [4] [_____] enclosure with a corrosion resistant, baked epoxy finish as standard. Operate actuator in a temperature range of -40 to plus 65 degrees C -40 to plus 150 degrees F. Actuators must fail in last position unless otherwise indicated. Furnish electric operators with features noted on the [Operator Schedule] [Valve Schedule] in the contract drawings. [Provide limit switches on all actuators.]

2.20.13.4.1 Limit Switches

Limit switches must be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type [4] [_____] enclosure, and adjustable for open and closed valve positions.

2.20.13.4.2 Positioners

Provide positioners for modulating actuators to control valve positions as a function of the input signals. Operate positioner on [120 VAC, 60 Hz.] [_____] voltage. The mode of operation must be [direct acting] [reverse acting]. Operate modulating valve positioners on a [4 to 20 mA] [1 to 5 v DC] [_____] input signal unless otherwise indicated. Provide splash-and moisture-proof corrosion-resistant enclosures with gasketed covers for positioners.

2.20.14 Valve Accessories

2.20.14.1 Extension Bonnet for Valve Operator

Provide all extension bonnets as necessary, complete with stem and accessories applicable to the specific valve and operator.

2.20.14.2 Floor Stand and Extension Stem

Provide the nonrising, indicating type floor stand and extension stem, complete with stem, coupling, handwheel, stem guide brackets, and yoke attachment. Space stem guide such that stem L/R ratio does not exceed [200] [_____]. Supply anchors as required.

2.20.14.3 Floor Box and Stem

Provide the plain type floor box and stem for support of nonrising type stem; complete with stem, operating nut, and stem guide brackets. Space stem guide such that stem L/R ratio does not exceed [200] [_____]. Supply anchors as required.

2.20.14.4 Chain Wheel and Guide

Provide the handwheel direct-mount type chain wheel and guide, complete with galvanized or cadmium-plated chain.

2.21 DRAINS

Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.

2.21.1 Locations

[Locate drains as indicated on the contract drawings] [Drain all pipeline low points] [_____].

2.21.2 Sizes

For pipelines 65 mm 2.5 inch and larger, provide [20 mm 0.75 inch] [[_____] mm inch] drains equipped with [gate valves] [globe valves] [ball valves] [_____]. For pipelines [50 mm 2 inch] [[_____] mm inch] and smaller, provide [13 mm 1/2 inch] [[_____] mm inch] drains equipped with [gate valves] [globe valves] [ball valves] [_____].

2.22 SAMPLE PORTS

****

NOTE: Sample port materials of construction typically match the piping system.

For highly critical situations where the materials being sampled are very hazardous or where valves may tend to clog or leak, the first sampling valve option is used to specify a sampling valve. Otherwise, the second option is used to specify the sampling configuration.

****

[Sample ports, shown on the flow diagrams and piping and instrument diagrams of the contract drawings, may not be shown on the detailed drawings of the individual pipelines; their absence does not relieve the Contractor of the responsibility for providing them.] [Provide sample ports as indicated in the piping and instrument diagrams to complete the piping systems for the use intended.] Locate sample ports in easily accessible locations, and avoid potential stagnant points and/or areas where material could collect. [Provide a plug-type sampling valve with a stainless steel piston that extends beyond the inner surface of the pipe when closed at [all the sampling ports] [the sampling ports indicated]. Seal piston by two compressible replaceable [polytetrafluoroethylene (PTFE)] [_____] rings, one above the discharge port, the other below the discharge port. Provide valve body consisting of stainless steel Class [150] [_____] with a [male ASME B1.20.2MASME B1.20.1 pipe threads] [_____] inlet connection and [female ASME B1.20.2MASME B1.20.1 pipe threads] [_____] outlet connection] [Provide sampling ports comprised of pipe fittings, pipe, and [ball] [gate] [_____] valves which comply with material, temperature, and pressure requirements of the associated piping system as specified elsewhere in this Section.] [Provide a double block and bleed configuration] [_____].

2.23 MISCELLANEOUS PIPING COMPONENTS

2.23.1 Air Release and Vacuum Breakers

****

NOTE: For air and vacuum, vacuum, air release and combination valves, check trim materials for compatibility with service. In addition, discharge points should be designed to be safe for both the environment and personnel.

****

Locate air release vents, and vent such that a hazardous atmosphere will not be created upon operation.

2.23.1.1 Locations

[Locate air release and vacuum breakers as indicated on the contract drawings.] [Ensure all pipeline high points have air release vents [and vacuum breakers].] [_____]. [Provide vacuum breakers on all tanks and process equipment.]

2.23.1.2 Vacuum Breakers

Provide vacuum breakers [50] [_____] mm [2] [_____] inch and smaller of an angle type with all [bronze] [cast iron] [semi-steel] [_____] bodies and bonnets, and [install at least [152] [_____] mm [6] [_____] inch above the flood line of associated equipment] [and] [conforming to ASSE 1001 for pipe applied units].

2.23.1.3 Air and Vacuum Valve Suitable for Corrosive Service

Provide air and vacuum valve conforming to [ASSE 1001] [ASSE 1020] [_____], and automatically exhaust air during the filling of a system while allowing air to re-enter during draining or when vacuum occurs. Ensure valve is rated for [1.03] [_____] MPa [150] [_____] psig working

pressure and built with [a special short body] [a standard elongated body]. Provide valve consisting of a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Provide end connections as follows: for 13 through 80 mm 1/2 through 3 inch ASME B1.20.2MASME B1.20.1 pipe threaded inlet and outlet, for 100 mm 4 inch and larger [ASME B16.5] [ASME B16.1] Class [_____] flanged inlet with outlet. Fit air and vacuum valve with blowoff valve, quick disconnect couplings, and a minimum [2] [_____] m [6.6] [_____] feet of hose in order to permit back flushing after installation without dismantling the valve.

2.23.1.4 Air Release Valve Suitable for Corrosive Service

Use [Factory Mutual listed] [ASSE approved] [_____] air release valve to automatically exhaust entrained air that accumulates in a system. Ensure valve is rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. Provide valve consisting of a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Ensure valve end connections are [ASME B1.20.2MASME B1.20.1 pipe threaded] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [_____]. Fit air and vacuum valve with blowoff valve, quick disconnect couplings, and a minimum 2 m 6.6 feet of hose in order to permit back flushing after installation without dismantling the valve.

2.23.1.5 Combination Air Valve Suitable for Corrosive Service

The valve combines the operating functions of both an air and vacuum valve and an air release valve. The air and vacuum portion must automatically exhaust air during filling of a piping system and allow air to re-enter during draining or when a vacuum occurs. Air release portion must automatically exhaust entrained air that accumulates in the piping system. Provide valve consisting of a [single body unit] [or] [an individual air and vacuum valve and an air relief valve mounted on a common header]. Ensure valve is rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. Provide valve with a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Ensure valve end connections are [ASME B1.20.2MASME B1.20.1 pipe threaded] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [_____]. [The air and vacuum valve to be fitted with a blowoff valve, quick disconnect couplings, and a minimum [2] [_____] m [6.6] [_____] feet of hose in order to permit back flushing after installation without dismantling the valve.]

2.23.2 Backflow Preventer

****

NOTE: Under process conditions, backflow prevention can be handled with either a double check valve assembly or a backflow preventer specifically manufactured for that purpose. The backflow preventer should be used if pressure loss is a concern. However, if the backflow prevention device is to be installed on a potable water line at a treatment plant and the potential for contamination of the potable water line exists, a backflow preventer specifically manufactured for that purpose must be used.

The reduced pressure backflow preventer can be used on continuous duty systems only. The other backflow preventer can be used on either continuous or intermediate services.

****

The backflow preventer must be identical in size to pipe. Do not allow total head loss through the complete backflow assembly to exceed [70] [_____] kPa [10.1] [_____] psi at rated flow.

