

UFGS-22 15 00.13 40 (April 2007)

2.4.11	Type SS-6000B
2.4.12	Type SS-2000A
2.5	PIPING SPECIALTIES
2.5.1	Pressure Gages
2.5.2	Pressure Receiver Gages and Pneumatic Transmitters
2.5.2.1	Receiver Gages
2.5.2.2	Pneumatic Transmitters
2.5.3	Thermometers
2.6	MISCELLANEOUS MATERIALS
2.6.1	Bolting
2.6.2	Elastomer Calk
2.6.3	Escutcheons
2.6.4	Flashing
2.7	SUPPORTING ELEMENTS
2.7.1	General
2.7.2	Building Structure Attachments
2.7.3	Horizontal Pipe Attachments
2.7.4	Vertical Pipe Attachments
2.7.5	Hanger Rods and Fixtures
2.7.6	Supplementary Steel
PART 3 EXECUTION	
3.1	UNDERGROUND PIPING SYSTEMS INSTALLATION
3.2	ABOVEGROUND PIPING SYSTEMS INSTALLATION
3.2.1	General
3.2.2	Joints
3.2.3	Supporting Elements Installation
3.2.4	Sound Stopping
3.2.5	Sleeves
3.2.6	Escutcheons
3.2.7	Flashings
3.3	COMPRESSED AIR SYSTEMS TESTING
3.3.1	General
3.3.2	Test Gages
3.3.3	Acceptance Pressure Testing
3.3.4	Support Elements Testing
-- End of Section Table of Contents --	

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 A5.13 (2000) Specification for Surfacing Electrodes for Shielded Metal Arc Welding

AWS WHB-2.9 (2004) Welding Handbook; Volume Two - Welding Processes

ASME INTERNATIONAL (ASME)

ASME B16.10 (2001) Face-to-Face and End-to-End Dimensions of Valves

ASME B16.11 (2005) Forged Fittings, Socket-Welding and Threaded

ASME B16.25 (2003) Standard for Buttwelding Ends

ASME B16.34 (2004) Valves - Flanged, Threaded and Welding End

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 B18.2.2 (1987; R 2005) Square and Hex Nuts (Inch Series)

ASME B18.2.4.6M (1979; R 2003) Metric Heavy Hex Nuts

ASME B19.3 (1991; Addenda A 1994 and Addenda B 1995) Safety Standard for Compressors for Process Industries

ASME B31.3 (2004) Process Piping

ASME B36.10M (2004) Standard for Welded and Seamless Wrought Steel Pipe

ASME B36.19M	(2004) Stainless Steel Pipe
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments
ASME BPVC SEC II-C	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section II, Materials, Part C - Specifications for Welding Rods, Electrodes and Filler Metals
ASME BPVC SEC IX	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2005) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 106/A 106M	(2006) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 181/A 181M	(2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A 182/A 182M	(2006) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 193/A 193M	(2006a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(2006a Standard Specification for) Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both
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	(2006a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 307	(2004e1) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM A 312/A 312M	(2006) Standard Specification for Seamless, Welded, and Heavily Worked Austenitic Stainless Steel Pipes
ASTM A 403/A 403M	(2006) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 563	(2004a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 563M	(2006) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM B 148	(1997; R 2003e1) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B 370	(2003) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B 749	(2003) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM E 1	(2003a) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM F 568M	(2004) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

ISA - THE INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air
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MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-53	(1999; R 2002) Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components-Magnetic, Particle Examination Method
MSS SP-54	(1999; R 2002) Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components, - Radiographic Examination Method
MSS SP-55	(2001) Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
MSS SP-58	(2002) Standard for Pipe Hangers and

Supports - Materials, Design and
Manufacture

MSS SP-61 (2003) Pressure Testing of Steel Valves

MSS SP-69 (2003; R 2004) Standard for Pipe Hangers
and Supports - Selection and Application

PIPE FABRICATION INSTITUTE (PFI)

PFI ES 11 (2003; R 2004) Permanent Marking of Piping
Materials

PFI ES 21 (1998; R 2004) Internal Machining and
Fit-up of GTAW Root Pass Circumferential
Butt Welds

PFI ES 3 (2004) Fabricating Tolerances

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS FF-S-325 (Int Amd 3) Shield, Expansion; Nail,
Expansion; and Nail, Drive Screw (Devices,
Anchoring, Masonry)

FS HH-I-558 (Rev C) Insulation, Blocks, Boards,
Blankets, Felts, Sleeving (Pipe and Tube
Covering), and Pipe Fitting Covering,
Thermal (Mineral Fiber, Industrial Type)

FS L-C-530 (Rev C) Coating, Pipe, Thermoplastic Resin

FS WW-P-541 (1990e; Am 1) Plumbing Fixtures

1.2 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

Proposed Deviations from specified instructions shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Detail Drawings shall be submitted in accordance with paragraph entitled "General Requirements," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Underground Piping Materials
Aboveground Piping Materials
Air Compressors
Manual Valves
Piping Specialties
Miscellaneous Materials
Supporting Elements

SD-06 Test Reports

Test reports shall be submitted for the following items in accordance with the paragraph entitled, "Compressed Air Systems Testing," of this section.

Pressure Testing
System Testing
Acceptance Tests
Preliminary Tests

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Underground Piping Materials
Aboveground Piping Materials
Air Compressors
Manual Valves
Piping Specialties
Miscellaneous Materials
Supporting Elements

1.3 GENERAL REQUIREMENTS

NOTE: If Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING and/or Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT and/or Section 23 31 13.20 40 WELDING METAL DUCTWORK are not included in the project specification, applicable requirements from each, as required, should be inserted and the following applicable 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.]

Detail Drawings shall be submitted for the following high-pressure compressed air systems consisting of fabrication and assembly drawings for all parts of work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

Where the Contractor proposes to deviate from specified instructions, the Proposed Deviations shall be submitted to the Contracting Officer for approval.

PART 2 PRODUCTS

2.1 UNDERGROUND PIPING MATERIALS

NOTE: Select type of piping to suit project requirements.

Drawings shall show size, rating, and other details of piping requirements not covered in the specifications for specific project application.

Specified protection of underground piping is dependent upon 100-percent detection and elimination of coating faults to preclude accelerated metal loss at point failures of coating in possibly brackish ground water. Piping protection should be ensured by soil resistance surveys of proposed pipe routes

and by providing cathodic protection in the form of magnesium anode piles or rectifier impressed-current and high silicon iron anode pile systems when soil resistivity indicates need. Normally, soil resistivity of 10,000 ohms or less at pipe laying depth to 5 feet 1500 millimeter below pipe laying depth indicates need for cathodic protection.

Special consideration shall be given to situations where dielectric coupling isolation from connected systems is not practicable due to system pressures. Check typical dielectric coupling manufacturing source for pressure ratings. Where piping is not isolated, normal impressed current of 0.1 milliamp per square foot .09 square meter of surface protected will increase several fold. Check rectifier systems. Specify piles to be made up of 100-pound 45 kilogram anodes (a single 2-inch 50 millimeter outside diameter piece).

The following system pressures are for nonshock loading and are based on ASME B31.3, zero corrosion factor, welded joints and following materials stress values: 20,000 pounds per square inch (psi) 138 Megapascal for ASTM A 106/A 106M and ASTM A 312/A312M, Grade TP 316 or TP 347. System pressures shall be reduced if largest specified pipe size is increased, if service temperatures are increased over 100 degrees F, 38 degrees C, or if alloy specifications are changed.

Materials for piping systems with pressures to 10,000 psi at 100 degrees F 69 Megapascal at 38 degrees C may be specified in accordance with MSS SP-75 and MSS SP-65. The same specification may be used for 6,000 psi 41 Megapascal systems with pipe sizes larger than 3 inches DN80.

