Preparing Activity: NASA Superseding
UFGS-22 15 13.16 40 (November 2014)
UFGS-22 15 13.16 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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USACE / NAVFAC / AFCEC / NASA **UFGS-22 15 13.16 40 (November 2017)**

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SECTION 22 15 13.16 40

HIGH-PRESSURE COMPRESSED-AIR PIPING, PIPING COMPONENTS, AND VALVES, STAINLESS
11/17

****

NOTE: This guide specification covers the requirements for aboveground and underground piping systems and certain components with pressure ratings of 2410, 13790, and 41370 kilopascal 350, 2,000, and 6,000 pounds per square inch, gage.

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

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

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

****

PART 1 GENERAL

****

NOTE: If Section 23 30 00 HVAC AIR DISTRIBUTION and/or Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT and/or Section 40 17 30.00 40 WELDING GENERAL PIPING are not included in the project specification, insert applicable requirements from each, as required, and delete the following applicable paragraph.

****

[Section 23 30 00 HVAC AIR DISTRIBUTIONapplies 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 40 17 30.00 40 WELDING GENERAL PIPING applies to work specified in this section.
]

Where the deviations from specified instructions are proposed, submit the proposed deviations to the Contracting Officer for approval.

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

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

****

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	(2017) Steel Construction Manual

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.10	(2022) Face-to-Face and End-to-End Dimensions of Valves
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.25	(2017) Buttwelding Ends
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End

ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.2.6	(2010; Supp 2011) Fasteners for Use in Structural Applications
ASME B31.3	(2022) Process Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B36.19M	(2022) Welded and Seamless Wrought Stainless Steel Pipe
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.13/A5.13M	(2021) Specification for Surfacing Electrodes for Shielded Metal Arc Welding
AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2021) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A182/A182M	(2023) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications

ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A234/A234M	(2023a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM B148	(2014) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2011) Commodity Specification for Air;

5th Edition

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2021) International Plumbing Code

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 898-1	(2013) Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel — Part 1: Bolts, Screws and Studs with Specified Property Classes — Coarse Thread and Fine Pitch Thread

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air

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

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-53	(2021) Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method
MSS SP-54	(2013) Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components, - Radiographic Examination Method
MSS SP-55	(2011) Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-61	(2019) Pressure Testing of Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

PIPE FABRICATION INSTITUTE (PFI)

PFI ES 3	(2009) Fabricating Tolerances
PFI ES 11	(2014) Permanent Marking of Piping Materials
PFI ES 21	(2010) Internal Machining and Fit-up of GTAW Root Pass Circumferential Butt Welds

FS WW-P-541 (Rev E; Am 1; Notice 1; Notice 2) Plumbing Fixtures

1.2 SUBMITTALS

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

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

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

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

SD-01 Preconstruction Submittals

Proposed Deviations; G[, [____]]

SD-02 Shop Drawings

Detail Drawings; G[, [____]]

SD-03 Product Data

Underground Piping; G[, [____]]

Aboveground Piping; G[, [____]]

Air Compressors; G[, [____]]

Manual Valves; G[, [____]]

Piping Specialties; G[, [____]]

Miscellaneous Materials; G[, [____]]

Supporting Elements; G[, [____]]

SD-06 Test Reports

System Pressure Test; G[, [____]]

SD-07 Certificates

Underground Piping

Aboveground Piping

Air Compressors

Manual Valves

Piping Specialties

Miscellaneous Materials

Supporting Elements

1.3 QUALITY CONTROL

Submit detail drawings for 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.

PART 2 PRODUCTS

2.1 COMPONENTS

2.1.1 Air Compressors

Provide an air compressor complete with air tank, [air dryer,][air cooler,] and other appurtenances. Ensure that the compressor and installation conform to CAGI B19.1. Select a compressor of sufficient capacity to provide continuous control air when operating on a 1/3-on 2/3-off cycle. Provide the compressor with an oil-level sight indicator on the compressor and a coalescing oil filter on the compressor discharge line. [Ensure that the air dryers are of the continuous-duty type[silica-gel type with reactivation] [mass refrigerated dryer type] and it maintains the air in the system with a dew point low enough to prevent condensation in accordance with CGA G-7.1. Locate air dryer at the outlet

of the tank.]Ensure that the control air delivered to the system conforms to ISA 7.0.01.

2.1.2 Manual Valves

****

NOTE: Valves with "BCS" (Black 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.

Write pressure-reducing valve specifications to suit project conditions.

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

****

****

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

****

Ensure that the valve markings conform to MSS SP-25 and are supplemented by securely attached identification plates that identify manufacturer, catalog number, pressure and temperature rating, size, flow direction, and serial numbers. Also indicate body, stem, disc, seat, and hard-surfacing materials.

Ensure that the valve face-to-face and end-to-end dimensions conform to ASME B16.10.

Ensure that the valve body butt-welding end configuration conforms to the following requirements:

a. For piping systems rated at 13.7 Megapascal 2,000 psi and higher, PFI ES 21 applies.

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

Ensure that the valve body socket welding end configurations conform to ASME B16.11

****

NOTE: Select if specification is rewritten for flanged valves.

****

Ensure that the valve body flanged end configurations and pressure temperature ratings conform to ASME B16.5.

Ensure the pressure and temperature ratings for steel butt-welding end valves conform to ASME B16.5 or ASME B16.34.

Ensure that the valves conform to applicable provisions of ASME BPVC SEC VIII D1.

Ensure that the hydrostatic testing of steel valves conforms to MSS SP-61.

Provide bolts and studs conforming to ASTM A193/A193M, Grade B7, and nuts conforming to ASTM A194/A194M, Grade 2H.

For packing, use wire-reinforced, nonasbestos 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 the need for stress relief specified by ASME BPVC SEC VIII D1.

****

Ensure that the hard-surfacing alloy (HSA) conforms to AWS A5.13/A5.13M, Class RNiCr-B or Class RCoCr-B, where specified.

****

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

****

Visually inspect cast-steel valves in accordance with MSS SP-55.

****

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

****

[Ensure that the cast-steel valves are certified as inspected by using the dry-powder magnetic-particle method in accordance with MSS SP-53.

][Ensure that cast-steel valves are certified as inspected by using radiographic methods in accordance with MSS SP-54.

