****
USACE / NAVFAC / AFCESA / NASA **UFGS-40 18 00.00 40 (February 2011)**

Preparing Activity: NASA **Superseding**
UFGS-40 18 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2011
****

SECTION TABLE OF CONTENTS

DIVISION 40 - PROCESS INTEGRATION

SECTION 40 18 00.00 40

VACUUM SYSTEMS PROCESS PIPING

02/11

****
USACE / NAVFAC / AFCESA / NASA | UFGS-40 18 00.00 40 (February 2011)

Preparing Activity: NASA | Superseding
UFGS-40 18 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2011
****

SECTION 40 18 00.00 40

VACUUM SYSTEMS PROCESS PIPING
02/11

****
NOTE: This specification covers the requirements for aboveground low-vacuum systems defined for the purposes of this section as systems at pressures less than atmospheric and ranging to approximately 100 kilopascal (29.5 inches of mercury), 1.734 kilopascal (0.25144 psi) or 13 millimeter of mercury 29.5 inches of mercury vacuum or the approximately absolute; 0.25144 pound per square inch, absolute, 13,000 microns of mercury absolute, or 13 torr.

Drawings must 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.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(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

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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

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

****

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 314	(1990; R 2008) Standard Specification for Steel Anchor Bolts

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

ANSI/AISC 360	(2005) Specification for Structural Steel Buildings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C207	(2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C208	(2007; Errata 2009) Standard for Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C504	(2006; R 2010) Standard for Rubber-Seated Butterfly Valves

AMERICAN WELDING SOCIETY (AWS)

AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.22	(2001; R 2010) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.3	(2006) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.1	(2010) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Standard for Square and Hex Nuts
ASME B31.1	(2007; Addenda a 2008; Addenda b 2009) Power Piping
ASME B31.3	(2008) Process Piping
ASME B40.100	(2005) Pressure Gauges and Gauge Attachments
ASME B46.1	(2009) Surface Texture, Surface Roughness, Waviness and Lay

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2010) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 139/A 139M	(2004; R 2010) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A 181/A 181M	(2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A 183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 197/A 197M	(2000; R 2006) Standard Specification for Cupola Malleable Iron
ASTM A 216/A 216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 234/A 234M	(2010a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 351/A 351M	(2010) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A 436	(1984; R 2006) Standard Specification for Austenitic Gray Iron Castings
ASTM A 53/A 53M	(2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 694/A 694M	(2008) Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
ASTM B 148	(1997; R 2009) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B 164	(2003; R 2008) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B 280	(2008) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 370	(2009) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B 62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 749	(2003; R 2009) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C 592	(2010) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 920	(2010) Standard Specification for Elastomeric Joint Sealants
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM E 1	(2007) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM F 1120	(1987; R 2010) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications

ASTM F 147	(1987; R 2009) Standard Test Method for Flexibility of Non-Metallic Gasket Material
ASTM F 568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

FLUID SEALING ASSOCIATION (FSA)

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

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST-STD-CC1246D	(2002) Product Cleanliness Levels and Contamination Control Program

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

MSS SP-104	(2003) Wrought Copper Solder Joint Pressure Fittings
MSS SP-43	(2008; Errata 2010) Wrought Stainless Steel Butt-Welding Fittings
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2002a) Butterfly Valves
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-72	(2010) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2006) Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-86	(2009) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-C-6183	(1998; R 2007) Cork and Rubber Composition Sheet; for Aromatic Fuel and Oil Resistant

Gaskets

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-L-25567	(2005; Rev E; Notice 1) Leak Detection Compound, Oxygen Systems (Metric)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

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

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-02 Shop Drawings

Submit Detail Drawings in accordance with paragraph entitled,

"General Requirements," of this section.

Submit installation drawings for low-vacuum piping systems in accordance with paragraph entitled, "Aboveground Piping Systems Installation," of this section.

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Aboveground Piping Materials

Valves

Miscellaneous Materials

Supporting Elements

SD-06 Test Reports

Submit test reports for the following items showing Government and Contractor test personnel responsibilities, dates, test gage identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates.

Hydrostatic Tests

Leakage Tests

SD-07 Certificates

Submit certificates for the following items showing conformance with the referenced standards contained in this section.

Aboveground Piping Materials

Valves

Miscellaneous Materials

Supporting Elements

1.3 GENERAL REQUIREMENTS

****
NOTE: If Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS is not included in the project specification, applicable requirements therefrom should be inserted and the first paragraph deleted. If Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT is not included in the project specification, applicable requirements therefrom should be inserted and the second paragraph deleted. If Section 40 17 30.00 40 WELDING GENERAL PIPING is not included in the project specification, applicable requirements therefrom should be inserted and the third paragraph deleted.
****

[Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS apply to work specified in this section.]

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

[Section 40 17 30.00 40 WELDING GENERAL PIPING applies to work specified in this section.]

Detail drawings must include the manufacturer's design and construction calculations, the forces required to obtain rated axial and lateral movements, installation criteria, anchor and guide requirements, and all other pertinent data required for evaluation of proposed equipment. Drawings must specifically call out the procedures to be followed and provisions required to protect expansion joints during specified testing operations.

In lieu of separate hangers, the Contractor may submit for approval a detail drawing of proposed trapeze hangers with turnbuckles on rods and a solid or split-ring clamp for each pipe.

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

****
NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS are MANDATORY for all [NASA] [_____] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS for additional information regarding cost feasibility of PT&I.
****

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

PART 2 PRODUCTS

2.1 ABOVEGROUND PIPING MATERIALS

****
NOTE: Coordinate indicated and specified vacuum and pressure ratings with test criteria.

****

2.1.1 Vacuum Systems To 100 Kpa 29.5 Inches Of Mercury Vacuum

Type BCS: Black carbon steel

Pipe DN6 through DN30 1/8 inch through 1-1/2 inches: Schedule 40, furnace butt weld, black carbon steel, conforming to ASTM A 53/A 53M, Type F

Pipe DN50 through DN200 2 through 8 inches where indicated: Schedule 40, seamless (Type 5) or electric (Type E) resistance-welded, black carbon steel, conforming to ASTM A 53/A 53M, Grade B, Type [E] [S]. Grade A should be used for permissible field bending.

