****
USACE / NAVFAC / AFCESA / NASA **UFGS-23 05 00.00 40 (June 2006)**

Preparing Activity: NASA **Superseding**
UFGS-23 05 00.00 40 (April 2006)
NASA-15050S (December 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 18 July 2006

Latest change indicated by CHG tags
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 05 00.00 40

COMMON WORK RESULTS FOR HVAC

06/06

-- End of Section Table of Contents --

SECTION 23 05 00.00 40

COMMON WORK RESULTS FOR HVAC
06/06

****
NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers standard basic mechanical work and should be supplemented by use of other mechanical sections as required.

Show on the drawings detailed upstream and downstream piping anchor provisions.

Install flexible metallic pipe vertically to keep dirt out of convolutions.

Coordinate design detail and specification for each installation with the manufacturer to ensure that length, stiffness of hose, and slack are suitable for the intended offset, travel, and imposed service under normal and shock conditions.

Indicate on the drawings use for main steamline dripping where amount of expansion and contraction is such that movement cannot be readily accommodated by piping configuration, with excessive stress on pressurized components or where there is a tendency to cause leaks at connections to mains. Tunnels, trenches, manholes, and above-ground steamlines are prime locations; pressure rating must provide for water-hammer shock. This specification is limited to 15 millimeter through 25 millimeter1/2 inch through 1 inch. Use welded pipe, valve, and hole connections wherever possible. Provide a welded end steam strainer upstream of hose to prevent welding bead penetration of bellows upon start up. Wherever possible, install flexible metal steam hose vertically.

Show on the Drawings, or supplement the specifications to include, calculated movement of piping, operating pressure and temperature ranges, fluid velocity, piping anchor and guiding provisions, limit stops, installation length, end connections, and special conditions such as angular displacement and vibration analysis in one or more planes.

This specification does not include slip-type expansion joints or ball joints.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

****

PART 1 GENERAL

1.1 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 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.

****

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.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2005e13) Manual of Steel Construction

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(1992; R 2004) Specification for Filler Metals for Brazing and Braze Welding
AWS WHB-2.9	(2004) Welding Handbook; Volume Two - Welding Processes

ASME INTERNATIONAL (ASME)

ASME A112.18.1	(2003) Standard for Plumbing Fixture Fittings
ASME A112.19.2	(2003) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME B1.20.7	(1991; R 2003) Standard for Hose Coupling Screw Threads (Inch)
ASME B1.21M	(1997; Addenda 1998) Standard for Metric Screw Threads - MJ Profile
ASME B16.1	(1998) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.11	(2005) Standard for Forged Steel Fittings, Socket-Welding and Threaded
ASME B16.22	(2001) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.25	(2003) Standard for Buttwelding Ends
ASME B16.26	(1988) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.39	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(1998) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2003) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(2004) Standard for Process Piping

ASME B36.10M	(2004) Standard for Welded and Seamless Wrought Steel Pipe
ASME B40.1	(1998) Standard for Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2004) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2004) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2005) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 106/A 106M	(2004) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 126/A 126M	(2004) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 183	(2003) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 197/A 197M	(2000) Standard Specification for Cupola Malleable Iron
ASTM A 216/A 216M	(2004) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 234/A 234M	(2005) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 276	(2005) Standard Specification for Stainless Steel Bars and Shapes
ASTM A 278/A 278M	(2001) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A 307	(2004) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(2005) Standard Specification for Seamless, Welded, and Heavily Worked Austenitic Stainless Steel Pipes
ASTM A 480/A 480M	(2004) Standard Specification for General

	Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A 53/A 53M	(2004a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 563	(2004) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 563M	(2004) Standard Specification for Carbon and Alloy Steel Nuts [Metric]
ASTM A 6/A 6M	(2005) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 74	(2005) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B 32	(2004) Standard Specification for Solder Metal
ASTM B 370	(2003) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B 62	(2002) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 749	(2003) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B 88	(2003) Standard Specification for Seamless Copper Water Tube
ASTM B 88M	(2003) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C 109/C 109M	(2005) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C 404	(2004) Standard Specification for Aggregates for Masonry Grout
ASTM C 476	(2002) Standard Specification for Grout for Masonry
ASTM C 553	(2002) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 564	(2003a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 67	(2003a) Standard Test Methods for Sampling

	and Testing Brick and Structural Clay Tile
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 2000	(2005) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2308	(2002) Standard Specification for Thermoplastic Polyethylene Jacket for Electrical Wire and Cable
ASTM E 1	(2003a) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E 814	(2002) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM F 104	(2003) Standard Classification System for Nonmetallic Gasket Materials
ASTM F 568M	(2004) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

FLUID SEALING ASSOCIATION (FSA)

FSA-0017	(1995e6) Standard for Non-Metallic Expansion Joints and Flexible Pipe Connectors Technical Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 515	(2004) Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications

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

MSS SP-125	(2000) Standard for Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002a; R 2004) Standard for Butterfly Valves
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Standard for Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Standard for Gray Iron Swing Check

	Valves, Flanged and Threaded Ends
MSS SP-72	(1999) Standard for Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-85	(2002) Standard for Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

U.S. DEPARTMENT OF DEFENSE (DOD)

MS MIL-C-18480	(1987b) Military Standard for Coating Compound, Bituminous, Solvent, Coal-Tar Base
MS MIL-E-17813	(1992f) Military Standard for Expansion Joints, Pipe, Metallic Bellows

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1922	(1995, R 2001-Rev A; Notice 1) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(1995, R 2001-Rev A; Notice 1) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-55614	(1995, R 2001) Shield, Expansion (Non-Drilling Expansion Anchors)
CID A-A-55615	(1995, R 2001) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors
FS A-A-1924	(1995, R 2001-Rev A) Standard for Shield, Expansion; (Self Drilling Tubular Expansion Shell Bolt Anchors)
FS A-A-1925	(1995, R 2001-Rev A; Notice 1) Standard for Shield, Expansion (Nail Anchors)

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003) Standard for Fire Tests of Through-Penetration Fire Stops

1.2 GENERAL REQUIREMENTS

****

NOTE: If Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING is not included in the project specification, applicable requirements thereof should be inserted and the first paragraph deleted. If Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT is not included in the project specification, applicable requirements thereof should be inserted and the second paragraph deleted. If Section 23 31 13.20 40 WELDING METAL DUCTWORK is not included in the project specification, applicable

requirements thereof should be inserted and the third paragraph deleted.

****

[Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING applies to work specified in this section.]

[Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT applies to work specified in this section.]

[Section 23 31 13.20 40 WELDING METAL DUCTWORK applies to work specified in this section.]

Submit Records of Existing Conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes Contractor's acceptance of the existing conditions.

Include with Equipment Foundation Data for piping systems all plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Submit Fabrication Drawings for pipes, valves and specialties consisting of fabrication and assembly details to be performed in the factory.

Submit Material, Equipment, and Fixture Lists for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Provide a complete list of construction equipment to be used.

Submit Manufacturer's Standard Color Charts for pipes, valves and specialties showing the manufacturer's recommended color and finish selections.

Include with Listing of Product Installations for piping systems identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include in the list purchaser, address of installation, service organization, and date of installation.

Submit Record Drawings for pipes, valves and accessories providing current factual information including deviations and amendments to the drawings, and concealed and visible changes in the work.

Submit Connection Diagrams for pipes, valves and specialties indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit Coordination Drawings for pipes, valves and specialties showing coordination of work between different trades and with the structural and architectural elements of work. Detail all drawings sufficiently to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate on drawings where conflicts or clearance problems exist between various trades.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

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

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists must be submitted for construction equipment to be used.