]2.1.2.1 Type BCS-6000A

Type BCS-6000A valves are Y-body globe type, rated at 17 Megapascal 2,500 pounds, and 41 Megapascal 6,000 psi with a 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 valve wheels and handles.

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A105/A105M.

Ensure that the trim conforms to ASTM A182/A182M, Grade F6.

Provide a bronze stem bushing conforming to ASTM B148, No. C95300, heat-treated, or an approved equal.

****

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

****

[Select valves that have a full port.

][Select valves that have full or reduced ports.

] Provide a valve body with butt weld ends, except that valves 40 mm 1-1/2-inch iron pipe size (ips) and smaller may be the socket weld end type.

2.1.2.2 Type BCS-6000B

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A105/A105M.

Ensure that the trim conforms to ASTM A182/A182M, Grade F 11.

Ensure that the spring is corrosion-resistant steel.

Provide a valve body with butt weld ends, except that valves 40 mm 1-1/2 inch ips (iron pipe size) and smaller may be the socket weld end type.

2.1.2.3 Type BCS-2000A

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A105/A105M.

Ensure that the trim conforms to ASTM A182/A182M, Grade F6, or the manufacturer's standard equivalent materials for the specified service.

Provide a valve body with butt weld ends, except that valves 40 mm 1-1/2-inch ips and smaller may be the socket weld end type.

2.1.2.4 Type BCS-2000B

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A105/A105M, Class 70, or cast carbon steel conforming to ASTM A216/A216M, Grade WCB.

Ensure that the trim is the manufacturer's standard for the service.

Provide a corrosion-resistant steel spring.

Install valve body with butt weld ends, except that the forged steel

valves may be the socket weld end type up to 50 mm 2-inch ips in size.

2.1.2.5 Type BCS-2000C

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A105/A105M.

Ensure that the trim conforms to ASTM A182/A182M, Grade F6, or the manufacturer's standard equivalent materials for the specified service.

Install valve body with butt weld ends except that valves 40 mm 1-1/2-inch ips and smaller may be the socket weld end type.

2.1.2.6 Type BCS-350A

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A216/A216M, Grade WCB.

Ensure that the stem material conforms to ASTM A182/A182M, Grade F6.

****
NOTE: If valves smaller than 25 mm 1-inch ips are required, use Type BCS-2000A.
****

For a valve body in sizes 50 mm 2 inches and larger, select butt weld ends.

2.1.2.7 Type BCS-350B

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A216/A216M, Grade WCB.

Ensure that the seating materials conform to ASTM A182/A182M, Grade F6.

****
NOTE: If valves smaller than 25 mm 1-inch ips are required, use Type BCS-2000B.
****

For valve body in sizes 50 mm 2 inches and larger, select butt weld ends.

2.1.2.8 Type BCS-350C

Type BCS-350C valves are gate type, rated at 2070 kilopascal and 5100 kilopascal 300 pounds and 740 psi with a bolted bonnet, OS&Y,

hard-surfaced solid or one-piece flexible wedge disk, hard-surfaced seats, minimum 350 Brinell backseating, swing-eye gland bolts, and a malleable iron wheel.

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A216/A216M, Grade WCB.

Ensure that the stem material conforms to ASTM A182/A182M, Grade F6.

****
NOTE: If valves smaller than 25 mm 1-inch ips are required, use Type BCS-2000C.
****

For valve body in sizes 50 mm 2 inches and larger select butt weld ends.

2.1.2.9 Type SS-6000A

Type SS-6000A valves are Y-body globe type, rated at 17 Megapascal and 41 Megapascal 2,500 pounds and 6,000 psi with a seal-welded or pressure-sealed bonnet, OS&Y, hard-surfaced body-guided 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.

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A182/A182M, Grade F 316.

Ensure that the trim conforms to ASTM A182/A182M, Grade F 316.

Ensure that bronze stem bushings conform to ASTM B148, No. C95300, heat-treated.

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

[Select valves that have a full port.

][Select valves that have full or reduced ports.

] Use valve bodies with butt weld ends, except that valves 40 mm 1-1/2-inch ips and smaller may be the socket weld end type.

2.1.2.10 Type SS-6000B

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A182/A182M, Grade F 316.

Ensure that the trim conforms to ASTM A182/A182M, Grade F 316.

Provide a corrosion-resistant steel spring.

Use valve bodies with butt weld ends, except that valves 40 mm 1-1/2-inch ips and smaller may be the socket weld end type.

2.1.2.11 Type SS-2000A

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

Provide a forged carbon steel body and bonnet assembly conforming to ASTM A182/A182M, Grade F 316.

Ensure that the trim conforms to ASTM A182/A182M, Grade F 316, or the manufacturer's standard equivalent materials for the specified service.

Use valve bodies with butt weld ends, except that valves 40 mm 1-1/2-inch ips and smaller may be the socket weld end type.

2.1.3 Supporting Elements

****

NOTE: Completely detail the following on the drawings: 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 specification.

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.

****

2.1.3.1 General

Provide all necessary piping system components and miscellaneous supporting elements required, including 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. Ensure that all supporting elements are suitable for stresses imposed by system pressures and temperatures, along with natural and other external forces.

Ensure that the supporting elements are UL-approved or listed and conform to the requirements of ASME B31.3, MSS SP-58, and MSS SP-69, or ICC IPC, except as supplemented and modified by these specifications.

Code-mark and submit individual supporting element details as part of the shop drawings for all piping systems.

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

Individually bundle and tag each coded assembly with a code mark before delivery to the site.

[Provide constant supports, with travel stops where necessary, at vertically drifting piping to preclude excessive stresses at terminal points.
]

****
NOTE: On the drawings, show reactive forces (in Newton/pounds) generated by system operation that normally cannot be anticipated by device manufacturer.
****

Provide shock absorbers and sway suppressors to absorb the system reactive forces where indicated.

Ensure that the attachments welded to the pipe are of identical material to that of the pipe or of materials accepted as permissible raw materials by referenced codes or standard specification. Ensure that heat treatment for attachment stress relief is performed in a furnace allowing for controlled conditions and uniformity of temperature. The type of devices specified herein are defined in the cited MSS Standard, unless otherwise noted.

2.1.3.2 Building Structure Attachments

Provide adjustable positions for cast-in-floor mounted-equipment anchor devices.