2.23.2.1 Double Check Valve Assembly

Provide backflow preventer consisting of two [check valves] [independently operating, spring loaded, "Y" check valves] rated for [1.25] [_____] MPa [175] [_____]psig service at 60 degrees C 140 degrees F, with [one isolation gate valve] [one isolation ball valve], [one differential relief valve], [and testing cocks]. Use port size of [25] [_____] mm [1] [_____] inch and ASME B1.20.2MASME B1.20.1 threaded, [female] [male]. Ensure check valve assembly is rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. Provide assembly meeting the requirements of [ASSE 1015] [AWWA C510].

2.23.2.2 Reduced Pressure Backflow Preventer

Provide assembly body consisting of two independent [bronze] [epoxy coated cast iron] [_____] body check valves rated at [1.2][_____] MPa [150] [_____] psig at 60 degrees C 140 degrees F, with an intermediate relief valve, and [isolation gate valve,] [full-ported [ball valves] [gate valves] [_____]] as testing cocks. [Ensure all internal parts are serviceable in-line.] Use port sizes of [25] [_____] mm [1] [_____] inch and ASME B1.20.2MASME B1.20.1 threaded, [female] [_____]. Ensure reduced pressure backflow prevention assembly is rated for [1.03] [_____]MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. Provide assembly body in accordance with [AWWA C511] [ASSE 1013].

2.23.2.3 Backflow Preventer with Intermediate Vent

Provide assembly body consisting of two independent [bronze] [epoxy coated cast iron] [_____] body check valves rated at [1.2] [_____] MPa [175] [_____] psig at 60 degrees C 140 degrees F, with an intermediate atmospheric vent, and [isolation gate valve,] [full-ported [ball valves] [gate valves] [_____]] as testing cocks. Use port sizes of [25] [_____] mm [1] [_____] inch and ASME B1.20.2MASME B1.20.1 threaded, [female] [_____]. Ensure backflow prevention assembly is rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. Provide assembly body in accordance with [AWWA C511] [ASSE 1012].

2.23.3 Strainers

Provide [simplex] [duplex] strainers with a [Y-pattern] [_____] body. Use port sizes of [25] [_____] mm [1] [_____] inch and ASME B1.20.2M ASME B1.20.1 threaded, [female] [male]. Ensure strainers are rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F and conform to [ASTM F1199] [ASTM F1200]. Provide body consisting of [cast bronze] [cast iron] [welded steel] [_____] with a [screwed bronze] [bolted iron] [_____] cap. The screen must be heavy-gauge [stainless steel] [Monel] [_____], [30] [_____] mesh [and equipped with a ASME B1.20.2MASME B1.20.1 pipe threaded blowoff hole].

2.23.4 Indicating Devices

****
NOTE: This subparagraph will be coordinated with requirements for remote or control instrumentation. The devices specified by this section may be in addition to the control instrumentation.
****

2.23.4.1 Pressure and Vacuum Gauges

Pressure and vacuum gauges must be [stem] [flush] [semi-flush] [panel] [_____] mounted, with [phenolic] [aluminum] [glass filled nylon] [glass filled polypropylene (PP)] [stainless steel] [brass] [acrylonitrile-butadiene-styrene (ABS)] [_____] cases [equipped with safety pressure blowout backs] and [dry] [[glycerine] [_____] -filled] [_____] dials. The gauge sensors must be [diaphragm] [C-Type Bourdon tube] [helical Bourdon tube] [bellows] [_____] actuated and constructed of [phosphor bronze] [stainless steel] [Monel] [silicone rubber] [Inconel] [beryllium-copper] [_____]. Equip gauges with [brass] [Monel] [TP316L stainless steel] [alloy steel] [_____] threaded [8] [_____] mm [0.25] [_____] inch [male] [female] connections. The dials of the gauges must be [114] [152] [_____]mm [4.5] [6] [_____]inch in diameter with scale readings in [MPa and mm of mercury psig and inches of mercury] [_____] ranging from zero to approximately twice the anticipated process operating or equipment pressure. Provide a slotted adjustable pointer with accuracy to conform to [ASME B40.100, Grade A] [_____]. [Provide a lever handled gauge cock and filter type snubber.][Install snubber between the pipeline and the gauge.] [Isolate the gauges from the process fluids using remote corrosion resistant diaphragm seals. Construct the housing of the corrosion resistant seals of [stainless steel] [Monel] [tantalum] [titanium] [polytetrafluoroethylene (PTFE)] [polypropylene (PP)] [polyvinyl chloride (PVC)] [Inconel] [Hastelloy] [_____]. Compose seals of [stainless steel] [Monel] [Hastelloy] [nickel] [polytetrafluoroethylene (PTFE)] [_____].]

2.23.4.2 Thermometers

Provide bi-metal actuated thermometers, with [127] [_____] mm [5] [_____] inch dished anti-parallax dials that have [external] [_____] calibration adjustment and [stainless steel] [_____] cases. Do not use mercury in thermometers. Use thermometers with [stainless steel] [_____] stems, [adjustable angle] [back-connection] [left side-connection] [or] [right side-connection] type for the correct viewing angle. Include union connections with associated thermowells. Scale must be [-5 to plus 50 degrees C 25 to 125 degrees F] [[_____] to [_____] degrees C degrees F] with accuracy within one scale division.

2.23.4.3 Thermowells

Provide [TP316 stainless steel] [brass] [steel] [_____] thermowells with a diameter of [25] [_____] mm [1] [_____] inch. Use length as shown on the contract drawings and coordinate with the associated temperature element. Construct process connections of [stainless steel] [_____] with [flanges, faced and drilled to ASME B16.5 Class [150] [300] [_____]] [fixed hex nipples [male ASME B1.20.2MASME B1.20.1 threaded] [female ASME B1.20.2M ASME B1.20.1 threaded sockets]] [_____]. Use thermowells, equipped with terminal connection heads rated NEMA 250 Type [4X] [4] [7] [_____], with

thermocouples or RTDs.

2.23.5 Static Mixer

Design static mixer to disperse the design flow, [_____] cubic m/s gpm of added chemicals in a process flow stream with flows ranging from [_____] to [_____] cubic m/s gpm. The minimum allowable pressure drop is [_____] kPa feet of water column. The maximum allowable pressure drop for the static mixer is [_____] kPa feet of water column in accordance with the requirements of the process stream pumping system. Size diameter of the mixer housing identical to the process piping. Use length in accordance with the number of mixing elements required. Provide [TP316 stainless steel] [_____] housing materials, providing chemical resistance to both the chemical additives and process stream. [Ensure coatings on coated components are factory spark-tested to verify that the coating is free from pinholes.] Ensure end configurations are [plain ends] [ends prepared for welding] [ASME B1.20.2MASME B1.20.1 threaded ends] [[forged steel, [ASTM A105/A105M] [ASTM A727/A727M]] [_____], flanged faced and drilled to [ASME B16.5] [ASME B16.1] Class [150] [300] [_____]] [_____] and compatible with the piping system. Provide injection ports of the same materials as the mixer housing in the number, dimensions, and positions shown on drawings, and with [female ASME B1.20.2MASME B1.20.1 threaded] [flanged] [_____] connections compatible with the chemical feed piping system. Supply each housing with a name plate which at a minimum provides the manufacturer's name and address, part model number, and direction of flow. Construct mixing elements of [TP316 stainless steel] [_____] providing resistance to both the chemical additives and process stream. Install elements consecutively, with the number required designed to provide mixing with a homogeneity of the final mix of less than or equal to [0.05] [_____] by the end of the static mixer.

2.23.6 Expansion Joints

****

NOTE: Thermal expansion of the piping systems must be taken into account. One of the most common methods to accommodate thermal expansion, the incorporation of expansion loops into the piping system, should be carefully investigated when corrosive materials are handled due to the potential of inducing stress corrosion. Alternatives are expansion joints and flexible connections or sections. Calculate maximum expansion compensation based on maximum pipeline temperature and pressure.

****

Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.

