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Preparing Activity: NASA Superseding
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2012

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SECTION 23 05 15

COMMON PIPING FOR HVAC

02/09

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SECTION 23 05 15

COMMON PIPING FOR HVAC 02/09

NOTE: This guide specification covers the requirements for standard basic mechanical work and should be supplemented by use of other mechanical sections as required.

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

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

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

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

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

planes.

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

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

1.1 REFERENCES

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

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

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

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

[AISC 325](#) (2011) Steel Construction Manual

AMERICAN WELDING SOCIETY (AWS)

[AWS A5.8/A5.8M](#) (2011) Specification for Filler Metals for

Brazing and Braze Welding

AWS WHB-2.9

(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASME INTERNATIONAL (ASME)

ASME A112.18.1/CSA B125.1

(2011) Plumbing Supply Fittings

ASME A112.19.2/CSA B45.1

(2008; Update 1 2009; Update 2 2011)
Standard for Vitreous China Plumbing
Fixtures and Hydraulic Requirements for
Water Closets and Urinals

ASME B1.20.7

(1991; R 2008) Standard for Hose Coupling
Screw Threads (Inch)

ASME B1.21M

(1997; R 2008) Standard for Metric Screw
Threads - MJ Profile

ASME B16.1

(2010) Gray Iron Pipe Flanges and Flanged
Fittings Classes 25, 125, and 250

ASME B16.11

(2011) Forged Fittings, Socket-Welding and
Threaded

ASME B16.22

(2001; R 2010) Standard for Wrought Copper
and Copper Alloy Solder Joint Pressure
Fittings

ASME B16.25

(2007) Standard for Buttwelding Ends

ASME B16.26

(2011) Standard for Cast Copper Alloy
Fittings for Flared Copper Tubes

ASME B16.3

(2011) 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 B16.4

(2011) Standard for Gray Iron Threaded
Fittings; Classes 125 and 250

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 B31.3

(2010) Process Piping

ASME B36.10M

(2004; R 2010) Standard for Welded and
Seamless Wrought Steel Pipe

ASME B40.100

(2005; R 2010) Pressure Gauges and Gauge
Attachments

ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2011a) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2011) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A197/A197M	(2000; R 2011) Standard Specification for Cupola Malleable Iron
ASTM A216/A216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A234/A234M	(2011a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A276	(2010) Standard Specification for Stainless Steel Bars and Shapes
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	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A312/A312M	(2012) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A480/A480M	(2012) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A6/A6M	(2012) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A74	(2009) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM B370	(2011e1) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B749	(2003; R 2009) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2005; R 2011) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C109/C109M	(2011b) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C404	(2011) Standard Specification for Aggregates for Masonry Grout
ASTM C476	(2010) Standard Specification for Grout for Masonry
ASTM C553	(2011) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C564	(2011) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C67	(2012) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants

ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2308	(2007) Standard Specification for Thermoplastic Polyethylene Jacket for Electrical Wire and Cable
ASTM E1	(2007) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E814	(2011a) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials
ASTM F568M	(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
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 515	(2011) Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications
IEEE C2	(2012; Errata 2012; INT 1 2012; INT 2 2012) National Electrical Safety Code

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

MSS SP-125	(2010) Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2011) Gray Iron Swing Check Valves, Flanged and Threaded Ends

MSS SP-72 (2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-85 (2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2011) Motors and Generators

NEMA MG 10 (2001; R 2007) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors

NEMA MG 11 (1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; Errata 2 2012) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-18480 (1982; Rev B; Notice 2 2009) Coating Compound, Bituminous, Solvent, Coal-Tar Base

MIL-DTL-17813 (2009; Rev H; Supp 1 2009) Expansion Joints, Pipe, Metallic Bellows, General Specification for

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-1925 (Rev A; Notice 2) Shield Expansion (Nail Anchors)

CID A-A-55614 (Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)

CID A-A-55615 (Basic; Notice 2) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors)

UNDERWRITERS LABORATORIES (UL)

UL 1479 (2003; Reprint Mar 2010) Fire Tests of Through-Penetration Firestops

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 thereof should be inserted and the first paragraph deleted. If Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT is not included in the project specification, applicable requirements thereof should be inserted and the second paragraph deleted. If Section 40 17 30.00 40 WELDING GENERAL PIPING is not included in the project specification, applicable requirements thereof should be inserted and the third paragraph deleted.

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

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

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

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

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

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

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

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

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

Submit [Record Drawings](#) for pipes, valves and accessories providing current factual information including deviations and amendments to the drawings,

and concealed and visible changes in the work.

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

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

1.3 SUBMITTALS

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

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.

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

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

[SD-01 Preconstruction Submittals](#)

Submit [Material, Equipment, and Fixture Lists](#) for construction equipment to be used.

