****
USACE / NAVFAC / AFCEC / NASA **UFGS-22 15 14.00 40 (November 2014)**

Preparing Activity: NASA **Superseding UFGS-22 15 14.00 40 (February 2011)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2016
****

SECTION TABLE OF CONTENTS

DIVISION 22 - PLUMBING

SECTION 22 15 14.00 40

GENERAL SERVICE COMPRESSED-AIR SYSTEMS, LOW PRESSURE

11/14

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA | **UFGS-22 15 14.00 40 (November 2014)**

Preparing Activity: NASA | **Superseding UFGS-22 15 14.00 40 (February 2011)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2016

****

SECTION 22 15 14.00 40

GENERAL SERVICE COMPRESSED-AIR SYSTEMS, LOW PRESSURE
11/14

****

NOTE: This guide specification covers the requirements for aboveground and underground piping systems and certain components with pressure ratings of 862 kilopascal 125 pounds per square inch, gage and less, using existing air supply.

Show on the drawing, size, rating, or other details of piping requirements for specific project application not covered in the specifications.

Use symbols or legends on the drawing indicated herein, adding proper suffix where provided. For example," 100 millimeter 4-inch Type BCS-PS."

Indicate on drawing underground piping requiring supports from slabs.

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 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

****

NOTE: 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 following paragraph deleted.
****

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

1.1 REFERENCES

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

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

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

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2013) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C504	(2010) Standard for Rubber-Seated Butterfly Valves

AMERICAN WELDING SOCIETY (AWS)

AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1
AWS-03	(2011) Welding Handbook, Volumes 1 thru 4

ASME INTERNATIONAL (ASME)

ASME A112.18.1/CSA B125.1	(2012) Plumbing Supply Fittings
ASME B16.1	(2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.22	(2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2014) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2014; INT 1-47) Power Piping
ASME B31.3	(2014) Process Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC	(2010) Boiler and Pressure Vessels Code
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181/A181M	(2014) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A183	(2014) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A197/A197M	(2000; R 2011) Standard Specification for Cupola Malleable Iron
ASTM A216/A216M	(2014; E 2015) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A234/A234M	(2013; E 2014) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A278/A278M	(2001; R 2011) Standard Specification for

	Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A307	(2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A395/A395M	(1999; R 2014) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A436	(1984; R 2011) Standard Specification for Austenitic Gray Iron Castings
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A666	(2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM B148	(2014) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B280	(2013) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B584	(2014) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B61	(2015) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2015) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B749	(2014) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C592	(2013) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)

ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2239	(2012) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials
ASTM F568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

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

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-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

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

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1922	(Rev A; Notice 2) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(Rev A; Notice 2) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 2) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-55614	(Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)
FS L-C-530	(Rev C; Notice 1) Coating, Pipe, Thermoplastic Resin

1.2 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 following paragraph deleted.

****

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

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 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.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings[; G[, [_____]]]

SD-03 Product Data

Equipment and Performance Data[; G[, [_____]]]

Underground Piping Materials[; G[, [_____]]]

Aboveground Piping Materials[; G[, [_____]]]

Piping Specialties[; G[, [_____]]]

Supporting Elements[; G[, [_____]]]

Air Compressors[; G[, [_____]]]

Valves[; G[, [_____]]]

Accessories[; G[, [_____]]]

Miscellaneous Materials[; G[, [_____]]]

Vibration Isolation[; G[, [_____]]]

SD-05 Design Data

Design Analysis and Calculations[; G[, [_____]]]

SD-06 Test Reports

Hydrostatic Testing[; G[, [_____]]]

Compressed Air Systems Testing[; G[, [_____]]]

Valve-Operating Tests[; G[, [_____]]]

Drainage Tests[; G[, [_____]]]

Pneumatic Testing[; G[, [_____]]]

SD-07 Certificates

Underground Piping Materials[; G[, [_____]]]

Aboveground Piping Materials[; G[, [_____]]]

Supporting Elements[; G[, [_____]]]

Valves[; G[, [_____]]]

Miscellaneous Materials[; G[, [_____]]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals[; G[, [_____]]]

1.4 QUALITY CONTROL

1.4.1 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 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 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 SYSTEM DESCRIPTION

Submit installation drawings for low-pressure compressed air systems in accordance with paragraphs ABOVEGROUND PIPING MATERIALS and UNDERGROUND

PIPING MATERIALS.

Accompany drawings with curves indicating that an essentially flat reduced pressure curve for the capacity demand of the system is met by the proposed valves.

In lieu of separate hangers, a shop drawing of trapeze hangers with a solid or split-ring clamps may be submitted for approval.

2.1.1 Design Requirements

Provide equipment and performance data submitted for piping systems showing conformance with ASME Code.

Provide design analysis and calculations for low-pressure compressed air systems that consist of flow rates, air distribution, pressure requirements and insulation requirements meeting requirements for referenced standards contained in this section.

2.2 EQUIPMENT

2.2.1 Piping Specialties

2.2.1.1 Air Pressure Reducing Stations

Install a pressure reducing station complete with relieving type pressure reducing valve, valve bypass, particle filter, pressure indicator upstream of station, pressure indicator downstream of station, and regulated air pressure relief valve.

Construct pressure regulator body of zinc or aluminum die castings, rated for the service. Diaphragm material is a reinforced air-, oil-, and water-resistant elastomer. All components, exposed to fluid stream being controlled, are of [nonferrous] [suitable nonmetallic materials]. Ensure valves are a balanced construction relieving type to automatically prevent excess pressure buildup.

Construct filters of [zinc] [aluminum] die castings, rated for the service, and furnished with ips connections. Ensure bowl materials are aluminum and the filter is serviceable by bowl quick-disconnect devices. Equip bowl with manual drain cock. Separate liquid particles by centrifugal and quiet zone action. Remove solid particles to 15-micrometer size by filter elements of [sintered bronze] [corrosion-resistant steel] mesh.

[Combination manual drain filter-regulator units conforming to the above requirements are acceptable in lieu of separate units.

] Rate pressure relief valves for the pressure of the high-pressure side and sized for the full installed capacity of the pressure regulating station at the pressure of the low-pressure side. Set valve at not more than [20] [_____] percent more than the correct low side pressure. Rate and label valve. Ensure seat material is suitable for the service.

2.2.1.2 Air Line Lubricators

Install air line lubricators of the pulse-type, with pickup tube, polycarbonate resin bowl, large fill opening, metering rod flow adjuster, sight ball, and drain cock.