Provide built-in masonry anchor devices, unless otherwise approved by the Contracting Officer.

Do not use powder-actuated anchoring devices to support any mechanical system components.

Use center-loading beam clamps, MSS SP-58 Type 21, 28, 29, or 30, UL-listed, catalogued and load-rated, commercially manufactured products.

Do not use C-clamps.

Construct concrete inserts in accordance with the requirements of MSS SP-58 for Type 18 and MSS SP-69. When applied to piping in sizes 50 mm 2-inch ips and larger and where otherwise required by imposed loads, insert and wire a 300 millimeter 1-foot length of 15 millimeter 1/2-inch reinforcing rod through wing slots. Proprietary-type continuous inserts may be similarly used when approved by the Contracting Officer.

2.1.3.3 Horizontal Pipe Attachments

For single pipes, wherever possible, support the piping by MSS SP-58 Type 2, Type 3, or Type 4 attachments. Pipe rolls are Type 41 or 49. Where clamps and rolls are not used, pipe supports are Type 1.

Provide spring supports in accordance with cited standards.

2.1.3.4 Vertical Pipe Attachments

Vertical pipe attachments are Type 8.

Provide spring supports in accordance with cited codes and standards.

2.1.3.5 Hanger Rods and Fixtures

Use only circular-cross-section rod hangers to connect building structure attachments to pipe support devices. Use pipe straps or bars of equivalent strength for hangers only where approved by the Contracting Officer.

Provide turnbuckles, swing eyes, and clevises as required by the support system to accommodate pipe accessibility and for adjustment to load and pitch.

2.1.3.6 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, design and fabricate such supplementary steel in accordance with AISC 325.

2.1.4 Piping Specialties

2.1.4.1 Pressure Gages

Ensure that the pressure gages conform to ASME B40.100 and to the requirements specified herein. Provide a pressure gage size of 115 millimeter 4-1/2 inches nominal diameter for system pressures less than 2500 kilopascal, and 200 millimeter 350 psi, and 8 inches nominal diameter for all higher pressures. Provide cast-aluminum cases. Equip all gages with adjustable red marking pointer and damper screw adjustment in the inlet connection. Ensure that the Bourdon tubes have a bleeding device to facilitate cleaning and bleeding the trapped gas.

Provide gage cases with a one-piece solid front with a safety-release back cover. Ensure that the windows are shatterproof glass and the gage dials are white with dual seals. Ensure that the outer scale has red markings graduated in SI units and that the inner scale has black markings graduated in psi units.

****

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

****

2.1.4.2 Receiver Gages

Install indicating gages with 150 millimeter 6-inch white background dial face and black lettering that are suitable for indicating transmitted air pressure in the range from 20 to 105 kilopascal 3 to 15 psi. Provide an adjustable micrometer pointer. Provide overload and underload stops. Ensure that the Bourdon tube and movement are AISI Type 316 and 300 series stainless steel, respectively. Ensure that the connection is 6 mm 1/4-inch ips or tube size, depending on the system makeup. Ensure that the case is black-finish cast aluminum for indicated mounting. Ensure that the accuracy is within 0.5 percent of scale range.

****

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

[Provide a gage scale range as indicated.

]2.1.4.3 Pneumatic Transmitters

Provide a nonsuppressed, nonindicating transmitter complete with sensitive relay, dual Bourdon tube-actuated motion balance system, zero and span adjustment, and accessories. Provide a weatherproof case that is kept free of foreign particulate matter by purging air and that is constructed of manufacturer's standard-finish steel base with a safety blowout disk and an aluminum cover.

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

Install phosphor bronze Bourdon tubes with brass tips and connections. Ensure that the unit inlets are screened.

Ensure Bourdon tubes, tips, and connections are AISI Type 316 corrosion-resistant steel. Ensure that the unit inlets are screened.

Ensure that the unit is self-compensating under varying ambient temperature conditions. Minimum speed of response is 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 inside diameter tubing with a time constant of 4 seconds. Ensure that the accuracy is within 0.5 percent of scale range. Ensure that the sensitivity is within 0.1 percent of pressure range.

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

Ensure that the unit range is as indicated. Provide an output range of 20 to 105 millimeter 3 to 15 psi. Provide one pneumatic transmitter for each pressure-receiver gage, unless otherwise specified.

[Provide a pipe-type pneumatic-transmitter assembly mounting.
]
****
NOTE: Select the following paragraph only after checking the specific regulator requirements. Rewrite if necessary to suit project conditions.
****

Provide the manufacturer's standard pressure-rated filter-regulator assembly and 50 millimetera 2-inch dial face for both supply air and transmitted air pressure gages.

2.1.4.4 Thermometers

Ensure that the thermometers conform to ASTM E1 and to requirements specified herein. Provide industrial-pattern thermometers Type 1, Class 3. All thermometers that are installed 1800 millimeter 6 feet or higher above the floor require an adjustable-angle body. Provide a scale that is at least 180 millimeter 7 inches long. Provide a case face manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range is as indicated. Ensure all thermometers have AISI Type 316 corrosion-resistant steel separable wells.

2.2 MATERIALS

2.2.1 Underground Piping

****

NOTE: Select the type of piping to suit project requirements.

Develop drawings that show size, rating, and other details of piping requirements not covered in the specifications for the 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 groundwater. 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 the need. Normally, a soil resistivity of 10,000 ohms or less at a pipe laying depth of 1500 millimeter 5 feet indicates need for cathodic protection.

Give special consideration to situations where dielectric coupling isolation from connected systems is not practicable due to system pressures. Check a typical manufacturing source dielectric coupling for pressure ratings. Where piping is not isolated, normal impressed current of 0.1 milliamp per 0.09 square meter square foot of surface protected will increase several fold. Check rectifier systems. Specify piles to be made up of 45 kilogram 100-pound anodes (a single 50 millimeter 2-inch outside diameter piece).

The following system pressures are for nonshock loading and are based on ASME B31.3, zero corrosion factor, welded joints, and the following materials stress values: 138 Megapascal 20,000 pounds per square inch (psi) for ASTM A106/106M and ASTM A312/A312M, Grade TP 316 or TP 347. Reduce system pressures if the largest specified pipe size is increased, if service temperatures are increased over 38 degrees C, 100 degrees F, or if alloy specifications are changed.