SD-02 Shop Drawings

Submit the following for pipes, valves and specialties showing conformance with the referenced standards contained within this section.

Record Drawings
Connection Diagrams
Coordination Drawings
Fabrication Drawings

Submit Installation Drawings for pipes, valves and specialties in accordance with the paragraph entitled, "Pipe Installation," of this section.

SD-03 Product Data

Submit equipment and performance data for the following items consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

Submit Manufacturer's catalog data for the following items:

Pipe and Fittings
Piping Specialties
Valves
Miscellaneous Materials
Supporting Elements

Equipment Foundation Data must be in accordance with paragraph entitled, "General Requirements," of this section.

SD-04 Samples

Submit Manufacturer's Standard Color Charts in accordance with paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Submit design analysis and calculations for the following items consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

Pipe and Fittings
Piping Specialties
Valves

SD-06 Test Reports

Submit test reports on the following tests in accordance with paragraph entitled, "Piping Installation," of this section.

Hydrostatic Tests
Air Tests
Valve-Operating Tests
Drainage Tests
Pneumatic Tests
Non-Destructive Electric Tests
System Operation Tests

SD-07 Certificates

Submit Listing of Product Installations for piping systems verifying proper qualifications.

Submit Records of Existing Conditions by the Contractor prior to

start.

Submit Certificates for the following in accordance with paragraph entitled, "Pipe Installation," of this section.

Surface Resistance
Shear and Tensile Strengths
Temperature Ratings
Bending Tests
Flattening Tests
Transverse Guided Weld Bend Tests

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with paragraph entitled, "Operation and Maintenance," of this section.

PART 2 PRODUCTS

2.1 ELECTRICAL HEAT TRACING

Heat trace systems for pipes, valves, and fittings must be in accordance with IEEE Std 515 and be UL listed. System must include all necessary components, including heaters and controls to prevent freezing.

Provide self-regulating heaters consisting of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. Heater must be able to be crossed over itself without overheating and be approved before used directly on plastic pipe. Heater must be covered by a radiation cross-linked modified polyolefin dielectric jacket in accordance with ASTM D 2308.

[For installation on plastic piping, apply the heater using aluminum tape. Heater must have an outer braid of tinned-copper and an outer jacket of modified polyolefin in accordance with ASTM D 2308, to provide a good ground path and to enhance the heater's ruggedness.]

****
NOTE: Self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 4 degrees C 40 degrees F pipe temperature operation to 66 degrees C 150 degrees F pipe temperature operation.
****

Provide heater with self-regulating factor of at least [90] [_____] percent, in order to provide energy conservation and to prevent overheating.

Heater must operate on line voltages of [120] [208] [220] [240] [277] volts without the use of transformers.

****
NOTE: Required heater output rating is in watts per meter at 10 degrees C foot at 50 degrees F. Heater selection based on 25 millimeter one-inch fiberglass insulation on metal piping.
****

Size Heater according to the following table:

Pipe Size (DN) (Millimeter Diameter)	Minus 23 degrees C	Minus 29 degrees C
80 or less	16 watts per meter (wpm)	16 watts per meter (wpm)
100	16 wpm	26 wpm
150	26 wpm	26 wpm
200	2 strips/16 wpm	2 strips/26 wpm
300 to 356	2 strips/26 wpm	2 strips/26 wpm

Pipe Size (Inch, Diameter)	Minus 10 degrees F	Minus 20 degrees F
3 inches or less	5 watts per foot (wpf)	5 wpf
4 inch	5 wpf	8 wpf
6 inch	8 wpf	8 wpf
8 inch	2 strips/5 wpf	2 strips/8 wpf
12 inch to 14 inch	2 strips/8 wpf	2 strips/8 wpf

System must be controlled by an ambient sensing thermostat set at 4 degrees C 40 degrees F either directly or through an appropriate contactor.

2.2 PIPE AND FITTINGS

2.2.1 Type BCS, Black Carbon Steel

****
NOTE: This pipe is applicable for chilled, hot, dual-temperature, and cooling-tower water.
****

Pipe (DN6 through DN300) (1/8 through 12 inches) must be Schedule 40 black carbon steel, conforming to ASTM A 53/A 53M.

Pipe (DN6 through DN250) (1/8 through 10 inches) must be Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A 53/A 53M, [Type E, Grade B (electric-resistance welded)] [Type S (seamless)]. Grade A should be used for permissible field bending, in both cases.

Pipe (DN300 through DN610) (12 through 24 inches) must be 9.52 millimeter 0.375-inch wall seamless black carbon steel, conforming to ASTM A 53/A 53M, [Type E, Grade B (electric-resistance welded)] [Type S (seamless)].

Fittings (DN50 and under) (2 inches and under) must be 1034 kilopascal 150-pounds per square inch, gage (psig) working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A 197/A 197M and ASME B16.3.

Unions (DN50 and under) (2 inches and under) must be 1724 kilopascal (250 psi) 250 pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.

Fittings (DN65 and over) (2-1/2 inches and over) must be Steel butt weld, conforming to ASTM A 234/A 234M and ASME B16.9 to match pipe wall thickness.

Flanges (DN65 and over) (2-1/2 inches and over) must be 1034 kilopascal (150-pound) 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

2.2.2 Type BCS-125, (862 kilopascal Service) (125-psi Service)

****
NOTE: This pipe is applicable for steam- and condensate-piping systems at pressures less than 125 pounds per square inch (psi) 862 kilopascal. Avoid screwed-end connections in condensate piping wherever possible. See Section 23 20 00.00 40 HVAC PIPING AND PUMPS for black carbon steel pipe for higher pressure ratings.
****

Pipe (DN6 through DN40) (1/8 through 1-1/2 inches) must be Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A 53/A 53M, Type F (furnace butt welded, continuous welded) and ASME B36.10M.

Pipe (DN50 through DN250) (2 through 10 inches) must be Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to ASTM A 53/A 53M [Type E, Grade B (electric-resistance welded)] [Type S (seamless)] and ASME B36.10M.

****
NOTE: For condensate piping, modify following (for 12 inches DN300 and over) to schedule 40 or schedule 80, if necessary.
****

Pipe (DN300 through DN610) (12 through 24 inches) must be 9.52 millimeter 0.375-inch wall, [seamless] [electric-resistance] welded black carbon steel, conforming to ASTM A 53/A 53M [Type E, Grade B (electric-resistance welded)] [Type S (seamless) and ASME B36.10M].

[Fittings (DN50 and under) (2 inches and under) must be 862 kilopascal 125-psig wsp, cast iron, screwed end, conforming to ASTM A 126/A 126M Class A and ASME B16.4.]

[Fittings (DN50 and under) (2 inches and under) must be 1034 kilopascal 150-psig wsp banded black malleable iron screwed, conforming to ASTM A 197/A 197M and ASME B16.3.]

[Fittings (DN25 through DN50) (1 through 2 inches) must be 14 or 21 megapascal 2,000-or 3,000-psi water, oil, or gas (wog) to match pipe wall, forged carbon steel socket weld, conforming to ASTM A 105/A 105M and ASME B16.11.]

[Fittings (DN50 and under) (2 inches and under) must be 862 kilopascal 125-psig wsp, cast iron, screwed end, conforming to ASTM A 126/A 126M Class A and ASME B16.4.]

[Fittings (DN65 and over) (2-1/2 inches and over) must be wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB and ASME B16.9.]