Use lubricators suitable for 1380 kilopascal at 74 degrees C 200 psig at 165 degrees F.

2.2.1.3 Compressed Air Receivers

Ensure compressed air receivers conform to the sizes and capacities specified. Design such vessels for the applicable working pressures and service in accordance with the ASME BPVC SEC VIII D1, and label.

Provide complete vessels, with connections for drain, supports, and other required accessories.

2.2.1.4 Grooved Pipe Couplings and Fittings

Fabricate the housing for couplings in at least [two] [_____] parts of [malleable] [ductile] iron castings. Ensure coupling gaskets are molded synthetic rubber conforming to requirements of ASTM D2000. Coupling bolts are oval-neck track-head type with hexagonal heavy nuts, conforming to ASTM A183.

Fabricate pipe fittings used with couplings of [malleable] [ductile] iron castings. Where a manufacturer's standard size [malleable] [ductile] iron fitting pattern is not available, fabricated fittings may be used.

Fabricate fittings from [Schedule 40][10 millimeter 0.375-inch wall], in accordance with ASTM A53/A53M, Grade B, seamless steel pipe. Ensure long radius seamless welding fittings match their wall thickness to pipe, conforming to ASTM A234/A234M and ASME B16.9.

2.2.1.5 Pressure Gages

Ensure pressure gages conform to ASME B40.100 and are Type I, Class 1, (pressure) for pressures indicated. Pressure gage size is90 millimeter 3-1/2-inches nominal diameter. Case construction is corrosion-resistant steel conforming to [the AISI 300 series] [ASTM A666] with an ASM No. 4 standard commercial polish or better. Equip gages with damper screw adjustment in inlet connection.

[Equip gages with an adjustable, red marking indicator.

]2.2.1.6 Thermometers

Ensure thermometers conform to ASTM E1 and are industrial pattern Type I, Class 3. All thermometers installed [1830] millimeter [6]-feet [_____] or higher above the floor require an adjustable angle body. Scale cannot be less than [178] millimeter [7]-inches [_____] long, and the case face of [manufacturer's standard polished aluminum] [AISI 300 series polished corrosion-resistant steel]. Thermometer range is as required for service, and provided with nonferrous separable wells.

2.2.1.7 Line Strainers

Install [Y-type] [T-type grooved end] strainers with removable basket. Strainers in sizes DN50 2-inch ips and smaller have screwed ends and in sizes DN65 2-1/2-inch ips and larger have flanged ends. Body working pressure rating is required to exceed maximum service pressure of system in which installed by at least 50 percent. Ensure body has cast-in arrows to indicate direction of flow. Ensure strainer bodies fitted with screwed screen retainers have straight threads and gasketed with nonferrous metal.

Strainer bodies fitted with bolted-on screen retainers have offset blowdown holes. Fit strainers larger than DN65 2-1/2-inches with manufacturer's standard blowdown valve. Body material is [cast bronze conforming to ASTM B62] [cast iron conforming to ASTM A278/A278M Class 30] [ductile iron conforming to ASTM A536]. Where system material is nonferrous, strainer body material is nonferrous.

Minimum free-hole area of strainer element is equal to not less than [3.4] [_____] times the internal area of connecting piping. Ensure strainer screens for air service have mesh cloth not to exceed [0.15] millimeter [0.006]-inch [_____]and have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material is [AISI Type [304] [316] corrosion-resistant steel] [Monel metal].

2.2.2 Air Compressors

Provide an air compressor of the standard piston type complete with air tank, [air dryer,][air cooler,] and other appurtenances. Ensure compressor and installation conforms to CAGI B19.1. Ensure compressor capacity is as required for service and provide continuous control air when operating on a 1/3-on 2/3-off cycle. Provide an oil-level sight indicator on the compressor and a coalescing oil filter on the compressor discharge line. [Air dryers are of the [continuous duty silica-gel type with reactivation] [mass refrigerated dryer type] and maintains the air in the system with a dew point low enough to prevent condensation at minus 11 degrees C at 124 kilopascal 13 degrees F at 18 psi main pressure. Locate air dryer at the outlet of the tank.] Ensure control air delivered to the system conforms to ISA 7.0.01.

2.2.3 Valves

2.2.3.1 Ball Valves (BAV)

Ensure ball valves conform to MSS SP-72 and are Style [1] [3].

Grooved end ball valves may be used provided that the manufacturer certifies valve performance in accordance with MSS SP-72.

Rate valves for service at not less than [1207] [_____] kilopascal at [93] [_____] degrees C [175] [_____] psi at [200] [_____] degrees F.

For valve bodies in sizes DN50 2-inch ips and smaller, use screwed end connection type constructed of Class A copper alloy.

For valve bodies in sizes DN65 2-1/2-inch ips and larger, use flanged-end connection type constructed of Class [D] [E] [F] material.

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

Balls and stems of valves DN65 2-1/2-inch ips and larger are manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plate. In valves DN150 6-inch ips and larger, balls are Class D with 900 Brinell hard chrome plate. Electroless nickel plating is acceptable.

Design valves for flow from either direction and seal equally tight in either direction.

Ensure valves have full pipe size flow areas.

Valves with ball seals kept in place by spring washers are not acceptable. Ensure all valves have adjustable packing glands. Use tetrafluoroethylene seats and seals.

Ensure valve body construction is such that torque from a pipe with valve in installed condition does not tend to disassemble the valve by stripping setscrews or by loosening body end inserts or coupling nuts. Torque from a pipe is resisted by a one-piece body between end connections or by bolts in shear where body is of mating flange or surface-bolted construction.

2.2.3.2 Butterfly Valves (BUV)

Ensure butterfly valves conform to MSS SP-67.

Grooved end butterfly valves may be used in services to 110 degrees C 230 degrees F provided the manufacturer certifies valve performance in accordance with MSS SP-67.

Use wafer type butterfly valves for mounting between specified flanges and rated for 1034 kilopascal 150-psig shutoff and nonshock working pressure. Select a cast ferrous metal body conforming to ASTM A126, Class B, and to ASME B16.1 for body wall thickness.

Provide valves installed in insulated piping systems with extended bonnets, placing the operator beyond the specified insulation.

Ensure butterfly valves used in buried piping systems conform to requirements of AWWA C504, Class 150B, with integrally cast flanges and manual worm gear operator. Design and construct valves for buried or 60 kilopascal 20-foot head submerged service in brackish water. Ensure flanged ends conform to requirements of ASME B16.1. Operation requires at least [20] [_____] turns for full closure of the valve with an input effort of [68] [_____] newton per meter [50] [_____] foot-pounds of torque. Coat external surfaces with bituminous sealer conforming to AWWA C104/A21.4.