Materials for piping systems with pressures to 69 Megapascal at 38 degrees C 10,000 psi at 100 degrees F may be specified in accordance with MSS SP-75 and MSS SP-65. The same specification may be used for 41 Megapascal 6,000 psi systems with pipe sizes larger than 80 mm 3 inches.

The following materials specifications do not take into account material temperatures less than minus 29 degrees C 20 degrees F. Pipe trade regards seamless piping in sizes less than 50 mm 2 inches as tubing. Tubing sources are limited and tubing costs in small quantities may range from 3 to 5 times pipe costs. Project costs frequently should be reduced and deliveries improved by oversizing lines to be cataloged as piping.

The operating temperature limit of Type BCS-PS and Type SS-PS pipe is 66 degrees C 150 degrees F and is limited by the polyethylene sheath and adhesive.

****

2.2.1.1 Type BCS-PS-6000

For pipe or tube 13 mm through 80 mm 1/2 through 3 inches, provide XXS, seamless, black carbon steel conforming to ASTM A106/A106M, Grade B and ASME B36.10M, sheathed with thermoplastic (polyethylene).

For fittings 13 mm through 40 mm: 62 Megapascal 1/2 through 1-1/2 inches: 9,000-pound, provide socket-welded, forged carbon steel conforming to ASTM A105/A105Mand ASME B16.11

For fittings 13 mm through 40 mm: 62 Megapascal 2 through 3 inches, provide XXS, long-radius, butt-welded, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

For thermoplastic sheaths for pipe and fittings, ensure that sheath joints with thermally fitted shrinking sleeves are applied with factory-approved shrinking devices. Make taped fitting protection and repairs in accordance with the manufacturer's instructions. Electrical flaw detection testing at the factory requires 10,000 volts to be impressed across the sheath. Sheath breakdown voltage cannot be less than 13,000 volts.

2.2.1.2 Type BCS-PS-2000

For pipe or tube 13 mm through 80 mm 1/2 through 3 inches, provide Schedule 40, seamless, black carbon steel conforming to ASTM A106/A106M, Grade B, and ASME B36.10M, sheathed with thermoplastic (polyethylene).

For fittings 13 mm through 80 mm: 20 Megapascal 1/2 through 1-1/2 inches: 3,000-pound, provide socket-welded, forged carbon-steel, conforming to ASTM A105/A105M, and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide Schedule 40, long-radius, butt-weld, black carbon-steel conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

For thermoplastic sheaths for pipe and fittings, ensure that sheath joints with thermally fitted shrinking sleeves are applied with factory-approved shrinking devices. Make taped fitting protection and repairs in accordance with the manufacturer's instructions. Electrical flaw detection testing at the factory requires 10,000 volts to be impressed across the sheath. Sheath breakdown voltage cannot be less than 13,000 volts.

2.2.1.3 Type BCS-PS-350

For pipes or tubes 13 mm through 610 mm 1/2 through 24 inches, provide Schedule 40, seamless, black carbon-steel conforming to ASTM A106/A106M, Grade B, and ASME B36.10M sheathed with thermoplastic (polyethylene).

For fittings 13 mm through 80 mm: 20 Megapascal 1/2 through 1-1/2 inches: 3,000-pound, provide socket-welded, forged carbon steel fittings, conforming to ASTM A105/A105M and ASME B16.11.

For fittings 50 mm through 610 mm 2 through 24 inches, provide Schedule 40, long-radius, butt-welded, black carbon-steel conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

For thermoplastic sheaths for pipe and fittings, ensure that sheath joints with thermally fitted shrinking sleeves are applied with factory-approved shrinking devices. Make taped fitting protection and repairs in accordance with the manufacturer's instructions. Electrical flaw detection testing at the factory requires 10,000 volts to be impressed across the sheath. Sheath breakdown voltage cannot be less than 13,000 volts.

2.2.1.4 Type SS-PS-6000

For pipes or tubes 13 mm through 80 mm 1/2 through 3 inches, provide XXS, seamless, corrosion-resistant steel conforming to ASTM A312/A312M, Grade TP 316, and ASME B36.19M, sheathed with thermoplastic (polyethylene).

For fittings 13 mm through 40 mm: 62 Megapascal 1/2 through 1-1/2 inches: 9,000-pound, provide socket-welded, forged, corrosion-resistant steel conforming to ASTM A182/A182M, Grade F 316, and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide XXS, long-radius, butt-welded, corrosion-resistant steel conforming to ASTM A403/A403M, WP 316, and ASME B16.9.

For thermoplastic sheaths for pipe and fittings, ensure that sheath joints with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Make taped fitting protection and repairs in accordance with the manufacturer's instructions. Electrical flaw detection testing at the factory requires 10,000 volts to be impressed across the sheath. Sheath breakdown voltage cannot be less than 13,000 volts. Use adhesives that do not contain free chloride ions.

2.2.1.5 Type SS-PS-2000

For pipes or tubes 13 mm through 80 mm 1/2 through 3 inches, provide Schedule 40S, seamless, corrosion-resistant steel conforming to ASTM A312/A312M, Grade TP 316, sheathed with thermoplastic (polyethylene).

For fittings 13 mm through 40 mm: 20 Megapascal 1/2 through 1-1/2

inches: 3,000-pound, provide socket-welded, forged, corrosion-resistant steel conforming to ASTM A182/A182M, Grade F 316, and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide Schedule 40S, long-radius butt-welded, corrosion-resistant steel conforming to ASTM A403/A403M, and WP 316, and ASME B16.9, sheathed with thermoplastic (polyethylene).

For thermoplastic sheaths for pipe and fittings, ensure that sheath joints with factory-approved shrinking sleeves are applied with factory-approved shrinking devices. Make taped fitting protection and repair in accordance with the manufacturer's instructions. Electrical flaw detection testing at the factory requires 10,000 volts to be impressed across the sheath. Sheath breakdown voltage cannot be less than 13,000 volts. Use adhesives that do not contain free chloride ions.

2.2.1.6 Type SS-PS-350

For pipes or tubes 13 mm through 250 mm 1/2 through 10 inches, provide Schedule 40, seamless, corrosion-resistant steel conforming to ASTM A312/A312M, Grade TP 316, and ASME B36.19M, sheathed with thermoplastic (polyethylene).