[Couplings (DN50 and under) (2 inches and under) must be commercial standard weight for Schedule 40 pipe and commercial extra heavy weight for Schedule 80 pipe, black carbon steel where threaded, and 14 or 21 megapascal 2,000-or 3,000-psi wog forged carbon steel, conforming to ASTM A 105/A 105M

and ASME B16.11, where welded.]

[Flanges (DN65 and over) (2-1/2 inches and over) must be 1035 kilopascal, 150-pound, forged carbon-steel welding neck, with raised face or flat face and concentric serrated finish, conforming to ASTM A 105/A 105M and ASME B16.5.]

[Conform grooved pipe couplings and fittings to paragraph entitled, "Grooved Pipe Couplings and Fittings."]

2.2.3 Type GCS, Galvanized Carbon Steel

****
NOTE: This pipe is applicable for potable water and rain water leader systems.
****

Pipe (DN15 through DN250), and where indicated (1/2 through 10 inches, and where indicated) must be Schedule 40 seamless or electric-resistance welded galvanized steel conforming to ASTM A 53/A 53M, Type E, Grade B (electric-resistance welded) or Type S (seamless).

Pipe (DN300 and over) (12 inches and over) must be 9.52 millimeter 0.375-inch wall, seamless, galvanized steel, conforming to ASTM A 53/A 53M, Grade B.

Fittings (DN50 and under) (2 inches and under) must be 1034 kilopascal 150-psig wsp banded galvanized malleable iron screwed, conforming to ASTM A 197/A 197M and ASME B16.3.

Unions (DN50 and under) (2 inches and under) must be 1034 kilopascal 150-psig wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint.

Fittings (DN65 and over) (2-1/2 inches and over) must be 862 kilopascal 125-psig wsp cast-iron flanges and flanged fittings, conforming to ASTM A 126/A 126M, Class A and ASME B16.1.

Conform grooved pipe couplings and fittings must conform to paragraph entitled, "Grooved Pipe Couplings and Fittings."

Contractor has the option of using 1034 kilopascal 150-psig wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A 197/A 197M and ASME B16.3.

2.2.4 Type GCS-DWV, Galvanized Steel Drain, Waste and Vent

****
NOTE: Nonferrous piping exposed to view in finished spaces and normally chrome plated is specified in Section 22 41 00.00 40 RESIDENTIAL PLUMBING FIXTURES
Select A53 pipe where bending and flattening tests are required.
****

Pipe (all sizes) must be Schedule 40 [seamless] [electric-resistance welded] galvanized carbon steel, conforming to ASTM A 53/A 53M, Grade A.

Furnace butt weld pipe is acceptable for sizes less than DN50 2 inches.

[Risers DN80 3 inches and larger must be Type CISP-DWV.]

[Fittings must be galvanized, [coated] [uncoated], screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A 126/A 126M.]

[Long radius fittings must be used wherever space permits. Short-turn tees, branches, and ells may be used for vent piping and connections of branch lines to battery fixtures, except wall-hung water closets.]

2.2.5 Type CISP-DWV, Cast-Iron Drain, Waste and Vent

****
NOTE: When project requires risers 3 inches DN80 and larger, include Type CISP-DWV materials specification.
****

Provide soil pipe drain, waste, and vent bell-and-spigot type pipe cast iron, conforming to ASTM A 74. Caulk and lead all joints in lines where necessary to provide proper leaktight support and alignment; other-wise joints may be two-gasket system type chloroprene, conforming to ASTM C 564. Pipe class must be extra heavy (CISP-DWV-XH).

2.2.6 Type CPR, Copper

****
NOTE: Copper pipe above ground and below ground is acceptable for chilled, hot, dual-temperature, cooling-tower water, and potable-water systems.
****

2.2.6.1 Type CPR-A, Copper Above Ground

Tubing (DN50 and under) (2 inches and under) must be seamless copper tubing, conforming to ASTM B 88M, ASTM B 88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).

Fittings (DN50 and under) (2 inches and under) must be 1034 kilopascal 150-psig wsp wrought-copper solder joint fittings conforming to ASME B16.22.

Unions (DN50 and under) (2 inches and under) must be 1034 kilopascal 150-psig wsp wrought-copper solder joint, conforming to ASME B16.22.

[Provide brazing rod with Classification BCuP-5, conforming to AWS A5.8/A5.8M.]

[Solder must be 60-40 tin-antimony, alloy Sb-5, conforming to ASTM B 32.]

2.2.6.2 Type CPR-U, Copper Under Ground

****
NOTE: For sizes under 3 inches DN80.
****

Provide Type K seamless copper tube piping, conforming to ASTM B 88M ASTM B 88. Socket-joint fittings must be wrought copper, conforming to ASME B16.22. Fittings for connection to corporation cocks must be cast

bronze, flared-type, conforming to ASME B16.26. Joints must be brazed.

2.2.6.3 Type CPR-INS, Copper Under Ground Insulated

****
NOTE: Type CPR-INS material is commercially available in sizes to and including 4 inches DN105 OD.

Since pipe is protected from soil by insulation system, Type L copper tube may be used if suitable for water carried at a cost saving of 10 percent.

Type CPR-INS material may be used for hot water supply and return connected to tunnel mains.
****

Provide insulated Type K seamless copper tube piping conforming to ASTM B 88M ASTM B 88. Socket-joint fittings must be wrought copper, conforming to ASME B16.22. Joints must be brazed.

Provide insulation not less than DN50 2 inches thick, suitable for continuous service temperatures of not less than 121 degrees C 250 degrees F. Insulation must be factory-molded, closed-cell polyurethane foam of not less than 40 kilogram per cubic meter 2.5 pounds per cubic foot density. Insulation must be waterproofed with an extruded rigid Type II virgin polyvinylchloride, with minimum wall thickness of 1.52 millimeter through 102 millimeter 60 mils through 4 inches outside diameter, 2.16 millimeter through 168.28 millimeter 85 mils through 6.625 inches and 2.79 millimeter through 273 millimeter 110 mils through 12.750 inches. Provide fitting covers fabricated from the same materials and thickness as adjacent pipe covering according to the manufacturer's directions.

2.2.7 Grooved Pipe Couplings and Fittings

Provide housing for all couplings, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Coupling gasket must be molded synthetic rubber, conforming to ASTM D 2000. Coupling bolts must be oval-neck, track-head type, with hexagonal heavy nuts conforming to ASTM A 183.

All pipe fittings used with couplings must be fabricated of black, ungalvanized malleable iron castings. Where a manufacturer's standard-size malleable iron fitting pattern is not available, approved fabricated fittings may be used.

Fittings must be fabricated from Schedule 40 or 19 millimeter (0.75-inch) 0.75-inch wall ASTM A 53/A 53M, Grade B seamless steel pipe; long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A 234/A 234M and ASME B16.9.

2.3 PIPING SPECIALTIES

2.3.1 Air Separator

Air separated from converter discharge water must be ejected by a reduced-velocity device vented to the compression tank.

[Commercially constructed separator must be designed and certified to

separate not less than 80 percent of entrained air on the first passage of water and not less than 80 percent of residual on each successive pass. Provide shop drawings detailing all piping connections proposed for this work.]

[Air separator must be carbon steel, designed, fabricated, tested, and stamped in conformance with ASME BPVC SEC VIII D1 for service pressures not less than 862 kilopascal 125 psi.]

2.3.2 Air Vents

[Manual air vents must be 10 millimeter 3/8-inch globe valves.]