Fittings DN50 2 inches and under: 1050 kilopascal 150-pounds per square inch, gage (psig) working steam-pressure (wsp), banded, black malleable iron, screwed, conforming to ASTM A 197/A 197M, ASTM A 234/A 234M and ASME B16.3

Unions DN50 2 inches and under: 1724 kilopascal 250-psig wsp, female, screwed, black malleable iron, with brass to iron seat and ground joint, conforming to ASME B16.39 and MSS SP-83

Couplings DN50 2 inches and under: Standard weight, screwed, black carbon steel

Fittings DN65 2-1/2 inches and over: Steel, butt weld, conforming to MSS SP-43, ASTM A 234/A 234M and ASME B16.9

Flanges DN65 2-1/2 inches and over: 1050 kilopascal 150-psig wsp, forged steel, welding neck, to match pipe wall thickness, conforming to ASME B16.5 and ASTM A 694/A 694M

Grooved pipe couplings and fittings DN65 2-1/2 inches and over: Contractor has the option of using malleable iron couplings and fittings conforming to requirements specified under "Grooved Pipe Couplings and Fittings" in this section

Type GCS: Galvanized carbon steel

Pipe DN6 through DN40 1/8 inch through 1-1/2 inches: Schedule 40, furnace butt weld, black carbon steel, conforming to ASTM A 53/A 53M, Type F

Pipe DN50 through DN200 2 through 8 inches where indicated: Schedule 40, seamless or electric resistance welded, galvanized steel, conforming to ASTM A 53/A 53M, Grade B, Type E or S

Fittings DN200 and under: 1050 kilopascal 8 inches and under: 150-psig wsp, banded, galvanized, malleable iron, screwed, conforming to ASTM A 197/A 197M, ASTM A 234/A 234M and ASME B16.3

Unions DN50 and under: 2068 kilopascal 2 inches and under: 300-psig wsp, female, screwed, galvanized, malleable iron with brass to iron seat and ground joint conforming to ASME B16.39.

****

NOTE: Type SWP wall thickness is based on stress values of 86.2 Megapascal 12,500 pounds per square inch (psi), 85 percent of external average collapse

pressure with a safety factor of 4.
****

Type SWP: Spiral welded pipe

Pipe[DN150 through DN900 6 through 36 inches:] Electric fusion welded, carbon steel, conforming to ASTM A 139/A 139M, Grade B, with wall thickness as follows:

NOMINAL DIAMETER MILLIMETER	MINIMUM WALL THICKNESS MILLIMETER (INCH)
300	3.18 (0.125)
350	3.58 (0.141)
400	4.37 (0.172)
450	4.78 (0.188)
550	5.56 (0.219)
600	6.35 (0.250)
700	7.14 (0.281)
750	7.92 (0.312)
900	9.53 (0.375)

NOMINAL DIAMETER INCHES	MINIMUM WALL THICKNESS INCH
12.00	0.125
14.00	0.141
16.00	0.172
18.00	0.188
22.00	0.219
24.00	0.250
28.00	0.281
30.00	0.312
36.00	0.375

Refer to "Supporting Elements Installation" in this section for additional requirements.

Fittings (all sizes)	Specify materials and thicknesses for pipe. Fittings configuration and dimensions must conform to

AWWA C208, Tables 1 and 2
and MSS SP-86

Fittings must be butt weld end type

13789 kilopascal, 2,000 pounds per square inch (psi),
forged carbon steel, threaded
half coupling, conforming to ASTM A 105/A 105M
and ASME B16.11

Retap threads after welding.

Flanges (all sizes)	Forged carbon steel, slip-on type, conforming to ASTM A 181/A 181M, Class 60 or 70, and AWWA C207, Class D, and ASTM A 105/A 105M concentric serrated finish
[Grooved couplings	Refer to "Grooved Pipe Couplings and Fittings" in this section. Pipe ends must have welded collars grooved to fit couplings, fabricated from ASTM A 53/A 53M pipe.]

2.1.2 Control And Instrumentation System Tubing

Type CPR-C&I: Copper

Tubing

All sizes DN8 1/4-inch minimum: Hard drawn or annealed, seamless copper, conforming to ASTM B 280, No. C12200

Fittings

All sizes: Solder joint, wrought copper, conforming to ASME B16.22 and MSS SP-104

Ball sleeve compression type, rod or
forged brass conforming to SAE A 360 or SAE
CA 377, UL-approved, with minimum pressure rating
of 1380 kilopascal at 38 degrees C 200 psi at 100 degrees F

Solder

95-5 tin-antimony, alloy Sb5, conforming
to AWS WHB-2.9.

2.1.3 Pressure Gages

Pressure gages must conform to ASME B40.100 and to requirements specified herein. Pressure gages must be Type II, Class 1 (pressure); Class 2 (vacuum); or Class 3 (pressure-vacuum). Pressure gage size must be 90 millimeter 3-1/2 inches nominal diameter. Case must be corrosion-resistant steel conforming to any of the AISI 300 series with an ASM No. 4 standard commercial polish or better. Equip all gages with adjustable red marking pointer and damper screw adjustment in inlet connection.

2.1.4 Thermometers

Thermometers must conform to ASTM E 1. Thermometers must be industrial pattern Type I, Class 3. Thermometers installed 1830 millimeter 6 feet or higher above the floor must have an adjustable angle body. Scale must be not less than 175 millimeter 7 inches long, and case face to be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Indicate thermometer range. Provide thermometers with nonferrous separable wells.

2.1.5 Grooved Pipe Couplings And Fittings

Couplings must have a housing fabricated in two or more parts of malleable iron castings. Coupling gasket must be molded synthetic rubber, conforming to requirements of ASTM D 2000. Coupling bolts must be oval neck track head type with hexagonal heavy nuts, conforming to ASTM A 183.