Ensure valve boxes are of not less than [4.7] millimeter [3/16]-inch [_____] thick cast-iron construction with locking cover with an appropriate identification legend. Install adjustable extension boxes with [screw] [slide-type] adjustment. Fit valves DN80 3-inches and under with 108 millimeter 4-1/4-inch diameter shaft and valves DN100 4-inches and fit larger with1 33 millimeter 5-1/4-inch shaft. Fit bases to the valve. Ensure full-extended length of box is greater than required by depth of cover by not less than 100 millimeter 4-inches. Supply one valve operating wrench for each size of valve wrench nut. Provide guide rings where operating rods are longer than 1830 millimeter 6-feet. Coat internal and external surfaces with bituminous sealer in accordance with AWWA C104/A21.4.

Ensure disk is free of external ribs and streamlined. Fabricate disk from cast [ferrous] [nonferrous] alloys conforming to [ASTM A126 for Class B, cast iron] [ASTM A436 for Type [1] [2] copper free austenitic cast iron] [ASTM A216/A216M for Grade WCB cast steel] [ASTM A395/A395M and ASTM A536 for ductile iron] [ASTM B62] [ASTM B584] [ASTM B148].

Use of taper pins to secure the valve disk to the shaft is prohibited.

Fabricate shafts from [AISI 300 series] [17-4 PH corrosion-resistant steel]

[nickel copper alloy conforming to ASTM B164] and may be [one-piece] [stub-shaft] type. Extend stub shafts into the disk hub at least 1-1/2 shaft diameters except for angle disk construction. Design connection between the valve shaft and disk to transmit shaft torque equivalent to not less than [75] [_____] percent of the torsion strength of the minimum required shaft diameter. Ensure the minimum nominal shaft diameter for all valves is in accordance with the following:

VALVE SIZE (DN) MILLIMETER	SHAFT DIAMETER MILLIMETER	VALVE SIZE (DN) MILLIMETER	SHAFT DIAMETER MILLIMETER
65	11	250	28
80	13	300	32
100	15	356	38
125	17	406	41
150	19	457	47
200	22	508	54

VALVE SIZE INCHES	SHAFT DIAMETER INCHES	VALVE SIZE INCHES	SHAFT DIAMETER INCHES
2-1/2	7/16	10	1-1/8
3	1/2	12	1-1/4
4	5/8	14	1-1/2
5	11/16	16	1-5/8
6	3/4	18	1-7/8
8	7/8	20	2-1/8

Use resilient elastomer seats and seals, designed for field removal and replacement. Elastomers are [Buna-N] [ethylene propylene terpolymer] [chloroprene] [_____] formulated for continuous immersion service at [107] degrees C [225] degrees F [_____] minimum. Apply at least [10] [_____] percent below maximum continuous service temperature. Apply bonding adhesives complying with elastomer temperature requirements and have an effective life equal to or greater than the elastomer.

Design seals on DN500 20-inch and smaller valves to use [standard split V packing] [dual O-rings] [quad rings] [the adjustable pulldown type].

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

Ensure seat or disk mating surfaces are corrosion-resistant material, and are [welded to substrate and ground] [mechanically retained]. Plated or similarly applied surfacing materials are not acceptable.

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

Provide padlocking feature to make valve tamperproof.

For balancing service, ensure valve operators have provision for infinite position locking.

Provide manual nonchain-operated valves through DN200 8-inches with not less than nine-position lever lock handles not exceeding [457] millimeter [18]-inches [_____] in length.

Provide manual valves DN250 10-inches and larger, or smaller if the application torque exceeds a pull of [108] newton-meter [80] pounds [_____], with gear operators.

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

Use worm-gear type operators. Totally enclose operator in a cast iron housing suitable for grease or oil lubrication. Ensure gears are "hobcut." Ensure cast-iron-housed traveling-nut operators conform to AWWA C504. Size operators to provide the required torque, static or dynamic, with a maximum manual pull of [108] newton-meter [80] pounds [_____] on the handwheel or chain wheel.

Provide modulating or remotely actuated two-position service valves with pneumatic operators, pilot positioners, valve position indicators, and boosters and relays.

Maximum load on a pneumatic operator cannot exceed [85] [_____] percent of rated operator capacity.

2.2.3.3 Diaphragm Control and Instrument Valves (DCIV)

In sizes DN8 and DN10 1/4- and 3/8-inch select diaphragm valves with a forged brass body with reinforced tetrafluoroethylene diaphragm, AISI 300 series corrosion-resistant steel spring, and round phenolic handle.

2.2.3.4 Gage Cocks (GC)

Provide T-head or lever handle ground key gage cocks, with washer and screw, constructed of polished ASTM B62 bronze, and rated for 862 kilopascal 125 psi saturated steam service. Ensure end connections suit the service, with or without union and nipple.

2.2.3.5 Gate Valves (GAV)

Ensure gate valves DN50 2-inches and smaller conform to MSS SP-80. Ensure packing is woven non-asbestos material impregnated with not less than [25][_____] percent, by weight, tetrafluoroethylene resin. Packing is woven non-asbestos material impregnated with not less than [25] [_____] percent, by weight, tetrafluoroethylene resin.

Gate valves DN65 2-1/2-inches and larger are Type I, Class 1, conforming to MSS SP-70. Install flanged valves, with bronze trim and outside screw and yoke (OS&Y) construction. Ensure packing is woven non-asbestos material impregnated with not less than [25][_____] percent, by weight, tetrafluoroethylene resin.

2.2.3.6 Globe and Angle Valves (GLV and ANV)

Ensure globe and angle valves DN50 2-inches and smaller conform to MSS SP-80. Valves located in tunnels, equipment rooms, or factory-assembled equipment, are union-ring bonnet, screwed-end type. Ensure disk is free to swivel on the stem in all valve sizes. Composition seating surface disk construction may be substituted for all metal disk construction. Packing is a woven material impregnated with not less than 25 percent, by weight, tetrafluoroethylene resin.

Ensure globe and angle valves DN65 2-1/2-inches and larger conform to MSS SP-80. Valve bodies composition is cast iron conforming to ASTM A126, Class A, as specified for Class 1 valves under MSS SP-70. Flange valve ends in conformance with ASME B16.1, and valve construction are OS&Y type. Packing is a woven material impregnated with not less than 25 percent, by weight, tetrafluoroethylene resin.