For fittings 13 mm through 40 mm: 20 Megapascal 1/2 through 1-1/2 inches: 3,000-pound, provide socket-welded, forged corrosion-resistant steel conforming to ASTM A182/A182M, Grade F316, and ASME B16.11.

For fittings 50 mm through 610 mm 2 through 24 inches, provide Schedule 40, long-radius, butt-welded, corrosion-resistant steel conforming to ASTM A403/A403M, WP 316, and ASME B16.9.

For thermoplastic sheaths for pipe and fittings, ensure that sheath joints with thermally fitted shrinking sleeves are applied with factory-approved shrinking devices. Make taped fitting protection and repairs in accordance with the manufacturer's instructions. Electrical flaw detection testing at the factory requires 10,000 volts to be impressed across the sheath. Sheath breakdown voltage cannot be less than 13,000 volts. Use adhesives that do not contain free chloride ions.

2.2.2 Aboveground Piping

****

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 the following allowable stress values for materials: 138 Megapascal 20,000 psi for ASTM A106/A106M and ASTM A312/A312M, Grade TP316 or TP347. Reduce system pressure if the largest specified pipe size is increased, if service temperatures are increased (over 38 degrees C 100 degrees F), or if alloy specifications are changed.

Materials for piping systems with pressures up to 69 Megapascal at 38 degrees C 10,000 psi at 100 degrees F may be specified in accordance with MSS SP-75 and MSS SP-65. The same specifications may be used for

41.3 megapascal 6,000 psi systems with pipe size larger than 80 mm 3 inches.

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

****

2.2.2.1 Type BCS-6000

For pipes or tubes 13 mm through 80 mm 1/2 through 3 inches, provide XXS, seamless, black carbon steel conforming to ASTM A106/A106M, Grade B, and ASME B36.10M.

For fittings 13 mm through DN4: 62 Megapascal 1/2 through 1-1/2 inches: 9,000-pound, provide socket-welded, forged carbon-steel conforming to ASTM A105/A105M and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide XXS, long-radius, butt-welded, black carbon-steel conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

Provide 17 and 41 Megapascal 2,500-pound, 6,000-pounds-per-square-inch (psi) forged carbon steel welding neck flanges conforming to ASTM A105/A105M and ASME B16.5, with raised face and concentric serrated finish.

Provide gaskets that are spiral-wound, nonasbestos-filled, carbon-steel, with centering provisions, conforming to ASME B16.5, Group 1.

Provide alloy-steel bolt studs conforming to ASTM A193/A193M, Grade B7, and semifinished heavy hexnuts conforming to ASTM A194/A194M, Grade 2H.

2.2.2.2 Type BCS-2000

For pipes or tubes 6 mm through 80 mm 1/8 through 3 inches, provide Schedule 40, seamless, black carbon-steel conforming to ASTM A106/A106M, Grade B, and ASME B36.10M.

For fittings 6 mm through 40 mm: 20 Megapascal 1/8 through 1-1/2 inches: 3,000-pound, provide socket-welded, forged carbon steel conforming to ASTM A105/A105M, and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide Schedule 40, long-radius, butt-welded, black carbon steel conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

Provide 25 mm through 80 mm: 6200 kilopascal, 14890 kilopascal 1 through 3 inches: 900-pound, 2,160-psi forged carbon steel, welding neck flanges conforming to ASTM A105/A105M and ASME B16.5, with raised face and concentric serrated finish.

Provide alloy-steel bolt studs con-forming to ASTM A193/A193M, Grade B7, and semifinished heavy hex nuts conforming to ASTM A194/A194M, Grade 2H.

2.2.2.3 Type BCS-350

For pipes or tubes 6 mm through 25 mm 1/8 through 10 inches, provide Schedule 40, seamless, black carbon steel, conforming to ASTM A106/A106M,

Grade B, and ASME B36.10M.

For fittings 6 mm through 40 mm: 20 Megapascal 1/8 through 1-1/2 inches: 3,000-pound, provide socket-welded, forged carbon steel conforming to ASTM A105/A105M, ASME B16.11.

For fittings 50 mm through 250 mm 2 through 10 inches, provide Schedule 40, long-radius, butt-welded, black carbon steel conforming to ASTM A234/A234M, Grade WPB and ASME B16.9.

Provide 25 mm through 250 mm: 2070 kilopascal, 5000 kilopascal 1 through 10 inches: 300-pound, 720 psi, forged carbon steel welding neck flanges conforming to ASTM A181/A181M, Class 70 and ASME B16.5, with raised face and concentric serrated finish.

Provide gaskets that are spiral-wound, nonasbestos-filled materials, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1.

Provide heavy hex-head carbon steel bolts or bolt studs conforming to ISO 898-1 ASTM A307, and semifinished heavy hex nuts conforming to ASTM A563M ASTM A563, Grade A. Square-head bolts are not acceptable.

2.2.2.4 Type SS-6000

For pipes or tubes 13 mm through 80 mm 1/2 through 3 inches, provide XXS, seamless, corrosion-resistant steel, conforming to ASTM A312/A312M, Grade TP 316, and ASME B36.10M.

For fittings 13 mm through 40 mm: 62 Megapascal 1/2 through 1-1/2 inches: 9,000-pound, provide socket-welded, forged corrosion-resistant steel conforming to ASTM A182/A182M, Grade F 316, and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide XXS, long-radius, butt-welded, corrosion-resistant steel conforming to ASTM A403/A403M, WP 316, ASME B16.9, and ASME B36.10M.

Provide 25 mm through 80 mm: 17 Megapascal, 41 Megapascal 1 through 3 inches: 2,500-pound, 6,000-psi, forged corrosion-resistant steel, welding neck flanges conforming to ASTM A182/A182M, Grade F 316, and ASME B16.5, with raised face and concentric serrated finish.

Provide gaskets that are spiral-wound, chloride-ion-free, nonasbestos-filled, corrosion-resistant steel conforming to ASME B16.5, Group 1, with centering provisions.

Provide alloy-steel bolt studs conforming to ASTM A193/A193M, Grade B8, and semifinished heavy hex nuts conforming to ASTM A194/A194M, Grade 8F.