The following materials specifications do not take into account material temperatures less than minus 20 degrees F 29 degrees C. Pipe trade regards seamless piping in sizes less than 2 inches DN50 as tubing. Tubing sources are limited and tubing costs in small quantities may range from 3 to 5 times pipe costs. Project costs frequently may be reduced and deliveries improved by oversizing lines to be cataloged as piping.

Operating temperature limit of Type BCS-PS and Type SS-PS is 150 degrees F 66 degrees C, limited by polyethylene sheath and adhesive.

2.1.1.1 Type BCS-PS-6000

Pipe or tube (DN15 through DN80) (1/2 through 3 inches): XXS, seamless, black carbon steel sheathed with thermoplastic (polyethylene), conforming to ASTM A 106/A 106M, Grade B and ASME B36.10M

Fittings (DN15 through DN40): 62 Megapascal (1/2 through 1-1/2 inches): 9,000-pound, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): XXS, long radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB, and ASME B16.9

Thermoplastic sheaths for pipe and fittings: Thermoplastic sheaths shall conform to FS L-C-530. Sheath joints shall be made with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Taped fitting protection and repairs shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts.

2.1.1.2 Type BCS-PS-2000

Pipe or tube (DN15 through DN80) (1/2 through 3 inches): Schedule 40, seamless, black carbon steel sheathed with thermoplastic (polyethylene), conforming to ASTM A 106/A 106M, Grade B, and ASME B36.10M

Fittings (DN15 through DN80): 20 Megapascal (1/2 through 1-1/2 inches): 3,000-pound, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M, and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): Schedule 40, long radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB, and ASME B16.9

Thermoplastic sheaths for pipe and fittings: Thermoplastic sheaths shall conform to FS L-C-530. Sheath joints shall be made with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Taped fitting protection and repairs shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts.

2.1.1.3 Type BCS-PS-350

Pipe or tube (DN15 through DN610) (1/2 through 24 inches): Schedule 40, seamless, black carbon steel sheathed with thermoplastic (polyethylene), conforming to ASTM A 106/A 106M, Grade B, and ASME B36.10M.

Fittings (DN15 through DN80): 20 Megapascal (1/2 through 1-1/2 inches): 3,000-pound, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M and ASME B16.11.

Fittings (DN50 through DN610) (2 through 24 inches): Schedule 40, long radius butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB, and ASME B16.9

Thermoplastic sheaths for pipe and fittings: Thermoplastic sheaths shall conform to FS L-C-530. Sheath joints shall be made with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Taped fitting protection and repairs shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts.

2.1.4 Type SS-PS-6000

Pipe or tube (DN15 through DN80) (1/2 through 3 inches): XXS, seamless, corrosion-resistant steel sheathed with thermoplastic (polyethylene), conforming to ASTM A 312/A 312M, Grade TP 316, and ASME B36.19M

Fittings (DN15 through DN40): 62 Megapascal (1/2 through 1-1/2 inches): 9,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): XXS, long radius, butt weld, corrosion-resistant steel conforming to ASTM A 403/A 403M, WP 316 and ASME B16.9

Thermoplastic sheaths for pipe and fittings: Thermoplastic sheaths shall conform to FS L-C-530. Sheath joints shall be made with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Taped fitting protection and repairs shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts. Adhesives shall contain no free chloride ions.

2.1.5 Type SS-PS-2000

Pipe or tube (DN15 through DN80) (1/2 through 3 inches): Schedule 40S, seamless, corrosion-resistant steel sheathed with thermoplastic (polyethylene), conforming to ASTM A 312/A 312M, Grade TP 316

Fittings (DN15 through DN40): 20 Megapascal (1/2 through 1-1/2 inches): 3,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): Schedule 40S, long radius butt weld, corrosion-resistant steel sheathed with thermoplastic (polyethylene), to ASTM A 403/A 403M, and WP 316, and ASME B16.9

Thermoplastic sheaths for pipe and fittings: Thermoplastic sheaths shall conform to FS L-C-530. Sheath joints shall be made with factory-approved shrinking sleeves applied with factory-approved shrinking devices. Taped fitting protection and repair shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts. Adhesives shall contain no free chloride ions.

2.1.6 Type SS-PS-350

Pipe or tube (DN15 through DN250) (1/2 through 10 inches): Schedule 40, seamless, corrosion-resistant steel sheathed with thermoplastic (polyethylene), conforming to ASTM A 312/A 312M, Grade TP 316, and ASME B36.19M

Fittings (DN15 through DN40): 20 Megapascal (1/2 through 1-1/2 inches): 3,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A 182/A 182M, Grade F316, and ASME B16.11

Fittings (DN50 through DN610) (2 through 24 inches): Schedule 40, long

radius, butt weld, corrosion-resistant steel, conforming to
ASTM A 403/A 403M, WP 316, and ASME B16.9

Thermoplastic sheaths for pipe and fittings: Thermoplastic sheaths shall conform to FS L-C-530. Sheath joints shall be made with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Taped fitting protection and repairs shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts. Adhesives shall contain no free chloride ions.

2.2 ABOVEGROUND PIPING MATERIALS

NOTE: Select required systems materials and delete all others.

The following system pressures are based on ASME B31.3, zero corrosion factor, welded joints and following materials allowable stress values: 20,000 psi 138 Megapascal for ASTM A 106/A 106M and ASTM A 312/A312M, Grade TP316 or TP347. System pressures shall be reduced if largest specified pipe size is increased, if service temperatures are increased (over 100 degrees F 38 degrees C or if alloy specifications are changed.

Materials for piping systems with pressures to 10,000 psi at 100 degrees F 69 Megapascal at 38 degrees C may be specified in accordance with MSS SP-75 and MSS SP-65. The same specifications may be used for 6,000 psi 41.3 megapascal systems with pipe size larger than 3 inches DN80.

Following material specifications do not take into account materials with temperatures less than minus 20 degrees F 29 degrees C.

2.2.1 Type BCS-6000

Pipe or tube (DN15 through DN80) (1/2 through 3 inches): XXS, seamless, black carbon steel, conforming to ASTM A 106/A 106M, Grade B, and ASME B36.10M

Fittings (DN15 through DN40): 62 Megapascal (1/2 through 1-1/2 inches): 9,000-pound, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): XXS, long radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB, and ASME B16.9

Flanges: 17 and 41 Megapascal 2,500-pound, 6,000-pounds per square inch (psi) forged carbon steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A 105/A 105M and ASME B16.5

Gaskets: Spiral wound, non-asbestos filled material, carbon steel, with

centering provisions, conforming to ASME B16.5, Group 1

Bolting: Alloy-steel bolt studs conforming to ASTM A 193/A 193M, Grade B7, and semifinished heavy hexnuts conforming to ASTM A 194/A 194M, Grade 2H

2.2.2 Type BCS-2000

Pipe or tube (DN6 through DN80) (1/8 through 3 inches): Schedule 40, seamless, black carbon steel, conforming to ASTM A 106/A 106M, Grade B, and ASME B36.10M

Fittings (DN6 through DN40): 20 Megapascal (1/8 through 1-1/2 inches): 3,000-pound, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M, and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): Schedule 40, long radius, butt weld, black carbon steel conforming to ASTM A 234/A 234M, Grade WPB, and ASME B16.9

Flanges (DN25 through DN80): 6200 kilopascal, 14890 kilopascal (1 through 3 inches): 900-pound, 2,160-psi forged carbon steel, welding neck, with raised face and concentric serrated finish conforming to ASTM A 105/A 105M and ASME B16.5