2.2.3.7 Eccentric Plug Valves (EPV)

Eccentric plug valves in sizes DN50 2-inches and smaller are [constructed of manufacturer's standard brass] [bronze materials conforming to [ASTM B61] [ASTM B62]] [cast iron conforming to ASTM A126, Class B]. Ensure valves are rated for service at 1207 kilopascal 175 psi maximum nonshock pressure at 93 degrees C 200 degrees F. Use a valve body with [screwed] [grooved] ends. Coat eccentric plug surfaces in contact with flow with a 60 to 70 Shore A durometer hardness elastomer resistant to compressed air.

Material for eccentric plug valves in sizes DN65 2-1/2-inches and larger consists of [Type 2 nickel alloy iron conforming to ASTM A436] [cast iron conforming to ASTM A126]. Ensure valves are rated for service at 1207 kilopascal 175-psi maximum nonshock pressure at 93 degrees C 200 degrees F. Use valve bodies with [screwed] [grooved] ends. Coat eccentric plug surfaces with a 60 to 70 Shore A durometer hardness elastomer resistant to compressed air. For specified applications, in sizes to DN125 5-inch ips, cross-sectional area of valve bore, when open, equals the pipe inlet area. Ensure valves used for combination shutoff and balancing service are fitted with a memory device. Memory device or mechanism permits a valve set at a balance point to be opened or closed, but not beyond the balance point. Fit valves up to DN150 6-inch ips with removable lever operator. For valves DN150 6-inch ips and larger, fit with totally enclosed flood-lubricated worm gear drive such that operating torque does not exceed [67] [_____] newton per meter [50] [_____] foot-pounds.

2.3 MATERIALS

2.3.1 Underground Piping Materials

2.3.1.1 Piping Types

****

NOTE: Type BCS-PS materials are suitable for leak tight compressed air 862 kilopascal 125 pounds per square inch gage and less, all butt weld (no flange,

no thread) construction.

Anode and rectifier cathodic protection should be used to protect against rapid point metal loss due to failure to detect a fault or "holiday."

****

Ensure type BCS-PS black carbon steel piping with polyethylene sheath conforms to ASTM A53/A53M, Type [E] [S], in sizes through DN250 10-inch iron pipe size (ips). For pipe in size DN300 12-inches and larger, select Schedule 40 or be 10 millimeter 0.375-inch thick.

Ensure thermoplastic sheath conforms to FS L-C-530. Make sheath joints with thermally fitted shrinking sleeves applied with factory-approved shrinking devices. Make taped fitting protection and repairs in accordance with manufacturer's instructions. Ensure 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.

2.3.1.2 Fittings

Provide long radius butt weld carbon steel fittings conforming to ASTM A234/A234M and ASME B16.9 to match pipe wall thickness. Pipe bending is not permitted. Aboveground terminal fittings are 1034 kilopascal 150-pound working steam pressure (wsp) forged steel weld neck flanges to match wall thickness, conforming to ASME B16.5 and ASTM A181/A181M Class 60.

2.3.2 Aboveground Piping Materials

2.3.2.1 Compressed Air Systems 862 Kilopascal 125 Psig And Less

a. Type BCS Black Carbon Steel

Pipe DN6 through DN40 1/8 through 1-1/2-inches is Schedule 40, furnace butt welded, black carbon steel, conforming to ASTM A53/A53M, Type F, Grade B.

Pipe DN50 through DN250 2 through 10-inches is Schedule 40, [seamless] [electric resistance welded], black carbon steel, conforming to ASTM A53/A53M, Grade B, Type [E] [S]. Grade A pipe should be used for permissible field bending.

Pipe DN300 12-inches and over is 10 millimeter 0.375 inch wall, [seamless, black carbon steel, conforming to ASTM A53/A53M, Grade B, Type [E] [S]].

Fittings DN50 2-inches and under are 1034 kilopascal gage 150-pounds per square inch, gage (psig) wsp, banded, black malleable iron, screwed, conforming to ASTM A197/A197M and ASME B16.3.

Unions 50 millimeter 2-inches and under are 1724 kilopascal gage 250-psig wsp, female, screwed, black malleable iron, with brass-to-iron seat and ground joint conforming to ASME B16.39, ductile iron conforming to ASTM A536 for grooved pipe couplings.

Couplings DN50 2-inches and under are [standard weight, screwed, black carbon steel] [ductile iron conforming to ASTM A536].

Fittings 65 millimeter 2-1/2-inches and over are [steel, butt welded, to match pipe wall thickness, conforming to ASTM A234/A234M and ASME B16.9] [ductile iron conforming to ASTM A536].

Flanges 65 millimeter 2-1/2-inches and over are 1034 kilopascal 150-psig wsp, forged steel, welding neck to match pipe wall thickness, conforming to ASME B16.5.

Grooved pipe couplings and fittings DN65 2-1/2-inches and over are malleable iron couplings and fittings conforming to paragraph PIPING SPECIALTIES.

b. Type GCS Galvanized Carbon Steel

Pipe DN15 through DN250 1/2 through 10-inches is Schedule 40, [seamless] [electric resistance welded], galvanized steel, conforming to ASTM A53/A53M, Grade B, Type [E] [S]. Type F is acceptable for sizes less than DN50 2-inches.

Fittings DN50 2-inches and under are 1034 kilopascal 150-psig wsp, [banded, galvanized, malleable iron, screwed, conforming to ASTM A197/A197M, ASME B16.3] [ductile iron conforming to ASTM A53/A53M and ASTM A536].

Fittings DN65 2-1/2-inches and over are 862 kilopascal 125-psig wsp, cast-iron flanges and [flanged fittings, conforming to ASTM A126, Class A, and ASME B16.1] [ductile iron conforming to ASTM A53/A53M and ASTM A536].

Unions 50 millimeter 2-inches and under are 2068 kilopascal 300-psig wsp, female, screwed, galvanized, malleable iron with brass-to-iron seat and ground joint.

2.3.2.2 Control and Instrumentation Tubing, to 207 Kilopascal 30 Psig

a. Copper

All tubing sizes with DN8 1/4-inch minimum outside diameter are [hard-drawn] [annealed] seamless copper, conforming to ASTM B280.

Provide solder joint wrought copper fittings conforming to ASME B16.22.

Ensure ball sleeve is of the compression type, [rod] [forged brass], conforming to SAE [72] [88], UL approved, with minimum pressure rating 1380 kilopascal at 38 degrees C 200 pounds per square inch (psi) at 100 degrees F.