2.2.2.5 Type SS-2000

For pipes or tubes, provide Schedule 40S seamless, corrosion-resistant steel conforming to ASTM A312/A312M, Grade TP 316, and ASME B36.19M.

For fittings 13 mm through 40 mm: 20 Megapascal 1/2 through 1-1/2 inches: 3,000-pound, provide socket-welded, forged corrosion-resistant steel conforming to ASTM A182/A182M, Grade F 316, and ASME B16.11.

For fittings 50 mm through 80 mm 2 through 3 inches, provide Schedule 40S, long-radius, butt-welded, corrosion-resistant steel conforming to

ASTM A403/A403M, WP 316, and ASME B16.9, and ASME B36.19M.

Provide 25 mm through 80 mm: 6200 kilopascal, 15 Megapascal 1 through 3 inches: 900-pound, 2,160-psi, forged corrosion-resistant steel welding neck flanges conforming to ASTM A182/A182M, Grade F 316 and ASME B16.5, with raised face and concentric serrated finish.

Provide gaskets that are spiral-wound, chloride-ion-free, nonasbestos-filled, corrosion-resistant steel conforming to ASME B16.5, Group 1, with centering provisions.

Provide corrosion-resistant steel bolt studs conforming to ASTM A193/A193M, Grade B8, and semifinished heavy hex nuts conforming to ASTM A194/A194M, Grade 8A.

2.2.2.6 Type SS-350

For pipes or tubes 13 mm through 250 mm 1/2 through 10 inches, provide Schedule 40S, seamless, corrosion-resistant steel conforming to ASTM A312/A312M, Grade TP 316, and ASME B36.19M.

For fittings 13 mm through 25 mm: 20 Megapascal 1/2 through 1 inch: 3,000-pound, provide socket-welded, forged corrosion-resistant steel conforming to ASTM A182/A182M, Grade F 316, and ASME B16.11.

For fittings 25 mm through 250 mm 1 through 10 inches, provide Schedule 40, long-radius, butt-welded, corrosion-resistant steel conforming to ASTM A403/A403M, WP 316, and ASME B16.9.

Provide 25 mm through 250 mm: 2070 kilopascal, 5000 kilopascal 1 through 10 inches: 300-pound, 720-psi, forged corrosion-resistant steel welding neck flanges conforming to ASTM A182/A182M, Grade F 316, and ASME B16.5, with raised face and concentric serrated finish.

Provide gaskets that are spiral-wound, chloride-ion-free nonasbestos-filled, corrosion-resistant steel conforming to ASME B16.5, Group 1, with centering provisions.

Provide heavy hex-head, corrosion-resistant steel bolts or bolt studs conforming to ASTM A193/A193M, Grade B8, and semifinished, heavy hex nuts conforming to ASTM A194/A194M, Grade 8A. Square-head bolts are not acceptable.

2.2.3 Miscellaneous Materials

2.2.3.1 Bolting

For general-purpose bolting, use hex-head bolts conforming to ISO 898-1 ASTM A307. Ensure that heavy hex nuts conform to ASME B18.2.6 ASME B18.2.2. Square-head bolts and nuts are not acceptable.

2.2.3.2 Elastomer Caulk

Use a two-component, polysulfide- or polyurethane-base, elastomer caulking material conforming to ASTM C920.

2.2.3.3 Escutcheons

Manufacture chrome-plated escutcheons from nonferrous metals except when

AISI 300 series corrosion-resistant steel is provided. Ensure that the metals and finish conform to FS WW-P-541.

Use one-piece or split-pattern escutcheons. Ensure that the escutcheons have provisions for internal spring-tension devices or setscrews to maintain a fixed position against a surface.

2.2.3.4 Flashing

Provide sheet lead conforming to ASTM B749, Grade B, C, or D, and weighing not less than 20 kilogram per square meter 4 pounds per square foot.

Provide sheet copper conforming to ASTM B370, and weighing not less than 4.8 kilogram per square meter 16 ounces per square foot.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 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.

****

Fabricate and install piping systems in accordance with the requirements of the following codes and standards except as supplemented and modified by these specifications:

a. ASME B31.3

b. MSS SP-69

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

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

Strict compliance is 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 supersede code and standards requirements.

Ensure that the installation of piping systems materials conforms to the published or written instructions of the manufacturer for the project application except as otherwise specified herein.

When proposing to deviate from specified instructions, submit the proposed deviation to the Contracting Officer for approval.

Conduct work in the presence of the Contracting Officer. Notify the Contracting Officer 48 hours before start of the work.

Ensure that piping is permanently identified in accordance with PFI ES 11. Locate identification at points designated by the Contracting Officer and ensure that identification is marked legibly and conspicuously with yellow fluorescent aerosol paint.

Coordinate the exact location of piping among trades so that there is no interference with lighting fixtures, piping, ducts, or other construction.

Fabricate pipe to measurements established on the job, and carefully work the piping into place without springing or forcing. Make adequate provision 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 the pipe bore; use phosphoric acid rust-preventive treatment.

****

Ensure that pipes, tubing, fittings, valves, equipment, and accessories are clean and free of all foreign material before installed in their respective systems. Clean pipe by hammering, shaking, or swabbing, or by a combination of those methods. Purge lines with dry, oil-free compressed air after erection, but do not rely on purging for removing all foreign matter. Purge the lines at a velocity in excess of the maximum normal-flow velocity and as approved by the Contracting Officer. During the progress of construction, properly protect open ends of pipes, fittings, and valves at all times to prevent the admission of foreign matter. Place plugs and caps in the ends of installed work at all times, except when connections are being made. Provide commercially manufactured plugs and caps, unless otherwise approved by the Contracting Officer.

3.1.2 Underground Piping Systems

Install compressed-air systems in accordance with the requirements specified herein.

Ensure that the excavations are dry and clear of extraneous materials when pipe is being laid.

Blocking and wedging of the pipe is not permitted.

****

NOTE: Indicate on drawings the underground piping requiring support from slabs.

****

For underground piping that is below a supported or suspended slab, support the pipe from the slab with a minimum of two supports per length of pipe. Protect supports with a coating of bitumen.

****

NOTE: Coordinate the following two paragraphs with drawings.

****

Pipes passing through walls below grade and the ground floor slab require pipe sleeves as indicated.