Pipe fittings used with couplings must be fabricated of malleable iron castings. Where a manufacturer's standard size malleable iron fitting pattern is not available, use fabricated fittings.

Fabricate fittings from Schedule 40 or 9.53 millimeter 0.375-inch wall ASTM A 53/A 53M, seamless steel pipe; long-radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A 234/A 234M, ASME B16.9 and MSS SP-43.

2.1.6 Metallic Expansion Joints

****
NOTE: This specification does not include slip type expansion joints or ball joints.
****

Expansion joints must be packless bellows type conforming to ASTM F 1120, except as otherwise modified or supplemented by requirements.

Design metallic bellows in accordance with ASME B31.3, Appendix X, and Standards of the Expansion Joint Manufacturers Association.

Expansion joints must be [Type I, Class 1.] [Type I, Class 2.] [Type II, Class 1.] [Type II, Class 2.] [tied, hinged, or gimbaled.]

Design and construct joints to absorb all movement of the pipe sections in which they are installed with no detrimental effect on the pipe or supporting structure.

[Operating pressures and temperatures for each joint must be as shown.

][Rate, design, and construct joints for service with vacuum to 2 millimeter of mercury absolute, pressures to 345 kilopascal 50 psig, and temperatures to 121 degrees C 250 degrees F.

][Rate, design, and construct joints for service with vacuum to 2 millimeter of mercury absolute, pressures to 1050 kilopascal 150 psig, and temperatures to 260 degrees C 500 degrees F.

] Design joints with bursting strength in excess of four times their rated pressure.

Joints must be capable of withstanding a hydrostatic tests of 1.5 times their rated pressure without leakage or distortion while held at their uncompressed length. Life expectancy must be not less than 10,000 cycles.

Movement capability of each joint must exceed calculated movement of piping by [33] [_____] percent.

Bellows and internal sleeve material must be AISI 304[L] corrosion-resistant steel. Use Type C-22 Hastelloy alloy for bellows exposed to highly corrosive environments, such as those found within 1 mile of the ocean or at a launch pad utilizing propellants with corrosive exhaust products.

End connections must be as indicated and require no field preparation other than maintenance of cleanliness.

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

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

] Van stone flanges must not be acceptable.

Joints 65 millimeter 2-1/2 inches and smaller must have internal guides and limit stops.

Provide joints 75 millimeter 3 inches and larger with removable external covers, internal sleeves, and purging connection. Size sleeves to accommodate lateral clearance required with minimum reduction of flow area, using oversized bellows where necessary. When sleeve requires a gasket as part of locking arrangement, this gasket must be provided by the manufacturer. Joints without purging connections may be provided; however, these must be removed from the line or not installed until after cleaning operations have been completed.

[Provide cylindrical end portion of the reinforced bellows element with a thrust sleeve of sufficient thickness to bring this portion within applicable code allowable stress. This sleeve must provide 360-degree support for the element and end reinforcing ring.

][Expansion joints must have four, equidistant, permanent tram points clearly marked on each joint end. Locate points to prevent obliteration during installation. Distance between tram points (indicating installed lengths) must be as noted. Overall dimension is subject to approval by the Contracting Officer after joint installation.

] Expansion joints must have adjustable clamps or yokes provided at quarter points straddling the bellows. Set overall joint length by the manufacturer to maintain joints in manufacturer's recommended position during installation.

Clearly and legibly mark joints with the manufacturer's name or trademark and serial number and with the size and series or catalogue number, bellows material, and directional flow arrow.

Preservation provisions must be Level A of ASTM F 1120.

Packing provisions must be Level B of ASTM F 1120.

2.2 VALVES

2.2.1 Ball Valves, Vacuum (BAVV)

Ball valves must conform to MSS SP-72 Style [1] [3].

Valves must be UL approved for certain compressed gases and a pressure rating of not less than 1210 kilopascal at 93 degrees C 175 psi at 200 degrees F; and certified suitable for leaktight service under a vacuum of 2 millimeter of mercury absolute.

Valve bodies in sizes DN50 2-inch iron pipe size (ips) and smaller must be screwed-end-connection type constructed of Class A copper alloy.

Valve bodies in sizes DN75 2-1/2-inch ips and larger must be flanged-end-connection type constructed of Class [D] [E] [F] material, unless otherwise specified.

Balls and stems of valves DN50 2-inch ips and smaller must be manufacturer's standard Class A copper alloy with 900 Brinell hard chrome-plating finish or Class C corrosion-resistant steel alloy with hard chrome-plating. Electroless nickel-plating is acceptable.

Balls and stems of valves DN75 2-1/2-inch ips and larger must be manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome-plating. In valves DN150 6-inch ips and larger, balls may be Class D with 900 Brinell hard chrome-plating. Electroless nickel-plating is acceptable.

Valves must be suitable for flow from either direction and sealed tightly in either direction.

Valves must have full pipe size flow areas where noted.

Valves with ball seats kept in place by spring washers are not acceptable. Seats and seals must be filled tetrafluoroethylene or manufacturer's standard material for the specified service.

Valve body construction must be such that:

Torque from a pipe with valve installed must not tend to disassemble the valve by stripping setscrews or by loosening body end inserts or coupling nuts.

Resist torque from a pipe by a one-piece body between end connections or by bolts in shear where body is of mating flange or surface bolted construction.

2.2.2 Butterfly Valves, Vacuum (BUVV)

****

NOTE: Review service temperature range prior to selection of materials to ensure long elastomer life under nonlubricated conditions.

The following is limited to valve sizes through

DN1050 42 inches. Drawings must show temperature range and negative (vacuum) and positive pressures at which system will operate. Check for sonic velocities. Coordinate with shaft selection. Mass spectrometer tests utilizing helium should be specified only if necessary with leak detector sensitivity of at least 1 times 10 to the minus 6 cubic centimeter per second.

****

Butterfly valves must conform to MSS SP-67.

Butterfly valves through DN500 20 inches must be wafer type; in sizes larger than DN500 20 inches, valves must be the two-flange type for mounting between specified flanges. Drilled and tapped holes at the valve bearing areas will be acceptable for valves larger than DN500 20 inches.