Solder is 95-5 tin-antimony, alloy Sb 5, conforming to AWS WHB-2.9.

Copper tubing systems may be installed using mechanical pipe couplings of a bolted type with a central cavity design pressure responsive gasket. Groove copper pipe and fittings in accordance with the coupling manufacturer's recommendations.

b. Polyethylene

Tubing is black virgin polyethylene, conforming to ASTM D2239, Type I, Grade 2, Class C, conforming to stress-crack tests performed in accordance with ASTM D1693. Multitube harness with polyester film barrier and vinyl jacket cannot be less than [1.57] millimeter [0.062]-inch [_____] thick.

Ensure ball sleeve fittings are the compression type, and manufactured from [brass] [aluminum] [acetal resin].

2.4 ACCESSORIES

2.4.1 Miscellaneous Materials

2.4.1.1 Bolting

For flange and general-purpose bolting, use hex-head bolts and conform to ASTM F568M, Class 4.8 or above ASTM A307, Grade B. Ensure heavy hex-nuts conform to ASTM A563M ASME B18.2.2. Square-head bolts are not acceptable.

For grooved couplings, utilize bolts and nuts of heat treated carbon steel conforming to ASTM A183.

2.4.1.2 Elastomer Caulk

[Polysulfide] [polyurethane base] elastomer caulking material is a two-component type conforming to ASTM C920.

2.4.1.3 Escutcheons

Provide escutcheons manufactured from nonferrous metals and [chrome plated] [hot-dipped galvanized] except when AISI 300 series corrosion-resistant steel is provided. Select metals and finish are in accordance with ASME A112.18.1/CSA B125.1.

Select [one-piece] [split-pattern] escutcheons. Ensure escutcheons maintain a fixed position against a surface by means of internal spring tension devices or setscrews.

2.4.1.4 Flashing

Ensure sheet lead conforms to ASTM B749, Grade [B] [C] [D] and weigh not less than [19] [_____] kilogram per square meter [4] [_____] pounds per square foot.

Ensure sheet copper conforms to ASTM B370 and weigh not less than [16] [_____] ounces per square [4.88] [_____] kilogram per square meterfoot.

2.4.1.5 Flange Gaskets

Ensure compressed non-asbestos sheet conforms to ASTM F104, Type 1, and be coated on both sides with [graphite] [_____].

Ensure grooved flange adapters gasketing is a pressure responsive elastomer conforming to ASTM D2000.

2.4.1.6 Pipe Thread Compounds

Use tetrafluoroethylene tape not less than [0.05] [0.08] millimeter [2] [3] mils thick in compressed air systems for pipe sizes to and including DN25 1-inch ips.

Tetrafluoroethylene dispersions and other suitable compounds may be used for other applications upon approval by the Contracting Officer.

2.4.2 Supporting Elements

Provide all necessary piping system components and miscellaneous required supporting elements. Ensure supporting elements are suitable for stresses

imposed by system pressures and temperatures, and natural and other external forces.

****
NOTE: Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation considerations.
****

Ensure supporting elements are [FM-approved] [UL-listed] and conform to requirements of ASME B31.3, and MSS SP-58, except as otherwise noted. Type devices specified herein are defined in MSS standards unless otherwise noted.

2.4.2.1 Building Structure Attachments

Use concrete and masonry anchor devices that conform to requirements of CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-55614.

Install cast-in floor-mounted equipment anchor devices that provide adjustable positions.

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

Do not use power actuated anchoring devices to support mechanical systems components.

Ensure beam clamps are center loading Type [21] [28] [29] [30], UL listed, cataloged, and load rated, and commercially manufactured.

****
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.
****

[Do not use C-clamps.]

[Use clamps to support piping sizes DN40 1-1/2-inches and smaller. Provide FM approved and UL listed C-clamps with hardened cup tip, setscrew, locknut, and retaining strap. Use a retaining strap section of not less than [3 by 25] millimeter [1/8 by 1]-inch [_____]. Beam flange thickness to which clamps are attached cannot exceed 15 millimeter 0.60-inch.

][Construct concrete inserts in accordance with the requirements of MSS SP-58, for Type 18 hangars. When applied to piping in sizes DN50 2-inch ips and larger and where otherwise required by imposed loads, insert a 305 millimeter length of 13 millimeter 1-foot length of 1/2-inch reinforcing rod and wired through wing slots. Approved proprietary-type continuous inserts may be similarly used upon approval by the Contracting Officer.

]2.4.2.2 Horizontal Pipe Attachments

Support piping in sizes to and including DN50 2-inch ips by Type 6 solid malleable-iron pipe rings except that split-band-type rings may 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.

Support piping in sizes larger than DN200 8-inch ips with Type [41] [49] pipe rolls.

Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts in congested areas and where multiple pipe runs occur. Structural steel shapes [conform to supplementary steel requirements] [are a commercially available, proprietary-design, rolled steel].

2.4.2.3 Vertical Pipe Attachments

Use Type 8 vertical pipe attachments.

2.4.2.4 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.

2.4.2.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design and fabricate such supplementary steel in accordance with AISC 360.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Underground Piping System

3.1.1.1 Compressed Air System Installation

Perform installation of compressed air systems in accordance with the manufacturer's instructions. Conduct installation in the presence of the Contracting Officer. Notify the Contracting Officer [48] [_____] hours in advance of the work.

Conduct excavations in accordance with Section 31 00 00 EARTHWORK.

Lay piping at the beginning at the low point of a system, and when in final position, is true to the grades and alignment with unbroken continuity of invert.

[Blocking and wedging is not permitted.

] Ensure that pipes passing through walls below grade and ground floor slabs pass through pipe sleeves.

In fill areas, ensure pipe passing under or through building grade beams have a minimum of [100] millimeter [4]-inches [_____] clearance in all directions.

Where pipe penetrates earth or concrete grade, ensure that not less than [300] millimeter [12]-inches [_____] of polyethylene-coated Type BCS-PS pipe is exposed to view.

Install Type BCS-PS materials in accordance with the applicable requirements 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. Prior to being lowered into a trench, check sheathing for continuity with 10,000 volts applied by a continuity detector. In the trench, after joints and fittings are made, check previously untested surfaced for continuity. Where discontinuities in thermoplastic are found, discard not less than [0.30] millimeter [12]-inches [_____] of material upstream and downstream of fault.