Where pipe penetrates earth or concrete grade, expose to view at least 300 millimeter 12 inches of polyethylene-coated Type BCS-PS pipe. Provide additional piping protection for concrete penetration points as indicated.

Install Type BCS-PS materials in accordance with the applicable requirements specified herein for underground piping and aboveground piping. Palletize pipe in padded pallets at the factory and handle from pallet to final position with padded gear. Protect surfaces from the sun with black polyethylene sheeting. Before lowering pipe into a trench, check sheeting for continuity with 10,000 volts applied by a continuity detector with an audible alarm. In the trench, after joints and fittings are made, check previously untested surfaces for continuity. Where discontinuities in thermoplastic sheeting are found, remove and replace at least 300 millimeter 12 inches of material upstream and downstream of the fault.

Distinctly mark and promptly remove defective materials from the site.

3.1.3 Aboveground Piping Systems

****

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

****

Install piping straight and true with approved offsets around obstructions, expansion bends, or fitting offsets and as necessary to increase headroom or to avoid interference with the building construction, electric conduit, or facilities equipment.

****

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

****

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

Provide horizontal piping with a grade of 25 millimeter per 30.5 meter 1 inch per 100 feet.

Use eccentric reducers where required to permit proper drainage of pipe lines. Bushings are not permitted for this purpose. Provide drain valves where indicated.

Install piping in a manner that prevents stresses and strains from being imposed upon connected equipment.

3.1.3.1 Pipe Bending

Configure expansion bends as indicated. Construct expansion U-bends that are cold-sprung and welded into the line. Anchor the expansion U-bend before removing the spreader. Ensure that the amount of cold spring is as indicated.

Use standard long-sweep pipe fittings for changes in direction. No mitered joints or unapproved pipe bends are permitted.

Shop-make pipe bends by the sand-filled, hot-bending process provided:

a. Bend radius is not less than 6 times the nominal pipe diameter.

b. Fabrication tolerances are in accordance with PFI ES 3 for the applicable wall thickness.

c. Preheat and postheat treatment procedures, where applicable, are in accordance with cited standards.

d. After bending operations, piping is cleaned with a turbine cutter assembly followed by shot or sand-blasting

e. All operations are performed to preclude detrimental wall thickness reduction.

f. The fabricating shop is a member of the Pipe Fabricating Institute and is approved by the Contracting Officer.

3.1.3.2 Joints

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

Ensure that field-welded joints conform to the requirements of the AWS WHB-2.9 and ASME B31.3.

[Piping systems rated at 14 Megapascal 2,000 psi and higher require butt weld joints made with consumable insert rings, using inert-gas tungsten-arc root pass welding together with inert-gas purging of inside diameter of pipe. Ensure that consumable insert ring materials are compatible with all materials being joined. Ensure that joint configuration conforms to PFI ES 21. Provide root pass joint preheat treatment at temperatures necessary to avoid cracking.

][Piping systems rated at 2400 kilopascal 350 psi and lower require butt weld joints made with backing rings. Ensure that the backing ring materials are compatible with materials being joined. Ensure that the joint configuration conforms to ASME B16.25.
]

****
NOTE: before selection of one of the following two paragraphs, review requirements of ASME B31.3, and ASME BPVC SEC IX to avoid conflict and redundancy.
****

[Perform preheat and postheat treatment of welds in accordance with

ASME BPVC SEC IX.

][Perform preheat and postheat treatment of welds in accordance with ASME B31.3.

] Assemble flanged joints with appropriate flanges, gaskets, and bolting. Create sufficient clearance between flange faces to ensure that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Ensure that flange faces are parallel and the bores concentric; center gaskets on the flange faces without projecting into the bore. Lubricate bolting with oil and graphite before assembly to ensure uniform bolt stressing. Draw up and tighten flange bolts in staggered sequence in order to prevent unequal gasket compression and deformation of the flanges. After testing the piping system, retighten bolts to provide required gasket stress.

3.1.3.3 Supporting Elements Installation

Provide supporting elements in accordance with the requirements of cited codes and standards, except as supplemented or modified herein.

Hang piping from building construction. Hang no piping from the roof deck or from other piping.

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

Embed fish plates in the concrete to transmit hanger loads to the reinforcing steel where hanger rods exceed 22 millimeter 7/8 inch in diameter.

Construct masonry anchors selected for overhead applications of ferrous materials only.

Pneumatic tools are not allowed. Select percussive-action electric hammers, and combination rotary-electric hammers used for the installation of self-drilling anchors in accordance with the following guide:

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

b. Anchor devices, with nominal sizes M6 5/8 inch and larger, hammer-type only, rated at load to draw not more than 8.0 amperes when operating on 120-volt, 60-hertz power. Ensure that combination rotary-hammer tools on the same power supply 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**

****

Size the inserts and anchors for the total stress applied. Use a safety factor as required by applicable codes, but in no case have a safety factor of less than 4. Submit complete shop drawings.

Insert anchor devices into concrete sections at least twice the overall length of the device, and locate the anchor devices at least 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, the center-to-center distance may be reduced to 50 percent of the given distance, provided that the load on the device is reduced in direct proportion to the reduced distance.

Run new piping parallel with the lines of the building. Space and install the piping and components so that there is at least 15 millimeter 1/2 inch of clear space between the finished surface and other work and between the finished surfaces of parallel adjacent piping.

For installation of parallel pipe runs, allow for a tool space around mechanical connections. Where it is necessary to avoid any transfer of load from support to support or onto connecting equipment, use constant-support pipe hangers.

Weld anchors and pipe-alignment guides to the piping in accordance with requirements specified herein, and attach them to the building structure in a manner indicated or approved by the Contracting Officer.

Brace piping against reaction, sway, and vibration. Bracing consists of hydraulic and spring devices, brackets, anchor chairs, rods, and structural steel.

Locate pipe lines, when supported from roof purlins, not greater than one-sixth of the purlin span from the roof truss. The load per hanger cannot exceed 1800 Newton 400 pounds when support is from a single purlin, or 3600 Newton 800 pounds when a hanger load is applied 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 is 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, furnish and install reinforcing of the roof purlins or additional support beam(s). When an additional beam is used, ensure that the beam bears on the top chord of the roof trusses, and the bearing is over the gusset plates of the top chord. Stabilize the beam by connection to the roof purlin along the bottom flange.