2.23.6.1 Expansion Joint for Metallic Pipe

The expansion joint must be a [single slip] [double slip] [ball] [bellows] [elastomer sleeve] [_____] type with [stainless steel] [_____] wetted materials of construction. Size expansion joint to match the associated piping. The maximum allowable working pressure is [1.03] [_____] MPa [150] [_____] psig at [48.9] [_____] degrees C [120] [_____] degrees F. Size expansion joint for a maximum axial [compressing] [expanding] deflection of [_____] mm inches [, a lateral movement of [_____] mm inch,]

[and] [an angular rotation of [15] [_____] degrees.] End connections must be [as specified for the associated pipe joints] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [ASME B16.11 [threaded] [welding]]. Provide required accessories for a complete assembly including: [swivel joints,] [limit stops,] [internal guides,] [anti-torque device,] [internal flow liners,] [control rods,] [control cables,] [_____].

2.23.6.2 Expansion Joint for Nonmetallic Piping

Provide a bellows expansion joint with a minimum of [_____] convolutions to accommodate an axial deflection of [_____] mm inch, [a lateral movement of [_____] mm inch,] [and] [an angular rotation of [_____] degrees,] with [[ductile iron] [_____] flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [125] [150] [300] [_____],] [_____] end connections, and metal reinforcing bands. The maximum allowable working pressure is [960] [_____] kPa [140] [_____] psig at [49] [_____] degrees C [120] [_____] degrees F. Limit bolting to restrain the force developed by [1.5] [_____] times the specified maximum allowable operating pressure. Size expansion joint to match the associated piping.

2.23.7 Pressure Relief Devices

****

NOTE: Pressure relief devices must discharge to a safe location that does not endanger either operators or the environment. Discharge piping and the supports for the discharge piping must be carefully designed to prevent failure during a pressure relief event. Select all materials based upon the application; refer to manufacturers' catalogs.

****

Provide pressure relief devices conforming to the requirements of ASME B31.3.

2.23.7.1 Pressure-Relief Valve

****

NOTE: Verify that the valve schedule is included in the contract drawings.

****

Provide pressure-relief valves conforming to the following:

a. Pressure-relief valves, 50 mm 2 inch and smaller, must be a direct diaphragm, spring controlled type with [cast iron] [_____] bodies and spring cases. Trim must be [bronze] [stainless steel] [_____] and seats, [nitrile] [_____]. Diaphragms must be elastomeric, [chloroprene] [nylon reinforced butadiene acrylonitrile rubber] [or] [_____]. Ensure miscellaneous parts such as the valve stems, nuts, and springs are [stainless steel] [_____]. Ensure end connections are [flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [150] [300] [_____]] [ASME B16.11 [threaded] [welding]] [_____]. The valves must open when the upstream pressure reaches a maximum set point. Sizes and ratings [as shown in the Valve Schedule in the contract drawings.] [as follows: PSV- [_____] [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig].

b. Pressure relief valves, 65 mm 2.5 inch and larger, must be hydraulically operated, diaphragm actuated, pilot controlled [globe] [angle] valves with externally mounted strainers and test cocks. Provide bodies consisting of [cast iron] [ductile iron] [forged steel] [_____] and trim consisting of [bronze] [stainless steel] [_____]. Stem must be [stainless steel] [_____]. Ensure end connections are [flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [150] [300] [_____]] [ASME B16.11 [threaded] [welding]] [_____]. The valves must open when the upstream pressure reaches a maximum set point. Sizes and ratings [as shown in the Valve Schedule in the contract drawings.] [as follows: PSV- [_____] [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig].

2.23.7.2 Rupture Discs

****
NOTE: Verify that the rupture discs are sized and rated in the contract drawings.
****

Provide [tension loaded] [compression loaded] type rupture discs [as indicated in contract drawings]. Provide discs consisting of [copper] [aluminum] [stainless steel] [dual element with a seal composed of [metal] [plastic] [_____] conforming to piping system] with a maximum operating ratio of [70] [85] [90] [_____] percent. [Provide vacuum support, if required, by the manufacturer.] [Knife blades are not necessary for initiating rupture.] The discs must rupture when the upstream pressure reaches a set maximum. Sizes and ratings [as shown in the contract drawings.] [as follows: PSE- [_____] [_____] mm inch, diameter. Rupture pressure is [_____] MPa psig].

2.24 PIPE SUPPORTS AND PENETRATIONS

****
NOTE: Pipe-support is a major design consideration of any process piping system; carefully design and edit the following paragraphs.
****

Provide auxiliary steel where the support of piping systems and equipment is required between building structural elements. Provide light gauge and structural steel shapes conforming to the requirements of ASTM A36/A36M. The Contractor has the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted. Where auxiliary steel is indicated as stainless steel, provide [TP304] [_____] stainless steel conforming to [ASTM A167, No. 1 Finish] [_____].

2.24.1 Pipe Supports

Provide pipe supports conforming to the requirements of MSS SP-58. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither has a deteriorating action on the other.

2.24.1.1 Beam Clamps

For upper attachments on structural steel, provide beam clamps of [ASTM A36/A36M carbon steel] [or] [ASTM A181/A181M forged steel] [_____] and MSS SP-58 Types [19 through 23, 25 or 27 through 30] [_____]. Holes drilled in structural steel for hanger support rods will not be permitted. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place. Base clamp size selection only on the support of the required load.

2.24.1.2 Riser Clamps

Support vertical runs of piping at each floor, or closer where required, with [ASTM A36/A36M carbon steel] [_____] clamps bolted around pipes and attach to the building construction. [Provide copper plated clamps for copper tubing support.] [Use two bolt-type clamps designed for installation under insulation on insulated pipe runs.]

2.24.1.3 Brackets

Where piping is run adjacent to walls or steel columns, provide welded [ASTM A36/A36M steel] [_____] brackets, pre-punched with a minimum of two fastener holes.

2.24.1.4 Offset Pipe Clamp

Where pipes are indicated as offset from wall surfaces, supply a double-leg design two-piece pipe clamp.

2.24.1.5 Racks

Fabricate multiple pipe racks or trapeze hangers from [ASTM A36/A36M steel] [_____], and design to suit the conditions at the points of installation. Keep pipes in their relative positions to each other by the use of clamps or clips. Pipelines subject to thermal expansion must be free to slide or roll.

2.24.1.6 Hangers

Fabricate hangers of [malleable iron, ASTM A47/A47M] [or] [ASTM A36/A36M carbon steel] [_____]. Ensure all hangers are of a uniform type and material for a given pipe run and application. Use coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe. Ensure hangers for pipe sizes 65 mm 2.5 inch or larger incorporate a means of vertical adjustment after erection while supporting the load. For piping systems with operating temperatures from 50 to 230 degrees C 122 to 446 degrees F, use the following: [MSS SP-58 Type [1] [or] [3 through 12] [_____] hangers with overhead support and appropriate saddle of MSS SP-58 Type [40] [_____] for insulated pipe;] [MSS SP-58 Types [41] [or] [43 through 46] [_____] hangers or supports with roller support and appropriate saddle of MSS SP-58 Type [39] [_____] on insulated pipe;] [MSS SP-58 Types [35 through 38] for sliding support]. For piping systems with liquid temperatures up to 50 degrees C 122 degrees F, use the following: MSS SP-58 [Types 1,3 through 12,] [Types 24 and 26 with overhead support,] [or] [Types 35 through 38 with support from below].

2.24.1.7 Hanger Rods

Provide carbon steel hanger rods conforming to ASTM A576. The diameter of

the rods for piping system support must conform to [the contract drawings] [ASME B31.1].

2.24.2 Pipe Guides

2.24.2.1 Intermediate Guides

For piping [150 mm 6 inch] [[_____] mm inch] and smaller, provide a pipe clamp with an oversize pipe sleeve for a minimum [4 mm 0.16 inch] [[_____] mm inch] clearance. For piping [200 mm 8 inch] [[_____] mm inch] and larger, use U-bolts with double nuts that are manufactured for the purpose to provide a minimum [7 mm 0.28 inch] [[_____] mm inch] clearance around pipe. The stock sizes for the U-bolts are as follows: for a [200 mm 8 inch] [[_____] mm inch] pipe use a [16 mm 0.625 inch] [[_____] mm inch] U-bolt; for a [250 mm 10 inch] [[_____] mm inch] pipe, use a [19 mm 3/4 inch] [[_____] mm inch] U-bolt; for a [300 mm 12 inch] [[_____] mm inch] to [400 mm 16 inch] [[_____] mm inch] pipe, use a [24 mm 0.875 inch] [[_____] mm inch] U-bolt; and for [450 mm 18 inch] [[_____] mm inch] to [750 mm 30 inch] [[_____] mm inch] pipes use [25 mm 1 inch] [[_____] mm inch] U-bolts.