[After valves, valve operators, and valve boxes have been inspected and not less than [48] [_____] hours prior to being lowered into a trench, coat external surfaces with a compatible bituminous coating for protection against brackish ground water. Apply as a single coat in accordance with the manufacturer's instructions, and result in a dry-film thickness of not less than [0.30] millimeter [12] mils [_____].

]3.1.1.2 Valve Boxes

Set valves and valve boxes plumb. Center valve boxes on the valves.

[Provide concrete slabs 100 millimeter 4-inches thick to protect valve boxes.

]3.1.2 Above Ground Piping System

3.1.2.1 Piping Systems

Fabricate and install piping systems in accordance with ASME B31.3, MSS SP-58, ASME BPVC, and applicable AWS requirements.

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

****

NOTE: When the following paragraph does not provide for cleanliness required by project conditions and if pickling of pipe and temporary line strainers are required, rewrite the following paragraph. Do not oil pipe bore. Use phosphoric acid rust preventing treatment.

****

Ensure pipe, tubing, fittings, valves, equipment, and accessories is clean and free of all foreign material before being installed in their respective systems. Clean pipe by a method approved by the Contracting Officer. Purge lines with dry, oil-free compressed air after erection, but do not rely on purging for removing all foreign matter. Purge lines at a velocity equal to 1-1/2 times maximum normal flow velocity. During the progress of construction, protect open ends of pipe, fittings, and valves at all times to prevent the admission of foreign matter. Except when connections are actually underway, install plugs or caps on all pipe and component openings. Use plugs or caps that are 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.

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

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

Make tee connections with screwed tee fittings or grooved tee fittings. Where pipe is being welded, make branch connections with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Provide branch outlet fittings that are forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full burst-pressure strength requirements. Provide tool space between parallel piping runs whenever threaded unions or couplings are installed.

Install horizontal piping with a grade of [25.0 millimeter per 30480 millimeter] [1-inch per 100-feet] [_____].

Use eccentric reducers where required to permit proper drainage of pipe lines. Do not permit bushings for this purpose. Provide drain valves in piping systems at low points. Pipe drains consist of DN15 1/2-inch globe valves with renewable disks and 20 millimeter 3/4-inch hose adapter.

Perform installation of piping in a manner that prevents stresses and strains from being imposed on connected equipment.

Make expansion bends in steel pipe from pipe sections and long-radius welding elbows in sizes DN25 1-inch and larger. Ensure expansion U-bends are cold sprung and welded into the line. Anchor line before removing the spreader from the expansion U-bend.

3.1.2.2 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 exercise care to prevent compound from reaching the interior of the pipe.

Provide screwed unions, welded unions, or bolted 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. Provide clearance between flange faces such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Ensure 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 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, machine the raised face to a smooth matching surface, and a full facegasket used. After the piping system has been tested and is in service at its maximum temperature, re-tighten bolting. Only use hex-head nuts and bolts. Provide fresh stock gasket material, 1.6 millimeter 1/16-inch thick.

Ensure field welded joints conform to the requirements of the AWS-03 and ASME B31.3.

Square cut copper tubing for solder joints, remove burrs with approved cutting and reaming tools. Clean inside surfaces of fittings and outside surfaces of tubes in joint area before assembly of joint. Apply joint flux, solder, and heat source in accordance with the manufacturer's instructions to provide proper capillary action to fill the socket space and to achieve 100 percent of shear-line strength capability. Ensure valves in copper piping have screwed ends with end adapters to suit mechanical connections, unless solder joining is specified for a given application. Remake copper joints that fail pressure tests with new materials, including pipe or tubing fittings and filler metal.

Cut square, tubing for mechanical joints and remove burrs. Exercise care to avoid work-hardened copper surfaces and cut off or anneal tube ends. Meet heating temperature and air-cooling requirements in accordance with the manufacturer's instructions.

3.1.2.3 Control and Instrument Air Tubing

Conceal tubing, except in mechanical rooms or areas where other piping is exposed.

Use hard-drawn copper tubing in exposed areas. Do not use anneal copper in concealed locations.

For supply system copper tubing,use wrought copper solder joint-type fittings, except at connection to apparatus where specified brass mechanical and ips thread adapter fittings are used. Tool-made bends in lieu of fittings are acceptable. Neatly nest multiple tube runs.

[Use fittings for plastic tubing in accordance with the manufacturer's instructions.

][Plastic tubing, sheathed or unsheathed, may be used in lieu of copper tubing, provided:

a. Plastic tubing is not exposed to ultraviolet light and continuous ambient temperatures in excess of 49 degrees C 120 degrees F at any point along run.

b. Plastic tubing is free from danger of mechanical damage and readily accessible for replacement with a minimum of tools and without need to remove plaster, furring, equipment, and similar permanent construction.

c. Plastic tubing is not embedded in concrete, concealed within walls of structure, or hot pipe and duct chases.

d. Plastic tubing is enclosed within control panel cabinets or concealed behind control panels.

e. Routing has prior approval of the Contracting Officer.

[Color][Number] code tubing installed inside or behind control panels. Neatly tie and support tubing. Neatly fasten connections bridging the cabinet and its door along the hinge side and protected against abrasion.

When the tubing run is less than 300 millimeter 12-inches, plastic tubing may be used. Otherwise, terminal single line is hard-drawn copper tubing.

] Mechanically attach tubing to supporting surfaces. Supports using adhesives are not acceptable.

For copper tubing horizontal supports with less than 3 tubes use a rigid 25 by 10 millimeter 1-by 3/8-inch metal channel, use a proprietary metal tube race for 3 or more tubes.

[Run exposed plastic tubing in mechanical rooms or spaces where copper tubing is exposed within adequately supported [metal raceway] [metallic or plastic electric conduit] [pipe].

][Use multiple-tube plastic harness or sheathing in place of single plastic tubes where a number of plastic tubes run to the same points.

][Multiple-tube plastic harness or sheathing may be imbedded in concrete or run in soil below concrete provided it is jointless, contains 30 percent spares, and prior approval of the Contracting Officer has been obtained.

] For runs imbedded in concrete use annealed copper tubing protected with [metallic] [plastic] electric conduit.

Ensure copper-tubing runs in soil are jointless. Protect the copper tubing from brackish ground water and leaching concrete alkali with 0.30 millimeter 12-mil thick [bituminous coating] [equivalent polyvinylchloride (PVC) tape wrapping].