Rate valves for indicated velocities and shutoff and nonshock working pressure.

Body must be cast ferrous metal conforming to minimum requirements of ASTM A 126, Class B and to ASME B16.1 for body wall thickness.

Certify all sizes of valves as tested and suitable for leaktight service under a vacuum of 2 millimeter of mercury absolute.

Laying lengths of wafer valves must conform to MSS SP-67.

Laying lengths of flanged valves must conform to AWWA C504, Table 3, and MSS SP-86 short body length.

Disk must be free of external ribs and streamlined. Fabricate disk from cast ferrous or nonferrous alloys conforming to ASTM A 436, Type 2 copper-free (austenitic cast iron), ASTM A 216/A 216M, Grade WCB (cast steel), ASTM A 351/A 351M, Grade CF8M (corrosion-resistant steel), or ASTM B 148, No. C95500 (aluminum bronze).

[Where vacuum piping systems are corrosion-protected internally, all ferrous valve surfaces exposed to airstream must be of corrosion-resistant steel or electroplated or flame-sprayed with a corrosion-resistant metal such as aluminum, zinc, tin or cadmium. Protection provided must be specifically certified as suitable for the intended service.

] Fabricate shaft from AISI 300 series or 17-4 pH corrosion-resistant steel, or nickel-copper alloy conforming to ASTM B 164, and may be one piece or stub-shaft type. Extend stub shafts into the disk hub at least 1-1/2 shaft diameters. Design the connection between the valve shaft and disk to transmit shaft torque equivalent to not less than 75 percent of the torsional strength of the minimum required shaft diameter. Minimum nominal shaft diameter for all valves must be in accordance with the following list:

****

NOTE: Select the following based on AWWA C504, Class 25A, and MSS SP-86 for normal service where dynamic torque is not involved.

****

VALVE SIZE MILLIMETER (DN)	SHAFT DIAMETER MILLIMETER	VALVE SIZE MILLIMETER (DN)	SHAFT DIAMETER MILLIMETER
75	13 (1/2)	400	34 (1-3/8)
100	16 (5/8)	450	38 (1-1/2)
150	19 (3/4)	500	38 (1-1/2)
200	22 (7/8)	600	44 (1-3/4)
250	25 (1)	750	50 (2)
300	28 (1-1/8)	900	63 (2-1/2)
350	31 (1-1/4)	1050	72 (2-7/8)

****

NOTE: Select the following based on AWWA C504, Class 75B, and MSS SP-86 where shaft diameters are suitable for seating and calculated dynamic torque.

****

VALVE SIZE INCHES	SHAFT DIAMETER INCHES	VALVE SIZE INCHES	SHAFT DIAMETER INCHES
3	1/2	16	1-3/8
4	5/8	18	1-1/2
6	3/4	20	1-1/2
8	7/8	24	1-3/4
10	1	30	2
12	1-1/8	36	2-1/2
14	1-1/4	42	2-7/8

VALVE SIZE MILLIMETER (DN)	SHAFT DIAMETER MILLIMETER	VALVE SIZE MILLIMETER (DN)	SHAFT DIAMETER MILLIMETER
75	13 (1/2)	400	38 (1-1/2)
100	16 (5/8)	450	41 (1-5/8)
150	19 (3/4)	500	48 (1-7/8)
200	22 (7/8)	600	57 (2-1/4)
250	25 (1)	750	70 (2-3/4)
300	28 (1-1/8)	900	89 (3-1/2)
350	35 (1-3/8)	1050	95 (3-3/4)

****

NOTE: Select the following based on AWWA C504, Class 150B, and MSS SP-86 where shaft diameters are suitable for seating and calculated dynamic torque.

****

VALVE SIZE INCHES	SHAFT DIAMETER INCHES	VALVE SIZE INCHES	SHAFT DIAMETER INCHES
3	1/2	16	1-1/2
4	5/8	18	1-5/8
6	3/4	20	1-7/8
8	7/8	24	2-1/4
10	1	30	2-3/4
12	1-1/8	36	3-1/2
14	1-3/8	42	3-3/4

VALVE SIZE MILLIMETER (DN)	SHAFT DIAMETER MILLIMETER	VALVE SIZE MILLIMETER (DN)	SHAFT DIAMETER MILLIMETER
75	13 (1/2)	400	50 (2)
100	16 (5/8)	450	57 (2-1/4)
150	25 (1)	500	63 (2-1/2)
200	28 (1-1/8)	600	76 (3)
250	35 (1-3/8)	750	92 (3-5/8)
300	38 (1-1/2)	900	111 (4-3/8)
350	44 (1-3/4)	1050	127 (5)

VALVE SIZE INCHES	SHAFT DIAMETER INCHES	VALVE SIZE INCHES	SHAFT DIAMETER INCHES
3	1/2	16	2
4	5/8	18	2-1/4
6	1	20	2-1/2
8	1-1/8	24	3
10	1-3/8	30	3-5/8
12	1-1/2	36	4-3/8
14	1-3/4	42	5

In the sealing areas, shaft must have a surface finish conforming to ASME B46.1, 0.27 millimeter root mean square or better.

****
NOTE: Cycle life of elastomer is severely reduced in dry service as pressure and temperature increase typically: 4,000 cycles at 24 degrees C at 1050 kilopascal 75 degrees F at 150 psi; 250 cycles at 107 degrees C at 517.1 kilopascal 225 degrees F at 75 psi. Rewrite following paragraph to include cycle life if necessary.
****

Seats and seals must be resilient elastomer type. Seats must be mechanically retained type, designed for field removal and replacement unless otherwise specified. Formulate elastomers for continuous nonlubricated service at indicated temperatures and pressures.

[Seats must be bonded type. Where bonding adhesives are used, these must comply with elastomer temperature requirements and have an effective life equal to or greater than the elastomer.

][Seats may be installed in the valve body or on the disk, except that circular cross-section O-ring construction is not acceptable.