Bolting: Alloy-steel bolt studs conforming to ASTM A 193/A 193M, Grade B7 and semifinished heavy hex-nuts conforming to ASTM A 194/A 194M, Grade 2H

2.2.3 Type BCS-350

Pipe or tube (DN6 through DN250) (1/8 through 10 inches): Schedule 40, seamless, black carbon steel, conforming to ASTM A 106/A 106M, Grade B, and ASME B36.10M

Fittings (DN6 through DN40): 20 Megapascal (1/8 through 1-1/2 inches): 3,000-pound, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M, ASME B16.11

Fittings (DN50 through DN250) (2 through 10 inches): Schedule 40, long radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB and ASME B16.9

Flanges (DN25 through DN250): 2070 kilopascal, 5000 kilopascal (1 through 10 inches): 300-pound, 720 psi, forged carbon steel welding neck, with raised face and concentric serrated finish, conforming to ASTM A 181/A 181M, Class 70 and ASME B16.5

Gaskets: Spiral wound, non-asbestos filled materials, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Heavy hexhead carbon steel bolts or bolt studs conforming to ASTM F 568M ASTM A 307, and semifinished heavy hex-nuts conforming to ASTM A 563M ASTM A 563, Grade A. Square-head bolts are not acceptable.

2.2.4 Type SS-6000

Pipe or tube (DN15 through DN80) (1/2 through 3 inches): XXS, seamless, corrosion-resistant steel, conforming to ASTM A 312/A 312M, Grade TP 316 and ASME B36.10M

Fittings (DN15 through DN40): 62 Megapascal (1/2 through 1-1/2 inches): 9,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.11

Fittings (DN50 through DN80) (2 through 3 inches): XXS, long radius, butt weld, corrosion-resistant steel, conforming to ASTM A 403/A 403M, WP 316, ASME B16.9, and ASME B36.10M

Flanges (DN25 through DN80): 17 Megapascal, 41 Megapascal (1 through 3 inches): 2,500-pound, 6,000-psi (DN25 through DN80): 17 Megapascal, 41 Megapascal, forged corrosion-resistant steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.5

Gaskets: Spiral wound, filled with chloride ion-free non-asbestos materials, corrosion-resistant steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Alloy-steel bolt studs conforming to ASTM A 193/A 193M, Grade B8 and semifinished heavy hex-nuts conforming to ASTM A 194/A 194M, Grade 8F

2.2.5 Type SS-2000

Pipe or tube: Schedule 40S seamless, corrosion-resistant steel, conforming to ASTM A 312/A 312M, Grade TP 316, and ASME B36.19M

Fittings (DN15 through DN40): 20 Megapascal (1/2 through 1-1/2 inches): 3,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.11

Fittings (2 through 3 inches) (DN50 through DN80): Schedule 40S, long radius, butt weld, corrosion-resistant steel conforming to ASTM A 403/A 403M, WP 316 and ASME B16.9, and ASME B36.19M

Flanges (DN25 through DN80): 6200 kilopascal, 15 Megapascal (1 through 3 inches): 900-pound, 2,160-psi, forged corrosion-resistant steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A 182/A 182M, Grade F 316 and ASME B16.5

Gaskets: Spiral wound, filled with chloride ion-free non-asbestos materials, corrosion-resistant steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Corrosion-resistant steel bolt studs conforming to ASTM A 193/A 193M, Grade B8 and semifinished heavy hex-nuts conforming to ASTM A 194/A 194M, Grade 8A

2.2.6 Type SS-350

Pipe or tube (DN15 through DN250) (1/2 through 10 inches): Schedule 40S, seamless, corrosion-resistant steel, conforming to ASTM A 312/A 312M, Grade TP 316, and ASME B36.19M

Fittings (DN15 through DN25): 20 Megapascal (1/2 through 1 inch): 3,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.11

Fittings (DN25 through DN250) (1 through 10 inches): Schedule 40, long radius, butt weld, corrosion-resistant steel, conforming to

ASTM A 403/A 403M, WP 316 and ASME B16.9

Flanges (DN25 through DN250): 2070 kilopascal, 5000 kilopascal (1 through 10 inches): 300-pound, 720-psi, forged corrosion-resistant steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A 182/A 182M, Grade F 316, and ASME B16.5

Gaskets: Spiral wound, filled with chloride ion-free non-asbestos materials, corrosion-resistant steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Heavy hex-head corrosion-resistant steel bolts or bolt studs conforming to ASTM A 193/A 193M, Grade B8, and semifinished heavy hex nuts conforming to ASTM A 194/A 194M, Grade 8A. Square-head bolts are not acceptable.

2.3 AIR COMPRESSORS

An air compressor of the standard piston type shall be provided complete with air tank, [air dryer,] and other appurtenances. Compressor and installation shall conform to ASME B19.3. Compressor shall be of sufficient capacity to provide continuous control air when operating on a 1/3-on 2/3-off cycle and shall be provided with an oil-level sight indicator on the compressor and a coalescing oil filter on the compressor discharge line. [Air dryers shall be of the continuous duty [silica-gel type with reactivation] [mass refrigerated dryer type] and shall maintain the air in the system with a dew point low enough to prevent condensation (minus 11 degrees C at 125 kilopascal (13 degrees F at 18 psi main pressure). Air dryer shall be located at the outlet of the tank.] Control air delivered to the system shall conform to ISA 7.0.01.

2.4 MANUAL VALVES

NOTE: Valves with "BCS" (Block Carbon Steel) prefix are for Type BCS piping systems; valves with "SS" (Stainless Steel) prefix are for Type SS piping systems. Number suffix applies to system pressure rating.

Pressure-reducing valve specifications shall be written to suit project conditions.

Select required valves; delete all others; and supplement to suit project conditions.

2.4.1 General

NOTE: Select from the following paragraphs to suit project requirements.

Valve marking shall conform to MSS SP-25 and shall be supplemented by securely attached identification plates which identify manufacturer, catalog number, pressure and temperature rating, size, flow direction, and serial numbers. Body, stem, disc, seat, and hard surfacing materials shall also be indicated.

Valve face-to-face and end-to-end dimensions shall conform to ASME B16.10.

Valve body, butt welding end configuration shall conform to the following requirements:

For piping systems rated at 13.7 Megapascal 2,000-psi and higher, PFI ES 21 shall apply.

For piping systems rated at 2500 kilopascal 350-psi water, oil, and gas (wog) and lower, ASME B16.25 shall apply.

Valve body socket welding end configurations shall conform to ASME B16.11

NOTE: Select if specification is rewritten for
flanged valves.

Valve body flanged end configurations and pressure temperature ratings shall conform to ASME B16.5.

Pressure and temperature ratings for steel butt welding end valves shall conform to ASME B16.5 or ASME B16.34.

Valves shall conform to applicable provisions of ASME BPVC SEC VIII D1.

Hydrostatic testing of steel valves shall conform to MSS SP-61.

Bolts and studs shall conform to ASTM A 193/A 193M, Grade B7; nuts shall conform to ASTM A 194/A 194M, Grade 2H.

Packing shall be wire reinforced, non-asbestos fiber materials jacketed, and impregnated with 30 percent tetrafluoroethylene or a corrosion-inhibiting lubricant specifically suitable for service with the stem material provided.

NOTE: If body materials are changed or if larger
carbon steel valves are used, review need for stress
relieving per ASME BPVC SEC VIII D1.

Hard surfacing alloy (HSA) shall conform to AWS A5.13, Class RNiCr-B or Class RCoCr-B, where specified.