Install hangers and supports for piping 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 the following intervals for project materials application that is permissible for combined bending and shearing stresses.

****

Base the load rating for all pipe hanger supports on weight and forces imposed on all lines. Deflection per span cannot exceed the slope gradient of the pipe. Ensure that Schedule 40 and heavier pipe supports are in accordance with the following minimum rod size and maximum allowable hanger spacing; concentrated loads reduce the allowable span proportionately:

PIPE SIZE MILLIMETER (DN)	ROD SIZE MILLIMETER	HANGER SPACING MILLIMETER
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

PIPE SIZE INCHES	ROD SIZE INCHES	HANGER SPACING FEET
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

Support vertical risers independently of connected horizontal piping wherever practical, and guide for lateral stability. Provide only one rigid support for risers subject to expansion.

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

3.1.3.4 Sound Stopping

Provide effective sound stopping and adequate operating clearance to prevent structure contact where pipes penetrate walls, floors, or ceilings. Where penetrations occur from pipe chases into occupied spaces, provide a special acoustic treatment of the ceiling. Occupied spaces include space above ceilings where no special acoustic treatment of ceiling is provided. Ensure the penetrations are compatible with the surface being penetrated.

Lead wool and viscoelastic damping compounds may be proposed for use where other sound-stopping methods are not practical, provided that the temperature and fire resistance characteristics of the compound are suitable for the service.

3.1.3.5 Sleeves

****
NOTE: Specify any sound-stopping requirements in this section.
****

Supply and install sleeves where the piping passes through roofs, through masonry or concrete walls, and through floors.

Where pipe sleeves are required after slabs and masonry are installed, make holes to accommodate these sleeves with core drills. Set sleeves in place with a two-component epoxy adhesive system approved by the Contracting Officer. Ensure that no load is carried by such sleeves unless approved by the Contracting Officer.

Install sleeves flush with ceilings and where indicated.

Install sleeves flush with the floor in finished spaces, and extend 50 millimeter sleeves 2 inches above the floor in unfinished spaces.

Continuously weld or braze sleeves passing through steel decks to the deck.

For sleeves extending through floors, roofs, load-bearing walls, and fire barriers, ensure that the sleeves are continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Form other sleeves from molded linear polyethylene liners or similar removable materials. Ensure that the diameter of the sleeve is large enough to accommodate the pipe, isolation, and sealing materials with a minimum of 10 millimeter 3/8-inch clearance. Install the sleeves to accommodate the mechanical and thermal motion of pipe.

Pack solid the space between a pipe and the inside of a pipe sleeve, or a construction surface penetration, with a mineral fiber conforming to ASTM C553, 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, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer caulk to a depth of 15 millimeter 1/2 inch. Ensure that all caulked surfaces are oil- and grease-free.

Caulk the exterior wall sleeves watertight with lead and oakum or

mechanically expandable chloroprene inserts with mastic-sealed metal components.

3.1.3.6 Escutcheons

Provide escutcheons at all pipe penetrations into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, provide plates at the underside only of such ceilings. In all occupied spaces, provide chrome-plated escutcheons that fully conceal openings in building construction. Firmly attach all escutcheons, preferably with setscrews.

3.1.3.7 Flashings

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

Provide all required flashings where mechanical systems penetrate building boundaries as indicated.

3.2 FIELD QUALITY CONTROL

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

Determine whether system supports are adequate for loads normal to specified hydrostatic testing.
****

3.2.1 System Pressure Test

Before acceptance of the work, pressure-test the completed systems in the presence of the Contracting Officer.

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

[Perform pneumatic tests using dry, oil-free compressed air, carbon dioxide, or nitrogen as specified for the system under test. Conduct pressure testing in two stages; i.e. preliminary and acceptance.

][Perform hydrostatic tests. Use only potable water for testing. The Government will supply testing water at a location determined by the Contracting Officer, but the Contractor is responsible for the approved disposal of contaminated water. Ensure that the temperature of the water used for testing does not cause condensation on system surfaces. Provide supplementary heat if necessary.

] Do not perform pressure tests in excess of 34 kilopascal 5 psi until personnel not directly involved in the tests are evacuated from the area.

Contractor may conduct tests for its own purposes, but preliminary tests and acceptance tests are conducted as specified herein.

****

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

****

System testing includes 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, isolate and repair the leaks, replace defective materials where necessary, and retest the system until specified requirements are met. Remake leaking gasket joints with new gaskets and new flange bolting. Do not use removed bolting and gaskets again.

****

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

****

Regardless of the amount of measured leakage, immediately repair visible leaks or defects in the pipeline.

Only use standard piping flanges, plugs, caps, and valves for sealing off piping for test purposes.

****

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

****

Vent compressed air trapped during high-pressure hydrostatic testing 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, in order to verify that water has reached all parts of the system.

Remove components from piping systems before testing whenever the component would otherwise sustain damage due to test pressure.

Check piping system components such as valves for proper operation under system test pressure.

Add no test media to a system during a test for a period as specified or to be determined by the Contracting Officer.

The test duration will be determined by the Contracting Officer. Test may be terminated by direction of the 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 the following paragraph only when

hydrostatic testing is specified.
****

Upon completion of testing, drain the dry piping system and purge it with dry air. Verify system dryness by hygrometer comparison with purging air.

3.2.1.1 Acceptance Pressure Testing

Conduct testing during steady ambient temperature conditions.

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

[_____]

3.2.1.2 Test Report

Prepare, maintain, and submit test records of piping systems tests for approval. Ensure that records 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. Deliver two [_____] record copies to the Contracting Officer after acceptance.

3.2.2 Test Gages

Ensure that the test gages conform to ASME B40.100 and have a dial size 200 millimeter 8 inches or larger. The maximum permissible scale range for a given test is such that the pointer has a starting position at midpoint of the dial or within the middle third of the scale range. Ensure that the certification of accuracy and correction table bear a date within 90 calendar days before the test date and show the test gage number and the project number, unless otherwise approved by the Contracting Officer.

3.2.3 Support Element Testing

Test systems containing hydraulic or spring shock absorbers for the ability to accommodate system forces by manipulation of system components as directed by the Contracting Officer. Include results with the piping system test report.

-- End of Section --