] Shaft seals must be of the four O-ring type, mounted in a nonferrous metal cage. Use two rings as a shaft seal; use the other two rings as a housing seal. Make provisions to introduce high-vacuum grease to lubricate all four O-rings. Submit high-vacuum grease for Contracting Officer approval.

Seat or disk mating surfaces must be corrosion-resistant steel, austenitic gray cast iron, or bronzes specified for the disk or the materials specified for stems. Weld these materials to substrate and ground or mechanically retain. Plated or similarly applied surfacing materials are not acceptable.

Bearings must be sleeve type of manufacturer's standard corrosion-resistant steel, bronze, nickel-copper alloy, or filled tetrafluoroethylene. Design bearings for a pressure not exceeding the published design load for the bearing material or one-fifth of the compressive strength of the bearing or shaft material. Provide operating end of the shaft with dual inboard bearings or a single inboard and an outboard bearing in or beyond the operator.

Provide valves larger than DN500 20 inches with thrust bearings set to hold disk firmly in place.

Provide locking feature to make valve tamperproof where indicated.

Provide manual nonchain-operated valves through DN200 8 inches with not less than nine-position-level lock handles not exceeding 450 millimeter 18 inches in length.

Manual valves DN250 10 inches and larger, or smaller if the application torque exceeds a pull of 110 newton-meter 80 foot-pounds or if so indicated, provide with gear operators.

Where valves are indicated to be chain operated, equip all sizes with gear operators, and chain length must be suitable for proper storage and operation.

Gear operators must be worm-gear type. Gears must be hob-cut and totally

enclosed in a cast-iron housing suitable for grease or oil-flood lubrication. Support gears and gear shafts on bronze or corrosion-resistant, lubricated bearings. Size operators to provide the required torque, static or dynamic, with a maximum manual pull of 110 newton-meter 80 foot-pounds on the handwheel or chain wheel.

Modulating or remotely actuated two-position service valves, where indicated, provide with pneumatic operators, pilot positioners, valve position indicators, and boosters and relays where necessary. Note operating air-supply pressure.

Maximum load on a pneumatic operator must not exceed 85 percent of rated operator capacity.

2.2.3 Diaphragm Control And Instrument Valves (DCIV)

Diaphragm valves in sizes DN8 and DN10 1/4- and 3/8-inch must have a forged brass body with reinforced tetrafluoroethylene diaphragm, an AISI 300 series corrosion-resistant steel spring, and a round phenolic handle. Fit handle with ISA color code disks.

2.2.4 Gage Cocks (GC)

Gage cocks must be T-head or lever handle ground key type with washer and screw, constructed of polished ASTM B 62 bronze and rated for 862 kilopascal 125-psi saturated steam service. End connections must suit the service, with or without union and nipple.

2.2.5 Globe And Angle Valves (GLV And ANV)

Globe and angle valves DN50 2 inches and smaller, must conform to MSS SP-80 and to requirements specified herein. Valves must be union-ring bonnet, screwed end type with backseating stem. Disk must be free to swivel on the stem in all valve sizes and have a fiberglass filled, tetrafluoroethylene composition seating surface. Packing must be woven non-asbestos fiber impregnated with not less than 25 percent, by weight, of tetrafluoroethylene resin.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Bolting

Flange and general purpose bolting must be hex-bolts and conform to ASTM F 568M ASTM A 307, Grade B. Heavy hex-nuts shall conform to ASME B18.2.1 ASME B18.2.2. Square-head bolts and nuts are not acceptable.

2.3.2 Elastomer Calk

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

2.3.3 Flashing

Lead

Sheet lead must conform to ASTM B 749 , Grade [B] [C] [D] and weigh not less than 95 kilogram per square meter 4 pounds per square foot.

Copper

Sheet copper must conform to ASTM B 370 and weigh not less than 5 kilogram per square meter 16 ounces per square foot.

2.3.4 Flange Gaskets

****
NOTE: For average vacuum service application use chloroprene, 60 to 65 shore a durometer hardness.
****

Type A: Soft chloroprene sheet, 45 to 60 Shore A durometer hardness, conforming to ASTM F 147 and SAE AMS-C-6183, Type II, Class 2, Grade A.

Type B: Medium chloroprene sheet, 60 to 65 Shore A durometer hardness, conforming to ASTM F 147 and SAE AMS-C-6183, Type II, Class 2, Grade B.

Type C: Firm chloroprene sheet, 70 to 80 Shore A durometer hardness, conforming to ASTM F 147 and SAE AMS-C-6183, Type II, Class 2, Grade C.

2.3.5 Pipe Thread Compounds

Tetrafluoroethylene tape not less than [_____] [0.0508] millimeter [2] mils thick must be used in compressed air systems for pipe sizes to and including DN25 1-inch ips. Tetrafluoroethylene dispersions and other suitable compounds may be used for all other applications upon approval by the Contracting Officer.

2.4 SUPPORTING ELEMENTS

****
NOTE: Type SWP piping horizontal and vertical piping attachments and mill-provided reinforcement of piping should be detailed to suit project conditions. Support spacing should be based on an allowable bending stress of approximately 20700 kilopascal (3000 psi), 3,000 pounds per square inch, desired deflections, and natural frequency of piping when connected to pulsating equipment.
****

2.4.1 Supports

Provide all necessary piping system components and miscellaneous supporting elements, including but not limited to, building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, pipe attachments, anchors, guides, shock absorbers, and variable and constant supports. All supporting elements must be suitable for stresses imposed by system pressures and temperatures and natural and other external forces. Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation considerations.

Supporting elements must be UL approved or listed and conform to requirements of ASME B31.1, MSS SP-58, and MSS SP-69.

"Type" devices specified are defined as MSS standards.

[Horizontal and vertical piping attachments and certain other details for

piping systems utilizing variable wall thickness, Type SWP spiral welded pipe materials must be as noted.

]2.4.2 Building Structure Attachments

Anchor devices, concrete and masonry

Anchor devices must conform to requirements of AASHTO M 314, and FS FF-S-325 FS FF-S-325, [Group I] [Group II, Type 2, Class 2, Style [1] [2]] [Group III] [Group VIII].