****
NOTE: This size vent is suitable for most systems, and will pass 9.40 liter per second of free air 20 cubic feet of free air per minute at a system pressure of 862 kilopascal 125 psi. Where a system must be filled at a certain rate, larger vents or a multiple assembly with safety features should be used.
****

[Automatic air vents on pumps, mains, and where indicated must be of ball-float construction. Vent inlet must be not less than DN20 3/4-inch ips and the outlet not less than 8 millimeter 1/4-inch ips. Orifice must be 3 millimeter 1/8 inch. Provide corrosion-resistant steel trim conforming to [ASTM A 276] [ASTM A 480/A 480M]. Vent must be fitted with try-cock. Vent must discharge air at any pressure up to 1034 kilopascal 150 psi. Outlet must be copper tube routed.]

2.3.3 Compression Tank

Provide compression tank designed, fabricated, tested, and stamped for a working pressure of not less than 862 kilopascal 125 psi in accordance with ASME BPVC SEC VIII D1. Tank must be hot-dip galvanized after fabrication to produce not less than 51 grams 1.5 ounces of zinc coating per square meter foot of single-side surface.

Tank accessories must include red-lined gage-glass complete with glass protectors and shutoff valves, air charger and drainer, and manual vent.

2.3.4 Dielectric Connections

Dissimilar pipe metals must be electrically insulated from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

2.3.5 Expansion Vibration Isolation Joints

****
NOTE: Drawings should show detailed piping anchor provisions where expansion vibration isolation joints are used.

This joint may also serve as a dielectric connector.
****

Single or multiple arch-flanged expansion vibration isolation joints must

be constructed of steel-ring reinforced chloroprene-impregnated cloth materials. Joint must be designed to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Flanges must be backed with ferrous-metal backing rings. Control rod assemblies must be provided to restrict joint movement. All nonmetallic exterior surfaces of the joint must be coated with chlorosulphinated polyethylene. Grommets must be provided in limit bolt hole to absorb noise transmitted through the bolts.

****
NOTE: If other elastomers are substituted for chloroprene, temperature limits may be lowered to 180 degrees F 82 degrees C or less.
****

Joints must be suitable for continuous-duty working temperature of at least 121 degrees C250 degrees F .

****
NOTE: Select the following paragraph where solids accumulating in arch would cause cutting of carcass. Note that all movements will be reduced by 50 percent.
****

Arches must be filled with soft chloroprene.

Joint, single-arch, movement limitations and size-related, pressure characteristics must conform to FSA-0017.

2.3.6 Flexible Pipe

****
NOTE: Drawings should show detailed upstream and downstream piping anchor provisions and location with respect to axis of motion where flexible pipe is used.

Grooved couplings and vibration-isolated pipe hangers should be considered.

Flexible pipe may also serve as a dielectric connector.

Select following paragraph for manufacturer's standard-service pipe.
****

Flexible pipe vibration and pipe-noise eliminators must be constructed of wire-reinforced, rubber-impregnated cloth and cord materials and must be flanged. Flanges must be backed with ferrous-metal backing rings. Service pressure-rating must be minimum 1.5 times actual service. Surge pressure must be at 82 degrees C 180 degrees F.

****
NOTE: Anticipated life of chloroprene units at 250 degrees F 121 degrees C is 5 to 10 years.
****

Flexible pipe vibration and pipe noise eliminators must be constructed of wire-reinforced chloroprene-impregnated cloth and cord materials and they must be flanged. Provide all flanges backed with ferrous-metal backing rings. Nonmetallic exterior surfaces of the flexible pipe must be coated with an acid- and oxidation-resistant chlorosulphinated polyethylene. Flexible pipe must be rated for continuous duty at 896 kilopascal and 121 degrees C 130 psi and 250 degrees F.

Unit pipe lengths, face-to-face, must be not less than the following:

****

NOTE: The following lengths are basic recommendations: each application should be reviewed for optimum length.

****

INSIDE DIAMETER (DN)	UNIT PIPE LENGTH
[To 65, inclusive	305 millimeter
80 to 100, inclusive	450 millimeter
125 to 300, inclusive	600 millimeter]
[To 80, inclusive	450 millimeter
110 to 250, inclusive	600 millimeter
300 and larger	914 millimeter]

INSIDE DIAMETER	UNIT PIPE LENGTH
[To 2-1/2 inches, inclusive	12 inches
3 to 4 inches, inclusive	18 inches
5 to 12 inches, inclusive	24 inches]
[To 3 inches, inclusive	18 inches
4 to 10 inches, inclusive	24 inches
12 inches and larger	36 inches]

2.3.7 Flexible Metallic Pipe

Flexible pipe must be the bellows-type with wire braid cover and must be designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Working pressure minimum rating must be [345] [690] kilopascal at 149 degrees C [50] [100] psi at 300 degrees F.

[Minimum burst pressure must be four times working pressure at 149 degrees C 300 degrees F. Bellows material must be AISI Type 316L corrosion-resistant steel. Braid must be AISI 300 series corrosion-resistant steel wire.]

[Welded end connections must be Schedule 80 carbon steel pipe, conforming

to ASTM A 106/A 106M, Grade [B] [C].]

[Threaded end connections must be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A 312/A 312M.]

[Flanged end connection rating and materials must conform to specifications for system primary-pressure rating.]

2.3.8 Flexible Metal Steam Hose

Hose must be bellows type with wire braid cover and must be designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Working steam pressure rating must be 862 kilopascal at 260 degrees C 125 psi at 500 degrees F.

[Minimum burst pressure must be nine times working steam pressure at 149 degrees C 300 degrees F.]

Bellows material must be AISI Type 316L corrosion-resistant steel. Braid must be AISI Type 300-series corrosion-resistant steel wire.

[Welded end connections must be Schedule 80 carbon steel pressure tube, conforming to ASTM A 106/A 106M, Grade [B] [C].]

[Threaded end connections must be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A 312/A 312M.]

[Flanged end connection rating and materials must conform to specifications for system primary-pressure rating.]

2.3.9 Metallic Expansion Joints

[Expansion joints must be metallic-bellows-type, conforming to MS MIL-E-17813.]

[Expansion joints must be Type I (corrugated bellows, unreinforced), [Class 1 (single bellows, expansion joint)], [Class 2 (double bellows, expansion joint)].]

Joints must be designed and constructed to absorb all of the movements of the pipe sections in which installed, with no detrimental effect on pipe or supporting structure.

Joints must be rated, designed, and constructed for pressures to 862 kilopascal 125 psig and temperatures to 260 degrees C 500 degrees F.

Joints must have a designed bursting strength in excess of [four] [_____] times their rated pressure.

Joints must be capable of withstanding a hydrostatic test of 1.5 times their rated pressure while held at their uncompressed length without leakage or distortion that may adversely affect their life cycle.

Life expectancy must be not less than 10,000 cycles.

Movement capability of each joint must exceed calculated movement of piping by [100] [_____] percent.

Bellows and internal sleeve material must be AISI Type 304, 304L, or 321 corrosion-resistant steel.

End connections must require no field preparation other than cleaning.

[Butt weld end preparation of expansion joints must conform to the same codes and standards requirements as applicable to the piping system materials at the indicated joint location.]

[Flanges of flanged-end expansion joints must conform to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.]

Joints, DN65 2-1/2 inches and smaller, must have internal guides and limit stops.

Joints, DN80 3 inches and larger, must be provided with removable external covers, internal sleeves, and purging connection. Sleeves must be sized to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, the gasket must be provided by the manufacturer. Joints without purging connection may be provided; however, these must be removed from the line prior to, or not installed until, cleaning operations are complete.