2.24.2.2 Alignment Guides

For piping, [200 mm 8 inch] [[_____] mm inch] and smaller, ensure alignment guides are [galvanized steel] [_____], [spider] [or] [sleeve] [_____] type. For piping, [250 mm 10 inch] [[_____] mm inch] and larger, ensure alignment guides are [galvanized steel] [_____], [roller] [_____] type guides.

2.24.3 Flashing Sleeves

[Install[galvanized steel] [_____] flashing sleeves wherever piping passes through concrete roof structures.] [Where piping penetrates roofs, provide [2 kg 4 lb.] [[_____] kg lb.] [lead] [_____] flashing.] Extend flashing [200 mm 8 inches] [[_____] mm inches] from the pipe in all directions, extend up the pipe, and fit with double-threaded flashing for pipes [75 mm 3 inches] [[_____] mm inches] and smaller. Turn down flashing inside the pipe for [100 mm 4 inch] [[_____] mm inch] and larger pipes.

2.24.4 Wall Penetrations

2.24.4.1 Above Grade Wall Penetrations

Provide piping which passes through fire-rated or smoke-rated walls, floors, or ceilings with insulated and encased pipe sleeves. Seal penetrations through an existing fire or fire barrier wall with a fire stop system that has an "F" rating no less than the required fire resistance rating of the penetrated wall. The fire stopping sealant for metal piping systems must be [[a water based] [vibration resistant, polysiloxane (also known as silicone) based,] nonslumping, premixed sealant with intumescent properties] [_____], that is rated for [3] [_____] hours pursuant to ASTM E814 and UL requirements. The fire stopping sealant for plastic and insulated piping systems must be a [polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties] [acrylic based, nonslumping, premixed sealant with intumescent properties] [_____], that is vibration and moisture resistant, and is rated for [3] [_____] hours pursuant to ASTM E814 and UL requirements with metal collars. Fit vented plastic pipe penetrations with galvanized steel collars that have intumescent inlays.

2.24.4.2 Below Grade Wall Penetrations

****
NOTE: For critical systems, use the interlocking rubber link system. In other instances, a nonslumping water-resistant elastomeric based sealant with intumescent properties may be used.
****

Provide below-grade wall penetrations with [hydrostatic seals designed to seal opening between pipe or conduit and a through-structure opening. The seals must be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening] [polysiloxane (also known as silicone) based, nonslumping, vibration and water resistant sealant with intumescent properties] [_____].

2.24.4.3 Galvanizing

Galvanizing must be [hot-dip applied and meet the requirements of ASTM A153/A153M] [or] [zinc or cadmium plating]. Stainless steel components may be substituted where galvanizing is specified.

2.25 MISCELLANEOUS MATERIALS

****
NOTE: In cold climates, exposed pipe, valves, and equipment should be insulated and potentially heat traced to prevent freezing. Method of heat trace will be dictated by hazard classification and site conditions.
****

2.25.1 Pipe Insulation Material

Provide insulation for pipes, valves, instrumentation and controls, and other equipment [in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS] [consisting of 25 mm one inch ASTM C552 cellular glass and integral moisture barriers][_____].

2.25.2 Heat Trace

****
NOTE: Delete subparagraphs a. b. and c. below if steam heat trace is used.
****

Heat trace must be [steam] [electrical] with materials selected for compatibility with transported liquids and ambient environment. The heat trace must be capable of maintaining the liquid process design temperature at [27] [_____] degrees C [80] [_____] degrees F maximum when subjected to an exterior temperature of [-29] [_____] degrees C [-20] [_____] degrees F.[Provide steam piping in accordance with Section 23 58 00.00 10 CENTRAL STEAM HEATING AND UTILITIES SYSTEMS.][Ensure electrical work is in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and UL listed, and includes all terminations, junction boxes, and automatic controls.] Perform work in conformance to hazard classifications indicated on the drawings[, and implement in accordance with NFPA 70,

Section 427].

a. Provide UL listed parallel conduction type heat tape, with adjustable thermostat for outdoor aboveground winterized piping. Ensure tape is not affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere. Provide flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation must prevent overheating and burnouts even where the cable overlaps itself.

b. Provide end seals for ends of circuits. Wire at the ends of circuits are not to be tied together.

c. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at [1.1] [_____] degrees C [34] [_____] degrees F minimum during winter outdoor design temperature as indicated, but not less than the following: 80 mm 3 inch pipe and smaller with 25 mm one inch thick insulation, 4 watts/0.3 m 4 watts/feet; and 100 mm 4 inch pipe and larger 38 mm 1.5 inch thick insulation, 8 watts/0.3 m 8 watts/feet of pipe.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 PREPARATION

3.2.1 Protection

Close pipe and equipment openings with caps or plugs during installation. Protect equipment from dirt, water, and chemical or mechanical damage.

3.2.2 System Preparation

3.2.2.1 Pipe and Fittings

Inspect pipe and fittings before exposed piping is installed or buried piping is lowered into the trench. Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.2.2.2 Damaged Coatings

Repair damaged coating areas in the field with material equal to the original coating, except promptly remove damaged glass-lined pipe from the site. Do not install damaged piping materials. Field repair damaged and uncoated areas of galvanized piping conforming to ASTM A780/A780M.

3.2.2.3 Field Fabrication

Notify the Contracting Officer at least [2] [_____] weeks prior to the field fabrication of pipe or fittings and at least [3] [_____] days prior to the start of any surface preparation or coating application work.

Perform field welding in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Provide welding electrodes in accordance with [Table 3.1 of AWS D1.1/D1.1M] [_____] as required for the applicable base metals and welding process. Fabricate fittings in accordance with the manufacturer's instructions.

3.3 EXPOSED PIPING INSTALLATION

Run exposed piping as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Install piping and appurtenances in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Install piping without springing or forcing the pipe.

3.3.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

3.3.1.1 Drilled-In Expansion Anchors and Fasteners

****

NOTE: This subparagraph addresses anchors and fasteners that are used with concrete or masonry applications. The first option is used for masonry brick and precast concrete hollow-core block anchoring/fastening systems and the second is suitable for cast-in-place concrete and solid precast concrete structural elements.

****

[Design anchors to accept both machine bolts and/or threaded rods. Such anchors must consist of an expansion shield and expander nut contained inside the shield. Fabricate and design the expander nut to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches, and bears against the shield bottom. Provide shield body consisting of four legs,taper the inside of each toward shield bottom (or nut end). Elongate the end of one leg and turn across shield bottom. Rib the outer surface of shield body for grip-action. The expander nut must be of square design with sides tapered inward from bottom to top. The anchor materials of construction must be [zinc plated steel] [TP304 stainless steel] [_____] of [300 MPa 43,541 psi] [[_____] MPa psi] minimum tensile strength. Provide fasteners consisting of machine bolts for use with above anchors; provide nuts and washers conforming to ASTM A194/A194M. Ensure the anchor length, diameter, and embedment depth meet the manufacturer's requirements for the maximum allowable working load of the application.] [Provide anchor/fastener assembly which is UL listed with a one-piece stud (bolt) that has integral expansion wedges, nuts and washers. [Construct stud of [TP304] [_____] stainless steel, and nut and washer of [TP304] [_____] stainless steel.] Ensure the anchor length, diameter, and embedment depth meet the manufacturer's requirements for the maximum allowable working load of the application.]

3.3.1.2 Drilled-In Adhesive Anchors

[Do not use drilled-in adhesive anchors for overhead applications.]

Compose anchors of an anchor rod assembly and an anchor rod adhesive cartridge. Provide anchor rod assembly composed of a chamfered and threaded stud rod of [zinc plated ASTM A36/A36M steel] [TP304 stainless steel] [_____] with a nut and washer of [ASTM A194/A194M alloy-steel] [TP316 stainless steel] [_____]. Use anchor length, diameter, and embedment depth meeting the manufacturer's requirements for the maximum allowable working load of the application. Ensure the adhesive cartridge is a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. Activate the capsule ingredients by the insertion procedure of the anchor rod assembly.