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

Masonry anchor devices must be built-in.

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

Beam clamps

Beam clamps must be center loading Type [21] [28] [29] [30], UL listed, catalogued and low rated, commercially manufactured products.

[
****
NOTE: C-clamps, as a means of attaching hangers to structural steel, should be avoided. Where used, consider vibration forces and single or accumulated load and resultant moment on structural steel.
****

C-clamps may be used to support piping sizes DN40 1-1/2-inches and smaller. C-clamps must be FM approved and UL listed with hardened cup tip, setscrew, locknut, and retaining strap. Retaining strap section must be not less than 3 by 25 millimeter 1/8 by 1 inch. Beam flange thickness to which clamps are attached must not exceed 15.2 millimeter 0.60 inch.

][Inserts, concrete

Construct concrete inserts in accordance with 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, insert and wire a 300 millimeter length of 15 millimeter 1-foot length of 1/2-inch reinforcing rod through wing slots. Approved proprietary-type continuous inserts may be similarly used.

]2.4.3 Horizontal Pipe Attachments

Single pipes

Piping in sizes to and including DN50 2-inch ips must be supported by Type 6 solid malleable iron pipe rings except that split-band-type rings must be used in sizes up to DN25 1-inch ips.

Support piping in sizes through DN200 8-inch ips inclusive by Types [1] [3] [4] attachments.

Pipe rolls must be Type 41 or Type 49.

Provide spring supports in accordance with referenced codes and standards. Submit complete shop drawing data for approval.

Parallel pipes

Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts, in congested areas and where multiple pipe runs occur. Structural steel shapes must conform to supplementary steel requirements or the support may be commercially available, proprietary design, rolled steel.

2.4.4 Vertical Pipe Attachments

Vertical pipe attachments must be Type 8, single pipes.

2.4.5 Hanger Rods And Fixtures

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

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

2.4.6 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 ANSI/AISC 360.

PART 3 EXECUTION

3.1 ABOVEGROUND PIPING SYSTEMS INSTALLATION

3.1.1 Piping Systems

****
NOTE: Projects with users requiring a high-grade vacuum and high-purity systems such as analytical laboratory or spaceflight operations should consider precision chemical cleaning for particulate and non-volatile residue (NVR) removal. The presence of residual hydrocarbons within piping may hamper the ability to pull and sustain high vacuum levels and pose contaminant migration to downstream services.
****

Fabricate and install systems in accordance with ASME B31.1, MSS SP-69 and AWS WHB-2.9.

Installation of piping systems materials must be in accordance with manufacturer's instructions.

Fabricate pipe to measurements established on the job and carefully work into place without springing or forcing. Make adequate provisions for

absorbing all expansion and contraction without undue stress in any part of the system.

Pipe, tubing, fittings, valves, equipment, and accessories must be clean and free of foreign material before being installed in their respective systems.

[Clean pipe by hammering, shaking, or swabbing or by a combination of methods.] [Precision cleaning shall be conducted in accordance with IEST-STD-CC1246D to a cleanliness level of 300A or lower.

] Purge lines with dry, oil-free compressed air after erection, but purging must not be relied upon for removing all foreign matter. Perform purging at a velocity greater than maximum normal-flow velocity and be approved by the Contracting Officer.

During the progress of construction, properly protect open ends of pipe, fittings, and valves at all times to prevent the admission of foreign matter. Place plugs or caps in the ends of all installed work at all times when connections are not actually under way. Plugs must be commercially manufactured products.

Install piping straight and true with approved offsets around obstructions and with necessary 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. Installation must also allow tool space around fittings subject to disassembly.

Use standard long-sweep pipe fittings for changes in direction, unless otherwise specified or approved by the Contracting Officer.

[Mitered joint fittings are not permitted.

][Mitered joint fittings are not permitted in Schedule 40 wall thickness piping systems but are permitted, as specified, in systems utilizing Type SWP materials.

] Pipe bends in seamless pipe of not less than five pipe diameters radius may be made with hydraulic benders in the field for pipe sizes to DN100 4-inch ips upon approval of the Contracting Officer.

Make T-connections with screwed T-fittings, grooved T-fittings, or where pipe is being welded, with either welding T-fittings or forged branch outlet fittings (without size limitations). Branch outlet fittings, where used, must be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe-burst strength requirements.

Short-radius elbows may be used only where specifically authorized by the Contracting Officer.

Horizontal piping must have a grade and slope direction as noted.

Eccentric reducers shall be used where required to permit proper drainage of pipe lines. Bushings shall not be used for this purpose.

[Provide drain valves in all piping systems at low points and where otherwise indicated. Pipe drains must consist of DN15 1/2-inch ball valves

with DN20 3/4-inch hose, gasketed, and capped adapter.

] When piping design permits flange loads on connected equipment, the load must not exceed 75 percent of maximum allowed by equipment manufacturer.

[Make expansion bends from pipe sections and long-radius welding elbows in sizes DN25 1 inch and larger. Expansion bends must be cold sprung and welded into the line, which must be anchored before removing the spreader from the expansion bend. Indicate amount of cold spring.

][Provide expansion joints at points indicated. Protect all expansion joint surfaces from mechanical damage, including weld spatter, during installation and testing operations.

] Install expansion joint with the sealed end of the internal sleeve as leading edge in direction of flow. Lateral stresses must not be induced by springing pipe during installation. Locate expansion joints close to an anchor with the first pipe guide located not more than 4 pipe diameters away from the joint and the second guide located not more than 12 to 14 pipe diameters from the joint. Intermediate pipe guide spacing must be in accordance with FSA-0017. Contracting Officer will reject any installed joint with nicks, scratches, dents, and other damage, even when otherwise properly installed.

Before acceptance of an expansion joint installation, cycle each joint from "zero" condition to maximum load not less than five times; joint, piping, and equipment alignment shall be checked each time in the presence of the Contracting Officer.

[Lubricate guides located in lines with expansion joints with silicone molybdenum disulfide lubricant.

]3.1.2 Joints

Ream pipe ends before joint connections are made.

Make up screwed joints with joint compound.