NOTE: Select the following paragraph whenever
cast-steel valves are specified.

Cast-steel valves shall be visually inspected in accordance with MSS SP-55.

NOTE: Normally select one or delete both of the
following paragraphs whenever cast-steel valves are
specified.

[Cast-steel valves shall be certified as inspected by the dry powder magnetic particle method in accordance with MSS SP-53.]

[Cast-steel valves shall be certified as inspected by radiographic methods in accordance with MSS SP-54.]

2.4.2 Type BCS-6000A

Type BCS-6000A valves shall be Y-body globe type, rated 17 Megapascal 2,500 pounds, and 41 Megapascal 6,000 psi with seal-welded or pressure-sealed bonnet, outside screw and yoke (OS&Y), hard-surfaced body-guided loose disk, hard-surfaced integral or inserted and welded seat, hard-surfaced backseating, loose backseat, swing-eye gland bolts, and malleable iron impact type valve wheels and handles.

Body and bonnet assembly shall be forged carbon steel conforming to ASTM A 105/A 105M.

Trim shall conform to ASTM A 182/A 182M, Grade F6.

Bronze stem bushing shall conform to ASTM B 148, No. C95300, heat treated, or approved equal.

NOTE: Select one of the following two paragraphs
after checking flow coefficient.

[Valves shall have a full port.]

[Valves shall have full or reduced ports.]

Valve body shall have butt weld ends except that valves DN40 1-1/2-inch iron pipe size (ips) and smaller may be socket weld end type.

2.4.3 Type BCS-6000B

Type BCS-6000B valves shall be Y-body type piston check, rated 17 Megapascal 2,500 pounds and 41.37 Megapascal 6,000 psi with seal-welded or pressure-sealed bonnet, hard-surfaced spring-loaded body-guided disk, and hard-surfaced integral or inserted and welded seat.

Body and bonnet assembly shall be forged carbon steel conforming to ASTM A 105/A 105M.

Trim shall conform to ASTM A 182/A 182M, Grade F 11.

Spring shall be corrosion-resistant steel.

Valve body shall have butt weld ends, except that valves DN40 1-1/2-inch ips and smaller may be socket weld end type.

2.4.4 Type BCS-2000A

Type BCS-2000A valves shall be globe type, rated 4100 kilopascal and 14 Megapascal 600 pounds and 2,000 psi with union, seal-welded or pressure-sealed bonnet, OS&Y, hard-surfaced loose disk, hard-surfaced seat, minimum 375 Brinell back seating, loose backseat where required for access, and malleable iron hand wheel or handle.

Body and bonnet assembly shall be forged carbon steel conforming to ASTM A 105/A 105M.

Trim shall conform to ASTM A 182/A 182M, Grade F6, or shall be manufacturer's standard equivalent materials for the specified service.

Valve body shall have butt weld ends, except that valves DN40 1-1/2-inch ips and smaller may be socket weld end type.

2.4.5 Type BCS-2000B

Type BCS-2000B valves shall be Y-body, piston check, rated 4100 kilopascal and 14 Megapascal 600 pounds and 2,000 psi with bolted, seal-welded or pressure-sealed bonnet, hard-surfaced spring-loaded body-guided disk, and hard-surfaced integral or inserted and welded seat.

Body and bonnet assembly shall be forged carbon steel conforming to ASTM A 105/A 105M, Class 70, or cast carbon steel conforming to ASTM A 216/A 216M, Grade WCB.

Trim shall be manufacturer's standard for the service.

Spring shall be corrosion-resistant steel.

Valve body shall have butt weld ends, except that forged steel valves may be socket weld end type up to DN50 2-inch ips.

2.4.6 Type BCS-2000C

Type BCS-2000C valves shall be gate type, rated 4100 kilopascal and 14 Megapascal 600 pounds and 2,000 psi with union, bolted, seal-welded or pressure-sealed bonnet, OS&Y, hard-surfaced solid wedge disk, hard-surfaced seats, minimum 375 Brinell back seating, and malleable iron handwheel.

Body and bonnet assembly shall be forged carbon steel conforming to ASTM A 105/A 105M.

Trim shall conform to ASTM A 182/A 182M, Grade F6, or shall be manufacturer's standard equivalent materials for the specified service.

Valve body shall have butt weld ends except that valves DN40 1-1/2-inch ips and smaller may be socket weld end type.

2.4.7 Type BCS-350A

Type BCS-350A valves shall be globe and angle type, rated 2070 kilopascal and 5100 kilopascal 300 pounds and 740 psi with bolted bonnet, OS&Y, hard-surfaced plug type loose disk, hard-surfaced seat, minimum 350 Brinell back seating, swing-eye gland bolts, and malleable iron wheel.

Body and bonnet assembly shall be cast carbon steel conforming to ASTM A 216/A 216M, Grade WCB.

Stem material shall conform to ASTM A 182/A 182M, Grade F6.

NOTE: If valves smaller than 1-inch DN25 ips are required, use Type BCS-2000A.

Valve body in sizes DN50 2 inches and larger shall have butt weld ends.

2.4.8 Type BCS-350B

Type BCS-350B valves shall be horizontal swing check, rated 2070 kilopascal and 5100 kilopascal 300 pounds and 740 psi with bolted bonnet.

Body and bonnet assembly shall be cast carbon steel conforming to ASTM A 216/A 216M, Grade WCB.

Seating materials shall conform to ASTM A 182/A 182M, Grade F6.

NOTE: If valves smaller than 1-inch DN25 ips are required, use Type BCS-2000B.

Valve body in sizes DN50 2 inches and larger shall have butt weld ends.

2.4.9 Type BCS-350C

Type BCS-350C valves shall be gate type, rated 2070 kilopascal and 5100 kilopascal 300 pounds and 740 psi with bolted bonnet, OS&Y, hard-surfaced solid or one-piece flexible wedge disk, hard-surfaced seats, minimum 350 Brinell back seating, swing-eye gland bolts, and malleable iron wheel.

Body and bonnet assembly shall be cast carbon steel conforming to ASTM A 216/A 216M, Grade WCB.

Stem material shall conform to ASTM A 182/A 182M, Grade F6.

NOTE: If valves smaller than 1-inch DN25 ips are required, use Type BCS-2000C.

Valve body in sizes DN50 2 inches and larger shall have butt weld ends.

2.4.10 Type SS-6000A

Type SS-6000A valves shall be Y-body globe type, rated 17 Megapascal and 41 Megapascal 2,500 pounds and 6,000 psi with seal-welded or pressure-sealed bonnet, OS&Y, hard-surfaced body guided disk, hard-surfaced integral or inserted and welded seat, hard-surfaced back seating, loose back seat, swing-eye gland bolts, and malleable iron impact-type valve wheels and handles.

Body and bonnet assembly shall be forged corrosion-resistant steel conforming to ASTM A 182/A 182M, Grade F 316.

Trim shall conform to ASTM A 182/A 182M, Grade F 316.

Bronze stem bushing shall conform to ASTM B 148, No. C95300, heat treated.

NOTE: Select one of the following two paragraphs after checking flow coefficient.

[Valves shall have a full port.]

[Valves shall have full or reduced ports.]

Valve body shall have butt weld ends, except that valves DN40 1-1/2-inch
ips and smaller may be socket weld end type.

2.4.11 Type SS-6000B

Type SS-6000B valves shall be Y-body, piston check, rated 17 Megapascal and
41 Megapascal 2,500 pounds and 6,000 psi with seal-welded or
pressure-sealed bonnet, and hard-surfaced spring-loaded body-guided disk,
hard-surfaced integral or inserted and welded seat.