3.3.2 Piping Expansion and Contraction Provisions

Install piping to allow for thermal expansion and contraction resulting from the difference between installation and operating temperatures. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial must have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI Handbook. Install anchors as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. Install an intermediate pipe guide for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, install pipe alignment guides adjacent to the expansion device and within [four] [_____] pipe diameters. Install expansion devices in accordance with the manufacturer's instructions [and at the locations shown in the contract drawings].

3.3.3 Piping Flexibility Provisions

Provide thrust protection as required. Install flexible couplings and expansion joints at connections to equipment, and where shown on the contract drawings. Provide additional pipe anchors and flexible couplings, beyond those shown on the contract drawings, to facilitate piping installation, in accordance with reviewed shop drawings.

3.3.4 Couplings, Adapters and Service Saddles

Thoroughly clean pipes of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Wipe gaskets clean prior to installation. Lubricate flexible couplings and flanged coupling adapter gaskets with [soapy water] [or] [the manufacturer's standard lubricant] before installation on the pipe ends. Install couplings, service saddles, and anchor studs in accordance with manufacturer's instructions. Tighten bolts progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Use torque-limiting wrenches to tighten bolts.

3.3.5 Piping Equipment/Component Installation

Install piping components and indicators in accordance with manufacturer's instructions. Provide required upstream and downstream clearances, isolation valves, and miscellaneous devices for an operable installation. [Make straight runs of piping upstream and downstream of flow measuring devices as shown in the contract drawings.] [Use upstream and downstream lengths of undisturbed piping in accordance with flow indicator manufacturer's recommendations.]

3.3.5.1 Backflow Preventers

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NOTE: Discharge to an open drain with an air gap is required on potable water lines.
****

Install backflow preventers with nameplate and test cocks accessible from front of unit, and with a minimum clearance of [310 mm 12.2 inches] [[_____] mm inches] between the port and grade. Install assemblies in accordance with local codes [and discharge to an open drain with an air gap]; vertical installation [must be avoided] [is prohibited].

3.3.5.2 Local Indicators

Install all direct-reading indicator devices, thermometers, and pressure gauges so that they can be easily read from floor level, and are readily accessible for maintenance and service. Coat all temperature sensing bulbs with a [silver base heat transfer grease] [_____] prior to insertion into the thermowell. Install pressure gauges and thermometers where indicated in the contract drawings. [Field calibrate all indicators at time of installation to ensure measuring and reading accuracy.] Install differential pressure gauges [across all process equipment] [across the process equipment indicated in the contract drawings], in accordance with the manufacturer's recommendations, and arranged for easy observation.

3.3.6 Pipe Flanges

****
NOTE: Specify the requirement for bolting to straddle the vertical centerline of the pipe for the installation of orientation sensitive devices such as some types of flow meters.
****

Pipe flanges must be set level, plumb, and aligned. Install flanged fittings true and perpendicular to the axis of the pipe. Ensure bolt holes are concentric to the centerline of the pipe [and straddle the vertical centerline of the pipe].

3.3.7 Valve Locations

Locate valves in accordance with the contract drawings where actuators are shown. Where actuators are not shown, locate and orient valves to permit easy access to the valve operator, and to avoid interferences.

3.3.8 Pipe Tap Connections

Taps to pipe barrels are unacceptable. Make taps to ductile iron piping only with a service saddle or at a tapping boss of a fitting, valve body, or equipment casting. Make taps to steel piping only with a welded threadolet connection.

3.3.9 Plastic Pipe Installation

Submit a statement signed by the [reinforced thermosetting resin pipe] [and] [plastic pipe] manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project. Cut, make up, and install all plastic pipe in

accordance with the pipe manufacturer's recommendations.

a. Perform heat joining in accordance with ASTM D2657. Perform electrofusion joining in accordance with ASTM F1290. Do not thread Schedule 40 pipe. Use Schedule 80 threaded nipples where necessary to connect to threaded valves or fittings. Use strap wrenches for tightening threaded plastic joints, and do not over tighten these fittings.

b. Do not lay pipe when the temperature is below [4.5 degrees C 40.1 degrees F] [[_____] degrees C degrees F], nor above [32 degrees C 90 degrees F] [[_____] degrees C degrees F] when exposed to direct sunlight. Ensure any plastic pipe installed above grade and outdoors is ultraviolet (UV) protected or UV resistant.

c. Shield pipe ends that are to be joined from direct sunlight prior to and during the laying operation. Provide adequate ventilation when working with pipe joint solvent cement and handle solvent cements, primers and cleaners in accordance with ASTM F402.

d. Provide and install supports and hangers [in accordance with the manufacturer's recommendations] [as specified and indicated] [_____]. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. Accomplish this with the use of expansion joints and offset piping arrangements. Hydrostatically test all lines [at the maximum operating pressures] [at the pressures listed in the Pipe Schedule shown on the contract drawings].

Submit [6] [_____] copies each of operation and maintenance manuals in indexed booklet form. Detail in the Operation Manuals the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment, and include piping layout and valve locations.

3.3.9.1 PVC Piping

Construct solvent-cemented joints in accordance with ASTM D2855.

3.3.9.2 FRP Piping

Cut, fabricate, and install pipe, duct, and fittings in strict accordance with the pipe manufacturer's written recommendations and as shown on the contract drawings. Ensure all FRP pipe and fittings have interior surfaces which are highly polished, with no exposed fibers. Cure field joints as recommended by the manufacturer. [Where it is absolutely necessary to make a field weld on pipe specified to be field flanged only, make the weld only under direct supervision of the pipe manufacturer's field representative, who is experienced in FRP pipe lay-up techniques.]

3.3.10 Double Containment Piping Installation

Factory trained field representatives of the piping supplier must provide technical field support during critical periods of piping [and leak detection system installation including final check out of the leak

detection/location system, and end user training].

3.3.11 Insulation

Install insulation on piping as indicated [on the Pipe Schedule] [in the contract drawings in accordance with the provisions of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.]

3.4 BURIED PIPE PLACEMENT

[Install thermoplastic piping systems underground in accordance with ASTM D2774.] [Install thermosetting resin and reinforced plastic mortar piping systems underground in accordance with ASTM D3839.]

3.4.1 Excavation and Backfilling

Perform earthwork as specified in Section 31 00 00 EARTHWORK. Accomplish backfilling after inspection by the Contracting Officer. Exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

3.4.2 Fittings

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Insert tubing fully into the fitting and then mark at the shoulder of the fitting. Check fitting alignment against the mark on the tubing to ensure the tubing is fully inserted before the joint is pressed. At valves and connections, dig out the trench bottom with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

3.4.3 Thrust Restraint

Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. Provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, provide thrust restraint at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

3.4.3.1 Thrust Blocks

Thrust blocking must be concrete of a mix not leaner than [1] [_____] cement, [2.5] [_____] sand and [5] [_____] gravel, and have a compressive strength of not less than [14 MPa 2000 psi] [[_____] MPa psi] after [28] [_____] days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, pour the base and thrust bearing sides of the thrust blocks against undisturbed earth. The sides of thrust blocks not subject to thrusts may be poured against forms. Provide area of bearing as shown or directed. Place blocking so that fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or a coating of bituminous paint, to anchor vertical down bends into gravity thrust blocks.

3.4.3.2 Restrained Joints

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NOTE: When the restrained pipe length is specified, this paragraph will be modified in accordance with the design requirement. Use UFC 3-230-01 for guidance.

****

[The restrained pipe length is [_____] m feet]. [For ductile iron pipe, design restrained joints in accordance with DIPRA TRD.]

3.4.4 Marking Tape

Provide and install pipe marking tape in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.4.5 Plastic Pipe Installation

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NOTE: Thrust blocking should be used only where slip joints are used. Otherwise, piping will be designed to withstand compression or expansion forces imposed by trench conditions.