Apply joint compounds to the male thread only, and care must be exercised to prevent compound from reaching the interior of the pipe.

Threads will be inspected by the Contracting Officer at midpoint of a cut for chaser alignment, proper grinding, thread track, chatter, and for coolant and lubricant effectiveness.

Provide unions or flanges wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system.

Assemble flanged joints with appropriate flanges, gaskets, and bolting. Clearance between flange faces must be such that the connections can be gasketed and bolted tight without imposing unaccounted strain on the piping system. Flange faces must be 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. Wherever a flange with a raised face is joined to a companion flange with a flat face, the raised face must be machined down to a smooth matching surface and use a full face gasket. After the piping system has been

tested, retighten all bolting. Only use hex-head nuts and bolts. Gasket material must be fresh stock, 1.6 millimeter 1/16 inch thick.

All field-welded joints must conform to AWS WHB-2.9 and ASME B31.1.

3.1.3 Control And Instrument Air Piping

Use hard core tubing in all exposed areas and either hard drawn or annealed if concealed.

Fittings for supply system copper tubing must be wrought-copper solder joint type except at connection to apparatus where specified brass mechanical and ips thread adapter fittings may be used. Tool-made bends in lieu of fittings are acceptable. Multiple tube runs must be neatly nested.

Tubing must be mechanically attached to supporting surfaces. Supports using adhesives are not acceptable.

Copper tubing horizontal supports for less than three tubes must be rigid 25 by 10 millimeter 1- by 3/8-inch metal channel. Provide proprietary metal tube race for three or more tubes.

Copper tubing runs embedded in concrete must be annealed and protected by metallic or plastic electric conduit.

Copper tubing runs in soil must be jointless and protected by 0.3048 millimeter 12-mil thick bituminous coating or equivalent PVC tape wrapping.

Tubing penetrations of concrete surfaces must be made with minimum DN25 1-inchips, Schedule 40 rigid unplasticized PVC pipe sleeves except that multitube harnesses DN40 1-1/2 inches od and larger need not have additional protection. Sleeve must extend 150 millimeter 6 inches above floors and 25 millimeter 1 inch below grade surface of slabs. Where water-or vapor-barrier sealing is required, 13 millimeter 1/2-inch deep elastomer calk must be applied to surfaces cleaned of oil and other deleterious substances.

Tubing must be sequentially purged with dry, oil-free compressed air to rid system of impurities generated during joint making and installation and atmospheric moisture before connecting control instruments.

3.1.4 Supporting Elements Installation

Provide supporting elements in accordance with the requirements of referenced codes and standards.

Hang piping from building construction. Do not hang piping from roof deck or from other pipe.

Welding and cutting of building structural steel is prohibited.

Attachment to building construction concrete must 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.

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.

Masonry anchors of AASHTO M 314 and FS FF-S-325, Group I; Group II, Type 2, Class 2, Style 1, or Style 2; or Group VIII must 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 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:

Tool for anchor devices, nominal sizes 6 through 13 millimeter 1/4-through 1/2-inch, may be hammer type only or combination rotary-hammer type and must be rated at load to draw not more than 5.0 to 5.5 amperes when operating on 120-volt 60-hertz power.

Tool for anchor devices, nominal sizes 16 millimeter 5/8 inch and larger, hammer-type only, must 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 must have a full load current rating not to exceed 10 amperes.

Size inserts and anchors for the total stress to be applied with a safety factor as required by applicable codes, but in no case less than 4.

Insert anchor devices into concrete sections not less than twice the overall length of the device and locate not less than the following distance from any side or end edge or centerline of adjacent anchor service:

Anchor Bolt Size M Designation	6	8	10	13	16	19	22
Minimum Edge Space (millimeter)*	90	85	105	130	150	180	200
Anchor Bolt Size (inches)	1/4	5/16	3/8	1/2	5/8	3/4	7/8
Minimum Edge Space (inches)*	3-1/2	3-1/4	4	5	6	7	8

*Except where manufacturer requires greater distance.

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

Run all piping parallel with the lines of the building unless otherwise indicated. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be not less than 13 millimeter 1/2 inch of clear space between the finished surface and adjacent piping. Hangers on different adjacent service lines running parallel with each other must be arranged in line with each other and parallel to the lines of the building.

Place identical service systems piping, where practicable, at same elevation and hung on trapeze hangers adjusted for proper pitch.

Spacing of trapeze hangers where piping is grouped in parallel runs must be the closest interval required for any size pipe supported.

Where it is necessary to avoid any transfer of load from support to support or onto connecting equipment, pipe hangers must be constant support type.

Weld anchors and alignment guides incorporated in piping systems to the piping and attached to the building structure in accordance with requirements specified herein or as approved by the Contracting Officer.

Suitably brace piping against reaction, sway, and vibration. Bracing must consist of hydraulic and spring devices, brackets, anchor chairs, rods, or structural steel, or any suitable combination thereof.

Locate pipe lines, when supported from roof purlins, not greater than one-sixth of the purlin span from the roof truss. Load per hanger must not exceed 1780 newton 400 pounds when support is from a single purlin or 3560 newton 800 pounds when hanger load is applied to purlins halfway between purlins by means of auxiliary support steel by supplied by the piping Contractor. When support is not halfway between purlins, the allowable hanger load must be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin service.

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

Purlins used to support fire protection sprinkler lines, electrical lighting fixtures, and electrical power duct or cable tray must be considered fully loaded, and supplemental reinforcing for these purlins or auxiliary support steel must be provided.

Install hangers and supports for piping at specified intervals 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.

Load rating for all pipe hangers must be based on weight and forces imposed on all lines. Deflection per span must not exceed slope gradient of pipe.

[Support provisions and support spacing for Type SWP materials must be in accordance with the manufacturer's recommendations for the application.