Body and bonnet assembly shall be forged corrosion-resistant steel
conforming to ASTM A 182/A 182M, Grade F 316.

Trim shall conform to ASTM A 182/A 182M, Grade F 316.

Spring shall be corrosion-resistant steel.

Valve body shall have butt weld ends, except that valves DN40 1-1/2-inch
ips and smaller may be socket weld end type.

2.4.12 Type SS-2000A

Type SS-2000A valves shall be globe type, rated 41 Megapascal and 14
Megapascal 6,000 pounds and 2,000 psi with union, seal-welded or
pressure-sealed bonnet, OS&Y, hard-surfaced loose disk, hard-surfaced seat,
minimum 375 Brinell back seating, loose back seat where required for
access, and malleable iron hand wheel or handle.

Body and bonnet assembly shall be forged corrosion-resistant steel
conforming to ASTM A 182/A 182M, Grade F 316.

Trim shall conform to ASTM A 182/A 182M, Grade F 316, or shall be
manufacturer's standard equivalent materials for the specified service.

Valve body shall have butt weld ends, except that valves DN40 1-1/2-inch
ips and smaller may be socket weld end type.

2.5 PIPING SPECIALTIES

2.5.1 Pressure Gages

Pressure gages shall conform to ASME B40.100 and to requirements specified
in kilopascal psi units herein. Pressure gage size shall be 115 millimeter
4-1/2 inches nominal diameter for systems pressures less than 2500
kilopascal and 200 millimeter 350 psi and 8 inches nominal diameter for all
higher pressures. Cases shall be of cast aluminum. All gages shall be
equipped with adjustable red marking pointer and damper screw adjustment in
inlet connection. Bourdon tubes shall have a bleeding device to facilitate
cleaning and bleeding trapped gas.

Gage cases shall be one-piece solid-front type with a safety-release back
cover. Windows shall be shatterproof glass. Dials shall be white with
dual seals. Outer scale shall have red markings graduated in SI units; the

inner scale shall have black markings graduated in psi units.

NOTE: Select following for high pressure gages in
control rooms and for applications in accordance
with NASA LRC safety policy.

2.5.2 Pressure Receiver Gages and Pneumatic Transmitters

2.5.2.1 Receiver Gages

Gages shall be indicating type with 150 millimeter 6-inch white background dial face and black lettering indicating transmitted air pressure and be suitable for transmitted air pressure range from 20 to 105 kilopascal 3 to 15 psi. Pointer shall be adjustable micrometer type. Overload and underload stops shall be provided. Bourdon tube and movement shall be AISI Type 316 and 300 series stainless steel, respectively. Connection shall be DN6 1/4-inch ips or tube size, depending on system makeup. Case shall be black finish cast aluminum for indicated mounting. Accuracy shall be within 0.5 percent of scale range.

NOTE: Select following paragraph or delete and
tabulate each instrument.

[Gage scale range shall be as indicated.]

2.5.2.2 Pneumatic Transmitters

Transmitter shall be nonsuppressed, nonindicating type complete with sensitive relay, dual Bourdon tube-actuated motion balance system, zero and span adjustment, and accessories. Case shall be weatherproof, kept free of foreign particulate matter by purging air, and shall be constructed of manufacturer's standard finish steel base with safety blowout disk and aluminum cover.

NOTE: Select first of following two paragraphs for
inlet pressures to 1,000 psi 70 Megapascal; select
second of following two paragraphs for inlet
pressures in excess of 1,000 psi 70 Megapascal.

Bourdon tubes shall be phosphor bronze; tips and connections shall be brass. Unit inlets shall be screened.

Bourdon tubes, tips, and connections shall be AISI Type 316 corrosion-resistant steel. Unit inlets shall be screened.

Unit shall be self-compensating under varying ambient temperature conditions. Minimum speed of response shall be the capability to raise pressure from 20 to 105 kilopascal 3 to 15 psi through 15.25 meter of 5 millimeter 500 feet of 3/16-inch id tubing with a time constant of 4 seconds. Accuracy shall be within 0.5 percent of scale range. Sensitivity shall be within 0.1 percent of pressure range.

**NOTE: Select following paragraph or delete and
rewrite to agree with receiver gage tabulation or to
suit other project conditions.**

Unit range shall be as indicated. Output range shall be 20 to 105
millimeter 3 to 15 psi. One pneumatic transmitter shall be provided for
each pressure-receiver gage, unless otherwise specified.

[Pneumatic-transmitter assembly mounting shall be pipe type.]

**NOTE: Select following paragraph only after
checking specific regulator requirements. Rewrite
if necessary to suit project conditions.**

Manufacturer's standard pressure rated filter-regulator assembly and 50
millimeter 2-inch dial face supply air and transmitted air pressure gages
shall be provided.

2.5.3 Thermometers

Thermometers shall conform to ASTM E 1 and to requirements specified
herein. Thermometers shall be industrial pattern Type 1, Class 3. All
thermometers installed 1800 millimeter 6 feet or higher above the floor
shall have an adjustable angle body. Scale shall be not less than 180
millimeter 7 inches long, and case face shall be manufactured from
manufacturer's standard polished aluminum or AISI 300 series polished
corrosion-resistant steel. Thermometer range shall be as indicated. All
thermometers shall be provided with AISI Type 316 corrosion-resistant steel
separable wells.

2.6 MISCELLANEOUS MATERIALS

2.6.1 Bolting

General purpose bolting shall be hex-head and shall conform to ASTM F 568M
ASTM A 307. Heavy hex-nuts shall conform to ASME B18.2.4.6M ASME B18.2.2.
Square-head bolts and nuts are not acceptable.

2.6.2 Elastomer Calk

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

2.6.3 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be
chrome plated except when AISI 300 series corrosion-resistant steel is
provided. Metals and finish shall conform to FS WW-P-541.

Escutcheons shall be one-piece or split-pattern type. All escutcheons
shall have provisions consisting of internal spring-tension devices or
setscrews to maintain a fixed position against a surface.

2.6.4 Flashing

Lead: Sheet lead shall conform to ASTM B 749, Grade B, C, or D and shall

weigh not less than 20 kilogram per square meter 4 pounds per square foot.

Copper: Sheet copper shall conform to ASTM B 370 and shall weigh not less than 4.8 kilogram per square meter 16 ounces per square foot.

2.7 SUPPORTING ELEMENTS

NOTE: Drawings shall completely detail anchors, restraining guides, sway braces, and shock absorbing provisions to accommodate reaction forces encountered, as well as other piping support elements not covered by the following specifications.

Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT if design may induce vibration considerations.

Select and supplement or rewrite the following paragraphs as required by project conditions.

2.7.1 General

Provide all necessary piping system components and miscellaneous supporting elements required, including but not limited to, building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; shock absorbers; and variable and constant supports. All supporting elements shall be suitable for stresses imposed by system pressures and temperatures, and natural and other external forces.

Supporting elements shall be UL approved or listed, shall conform to requirements of ASME B31.3, MSS SP-58, and MSS SP-69, or the BOCA National Plumbing Code, except as supplemented and modified by these specifications.

Individual supporting element details shall be code marked and submitted as part of the shop drawings for all piping systems.

Details shall include an exact bill of materials for components making up each assembly and shall include a dimensioned location plan for each assembly with respect to building structure or equipment.

Each coded assembly shall be individually bundled and tagged with code mark prior to delivery to the site.

[Constant supports, with travel stops where necessary, shall be provided at vertically drifting piping to preclude excessive stresses at terminal points.]

NOTE: Drawings shall show reactive forces (in pounds) newton generated by system operation which normally cannot be anticipated by device manufacturer.

Shock absorbers and sway suppressors shall be provided to absorb system reactive forces where indicated.