****

Cut, fabricate, and install plastic pipe in strict conformance with the pipe manufacturer's recommendations. Provide offset loops from the trench centerline as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial must have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI Handbook. Support flexible plastic pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between the plastic pipe at the flanged joint and the rigid structures is possible. [Do not use thrust blocking for flexible plastic piping. Design and install piping to withstand the compression and expansion forces imposed by the trench conditions.] [Construct concrete thrust blocks where shown in the contract drawings] [_____].

3.5 CONNECTING DISSIMILAR PIPE

Install flexible transition couplings, dielectric fittings and isolation joints in accordance with the manufacturer's instructions.

3.6 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.6.1 Underground Metallic Piping

Protect buried metallic piping from corrosion using [protective coatings] [and] [cathodic protection]. Provide cathodic protection for metallic underground piping systems as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Where dissimilar metals are joined underground, use gas-tight isolation joints. [Provide insulating joint material where shown to control galvanic or electrical action.]

3.6.2 Above Grade Metallic Piping

Do not paint nonferrous and stainless steel piping except for aluminum alloy piping. Where dissimilar metals are joined, use isolation joints.

3.6.2.1 Ferrous Piping

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Clean surfaces that contain loose rust, mill scale or other foreign substances mechanically by [power wire brushing] [commercial sand blasting conforming to SSPC SP 6/NACE No.3] and prime with a [ferrous metal primer] [vinyl type wash coat] [_____]. Finish primed surfaces with two coats of exterior [oil] [vinyl] [_____] paint in accordance with Section 09 90 00 PAINTS AND COATINGS. Provide cathodic protection as shown in the contract drawings for above ground ferrous piping systems as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

3.6.2.2 Aluminum Alloy Piping

Paint surfaces of aluminum alloy pipe and fittings to protect against corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by water, detergents or chemicals. Solvent clean surfaces must be solvent and treat with a [vinyl type wash coat] [_____]. Apply a first coat of aluminum paint and a second coat of [alkyd gloss enamel] [silicone alkyd copolymer enamel] [_____] in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.7 DOUBLE CONTAINMENT PIPING LEAK DETECTION SYSTEM

a. Install the system in accordance with the manufacturer's recommended installation procedures. Follow all local, state and federal codes and requirements. Install system by properly trained personnel. Provide a location map with the system by the Contractor indicating the "as built" system configuration and sensing string layout. Provide markings along the cable length as references to locate leaks. Base markings upon calibration points. Take and record calibration points along the sensing string in accordance with the manufacturer's recommended procedures. Provide cable not in containment piping with cable tags every [15 m 49.2 feet] [[_____] m feet].

b. Perform tests to demonstrate the ability of the system to detect and locate breaks, shorts and probes on the sensor string. Perform leak testing pursuant to the following procedure in order to verify operation and the ability to work with condensation pools or other static moisture. The double containment piping system leak detection field test procedures are as follows:

(1) Wet the sensor cable near the start of the sensor string and acknowledge the detection/location alarm and remap the system.

(2) Wet the sensor cable near the end of the sensor string with the first location still wetted and acknowledge the detection/location alarm and remap the system.

(3) Wet the sensor cable in three additional locations between the

first and second leak locations with each detection/location alarm being acknowledged and with all prior leak locations still wetted.

(4) Prepare and submit a report verifying each leak location and detection accuracy. Furnish a hard copy report of the test results.

3.8 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

Provide flexible joints at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded pipe joints are not. Joints may be flush with the structure face or may be located up to [1] [_____] pipe diameter away from face [, but not further than [450 mm 17.7 inches] [[_____] mm inches] away from face]. [For pipelines larger than [450 mm 18 inch] [[_____] mm inch] in diameter the first joint must be within [1] [_____] pipe diameter.]

3.9 CLOSURES

Install closure pieces as necessary to end pipe runs and conforming to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Provide pressure piping with closures of [butt-welded caps] [blind flanges] [threaded plugs] [plain end pieces, with thickness matching the nominal wall thickness of the associated pipe, mounted on double flexible couplings], unless otherwise shown on contract drawings or approved by the Contracting Officer. Ensure pipes with restrained joints have pipe closures installed with thrust tie-rod assemblies [as shown in contract drawings].

3.10 PENETRATIONS

Steel pipe sleeves must be hot-dipped galvanized after fabrication for above grade applications in nonsubmerged areas. For below grade, or in submerged and damp environments, line and coat steel pipe sleeves as specified in Section 09 90 00 PAINTS AND COATINGS. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations. Coatings must be as specified in Section 09 90 00 PAINTS AND COATINGS. Support wall pipes securely by form work to prevent contact with reinforcing steel and tie-wires. Ensure joints are [caulked with rubber sealant] [or] [sealed with a wall penetration seal]. For existing concrete walls, rotary drilled holes may be provided in lieu of sleeves.

3.11 VALVE INSTALLATION

Install flanged valve bolt holes so as to straddle the vertical centerline of pipe. Clean flanged faces prior to inserting the gasket and bolts, and then tighten the nuts progressively and uniformly. Clean threads of threaded ends by wire brushing or swabbing prior to installation.

3.11.1 Valve Orientation

Install operating stem of a manual valve in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations [1.37 m 4.5 feet] [[_____] m feet] or less above finished floor, unless otherwise shown on contract drawings. Install operating stem of a manual valve in a horizontal position in horizontal runs of pipe having centerline elevations between [1.37 m 4.5 feet] [[_____] m feet] and [2.05

m 6.75 feet] [[_____] m feet] above finish floor, unless otherwise shown on contract drawings. Install automatic valves in accordance with [the manufacturer's instructions] [and] [approved drawings].

3.11.1.1 Butterfly Valves

Orientation of butterfly valves must take into account changes in pipe direction. Orient valve shafts so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.11.1.2 Plug Valves

If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow must produce an "unseating" pressure, and the plug must open into the top half of valve; and for vertical flow, install the seat in the highest portion of the valve.

3.11.2 Line Size Ball Valves

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

3.11.3 Isolation Valve

Install safety isolation valves on compressed air supplies. Locate valve to provide accessibility for control and maintenance. If necessary, install access doors in finished walls and plaster ceilings for valve access.

3.11.4 Operator Extension Stems

Where the depth of the valve is such that its centerline is more than [925 mm 3 feet] [[_____] mm feet] below grade, furnish an operator extension stem with a [50 mm 2 inch] [[_____] mm inch] operating nut to bring the operating nut to a point [150 mm 5.9 inches] [[_____] mm inches] below the surface of the ground and/or box cover. Locate operating nut in a floor box.

3.11.5 Torque Tube

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

3.11.6 Chain Wheel and Guide

Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves located over [2.05 m 6.73 feet] [[_____] m feet] above finished floor elevation. Where chains hang in normally traveled areas, use appropriate ["L" type] [_____] tie-back anchors.

3.12 AIR RELEASE, DRAINS AND SAMPLE PORTS

Provide sample ports where indicated on the contract drawings. Install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown

on contract drawings.

3.13 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.13.1 General Support Requirements

Provide pipe support systems meeting the requirements of MSS SP-58. Install Contractor-designed and selected support systems in accordance with MSS SP-58, and as specified herein. Support piping connections to equipment by pipe supports and not off the equipment. Support large or heavy valves, fittings, and/or equipment independently of associated piping. Do not support pipes off other pipes. Provide supports at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Do not install pipe supports and hangers in equipment access areas or bridge crane runs. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, provide every pipe with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Provide pedestal type pipe supports under base flanges adjacent to rotating equipment and where required to isolate vibration. Brace piping [65 mm 2.5 inch] [[_____] mm inch] in diameter and larger for seismic forces. Install lateral supports for seismic loads at all changes in direction.

3.13.2 Support of Insulated Piping

Install oversized supports to fit the insulation inserts. Provide supports with galvanized or stainless steel protection shields and oversized rollers.

3.13.3 Dielectric Barriers

Install dielectric barriers between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.13.4 Support Spacing

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NOTE: Calculate spans and rod sizes pursuant to MSS SP-58. Coordinate with manufacturers data and/or other standards for guidance in determining maximum support spans. Duplicate the following subparagraphs as required.