Make tubing penetrations of concrete surfaces through minimum DN25 1-inch ips, Schedule 40, rigid unplasticized PVC pipe sleeves, except that multitube harness 40 millimeter 1-1/2-inches outside diameter and larger need not have additional protection. Extend sleeve [150] millimeter [6]-inches [_____] above floors and [25] millimeter [1]-inch [_____] below grade surface of slabs. Where water or vapor-barrier sealing is required, apply 15 millimeter 1/2-inch deep elastomer caulk to surfaces that are free from oil and other deleterious substances.

Systematically purge tubing with [dry, oil-free compressed air] [nitrogen] to rid system of impurities [generated during joint-making and installation] and atmospheric moisture before connection to control instruments.

3.1.2.4 General Service Valve Locations

Provide valves to permit isolation of branch piping and each equipment item from the balance of the system, to allow safe and convenient access without moving equipment, and to require a minimum of piping and equipment disassembly.

Provide valves in piping mains and branches at equipment and equipment items.

Provide riser and downcomer drains above piping shutoff valves in piping DN65 2-1/2-inches and larger. Tap and fit shutoff valve body with a DN15 1/2-inch plugged globe valve.

Provide three-valve bypass around each pressure-regulating valve.

Provide access panels for valves unavoidably located in furred or other normally inaccessible places.

3.1.2.5 Bypass Throttling Valves

Ensure valves are globe type with [metallic] [composition disc].

3.1.2.6 Supporting Elements Installation

Provide support elements in accordance with the requirements of ASME B31.1, and MSS SP-58. Hang piping from building construction. Do not hang piping from roof deck or from other pipe.

Attachment to building construction concrete is by approved cast-in concrete inserts wherever possible. Attachment to building construction solid masonry is by built-in anchors. Where attachment by either of above methods is not possible, 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 diameter.

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

Install masonry anchors conforming to CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-55614 in rotary, nonpercussion, electric drilled holes. Group III self-drilling anchors may be used provided masonry drilling is done with electric hammers selected and applied in a manner that precludes concrete spalling or cracking both visible or invisible. Pneumatic tool use is not allowed.

Use percussive action, electric hammers, and combination rotary-electric hammers for the installation of self-drilling anchors selected in accordance with the following guide:

a. For nominal anchor device sizes M6 through M14 1/4- through 1/2-inch, use a hammer type only or combination rotary-hammer type tool rated at load to draw not more than 5.0 amperes when operating on 120-volt, 60-hertz power.

b. For nominal anchor device sizes M16 5/8-inch and larger, use a hammer type only tool rated at load to draw not more than 8.0 amperes when operating on 120-volt, 60-hertz power. Ensure combination rotary hammer tools on the same power supply 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 them not less than the following applicable distance from any side or end edge or centerline of adjacent

anchor service:

Anchor Bolt Length (Millimeter)	Minimum Edge Space (Millimeter)
6	90
8	95
10	100
14	125
16	150
20	175
22	200

Anchor Bolt Length (Inches)	Minimum Edge Space (Inches)
1/4	3-1/2
5/16	3-3/4
3/8	4
1/2	5
5/8	6
3/4	7
7/8	8

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 reduced distance.

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there is not less than [13] millimeter [1/2]-inch [_____] of clear space between the finished surface and other work and between the finished surface and parallel adjacent piping. Arrange hangers on different adjacent service lines running parallel with each other to be in line with each other and parallel to the lines of the building.

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

Spacing of trapeze hangers where piping is grouped in parallel runs is 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, use constant support pipe hangers.

Provide approved pipe alignment guides, attached in an approved manner to the building structure, to control pipe movement in true alignment in the piping adjacent to and on each side of all pipe expansion loops.

Weld anchors incorporated in piping systems for the purpose of maintaining permanent pipe positions to the piping and attached to the building structure in a manner approved by the Contracting Officer.

Suitably brace piping against sway and vibration. Bracing consists of brackets, anchor chairs, rods, and structural steel for vibration isolation.

[Locate pipe lines supported from roof purlins not greater than [one-sixth] [_____] of the purlin span from the roof truss. Load per hanger cannot exceed [1780] newton [400] pounds [_____] when support is from a single purlin, [3560] newton [800] pounds [_____] when hanger load is applied to purlins halfway between purlins by means of auxiliary support steel installed by the 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 the reinforcing of the roof purlin(s) or additional support beam(s). When an additional beam is used, ensure the beam bears on the top chord of the roof trusses, and bearing is over gusset plates of top chord. Stabilize beam by connection to roof purlin along 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 the specified interval from each change in direction of piping.

Load rating for all pipe hanger supports is based on weight and forces imposed on all lines. Deflection per span cannot exceed slope gradient of pipe. Schedule 40 and heavier pipe supports are in accordance with the following minimum rod size. Maximum allowable hanger spacing and concentrated loads reduces allowable span proportionately:

PIPE SIZE MILLIMETER	ROD SIZE MILLIMETER	STEEL PIPE MILLIMETER
Up to 25	10	2438
32 to 40	10	3048
50	10	3660
65 to 90	15	3660
100 to 125	16	4880
150	20	4880
200 to 300	22	6100

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 to 12	7/8	20

Where possible, support vertical risers at the base at intervals specified and guide for lateral stability. Place clamps under fittings wherever possible. Support carbon steel pipe at each floor at not more than 4570 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, firmly tighten hanger rod nuts and jam nuts to prevent any movement.

3.1.2.7 Sound Stopping

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

Sound stopping provisions are essentially the materials and procedures specified under paragraph SLEEVES.

[Sound stopping and vapor barrier sealing of pipe shafts and large floor and wall openings are accomplished by packing to high density with properly supported mineral fiber or, where ambient or surface temperatures do not exceed 49 degrees C 120 degrees F, by foaming in place with self-extinguishing, 0.9 kilogram 2-pound density polyurethane foam to a depth not less than [150] millimeter [6]-inches [_____]. Finish foam with a rasp. Vapor barrier cannot be less than [3] millimeter [1/8]-inch [_____] thickness of vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire-stopping are a consideration, use only mineral fiber, in addition, cover openings with [1.6] millimeter [16]-gage [_____] sheet metal.

] Ensure all mineral materials conform to requirements specified under paragraph, "Sleeves," of this section.

Leadwool and viscoelastic damping compounds may be proposed for use where other sound-stopping methods are not practical, provided temperature and

fire-resistance characteristics of the compounds are suitable for the service.

3.1.2.8 Sleeves

Sleeves are required where piping passes through roofs, through masonry or concrete walls, or through floor.

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

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

Ensure sleeves are flush with all ceilings.

Ensure sleeves are flush with the floor in finished spaces and extend [50] millimeter [2]-inches [_____] above the floor in unfinished spaces.