[Cylindrical end portion of the reinforced bellows element must be provided with a thrust sleeve of sufficient thickness to bring that portion within applicable code-allowable stress. Sleeve must provide 360 degrees support for the element and end-reinforcing ring.]

[Expansion joints must have four, equidistant, permanent tram points clearly marked on each joint end. Points must be located to prevent obliteration during installation. Distance between tram points indicating installed lengths must be included in shop drawings. Overall dimension after joint installation must be subject to approval.]

Each expansion joint must have adjustable clamps or yokes provided at quarter points, straddling the bellows. Overall joint length must be set by the manufacturer to maintain joints in manufacturer's recommended position during installation.

****

NOTE: Pipe lines containing expansion joints must be securely anchored to completely resist the thrust due to the pressure acting on the full internal area of the corrugations. They must also be properly guided to prevent misalignment of the joint. Details of anchors and guides must be correlated for each application.

****

Each joint must be permanently and legibly marked with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

2.3.10 Hose Faucets

****

NOTE: Normally delete vacuum breaker when faucets are installed in nonpotable-water lines.

****

Hose faucets must be constructed with 15 millimeter 1/2 inch male inlet threads, hexagon shoulder, and 20 millimeter 3/4 inch hose connection, conforming to ASME A112.18.1. Hose-coupling screw threads must conform to ASME B1.21M ASME B1.20.7.

Vandalproof, atmospheric-type vacuum breaker must be provided on the discharge of all potable water lines.

2.3.11 Pressure Gages

Pressure gages must conform to ASME B40.1 and to requirements specified herein. Pressure-gage size must be 90 millimeter 3-1/2 inches nominal diameter. Case must be corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A 6/A 6M, with an ASM No. 4 standard commercial polish or better. Gages must be equipped with adjustable red marking pointer and damper-screw adjustment in inlet connection. Service-pressure reading must be at midpoint of gage range. All gages must be Grade B or better and be equipped with gage isolators.

****

NOTE: Retain the following paragraph only if pressure gages are used on steam piping.

****

[Steam gages must be fitted with black steel syphons and steam service pressure-rated gage cocks or valves.]

2.3.12 Sight-Flow Indicators

Sight-flow indicators for pressure service on 80 millimeter 3-inch ips and smaller must be constructed of bronze with specially treated single- or double-glass sight windows and must have a bronze, nylon, or tetrafluoroethylene rotating flow indicator mounted on an AISI Type [304] [316] corrosion-resistant steel shaft. Body may have screwed or flanged end. Assembly must be pressure- and temperature-rated for the applied service. Flapper flow-type indicators are not acceptable.

2.3.13 Sleeve Couplings

Sleeve couplings for plain-end pipe must consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.

2.3.14 Thermometers

Thermometers must conform to ASTM E 1, except for being filled with a red organic liquid. Thermometers must be an industrial pattern armored glass model, (well-threaded and seal-welded). Thermometers installed 1800 millimeter 6 feet or higher above the floor must have an adjustable angle body. Scale must be not less than 180 millimeter 7 inches long. Case face must be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range must be [_____]. Thermometers must be provided with nonferrous separable wells. Lagging extension to accommodate insulation thickness must be provided.

2.3.15 Pump Suction Strainers

****

NOTE: To preclude cavitation, check the following conditions prior to specifying: NPSH, flow rate, open area, screen size, and pressure drop across strainer.

****

Strainer body must be cast iron, rated for not less than 172 kilopascal at 38 degrees C 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction must be such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.

Minimum ratio of open area of each basket to pipe area must be 3 to 1. Basket must be AISI 300 series corrosion-resistant steel wire mesh with perforated backing.

Mesh must be capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than 5 kilopascal 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Reducing fittings from strainer-flange size to pipe size must be provided.

A [differential-pressure gage] [pressure gage with 2 kilopascal 0.25-pound graduations] fitted with a two-way brass cock must be provided across the strainer.

Manual air vent cocks must be provided in cap of each strainer.

2.3.16 Line Strainers, Water Service

Strainers must be Y-type with removable basket. Strainers in sizes DN50 2-inch ips and smaller must have screwed ends. In sizes DN65 2-1/2-inch ips and larger, strainers must have flanged ends. Body working-pressure rating must exceed maximum service pressure of system in which installed by at least 50 percent. Body must have cast-in arrows to indicate direction of flow. All strainer bodies fitted with screwed screen retainers must have straight threads and must be gasketed with nonferrous metal. Strainer bodies DN65 2-1/2-inches and larger, fitted with bolted-on screen retainers, must have offset blowdown holes. All strainers larger than DN65 2-1/2-inches must be fitted with manufacturer's standard ball-type blowdown valve. Body material must be [cast bronze conforming to ASTM B 62] [cast iron conforming to Class 30 ASTM A 278/A 278M]. Where system material is nonferrous, metal strainer body material must be nonferrous metal.

Minimum free-hole area of strainer element must be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens must have perforations not to exceed 1.14 millimeter 0.045-inch. Strainer screens must have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material must be [AISI Type [304] [316] corrosion-resistant steel] [Monel metal].

2.3.17 Line Strainers, Steam Service

Strainers must be Y-type with removable strainer element.

Body end connections must be flanged for all valves larger than DN50 2

inches, unless butt weld ends are specified. [Screwed] [Socket] weld must be used for sizes DN50 2 inches and under to suit specified piping system end connection and maintenance requirements [or be welded].

Strainers located in tunnels, trenches, manholes, and valve pits must have welded end connections.

Body working steam pressure rating must be the same as the primary valve rating for system in which strainer is installed, except where welded end materials requirements result in higher pressure ratings. Body must have integral cast or forged arrows to indicate direction of flow. Strainer bodies must be provided with blowdown valves that have discharge end plugged with a solid metal plug. Closure assembly must be made with tetrafluoroethylene tape. Bodies fitted with bolted-on screen retainers must have offset blowdown holes.

Body materials must be [cast steel conforming to ASTM A 216/A 216M, Grade WCB] [forged carbon steel conforming to ASTM A 105/A 105M] [manufacturer's standard metallurgical equivalents for service pressures of 1035 kilopascal 150-psi wsp and greater, and for lower pressure ratings where welding is required] [cast iron conforming to ASTM A 126/A 126M, Class B, for service pressures 862 kilopascal 125-psi wsp and less].

Minimum free-hole area of strainer element must be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens must have perforations not to exceed 0.51 millimeter 0.020 inch or equivalent wire mesh. Strainer screens must have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material must be AISI Type [304] [316] corrosion-resistant steel and must be fitted with backup screens where necessary to prevent collapse.

2.4 VALVES

****

NOTE: Figure 1A is a one piece body.

Figure 1B is a vertically split body. with the split to one side of the ball.

Figure 1C is a top entry.

Figure 1D is a three piece body.

****

2.4.1 Ball and Butterfly Valves

Ball valves must conform to MSS SP-72 for Figure [1A], 1 piece body [1B], vertically split body [1C], top entry [1D], three piece body and must be rated for service at not less than 1207 kilopascal at 93 degrees C 175 psig at 200 degrees F. Valve bodies in sizes DN50 2 inches and smaller must be screwed-end connection-type constructed of Class A copper alloy. Valve bodies in sizes DN50 DN65 2-1/2 inches and larger must be flanged-end connection type, constructed of Class [D] [E] [F] material. Balls and stems of valves DN50 2 inches and smaller must be manufacturer's standard with hard chrome plating finish. Balls and stems of valves DN65 2-1/2 inches and larger must be manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves DN150 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Valves must be suitable for flow from either direction and must

seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. All valves must have adjustable packing glands. Seats and seals must be tetrafluoroethylene.