] Schedule 40 and heavier pipe supports must be in accordance with the following minimum rod size and maximum allowable hanger spacing; concentrated loads will reduce allowable span proportionately:

PIPE SIZE MILLIMETER (DN)	ROD SIZE MILLIMETER (INCH)	STEEL PIPE MILLIMETER
Up to 25	10.0 (3/8)	2438
32 to 40	10.0 (3/8)	3048

PIPE SIZE MILLIMETER (DN)	ROD SIZE MILLIMETER (INCH)	STEEL PIPE MILLIMETER
50	10.0 (3/8)	3658
65 to 90	13.0 (1/2)	3658
100 to 125	16.0 (5/8)	4877
150	19.0 (3/4)	4877
200	22.0 (7/8)	6096

PIPE SIZE (INCHES)	ROD SIZE (INCHES)	STEEL PIPE (FEET)
Up to 1	3/8	8
1-1/4 to 1-1/2	3/8	10
2	3/8	12
2-1/2 to 3/1/2	1/2	12
4 to 5	5/8	16
6	3/4	16
8	7/8	20

Support vertical risers independently of connected horizontal piping wherever practicable and guide for lateral stability. Place clamps under fittings.

[Support pipe at each floor and at not more than 4500 millimeter 15-foot intervals for pipe DN50 2 inches and smaller, and at not more than 6100 millimeter 20-foot intervals for pipe DN65 2-1/2 inches and larger.

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

]3.1.5 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 special acoustic treatment of ceilings. Finish penetration to be compatible with surface being penetrated.

Sound stopping must 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 practicable provided temperature and fire-resistance characteristics of the compound are suitable for the service.

3.1.6 Sleeves

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

Lay out sleeve work before placement of slabs or construction of walls and roof, and set all sleeves necessary to complete the work.

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

Sleeves must be flush with ceilings.

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

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

Sleeves extending through floors, roofs, load bearing walls, and fire barriers must be continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Form all other sleeves by molded linear polyethylene liners or similar materials which are removable. Diameter of sleeves must be large enough to accommodate pipe and sealing materials with a minimum of 10 millimeter 3/8-inch clearance. Sleeve must 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 must be packed solid with a mineral fiber conforming to ASTM C 592, Form B, Class 8 wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and at other locations where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces. Fill space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer calk to a depth of 13 millimeter 1/2 inch. Surfaces to be calked must be oil- and grease-free.

3.1.7 Escutcheons

Provide escutcheons at all penetrations of piping 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. Escutcheons must be chrome-plated in occupied spaces and of sufficient size to conceal openings in building construction. Escutcheons must be firmly attached, preferably with setscrews.

3.1.8 Flashings

Provide required flashings at mechanical systems penetrations of building boundaries.

3.2 VACUUM SYSTEMS TESTING

****

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

****

3.2.1 Vacuum Systems

****

NOTE: If the specified system is identified as critical, configured, or mission essential, use Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS to establish predictive and acceptance testing criteria, above and beyond that listed below.

****

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

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

****

NOTE: Because of the expansive force of compressed air, pneumatic testing requires special precautions and competent supervision to prevent injury and damage should a failure occur.

****

Pressure tests must be pneumatic and utilize dry, oil-free compressed [air] [carbon dioxide] [nitrogen] for the system under test. Pressure testing must be done in two stages, preliminary and acceptance.

Personnel not directly involved in pneumatic pressure testing of ferrous piping in excess of 34.5 kilopascal 5 psi must be evacuated from the area.

Contractor may conduct tests for his purposes, but preliminary tests and acceptance tests must be conducted as specified herein.

Pressure testing of any system for any purpose must include preliminary testing by applying internal pressures not in excess of 35 kilopascal 5 psi, swabbing joints under test with standard high film-strength soap solution conforming to MIL-L-25567, and observing for bubbles.

When testing reveals that leakage exceeds specified limits, the leaks must be isolated, replace repaired defective materials where necessary, and retest the system until specified requirements are complied with. Remake leaking gasket joints with new gaskets and new flange bolting and discard used bolting and gaskets. Remake leaking tubing joints with the new fittings and new tube ends.

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

Remove components that would otherwise sustain damage due to test pressure from piping systems during testing. Check piping system components such as valves for proper operation under system test pressure.

[Protect expansion joints against system pressures by suitable

movement-limiting devices.

] Add no test media 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 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.

3.2.2 Test Gages

[Contractor's pressure test gages must conform to ASME B40.100 and have a dial diameter of at least 125 millimeter 4-1/2 inches. Maximum permissible scale range for a given pressure test must be such that the pointer during a test has a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table must bear a date within 90 calendar days prior to test use, test gage number, and the project number, unless otherwise approved by the Contracting Officer.

][Government will furnish vacuum test gages.

][Government will furnish pressure and vacuum test gages.

]3.2.3 Acceptance Pressure Testing

Testing must take place during steady-state ambient temperature conditions.

Test piping systems at 175 kilopascal 25 psi. Maintain test pressure for a period of not less than 2 hours with no pressure drop.

Test control and instrumentation tubing systems at 210 kilopascal 30 psi. Maintain test pressure for not less than 24 hours with no measurable pressure drop.

3.2.4 Acceptance Vacuum Testing

****
NOTE: Prior to selection of the following test criteria, review provisions to ensure suitability for project application.
****

Evacuate piping system to a pressure of 13 millimeter of mercury, absolute. Operate each system at least three times during leakage tests. Rate of pressure rise must not exceed 0.8 millimeter of mercury per hour.

When leakage exceeds the allowable rate, use the following methods to locate leakage source:

Test suspected area utilizing a helium mass spectrometer in either the detector-probe or tracer-probe configuration.

Detector Probe Method: Internally pressurize test piece with helium gas and a mass spectrometer (tuned for helium) must be used to probe the exterior surface to spatially isolate the leak. Employ a flexible line to scan a capillary tube over the surface to detect the leak.

Tracer Probe Method: Evacuate the test piece and flood the suspect area in helium gas. Simultaneously,use a helium mass spectrometer to examine the atmosphere within the test piece to determine the extent to which helium is drawn into the evacuated volume. For more accurate measurements, the suspect area can be jacketed and the area between the jacket and the test piece can be filled with 90 to 100-percent pure helium gas as the testing is conducted.

-- End of Section --