Attachments welded to pipe shall be made of material identical to that of pipe or of materials accepted as permissible raw materials by referenced code or standard specification. Heat treatment for attachment stress relieving shall be in a furnace allowing for controlled conditions and uniformity of temperature. Type devices specified herein are defined in referenced MSS Standard, unless otherwise noted.

2.7.2 Building Structure Attachments

Anchor devices, concrete, and masonry: Anchor devices shall conform to requirements of [FS FF-S-325](#), Group I; Group II, Type 2, Class 2, Style 1 or Style 2; Group III; or Group VIII.

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

Masonry anchor devices shall be built in, unless otherwise approved by the Contracting Officer.

Powder-actuated anchoring devices shall not be used to support any mechanical system components.

Beam clamps: Beam clamps shall be center-loading Type 21, 28, 29, or 30, UL-listed, catalogued and load-rated, commercially manufactured products.

C-clamps shall not be used.

Inserts, concrete: Concrete inserts shall be constructed in accordance with the requirements of [MSS SP-58](#) for Type 18 and [MSS SP-69](#). When applied to piping in sizes [DN50 2-inch](#) ips and larger and where otherwise required by imposed loads, a [300 millimeter 1-foot](#) length of [15 millimeter 1/2-inch](#) reinforcing rod shall be inserted and wired through wing slots. Proprietary-type continuous inserts may be similarly used when approved by the Contracting Officer.

2.7.3 Horizontal Pipe Attachments

Single pipes

Wherever possible, piping shall be supported by Type 2, Type 3, or Type 4 attachments.

Spring supports shall be provided in accordance with referenced standards.

Pipe rolls shall be Type 41 or 49.

Where clamps and rolls are not used, pipe supports shall be Type 1.

2.7.4 Vertical Pipe Attachments

Vertical pipe attachments shall be Type 8.

Spring supports shall be provided in accordance with referenced codes and standards.

2.7.5 Hanger Rods and Fixtures

Only circular cross section rod hangers shall be used to connect building

structure attachments to pipe support devices. Pipe straps or bars of equivalent strength shall be used for hangers only where approved by the Contracting Officer.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate pipe accessibility and for adjustment to load and pitch.

2.7.6 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 shall be designed and fabricated in accordance with **AISC 325**.

PART 3 EXECUTION

3.1 UNDERGROUND PIPING SYSTEMS INSTALLATION

Installation of compressed air systems shall be performed in accordance with the applicable requirements specified under "Aboveground Piping Systems Installation" in this section, the requirements specified herein, and in the presence of the Contracting Officer who shall be notified by the Contractor 48 hours in advance of start of the work.

All excavations shall be dry and clear of extraneous materials when pipe is being laid.

Blocking and wedging will not be permitted.

**NOTE: Drawings shall indicate underground piping
requiring support from slabs.**

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

**NOTE: Coordinate following two paragraphs with
drawings.**

Pipes passing through walls below grade and ground floor slab shall pass through pipe sleeves as indicated.

Where pipe penetrates earth or concrete grade, not less than **300 millimeter 12 inches** of polyethylene-coated Type BCS-PS pipe shall be exposed-to-view. Additional piping protection shall be provided concrete penetration points as indicated.

Type BCS-PS materials shall be installed in accordance with the applicable requirements specified herein for underground piping and aboveground piping. Pipe shall be palletized in padded pallets at the factory and shall be handled from pallet to final position with padded gear. Surfaces shall be protected from the sun with black polyethylene sheeting. Prior to being lowered into a trench, sheeting shall be checked for continuity with 10,000 volts applied by a continuity detector with an audible alarm. In the

trench, after joints and fittings are made, previously untested surfaces shall be checked for continuity. Where discontinuities in thermoplastic sheeting are found, not less than 300 millimeter 12 inches of material upstream and downstream of the fault shall be removed and replaced.

Defective materials found shall be distinctly marked and promptly removed from the site.

3.2 ABOVEGROUND PIPING SYSTEMS INSTALLATION

3.2.1 General

NOTE: Check for pertinent item inclusion, NASA
Langley Research Center standard procedures for
radiographic testing, and other requirements for
systems operating at pressures in excess of 125-psi
860 kilopascal wsp.

Piping systems shall be fabricated and installed in accordance with the requirements of the following codes and standards except as supplemented and modified by these specifications:

ASME B31.3

MSS SP-69

ASME BPVC SEC II-C, for applicable materials and procedures not specified herein

AWS WHB-2.9, for applicable materials and procedures not specified herein

Provisions of referenced codes and standards shall constitute minimum requirements for system materials, installation, and workmanship. Strict compliance therewith shall be required for all systems work except where the drawings and specification require better materials and methods of installation than the minimum requirements set forth in the code or standard. In all cases, the drawings and specifications shall supersede code and standards requirements.

Installation of piping systems materials shall conform to the published or written instructions of the manufacturer for the project application except as otherwise specified herein.

Where the Contractor proposes to deviate from specified instructions, the proposed deviation shall be submitted to the Contracting Officer for approval.

Work shall be done in the presence of the Contracting Officer who shall be notified 48 hours in advance of start of the work.

Permanent identification of piping shall conform to PFI ES 11. Identification shall be located at points designated by the Contracting Officer and shall be legibly and conspicuously marked by yellow fluorescent aerosol paint.

Exact location of piping shall be coordinated among trades so that there

will be no interference with lighting fixtures, piping, ducts, or other construction.

Pipe shall be fabricated to measurements established on the job and shall be carefully worked into place without springing or forcing. Adequate provision shall be made for absorbing all expansion and contraction without undue stress in any part of the system.

NOTE: If the following paragraph does not provide for cleanliness required by project conditions, and if pickling of pipe and temporary line strainers are required, refer to Ingersoll-Rand Form 3219B for suitable specification and strainer-design criteria and rewrite the following paragraph. Do not oil pipe bore; use phosphoric acid rust-preventive treatment.

Pipe, tubing, fittings, valves, equipment, and accessories shall be clean and free of all foreign material before being installed in their respective systems. Pipe shall be cleaned by hammering, shaking, or swabbing, or by a combination of those methods. Lines shall be purged with dry, oil-free compressed air after erection, but purging shall not be relied upon for removing all foreign matter. Lines shall be purged at a velocity in excess of maximum normal-flow velocity and as approved by the Contracting Officer. During the progress of construction, open ends of pipe, fittings, and valves shall be properly protected at all times to prevent the admission of foreign matter. Plugs and caps shall be placed in the ends of installed work at all times, except when connections are being made. Plugs and caps shall be commercially manufactured products, unless otherwise approved by the Contracting Officer.

NOTE: Prior to selection of the following paragraph, review design routing, reaction forces, and support provisions.

Piping shall be installed straight and true with approved offsets around obstructions, expansion bends or fitting offsets essential to a satisfactory installation, and as may be necessary to increase headroom or to avoid interference with the building construction, electric conduit, or facilities equipment.

Standard long-sweep pipe fittings shall be used for changes in direction. No mitered joints or unapproved pipe bends will be permitted.

Pipe bends shall be shop-made by the sand-filled hot-bending process provided (1) bend radius is not less than 6 times the nominal pipe diameter; (2) fabrication tolerances are in accordance with **PFI ES 3** for the applicable wall thickness; (3) preheat and postheat treatment procedures, where applicable, are in accordance with referenced standards; (4) piping is cleaned, after bending operations, with a turbine cutter assembly followed by shot or sand blasting; (5) all operations are performed to preclude detrimental wall thickness reduction; and (6) the fabricating shop is a member of the Pipe Fabricating Institute and is approved by the Contracting Officer.