Butterfly valves must conform to MSS SP-67. Valves must be wafer type for mounting between specified flanges and must be rated for 1034 kilopascal 150-psig shutoff and nonshock working pressure. Bodies must be cast ferrous metal conforming to ASTM A 126/A 126M, Class B, and to ASME B16.1 for body wall thickness. Seats and seals must be of the resilient elastomer type designed for field removal and replacement.

2.4.2 Drain, Vent, and Gage Cocks

Drain, vent, and gage cocks must be [T-head] [lever handle], ground key type, with washer and screw, constructed of polished ASTM B 62 bronze, and rated 862 kilopascal 125-psi wsp. End connections must be rated for specified service pressure.

Pump vent cocks, and where spray control is required, must be UL umbrella-hood type, constructed of manufacturer's standard polished brass. Cocks must be 15 millimeter 1/2-inch ips male, end threaded, and rated at not less than 862 kilopascal at 107 degrees C 125 psi at 225 degrees F.

2.4.3 Gate Valves (GAV)

Gate valves DN50 2 inches and smaller must conform to MSS SP-72. Valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated must be union-ring bonnet, screwed-end type. Packing must be made of non-asbestos type materials. Valves must be rising stem type.

Gate valves DN65 2-1/2 inches and larger, must be Type I, (solid wedge disc, tapered seats, steam rated); Class 125 (862 kilopascal 125-psig steam-working pressure at 178 degrees C 353 degrees F saturation); and 1379 kilopascal 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Valves must be flanged, with bronze trim and outside screw and yoke (OS&Y) construction. Packing must be made of non-asbestos type materials.

2.4.4 Globe and Angle Valves (GLV-ANV)

Globe and angle valves DN50 2 inchesand smaller, must be 862 kilopascal 125-pound, 125-psi conforming to MSS SP-85 and to requirements specified herein. Valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated must be union-ring bonnet, screwed-end type. Disc must be free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Packing must be made of non-asbestos type materials. Disk and packing must be suitable for pipe service installed.

Globe and angle valves DN65 2-1/2 inches and larger, must be cast iron with bronze trim. Valve bodies must be cast iron conforming to ASTM A 126/A 126M, Class A, as specified for Class 1 valves under MSS SP-70. Valve ends must be flanged in conformance with ASME B16.1. Valve construction must be outside screw and yoke (OS&Y) type. Packing must be made of non-asbestos type materials.

2.4.5 Standard Check Valves (SCV)

Standard check valves in sizes DN50 2 inches and smaller must be 862

kilopascal 125-psi swing check conforming to MSS SP-71, except as otherwise specified. Lift checks must be provided where indicated. Swing-check pins must be nonferrous and suitably hard for the service. Discs must be composition type. Swing-check angle of closure must be manufacturer's standard unless a specific angle is needed.

Check valves in sizes DN65 2-1/2 inches and larger must be cast iron, bronze trim, swing type. Valve bodies must be cast iron, conforming to ASTM A 126/A 126M, Class A. Valve ends must be flanged in conformance with ASME B16.1. Swing-check pin must be AISI Type or approved equal corrosion-resistant steel. Angle of closure must be manufacturer's standard unless a specific angle is needed. Valves must have bolted and gasketed covers.

Check valves must be provided with [external spring-loaded] [lever-weighted], positive-closure devices and valve ends must be [mechanical joint] [push-on] [flanged].

2.4.6 Nonslam Check Valves (NSV)

****
NOTE: The following specification is adequate for most construction situations. Where unusual hydraulic conditions occur, review closing time and in-service adjustment capability of helical-coil valve construction versus other construction.
****

Check valves at pump discharges in sizes DN50 2 inches and larger must be nonslam or silent-check type conforming to MSS SP-125. Valve disc or plate must close before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Valve must be Class 125 rated for 1379 kilopascal 200-psi maximum, nonshock pressure at 66 degrees C 150 degrees F in sizes to DN300 12 inches. Valves must be [wafer type to fit between flanges conforming to ASME B16.1] [fitted with flanges conforming to ASME B16.1]. Valve body may be cast iron, conforming to ASTM A 278/A 278M, Class 40 or equivalent strength ductile iron. Disks must be manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Pins, springs, and miscellaneous trim must be manufacturer's standard corrosion-resistant steel. Disk and shaft seals must be Buna-N elastomer tetrafluoroethylene.

2.5 MISCELLANEOUS MATERIALS

2.5.1 Bituminous Coating

Bituminous coating must be a solvent cutback, heavy-bodied material to produce not less than a 0.30 millimeter 12-mil dry-film thickness in one coat, and must be as recommended by the manufacturer to be compatible with factory-applied coating and rubber joints.

For previously coal-tar coated and uncoated ferrous surfaces underground, bituminous coating must be solvent cutback coal-tar type, conforming to MS MIL-C-18480.

2.5.2 Bolting

Flange and general purpose bolting must be hex-head and must conform to ASTM F 568M, Class 4.8 or above ASTM A 307, Grade B (bolts, for flanged

joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts must conform to ASTM A 563M ASTM A 563. Square-head bolts and nuts are not acceptable. Threads must be coarse-thread series.

2.5.3 Elastomer Calk

Polysulfide- or polyurethane-base elastomer calking material must be two-component type, conforming to ASTM C 920.

2.5.4 Escutcheons

Escutcheons must be manufactured from nonferrous metals and must be chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish must conform to ASME A112.19.2.

Escutcheons must be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. All escutcheons must have provisions consisting of [internal spring-tension devices] [setscrews] for maintaining a fixed position against a surface.

2.5.5 Flashing

Sheet lead must conform to ASTM B 749, [UNS Alloy Number L50049 (intended for use in laboratories and shops in general application)] [UNS Alloy Number L51121 (for use where lead sheet of high purity and improved structural strength is indicated)].

Sheet copper must conform to ASTM B 370 and must be of not less than 4.88 kilogram per square meter 16 ounces per square foot weight.

2.5.6 Flange Gaskets

Compressed non-asbestos sheet, conforming to ASTM F 104, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 399 degrees C 750 degrees F.

2.5.7 Grout

****

NOTE: When moisture or uncured concrete occurs, metallic grout may cause buildup of pressure that, under confinement, could be sufficient to misaligned equipment.

****

Shrink-resistant grout must be a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to ASTM C 404 and ASTM C 476.

****

NOTE: Epoxy grout must be specified particularly where mild chemical resistance is necessary or where oil soaking may occur.

For service with acids, polyester grouts should be specified.

Where high anchor-bolt torques (2,000 ft-lb) (2712 newton-meter) are applied, epoxy polyamides will cold-flow.

****

Shrink-resistant grout must be a combination of premeasured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength		13.100 Megapascal, minimum
Compressive strength	ASTM C 109/C 109M	96.527 Megapascal, minimum
Shrinkage, linear		0.003 mm per millimeter, maximum
Water absorption	ASTM C 67	0.1 percent, maximum
Bond strength to		6.895 Megapascal, minimum steel in shear minimum
Tensile strength		1,900 psi, minimum
Compressive strength	ASTM C 109/C 109M	14,000 psi, minimum
Shrinkage, linear		0.00012 inch per inch, maximum
Water absorption	ASTM C 67	0.1 percent, maximum
Bond strength to		1,000 psi, minimum steel in shear minimum

2.5.8 Pipe Thread Compounds

Tetrafluoroethylene tape not less than 0.05 to 0.08 millimeter 2 to 3 mils thick must be used in potable and process water and in chemical systems for pipe sizes to and including DN25 1-inch ips. Tetrafluoroethylene dispersions and other suitable compounds may be used for all other applications upon approval by the Contracting Officer; however, no lead-containing compounds may be used in potable water systems.