Continuously [welded] [brazed] sleeves passing through steel decks to the deck.

Use sleeves that continuously extend through floors, roofs, and load bearing walls, and sleeves through fire barriers and fabricated from Schedule 40 steel pipe with welded anchor lugs. Other sleeves may be formed by molded linear polyethylene liners or similar materials that are removable. Ensure sleeve diameter is large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and provide a minimum [10] millimeter [3/8]-inch [_____] clearance. Select a sleeve size to accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Pack solid the space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration with a mineral fiber conforming to ASTM C592, Form B, Class 8. Wherever the piping passes through firewalls, equipment room walls, floors and ceilings connected to occupied spaces, and other locations where sleeves or construction surface penetrations occur between occupied spaces, provide similar packing. 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 [13] millimeter [1/2]-inch [_____]. Ensure surfaces to be caulked are oil- and grease-free.

[Caulk watertight with lead and oakum] [Make watertight with mechanically expandable chloroprene inserts with mastic sealed metal components] exterior wall sleeves.

Ensure sleeve height above roof surface is [304.8] millimeter [12]-inches [_____].

3.1.2.9 Escutcheons

Provide escutcheons at 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. Provide plates at the

underside only of such ceilings, where suspended ceilings are installed. Install plates large enough to fit around the insulation, for insulated pipes. Use chrome-plated escutcheons in occupied spaces and of sufficient size to conceal openings in building construction. Firmly attach escutcheons with setscrews.

3.1.2.10 Flashings

Provide required flashings at mechanical systems penetrations of building boundaries.

3.1.3 Compressed Air Systems Identification

Protect and keep clean identification plates. Replace damaged and illegible identification plates at no additional expense.

Label and arrow piping at each point of entry and exit of piping passing through walls; at each change in direction, such as at elbows and tees; and in congested or hidden areas, at each point required to clarify service or indicate a hazard. Also label each riser.

In long straight runs, locate labels at distances visible to each other, but in no case the distance between labels exceed [22860] millimeter can [75]-feet [_____]. Ensure labels are legible from the primary service and operating area.

3.2 FIELD QUALITY CONTROL

3.2.1 Compressed Air Systems Testing

****
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, pressure-test completed systems in the presence of the Contracting Officer.

[Conduct testing in two stages: preliminary stage and acceptance stage, including gage tests.

][Perform no testing until personnel not directly involved in the test have been evacuated from the area.

][Contractor may conduct tests for his own purposes, but conduct the preliminary test and the acceptance test as specified.

] Each acceptance test requires the signature of the Contracting Officer. Deliver [two] [_____] record copies to the Contracting Officer after acceptance.

3.2.1.1 Preliminary Stage Tests

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

[Conduct pneumatic tests with dry, oil-free compressed air. Use carbon dioxide or nitrogen in metallic systems.

][Testing of any system for any purpose includes preliminary testing by swabbing joints under test with standard high-strength film soap solution and observing for bubbles at internal pressures not in excess of 35 kilopascal 5 psi.

] When testing reveals that leakage exceeds specified limits, isolate and repair the leaks, replace defective materials where necessary, and retest the system until specified limits are met. Remake leaking gaskets with new gaskets and new flange bolting, and discard used bolting and gaskets.

Other than standard piping flanges, plugs, caps and valves, only use commercially manufactured expandable elastomer plugs for sealing off piping for test purposes. Published safe test pressure rating of any plug used cannot be less than three times the actual test pressure being applied. During pneumatic testing or hydrostatic testing, evacuate personnel from areas where plugs are used.

Remove components that could be damaged by test pressure from piping systems to be tested.

Perform valve-operating tests and drainage tests according to referenced standards.

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

Do not add test media to a system during a test for a period specified or determined by the Contracting Officer.

Duration of a test is determined by the Contracting Officer and will be for a minimum of [15] [_____] minutes with a maximum of [24] [_____] hours. Test may be terminated by direction of the Contracting Officer at any point after it has been determined that the leakage rate is within limits.

Prepare and maintain test records of all piping systems tests. Records show Governmental and Contractor test personnel responsibilities, dates, test gage identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates.

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

[Only use potable water for hydrostatic testing. Government will supply testing water at a location determined by the Contracting Officer. Contractor is responsible for approved disposal of contaminated water. Temperature of water used for testing cannot be low enough to cause condensation of atmospheric moisture on system surfaces. Provide

supplementary heat, when necessary.

][To preclude injury and damage, take necessary precautions by venting the expansive force of compressed air trapped during high-pressure hydrostatic testing. When purging or vent valves are not provided, the Contracting Officer may require the removal of any system component such as plugs or caps to verify that the water has reached all parts of the system.

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

][Irrespective of the amount of measured leakage, immediately repair visible leaks or defects in the pipeline.

]3.2.1.2 Test Gages

Ensure test gages conform to ASME B40.100 and have a dial size of 200 millimeter 8-inches or larger. Maximum permissible scale range for a given test is 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. Ensure certification of accuracy and correction table bears a date within [90] [_____] calendar days prior to test use, test gage number, and the project number, unless otherwise approved by the Contracting Officer.

3.2.1.3 Acceptance Pressure Testing

Ensure testing takes place during steady-state ambient temperature conditions.

Test ferrous piping systems at [1-1/2] [_____] times maximum operating pressure. Maintain test pressure for a period of not less than [2] [_____] hours with an allowable pressure drop of [14] kilopascal [2] psi [_____] during that time unless otherwise approved by the Contracting Officer.

Test control and instrumentation tubing systems at [205] kilopascal [30] psi [_____]. Maintain test pressure for a period of not less than [24] [_____] hours with essentially no pressure drop during that time.

3.3 ADJUSTING AND CLEANING

Remove rust and dirt from the bore and exterior surface of all piping and equipment. Clean pipeline strainers, temporary and permanent, during purging operations, after startup, and immediately prior to final acceptance by the Government.

Flush and clean new steel piping with a suitable degreasing agent, [____], until visible, grease, dirt, and other contaminants have been removed. Dispose of degreased waste material including the degreaser itself in accordance with written instructions received from the Environmental Authority having jurisdiction through the Contracting Officer and in accordance with all local, State and Federal Regulations.

3.4 CLOSEOUT ACTIVITIES

Submit [6] [_____] copies of the operation and maintenance manuals [30]

[_____] calendar days prior to testing the low-pressure compressed air system. Update and resubmit data for final approval no later than [30] [_____] calendar days prior to contract completion.

-- End of Section --