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3.13.4.1 Acceptable Limits for Metallic Piping

[Stainless steel] [_____] [Schedule [10S] [_____]] with a wall thickness of [_____] mm inch, diameter [_____] mm inch, must have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm

inch.

3.13.4.2 Acceptable Limits for Thermoplastic Piping

[PVC] [_____], [Schedule [40] [_____]] [SDR [21] [_____]], diameter [_____] mm inch, must have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.4.3 Acceptable Limits for Rubber/Elastomer Piping

[Chloroprene] [_____], internal diameter [_____] mm inch, must have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.5 Support Methods

Provide piping support as specified and as shown in the contract drawings. Support single horizontal suspended piping by [adjustable swivel-ring,] [split-ring,] [or] [clevis] [_____] hangers. Support multiple horizontal suspended piping by [trapeze hangers with channel type supports] [_____]. Provide horizontal pedestal mounted piping with [saddle] [_____] type supports. Provide horizontal wall mounted piping with [wall brackets] [_____]. Support vertical piping by [wall brackets,] [base elbows,] [or] [riser clamps on floor penetrations] [_____].

3.13.6 Supports and Hangers for Stainless Steel Piping

Provide all hanger-pipe contact surfaces with a dielectric barrier consisting of [chloroprene rubber] [_____] wrapping [or plastic coated hangers]. The load rating of universal concrete inserts is not allowed to be less than that of the hanger rods they support.

3.14 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

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NOTE: Color coding for piping identification as required by the using agency will be developed and inserted in the Color Code Schedule (Table I) in Section 09 90 00 PAINTS AND COATINGS. For Air Force installations, piping will be color coded in accordance with Attachment 4 of Air Force Regulation 88-15.

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Ensure color, coating, and lettering requirements for exposed piping are in accordance with Section 09 90 00 PAINTS AND COATINGS. [Except where piping is required to be completely painted in its code color, piping or its insulation covering may be banded either with plastic adhesive tapes or painted stripes around pipe designating piping contents [in accordance with following options and requirements].] [Provide a single individual band, of plastic adhesive tape or paint, designating pipe contents with sufficient length to permit the stenciling of pipe contents in letters.] [Provide identification at branch connections, inlets and outlets of equipment, every [6 m 19.7 feet] [[_____] m feet] of straight run, upstream of valves, and within [1 m 3.3 feet] [[_____] m feet] of entrance to or exit from wall curtains, or other similar type barrier.]

3.15 FIELD QUALITY CONTROL

****

NOTE: The general pipe testing requirements are basically taken from ASME B31.3 for Chemical and Petroleum Refinery Piping. Test pressure for hydrostatic pressure and leakage tests will be the working pressure multiplied by 1.33. For a working pressure of 1.03 MPa 150 psig, the test pressure will be 1.38 MPa 200 psig. For other working pressures the test pressure will be adjusted accordingly.

Pneumatic testing should be avoided if possible. Specify pneumatic testing on systems where residual moisture in the lines could be a problem (such as with anhydrous liquid chlorine and hydraulic fluid), and where the use of another nontoxic liquid is not feasible. ASME B31.3 methods should be used.

****

3.15.1 Hydrostatic Tests

Where any section of a pipeline is provided with concrete thrust blocking for fitting, do not make the hydrostatic tests until at least [5] [_____] days after the installation of the concrete thrust blocking, unless otherwise approved by the Contracting Officer.

3.15.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, subject the newly laid piping or any valved section of piping, unless otherwise specified, for [1] [_____] hour to a hydrostatic test pressure [of [_____] MPa psig] [as listed in the Pipe Schedule in the contract drawings]. Open and close each valve several times during the test. Carefully examine exposed pipe, joints, fittings, and valves during the partially open trench test. Replace joints showing visible leakage as necessary. Remove defective pipe, joints, fittings, and valves found during the pressure test and replace with new material, and repeat the test until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Place backfill placed prior to the tests in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.15.1.2 Exposed Piping

Conduct hydrostatic testing in accordance with ASME B31.3. Test piping systems under normal service conditions (as indicated in the Pipe Schedule in the contract drawings) to demonstrate compliance. Test pressure less than [1.5] [_____] times the design pressure is prohibited. Use [water]

[_____] as the hydrostatic test fluid. Provide clean test water of such quality to prevent corrosion of the piping system materials. Open air release vents at all high points of the piping system in order to purge air pockets while the piping system is filling.

3.15.1.2.1 Rigid Piping

For rigid piping hydrostatic testing, calculate the maximum test pressure according to ASME B31.3, but do not exceed the yield strength of the piping system. The maximum velocity during filling is [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. [Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.] Test all parts of the piping system. Maintain hydrostatic test pressure continuously for [30] [_____] minutes minimum and for such additional time as necessary to conduct examinations for leakage. Examine all joints and connections for leakage. Ensure piping system, exclusive of possible localized instances at pump or valve packing, shows no visual evidence of leaking. Correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, leave the piping system full of water after leaks are repaired.

3.15.1.2.2 [Non-Rigid, Non-Metallic Piping] [and] [Metallic Piping with a Non-Metallic Liner]

For [non-rigid, non-metallic piping] [and] [metallic piping with a non-metallic liner] hydrostatic testing, calculate the maximum test pressure according to ASME B31.3, but do not exceed [1.5] [_____] times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling is [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. Pressurize the system initially to [50] [_____] percent of the normal service conditions and inspect. Repair any leaks . Then pressurize the system to the test pressure. Add small amounts of [water] [_____] as required on a hourly basis for a maximum of [3] [_____] hours in order to maintain the test pressure. After [4] [_____] hours, lower the test pressure by [70 kPa 10.2 psi] [[_____] kPa psi]. If the hydrostatic pressure remains steady for [1] [_____] hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. Allow piping system to relax for [8] [_____] hours before retesting.

3.15.1.3 Double Containment Primary Piping

Test the primary piping of a double containment piping system in accordance with Subparagraph [Buried Piping] [Exposed Piping] of this paragraph. Pneumatically pressure test secondary containment piping of a double containment piping system in accordance with Subparagraph Double Containment Secondary Piping. Pressure test at the maximum test pressure of [5 psi] [_____] or manufacturer's recommended maximum, [_____] times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling is [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. Pressurize the system initially to [50] [_____] percent of the normal service conditions and inspect. Repair any leaks. Then pressurize the system to the test pressure. Add small amounts of [water] [_____] as required on a hourly basis for a maximum of [3] [_____] hours in order to maintain the test pressure. After [4] [_____] hours, lower the test pressure by [70 kPa 10.2 psi] [[_____] kPa

psi]. If the hydrostatic pressure remains steady for [1] [_____] hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. Allow piping system to relax for [8] [_____] hours before retesting.

3.15.1.4 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Conduct tests for above ground pressure piping after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.15.2 Pneumatic Tests

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NOTE: Do not use pneumatic tests for primary piping of double containment piping systems.
****

Prepare for and conduct pneumatic testing in accordance with the requirements of ASME B31.3. Care must be taken to minimize the chance of a brittle fracture or failure during a pneumatic leak test. Use only non-toxic, nonflammable, inert gases or air.

3.15.2.1 Pressure Relief Device

During pneumatic testing, provide a pressure relief device for each piping section being tested. The device must have a set pressure no higher than the test pressure plus the lesser of [10] [_____] percent of the test pressure or [350 kPa 50.8 psi] [[_____] kPa psi].

3.15.2.2 Pneumatic Testing Procedures

The test fluid must be [air] [_____] and the test pressure must be [110] [_____] percent of the design pressure. Increase test pressure incrementally until the gage pressure reaches the lesser of [50] [_____] percent of the test pressure or [170 kPa 25 psig] [[_____] kPa psig]. Examine piping joints for leakage. If no leakage is occurring, continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until the test pressure is reached. Then reduce the test pressure to the design pressure and maintain for [10] [_____] minutes without additional energy expenditure. If the pneumatic pressure remains steady, then no leakage is indicated. Inspect for and repair leaks, and retest if necessary.