2.6 SUPPORTING ELEMENTS

All necessary piping systems and equipment supporting elements must be provided, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. All supporting elements must be suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Supporting elements must conform to requirements of ASME B31.3, MSS SP-58, and MSS SP-69 except as noted.

Attachments welded to pipe must be made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Supporting elements exposed to weather must be hot-dip galvanized or stainless steel. Materials must be of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Supporting elements in contact with copper tubing must be electroplated with copper.

Type designations specified herein are based on MSS SP-58 and MSS SP-69. Masonry anchor group-, type-, and style-combination designations must be in accordance with CID A-A-1922, CID A-A-1923, FS A-A-1924, FS A-A-1925 , CID A-A-55614, and CID A-A-55615. Support elements, except for supplementary steel, must be cataloged, load rated, commercially manufactured products.

2.6.1 Building Structure Attachments

****
NOTE: Review specific instructions relative to anchor devices in support elements installation paragraph prior to selection of following text.
****

2.6.1.1 Anchor Devices, Concrete and Masonry

Anchor devices must conform to CID A-A-1922, CID A-A-1923, FS A-A-1924, FS A-A-1925 , CID A-A-55614, and CID A-A-55615

Cast-in, floor mounted, equipment anchor devices must provide adjustable positions.

[Masonry anchor devices must be built-in.]

Powder-actuated anchoring devices must not be used to support any mechanical systems components.

2.6.1.2 Beam Clamps

Beam clamps must be center-loading MSS SP-58 Type [20] [21] [28] [29] [30] [_____].

[When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, MSS SP-58 Type [19] [20] [25] [27] may be used for piping sizes DN50 2 inches and less and for piping sizes DN50 through DN250 2 through 10 inches provided two counterbalancing clamps are used per point of pipe support. Where more than one rod is used per point of pipe support, rod diameter must be determined in accordance with referenced standards.]

2.6.1.3 C-Clamps

C-clamps must not be used.

2.6.1.4 Inserts, Concrete

Concrete inserts must be MSS SP-58 Type [18] [_____]. When applied to piping in sizes DN50 2 inches ips and larger and where otherwise required by imposed loads, a 305 millimeter 1-foot length of 13 millimeter 1/2-inch reinforcing rod must be inserted and wired through wing slots. Proprietary-type continuous inserts may be submitted for approval.

2.6.2 Horizontal Pipe Attachments

2.6.2.1 Single Pipes

Piping in sizes to and including DN50 2-inch ips must be supported by

MSS SP-58 Type 6 solid malleable iron pipe rings, except that split-band-type rings may be used in sizes up to DN25 1-inch ips.

Piping in sizes through DN200 8-inch ips inclusive must be supported by MSS SP-58 Type [1] [3] [4] attachments.

MSS SP-58 Type 1 and Type 6 assemblies must be used on vapor-sealed insulated piping and must have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Where thermal movement of a point in a piping system DN100 4 inches and larger would cause a hanger rod to deflect more than 4 degrees from the vertical or where a horizontal point movement exceeds 13 millimeter 1/2 inch, MSS SP-58 Type [41] [44 through 46] [49] pipe rolls must be used.

Piping in sizes larger than DN200 8-inch ips must be supported with MSS SP-58 Type [41] [44 through 46] [49] pipe rolls.

MSS SP-58 Type 40 shields must be used on all insulated piping. Area of the supporting surface must be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges must be rolled away from the insulation.

Insulated piping without vapor barrier on roll supports must be provided with MSS SP-58 Type 39 saddles.

Spring supports must be as indicated.

2.6.2.2 Parallel Pipes

Trapeze hangers fabricated from structural steel shapes, with U-bolts, must be used in congested areas and where multiple pipe runs occur. Structural steel shapes must [conform to supplementary steel requirements] [be of commercially available, proprietary design, rolled steel].

2.6.3 Vertical Pipe Attachments

Vertical pipe attachments must be MSS SP-58 Type 8.

Shop drawing data must include complete fabrication and attachment details of any spring supports.

2.6.4 Hanger Rods and Fixtures

Only circular cross section rod hangers may be used to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength must be used for hangers only where approved by the Contracting Officer.

Turnbuckles, swing eyes, and clevises must be provided as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.6.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel must be designed and fabricated in accordance with AISC 325.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Certificates must be submitted for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Certificates must verify Surface Resistance, Shear and Tensile Strengths, Temperature Ratings, Bending Tests, Flattening Tests and Transverse Guided Weld Bend Tests.

Test reports for Hydrostatic Tests, Air Tests, Valve-Operating Tests, Drainage Tests, Pneumatic Tests, Non-Destructive Electric Tests and System Operation Tests must be provided by the Contractor, in compliance with referenced standards contained within this section.

Piping systems must be fabricated and installed in accordance with ASME B31.3, MSS SP-69, and AWS WHB-2.9.

Installation Drawings must be submitted for pipes, valves and specialties. Drawings must include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular movements, installation criteria, anchor and guide requirements for equipment, and equipment room layout and design. Drawing must specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.

Connections between steel piping and copper piping must be electrically isolated from each other with [dielectric couplings (or unions)] [flanged with gaskets] rated for the service.

Final connections to equipment must be made with [unions] [flanges] provided every 30480 millimeter 100 feet of straight run. Unions must be provided in the line downstream of screwed- and welded-end valves.

All pipe ends must be reamed before joint connections are made.

Screwed joints must be made up with specified joint compound and not more than three threads must show after joint is made up.

Joint compounds must be applied to the male thread only and care must be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges must be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Piping systems must be securely supported with due allowance for thrust forces, thermal expansion and contraction, and must not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

Field welded joints must conform to the requirements of the AWS WHB-2.9, ASME B31.3, and ASME BPVC SEC IX.

[Piping systems butt weld joints must be made with backing rings. Backing ring materials must be compatible with materials being joined. Joint configuration must conform to ASME B16.25.]

****
NOTE: Prior to selection of one of the following two paragraphs, review requirements of ASME B31.3 And ASME BPVC SEC IX to avoid conflict and redundancy. Also review PFI ES-19 and PFI ES-28 if materials specifications have been rewritten or supplemented.
****

[Preheat and postheat treatment of welds must be done in accordance with ASME BPVC SEC IX and ASME B31.3.]

[All necessary precautions must be taken during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Installation must conform to manufacturer's instructions.]

3.2 VALVES

Valves must be provided in piping mains and all branches and at equipment where indicated and as specified.

Valves must be provided to permit isolation of branch piping and each equipment item from the balance of the system.

Riser and downcomer drains above piping shutoff valves in piping DN65 2-1/2 inches and larger must be provided. Shutoff valve body must be tapped and fitted with a DN15 1/2-inch plugged globe valve.

Valves unavoidably located in furred or other normally inaccessible places must be provided with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.3 SUPPORTING ELEMENTS INSTALLATION

Supporting elements must be provided in accordance with the referenced codes and standards.

Piping must be supported from building structure. No piping must be supported from roof deck or from other pipe.

Piping must run parallel with the lines of the building. Piping and components must be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there must be no less than DN15 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other must be arranged to be in line with each other and parallel to the lines of the building.