NOTE: Prior to selection of following paragraph,
review requirements of project application.

Branch connections shall be made with either welding tees or forged branch outlet fittings, within limitations of referenced codes and standards. Branch outlet fittings, where used, shall be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe-bursting strength requirements.

Horizontal piping shall have a grade of 25 millimeter per 30.5 meter 1 inch per 100 feet.

Eccentric reducers shall be used where required to permit proper drainage of pipe lines. Bushings are not permitted for this purpose. Drain valves shall be provided where indicated.

Piping shall be installed in a manner that will prevent stresses and strains from being imposed upon connected equipment.

Expansion bend configuration shall be as indicated. Expansion U-bend shall be cold sprung and welded into the line which shall be anchored before removing the spreader from the expansion U-bend. Amount of cold spring shall be as indicated.

3.2.2 Joints

NOTE: Review following requirements for inadequacy,
conflict, and redundancy.

Field-welded joints shall conform to the requirements of the AWS WHB-2.9 and ASME B31.3.

[Piping systems rated 14 Megapascal 2,000 psi and higher shall have butt weld joints made with consumable insert rings, utilizing inert-gas tungsten-arc root pass welding together with inert gas purging of id of pipe. Consumable insert ring materials shall be compatible with all materials being joined. Joint configuration shall conform to PFI ES 21. Root pass joint preheat treatment shall be provided at temperatures necessary to avoid cracking.]

[Piping systems rated 2400 kilopascal 350 psi and lower shall have butt weld joints made with backing rings. Backing ring materials shall be compatible with materials being joined. Joint configuration shall 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.

Preheat and postheat treatment of welds shall be performed in accordance with ASME BPVC SEC IX.

Preheat and postheat treatment of welds shall be performed in accordance with ASME B31.3.

Flanged joints shall be assembled with appropriate flanges, gaskets, and bolting. Clearance between flange faces shall be sufficient to ensure that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Flange faces shall be parallel and the bores concentric; gaskets shall be centered on the flange faces without projecting into the bore. Bolting shall be lubricated with oil and graphite before assembly to ensure uniform bolt stressing. Flange bolts shall be drawn up and tightened in staggered sequence in order to prevent unequal gasket compression and deformation of the flanges. After the piping system has been tested, bolting shall be retightened to provide required gasket stress.

3.2.3 Supporting Elements Installation

Supporting elements shall be provided in accordance with the requirements of referenced codes and standards, except as supplemented or modified herein.

Piping shall be hung from building construction. No piping shall be hung from roof deck or from other pipe.

Attachment to building construction concrete shall be by approved cast-in concrete inserts or by built-in anchors. Where attachment by either of above methods is not practical, specified masonry anchor devices may be used upon receipt of written approval from the Contracting Officer.

Fish plates shall be embedded in the concrete to transmit hanger loads to the reinforcing steel where hanger rods exceed 22 millimeter 7/8 inch in diameter.

Masonry anchors selected for overhead applications shall be constructed of ferrous materials only.

Masonry anchors conforming to FS FF-S-325, Group I; Group II, Type 2, Class 2, Style 1 or Style 2; or Group VIII shall be installed in rotary, nonpercussion electrically drilled holes. Self-drilling anchors (Group III) may be used provided masonry drilling is done with electric hammers selected and applied in a manner that will preclude concrete spalling or cracking (visible or invisible). Pneumatic tools will not be allowed.

Percussive action, electric hammers, and combination rotary-electric hammers used for the installation of self-drilling anchors shall be selected in accordance with the following guide:

Anchor-devices, nominal sizes M6 through M14 (1/4 through 1/2 inch) 1/4 through 1/2 inch, may be hammer type only or combination rotary-hammer type and shall be rated at load to draw not more than 5.0 to 5.5 amperes when operating on 120-volt, 60-hertz power.

Anchor devices, nominal sizes M6 (5/8 inch) 5/8 inch and larger, hammer-type only, shall be rated at load to draw not more than 8.0 amperes when operating on 120-volt, 60-hertz power. Combination rotary-hammer tools on the same power supply shall have a full load current rating not to exceed 10 amperes.

NOTE: Typical sources of electric hammer (h) and combination rotary-hammer (r-h) and blows per minute (bpm) :

Name and Model		Type	bpm	amps 120/60	bpm/amp
B & D	103-1	h	2,300	3.3	695
B & D	104-1	h	2,200	7.0	314
B & D	718	r-h	3,350	7.5	448
B & D	719	r-h	3,600	10.0	360
I-R	HS650U	h	3,000	8.0	375
Mil	5350	r-h	2,500	5.0	500
B & D	104-1	h	2,200	7.0	314
B & D	718	r-h	3,360	7.5	448
B & D	719	r-h	3,600	10.0	360
I-R	HS650U	h	3,000	8.0	375
Mil	5350	r-h	2,500	5.0	500
Mil	5300	r-h	3,250	10.0	325
Phil	K457	h	3,000	6.5	461
Rock-well	Kango	h	2,500	7.0	357
Skil	726	r-h	2,400	5.5	436
Skil	728	r-h	2,900	6.5	446
Skil	729	h	3,000	6.5	462

Inserts and anchors shall be sized for the total stress to be applied with a safety factor as required by applicable codes, but in no case less than 4. Complete shop drawings shall be submitted.

Anchor devices shall be inserted into concrete sections not less than twice the overall length of the device and shall be located not less than the following distance from any side or end edge or centerline of adjacent anchor service:

Anchor Bolt Size	M6	M8	M10	M15	M16	M20	M22	(Millimeter)
Minimum Edge	85	90	105	130	150	180	205	Space (Millimeter)*
Anchor Bolt Size	1/4	5/16	3/8	1/2	5/8	3/4	7/8	(Inches)
Minimum Edge	3-1/4	3-1/2	4	5	6	7	8	Space (Inches)*

* Except where manufacturer requires greater distance.

In special circumstances, with prior written approval of the Contracting Officer, center-to-center distance may be reduced to 50 percent of given distance provided load on the device is reduced in direct proportion to the reduced distance.

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that there shall be not less than 15 millimeter 1/2 inch of clear space between the finished surface and other work and between the finished surfaces of parallel adjacent piping.

Parallel pipe runs shall allow for tool space around mechanical connections. Where it is necessary to avoid any transfer of load from support to support or onto connecting equipment, pipe hangers shall be constant-support type.

Anchors and pipe-alignment guides shall be welded to the piping in accordance with requirements specified herein and attached to the building structure in a manner indicated or approved by the Contracting Officer.

Piping shall be suitably braced against reaction, sway, and vibration. Bracing shall consist of hydraulic and spring devices, brackets, anchor chairs, rods, and structural steel.

Pipe lines, when supported from roof purlins, shall be located not greater than one-sixth of the purlin span from the roof truss. Load per hanger shall not exceed 1800 newton 400 pounds when support is from a single purlin or 3600 newton 800 pounds when hanger load is applied to purlins halfway between purlins by means of auxiliary support steel supplied by the piping Contractor. When support is not halfway between purlins, the allowable hanger load shall be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin spacing.

When the hanger load exceeds the above limits, reinforcing of the roof purlin(s) or additional support beam(s) shall be furnished and installed. When an additional beam is used, the beam shall bear on the top chord of the roof trusses, and bearing shall be over gusset plates of top chord. Beam shall be stabilized by connection to roof purlin along bottom flange.

Hangers and supports for piping shall be installed at intervals specified herein at locations not more than 900 millimeter 3 feet from the ends of each runout and not over 25 percent of specified interval from each change in direction of piping.