3.15.2.3 Double Containment Secondary Piping

Hydrostatically test the primary piping of a double containment piping system in accordance with Subparagraph [Buried Piping] [Exposed Piping]. Pneumatically pressure test secondary containment piping of a double containment piping system at the maximum test pressure of [5 psi] [_____] or manufacturer's recommended maximum. The test fluid must be [air] [_____]. [Testing procedures must be in accordance with manufacturer's recommendations.] [Increase the test pressure incrementally until the gage pressure reaches [50] [_____] percent of the test pressure. Examine

piping joints for leakage. If no leakage is occurring, continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until the test pressure is reached. Then reduce the test pressure to the design pressure and maintain for [10] [_____] minutes without additional energy expenditure. If the pneumatic pressure remains steady, then no leakage is indicated.] Inspect for and repair leaks, and retest if necessary.

3.15.3 Pipe Leakage Tests

Unless approved by the Contracting Officer, conduct leakage testing after the pressure tests have been satisfactorily completed. The duration of each leakage test is at least [2] [_____] hours, and during the test, subject the piping to no less than [1.38 MPa 200 psig] [[_____] MPa psig] pressure. Leakage is defined as the quantity of the test liquid, [water] [_____], that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within [34.5 kPa 5 psi] [[_____] kPa psi] of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds [the values listed in the Pipe Schedule in the contract drawings] [or, if applicable,] [the allowable leakage determined by the following formula:

L = Cf x N x D x P0.5		
Cf	conversion factor	10.786 0.0001351
L	allowable leakage	mm3 per hour gallons per hour
N	number of joints in the length of piping tested	
D	nominal pipe diameter	mm inches
P	average test pressure during the test	MPa psig

]

Should any test disclose leakage greater than that allowed, locate the leaks and repair until the leakage is within the specified allowance, without additional cost.

3.15.4 Testing New to Existing Connections

Test new piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections. Isolate the new piping with pipe caps, spectacle blinds, or blind flanges. Test the joint between new piping and existing piping by methods that do not place the entire existing system under the test load. Proceed. then, with the testing of new piping systems as specified herein.

3.15.5 Valve Testing

Submit copies of all field test reports within [24] [_____] hours of the completion of the test. Valves may either be tested while testing pipelines, or as a separate step. Demonstrate that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. Count and record the number of turns required to open and close each valve, and

account for any discrepancies with manufacturer's data. Examine air and vacuum relief valves as the associated pipe is being filled to verify venting and seating is fully functional. Set, verify, and record set pressures for all relief and regulating valves. Test self-contained automatic valves at both maximum and minimum operating ranges, and reset upon completion of test to the design value. [Test automatic valves that are not self-contained in conjunction with control system testing.]

3.16 FINAL CLEANING

3.16.1 Interim Cleaning

Prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. Examine the piping to assure removal of these and other foreign objects prior to assembly and installation.

3.16.2 Flushing

Following assembly and testing, and prior to final acceptance, flush piping systems with [water] [_____] to remove accumulated construction debris and other foreign matter. Flush piping until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity is [0.76 m/s 2.5 fps] [[_____] m/s fps]. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Install cone strainers in the flushing connections of attached equipment and leave in place until cleaning is completed. Remove accumulated debris through drains, or by removing spools or valves.

3.16.3 Disinfection

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NOTE: Selectively require the Contractor to perform disinfection work for liquid process piping. This should be limited only to processes where bacteriological interferences could damage process equipment.

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Disinfect the [pipelines so noted in the Pipe Schedule in the contract drawings] [following pipelines: [_____]] [_____]. Before acceptance of piping system operation, disinfect each section of completed pipeline [in accordance with AWWA C651] [as specified herein]. After pressure tests have been made, thoroughly flush the piping section to be disinfected with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material must be [liquid chlorine] [calcium hypochlorite] [or] [sodium hypochlorite] [_____]. Ensure the chlorinating material provides a dosage of no less than [50] [_____] ppm and introduce into the piping in an approved manner. [Chlorinate PVC pipe lines using only the above specified chlorinating material in solution.] Do not introduce the agent into the line in a dry solid state. Retain the treated water in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time is at least 24 hours and produce no less than 25 ppm of free chlorine residual throughout the line at the end

of the retention period. Open and close all valves on the lines being disinfected several times during the contact period. Then flush the line with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, open and close each outlet on the line several times. From several points in the pipeline section, [the Contracting Officer will take samples of water in sterilized containers for bacterial examination] [Contractor personnel, approved by the Contracting Officer, must take samples in sterilized containers and have a bacterial examination performed by a commercial laboratory in accordance with state approved methods. The commercial laboratory must be certified by the state's approving authority for examination of potable water.] Repeat the disinfection until the piping system passes the bacterial examination for [2] [_____] consecutive days. The piping system will not be accepted until satisfactory bacteriological results have been obtained.

3.17 WASTE WATER DISPOSAL

Submit the method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests. Dispose of water used for testing, cleaning, flushing and/or disinfection in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. Provide the method proposed for disposal of waste water to the Contracting Officer for approval prior to performing any testing, cleaning, flushing and disinfection activities.

3.18 TABLES

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NOTE: The intention of the Table is to give the designer a structure to specify the most suitable piping system materials for a project. The designer will edit or delete this table to fit the project. Verify that each pipeline designation is identified for the Contractor and the Contracting Officer on the drawings. Consult EM 1110-1-4008 Liquid Process Piping to determine acceptable materials for each application. Allow the Contractor selection of the most economical of the acceptable systems. Table may be shown on the drawings and deleted from this section of the specifications.

As indicated in paragraph 2.16, Double Containment pipe is supplied in different materials of construction. Selection of which depends upon the fluids being handled and other conditions of installation; i.e., underground, above ground, and temperature.

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TABLE I
PIPE AND FITTING MATERIALS FOR COMMON PIPING SYSTEMS

Item No.	Pipe Material	SERVICE															
		A	B1	B2	C	D1	D2	E1	E2	E3	E4	E5	E6	E7	F	G	H
2.2	DI	x	x	x	x												
2.3	CS	x	x	x	x	x	x			x		x		x		x	
2.4	Lined Steel	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
2.5	SS	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
2.6	Nickel/Nickel Alloys	x	x		x	x	x		x	x	x	x				x	x
2.7	Aluminum	x	x		x	x	x		x	x		x	x		x	x	x
2.8	Copper	x	x	x	x	x	x			x				x	x	x	x
2.9	PVC	x	x					x	x	x	x		x		x	x	
2.10	CPVC	x	x					x	x	x	x		x	x	x	x	
2.11	PVDF	x	x			x		x	x	x	x	x	x		x	x	x
2.12	ABS	x	x					x	x	x							
2.13	PE	x	x				x	x	x	x	x		x		x	x	x
2.14	Rubber/Elastomer	x	x		x				x	x							
2.15	FRP	x	x				x	x	x	x	x	x	x				
2.16	Double Containment	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x

LEGEND:	
A	Underground
B1	Aboveground: with ambient temperature exposure -25 to plus 45 degrees C -13 to plus 113 degrees F and ultraviolet light exposure
B2	Aboveground: with heat trace and insulated jacket
C	Temperature, Greater than 80 degrees C 176 degrees F
D1	Solvents: non-polar
D2	Solvents: polar
E1	Chemical: [strong,][_____] percent [sulfuric][hydrochloric][____] acid
E2	Chemical: [weak,][_____] percent [sulfuric][hydrochloric][____] acid

TABLE I PIPE AND FITTING MATERIALS FOR COMMON PIPING SYSTEMS																	
Item No.	Pipe Material	SERVICE															
		A	B1	B2	C	D1	D2	E1	E2	E3	E4	E5	E6	E7	F	G	H
E3	Chemical: [weak,][_____] percent base																
E4	Chemical: [strong,][_____] percent base																
E5	Chemical: [chlorine][_____]																
E6	Chemical: [oxidizing agents][_____]																
E7	Chemical: [sulfate][_____]																
F	POLs																
G	NAPLs																
H	DNAPLs																

3.19 MANUFACTURER'S FIELD SERVICES

Submit a signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training. Follow manufacturer's instructions for installation.

-- End of Section --