Piping support elements must be installed at intervals specified hereinafter, at locations not more than 900 millimeter 3 feet from the ends of each runout, and not over 300 millimeter 1 foot from each change in direction of piping.

Load rating for all pipe-hanger supports must be based on insulated weight of lines filled with water and forces imposed. Deflection per span must not exceed slope gradient of pipe. Supports must be in accordance with the following minimum rod size and maximum allowable hanger spacing for

specified pipe. For concentrated loads such as valves, the allowable span must be reduced proportionately:

PIPE SIZE (DN) MILLIMETER	ROD SIZE MILLIMETER	STEEL PIPE MILLIMETER	COPPER PIPE MILLIMETER
25 and smaller	10	2500	1850
32 to 40	10	3050	2500
50	10	3050	3050
65 to 90	13	3700	3700
100 to 125	16	5000	4300
150	20	5000	5000
200 to 300	22	6100	6100
356 to 457	25	6100	6100
508 and over	32	6100	6100

PIPE SIZE INCHES	ROD SIZE INCHES	STEEL PIPE FEET	COPPER PIPE FEET
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8
2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14
6	3/4	16	16
8 to 12	7/8	20	20
14 to 18	1	20	20
20 and over	1-1/4	20	20

Vibration isolation supports must be provided where needed. Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT where A/C equipment and piping is installed.

Vertical risers must be supported independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Risers must be guided for lateral stability. For risers subject to expansion, only one rigid support must be provided at a point approximately one-third down from the top. Clamps must be placed under fittings unless otherwise specified. Carbon-steel pipe must be supported at each floor and at not more than 4572 millimeter 15-foot intervals for pipe DN50 2 inches and smaller and at not more than 6096 millimeter 20-footintervals for pipe DN65 2-1/2 inches and larger.

3.4 PENETRATIONS

Effective sound stopping and adequate operating clearance must be provided to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces must include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations must be finished to be compatible with surface being penetrated.

[Sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings must be accomplished by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed 49 degrees C 120 degrees F, by foaming-in-place with self-extinguishing, 0.9 kilogram 2-pound density polyurethane foam to a depth not less than 152 millimeter 6 inches. Foam must be finished with a rasp. Vapor barrier must be not less than 3 millimeter 1/8-inch thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, only mineral wool must be used and openings must also be covered with 1.6 millimeter 16-gage sheet metal.]

3.5 SLEEVES

Sleeves must be provided where piping passes through roofs, masonry, concrete walls and floors.

Sleeves passing through steel decks must be continuously [welded] [brazed] to the deck.

Sleeves that extend through floors, roofs, load bearing walls, and fire barriers must be continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. All other sleeves must be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves must be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and must provide a minimum 10 millimeter 3/8-inch clearance. Sleeve size must accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration must be packed solid with a mineral fiber conforming to ASTM C 553 Type V (flexible blanket),(to 538 degrees C) (to 1,000 degrees F). This packing must be provided wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration must be filled with an elastomer calk to a depth of 13 millimeter 1/2 inch. All surfaces to be calked must be oil- and grease-free.

Through-Penetration fire stop materials and methods must be in accordance with ASTM E 814 and UL 1479.

Exterior wall sleeves must be calked watertight with lead and oakum or

mechanically expandable chloroprene inserts with mastic-sealed metal components.

****
NOTE: Review roof flooding provisions before revising the following paragraph.
****

[Sleeve height above roof surface must be a minimum of 305 12 and a maximum of 457 millimeter 18 inches.]

3.6 ESCUTCHEONS

Escutcheons must be provided at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons must be provided on both sides of the partition. Where suspended ceilings are installed, plates must be provided at the underside only of such ceilings. For insulated pipes, the plates must be large enough to fit around the insulation. Escutcheons must be chrome-plated in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Escutcheons must be firmly attached with setscrews.

3.7 FLASHINGS

****
NOTE: Review roof flooding provisions.
****

[Flashings must be provided at penetrations of building boundaries by mechanical systems and related work.]

3.8 UNDERGROUND PIPING INSTALLATION

Prior to being lowered into a trench, all piping must be cleaned, visually inspected for apparent defects, and tapped with a hammer to audibly detect hidden defects.

Suspect cast-ferrous piping must be further inspected by painting with kerosene on external surfaces to reveal cracks.

Defective materials found must be distinctly marked using a road-traffic quality yellow paint; defective material must be promptly removed from the site.

After conduit has been inspected, and not less than 48 hours prior to being lowered into a trench, all external surfaces of cast ferrous conduit must be coated with a compatible bituminous coating for protection against brackish ground water. Application must be single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 0.30 millimeter 12 mils.

Excavations must be dry and clear of extraneous materials when pipe is being laid.

Cutting of piping must be by wheel cutters or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting will not be permitted.

Laying of pipe must begin at the low point of a system. When in final acceptance position, it must be true to the grades and alignment indicated, with unbroken continuity of invert. Blocking and wedging will not be permitted.

[Bell or grooved ends of piping must point upstream.]

Changes in direction must be made with long sweep fittings.

Necessary socket clamping, piers, bases, anchors, and thrust blocking must be provided. Rods, clamps, and bolting must be protected with a coating of bitumen.

Underground piping below supported or suspended slabs must be supported from the slab with a minimum of two supports per length of pipe. Supports must be protected with a coating of bitumen.

On excavations that occur near and below building footings, the backfilling material must consist of 13800 kilopascal 2,000-psi cured compressive-strength concrete poured or pressure-grouted up to the level of the footing.

Vertical downspouts; soil, waste, and vent stacks; water risers; and similar work must be properly supported on approved piers at the base and provided with approved structural supports attached to building construction.

[Cleanout, flushing, and observation risers must be provided.]

3.9 HEAT TRACE CABLE INSTALLATION

Heater tape must be field applied and cut to fit as necessary, linearly along the length of pipe after piping has been pressure tested and approved by the Contracting Officer. Secure the heater to piping with [cable ties] [fiberglass tape]. Thermal insulation must be labeled on the outside, "Electrical Heat Trace."

Power connection, end seals, splice kits and tee kit components must be installed in accordance with IEEE Std 515 to provide a complete workable system. Connection to the thermostat and ends of the heat tape must be terminated in a junction box. Cable and conduit connections must be raintight.

3.10 DISINFECTION

[Water piping, including all valves, fittings, and other devices, must be disinfected with a solution of chlorine and water. Solution must contain not less than 50 parts per million (ppm) of available chlorine. Solution must be held for a period of not less than 8 hours, after which the solution must contain not less than 10 ppm of available chlorine or the piping must be redisinfected. After successful sterilization, the piping must be thoroughly flushed before placing into service. Flushing must be complete when the flush water contains less than 0.5 ppm of available chlorine. Water for disinfected will be furnished by the Government. Contractor must be responsible for approved disposal of contaminated flush water in accordance with written instructions received from the Environmental authority having jurisdiction through the Contracting Officer and all Local, State and Federal Regulations.]

[Piping must be flushed with potable water until visible grease, dirt and other contaminants are removed (visual inspection).]

3.11 HEAT TRACE CABLE TESTS

Heat trace cable system must be tested in accordance with IEEE Std 515after installation and before and after installation of the thermal insulation. Heater cable must be tested using a [1000] [_____] vdc megger. Minimum insulation resistance must be [20 to 1000] [_____] megohms regardless of cable length.

3.12 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals must be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Test data must be clear and readily legible.

-- End of Section --