**NOTE: Check following intervals for project
materials application permissible for combined
bending and shearing stresses.**

Load rating for all pipe hanger supports shall be based on weight and forces imposed on all lines. Deflection per span shall not exceed slope gradient of pipe. Schedule 40 and heavier pipe supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing; concentrated loads will reduce allowable span proportionately:

<u>PIPE SIZE MILLIMETER (DN)</u>	<u>ROD SIZE MILLIMETER</u>	<u>HANGER SPACING MILLIMETER</u>
15 and smaller	10	1500
20 to 25	10	1800
32 to 40	10	2700
50	15	3000
65 to 80	15	3600
100 to 125	16	4500
150	20	4800
200 to 300	22	6100

<u>PIPE SIZE INCHES</u>	<u>ROD SIZE INCHES</u>	<u>HANGER SPACING FEET</u>
1/2 and smaller	3/8	5
3/4 to 1	3/8	6
1-1/4 to 1-1/2	3/8	9
2	1/2	10
2-1/2 to 3	1/2	12
4 to 5	5/8	15
6	3/4	16
8 to 12	7/8	20

Vertical risers shall be supported independently of connected horizontal piping wherever practical and shall be guided for lateral stability. Only one rigid support shall be provided for risers subject to expansion.

After the piping systems have been installed, tested, and placed in satisfactory operation, the Contractor shall tighten hanger rod nuts and jam nuts to prevent any loosening.

3.2.4 Sound Stopping

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where pipes penetrate walls, floors, or ceilings. Where penetrations occur from pipe chases into occupied spaces, special acoustic treatment of ceiling shall be provided. Occupied spaces include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping shall be as specified under "Sleeves" in this section.

Leadwool and viscoelastic damping compounds may be proposed for use where

other sound-stopping methods are not practical, provided temperature and fire-resistance characteristics of the compound are suitable for the service.

3.2.5 Sleeves

Sleeves shall be supplied and installed where piping passes through roofs, through masonry or concrete walls, and through floors.

Sleeve work shall be laid out before placement of slabs or construction of walls and roof, and all sleeves necessary to complete the work shall be set.

Where pipe sleeves are required after slabs and masonry are installed, holes to accommodate these sleeves shall be made with core drills. Sleeves shall be set in place with a two-component epoxy adhesive system approved by the Contracting Officer. No load shall be carried by such sleeves unless approved by the Contracting Officer.

Sleeves shall be flush with ceilings and where indicated.

Sleeves shall be flush with the floor in finished spaces and shall extend 50 millimeter 2 inches above the floor in unfinished spaces.

Sleeves passing through steel decks shall be continuously welded or brazed to the deck.

Sleeves extending through floors, roofs, load bearing walls, and fire barriers shall be continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Other sleeves shall be formed by molded linear polyethylene liners or similar materials which are removable. Diameter of sleeves shall be large enough to accommodate pipe and isolation and sealing materials with a minimum of 10 millimeter 3/8-inch clearance. Sleeves shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with a mineral fiber conforming to FS HH-I-558, Form B, Class 8 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 shall be filled with an elastomer calk to a depth of 15 millimeter 1/2 inch. All surfaces to be calked shall be oil- and grease-free.

Exterior wall sleeves shall be calked watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic sealed metal components.

3.2.6 Escutcheons

Escutcheons shall be provided at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Where suspended ceilings are installed, plates shall be provided at the underside only of such ceilings. Escutcheons shall be chrome-plated in all occupied spaces and shall be of sufficient size to

conceal openings in building construction. All escutcheons shall be firmly attached, preferably with setscrews.

3.2.7 Flashings

NOTE: Coordinate with drawings and check roof
flooding provisions, if any.

All required flashings shall be provided at mechanical systems penetrations of building boundaries as indicated.

3.3 COMPRESSED AIR SYSTEMS TESTING

NOTE: Delete paragraph title and following
paragraphs when compressed air systems are not
applicable to the project.

Determine whether or not systems supports are
adequate for loads normal to specified hydrostatic
testing.

3.3.1 General

Prior to acceptance of the work, completed systems shall be pressure tested in the presence of the Contracting Officer.

NOTE: Because of the expansive force of compressed
air at the 100-psi 690 kilopascal and higher range
of pressures normally used, pneumatic testing
requires special precautions and competent
supervision to prevent injury and damage should a
failure occur.

[Tests shall be pneumatic and shall use dry, oil-free compressed air, carbon dioxide, or nitrogen as specified for the system under test. Pressure Testing shall be done in two stages; i.e. preliminary and acceptance.]

[Tests shall be hydrostatic. Only potable water shall be used for testing. Government will supply testing water at a location determined by the Contracting Officer, but the Contractor shall be responsible for the approved disposal of contaminated water. Temperature of water used for testing shall not cause condensation on system surfaces. Supplementary heat shall be provided if necessary.]

Pressure tests in excess of 34 kilopascal 5 psi shall not be performed until personnel not directly involved in the tests are evacuated from the area.

Contractor may conduct tests for his own purposes, but Preliminary Tests and Acceptance Tests shall be conducted as specified herein.

**NOTE: Select the following paragraph only when
pneumatic testing is specified.**

System Testing shall include Preliminary Tests by applying internal pressures exceeding 34 kilopascal 5 psi swabbing all joints under test with a high film strength soap solution, and observing for bubbles.

If testing reveals that leakage exceeds specified limits, the leaks shall be isolated and repaired, defective materials shall be replaced where necessary, and the system shall be retested until specified requirements are met. Leaking gasket joints shall be remade with new gaskets and new flange bolting. Removed bolting and gaskets shall not be used again.

**NOTE: Select the following paragraph only when
hydrostatic testing is specified.**

Regardless of the amount of measured leakage, visible leaks or defects in the pipeline shall be immediately repaired.

Only standard piping flanges, plugs, caps, and valves shall be used for sealing off piping for test purposes.

**NOTE: Select following paragraph only when
hydrostatic testing is specified.**

Compressed air trapped during high pressure hydrostatic testing shall be vented to preclude injury and damage. If purging or vent valves are not provided, the Contracting Officer may require the removal of any system component such as plugs and caps to verify that water has reached all parts of the system.

Components shall be removed from piping systems prior to testing whenever the component would otherwise sustain damage due to test pressure.

Piping system components such as valves shall be checked for proper operation under system test pressure.

No test media shall be added to a system during a test for a period as specified or to be determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer. Test may be terminated by direction of Contracting Officer at any point during a 24-hour period after it has been determined that the permissible leakage rate has not been exceeded.

**NOTE: Select following paragraph only when
hydrostatic testing is specified.**

Dry piping system, upon completion of testing, shall be drained and purged with dry air. System dryness shall be verified by hygrometer comparison with purging air.

Test records of piping systems tests shall be prepared, maintained, and submitted for approval. Records shall show Government and Contractor test personnel responsibilities, dates, test gage identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates. Each acceptance test will be signed by the Contracting Officer, and two record copies shall be delivered to the Contracting Officer after acceptance.

3.3.2 Test Gages

Contractor's test gages shall conform to ASME B40.100 and shall have a dial size 200 millimeter 8 inches or larger. Maximum permissible scale range for a given test shall be such that the pointer shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to the test date and shall show test gage number and the project number, unless otherwise approved by the Contracting Officer.

3.3.3 Acceptance Pressure Testing

Testing shall be done during steady ambient temperature conditions.

NOTE: Specify hereunder system test pressures and
allowable leakage rates to suit project conditions.

3.3.4 Support Elements Testing

Systems containing hydraulic or spring shock absorbers shall be tested for ability to accommodate system forces by manipulation of system components as directed by the Contracting Officer.

-- End of Section --