[SD-02 Shop Drawings](#)

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

[Record Drawings](#)
[Connection Diagrams](#)
[Coordination Drawings](#)
[Fabrication Drawings](#)

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

[SD-03 Product Data](#)

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

Submit Manufacturer's catalog data for the following items:

[Pipe and Fittings](#)
[Piping Specialties](#)
[Valves](#)
[Miscellaneous Materials](#)
[Supporting Elements](#)

[Equipment Foundation Data](#) shall be in accordance with paragraph entitled, "General Requirements," of this section.

[SD-04 Samples](#)

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

[SD-05 Design Data](#)

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

[Pipe and Fittings](#)
[Piping Specialties](#)
[Valves](#)

[SD-06 Test Reports](#)

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

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

SD-07 Certificates

Submit [Listing of Product Installations](#) for piping systems verifying proper qualifications.

Submit [Records of Existing Conditions](#) by the Contractor prior to start.

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

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

SD-10 Operation and Maintenance Data

Submit [Operation and Maintenance Manuals](#) in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.4.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.3 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a

regular and emergency basis during the warranty period of the contract.

1.4.4 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.4.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

NOTE: Use this paragraph for other than
SOUTHNAVFACENGCOM projects.

[1.6 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors shall conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and

contactors shall have a maximum of 120 volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

]

**NOTE: Use this paragraph and its subparagraphs
regarding electrical components and energy efficient
motors for SOUTHNAVFACENGCOM projects.**

[1.7 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.7.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters [(except starters/controllers which are indicated as part of a motor control center)], control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, [the motor control equipment forming a part of motor control centers,] and the electrical power circuits shall be provided under Division 26, except internal wiring for components of package equipment shall be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.7.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.7.3 High Efficiency Motors

1.7.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.7.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, select polyphase motors based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings shall meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.7.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1.34 kilowattsone horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

]1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and trained in operating theory as well as practical operation and maintenance work.

Give instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 ELECTRICAL HEAT TRACING

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

Provide self-regulating heaters consisting of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. Heater shall

be able to be crossed over itself without overheating and be approved before used directly on plastic pipe. Heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket in accordance with ASTM D2308.

[For installation on plastic piping, apply the heater using aluminum tape. Heater shall have an outer braid of tinned-copper and an outer jacket of modified polyolefin in accordance with ASTM D2308, to provide a good ground path and to enhance the heater's ruggedness.]

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

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

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

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

Size Heater according to the following table:

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

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

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

2.2 PIPE AND FITTINGS

2.2.1 Type BCS, Black Carbon Steel

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

Pipe DN6 through DN300 1/8 through 12 inches shall be Schedule 40 black carbon steel, conforming to ASTM A53/A53M.

Pipe DN6 through DN250 1/8 through 10 inches shall be Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M, [Type E, Grade B (electric-resistance welded)] [Type S (seamless)]. Grade A should be used for permissible field bending, in both cases.

Pipe DN300 through DN610 12 through 24 inches shall be 9.52 millimeter 0.375-inch wall seamless black carbon steel, conforming to ASTM A53/A53M, [Type E, Grade B (electric-resistance welded)] [Type S (seamless)].

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

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

Fittings DN65 and over 2-1/2 inches and over shall be Steel butt weld, conforming to ASTM A234/A234M and ASME B16.9 to match pipe wall thickness.

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

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

NOTE: This pipe is applicable for steam- and condensate-piping systems at pressures less than 862 kilopascal 125 pounds per square inch (psi). Avoid screwed-end connections in condensate piping wherever possible. See Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS for black carbon steel pipe for higher pressure ratings.

Pipe DN6 through DN40 1/8 through 1-1/2 inches shall be Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A53/A53M, Type F (furnace butt welded, continuous welded) and ASME B36.10M.

Pipe DN50 through DN250 2 through 10 inches shall be Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M [Type E, Grade B (electric-resistance welded)] [Type S (seamless)] and ASME B36.10M.

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

Pipe DN300 through DN610 12 through 24 inches shall be 9.52 millimeter 0.375-inch wall, [seamless] [electric-resistance] welded black carbon steel, conforming to ASTM A53/A53M [Type E, Grade B (electric-resistance welded)] [Type S (seamless) and ASME B36.10M].

[Fittings DN50 and under 2 inches and under shall be 862 kilopascal 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.]

[Fittings DN50 and under 2 inches and under shall be 1034 kilopascal 150-psig wsp banded black malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.]

[Fittings DN25 through DN50 1 through 2 inches shall be 14 or 21 megapascal 2,000-or 3,000-psi water, oil, or gas (wog) to match pipe wall, forged carbon steel socket weld, conforming to ASTM A105/A105M and ASME B16.11.]

[Fittings DN50 and under 2 inches and under shall be 862 kilopascal 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.]

[Fittings DN65 and over 2-1/2 inches and over shall be wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB and ASME B16.9.]

[Couplings DN50 and under 2 inches and under shall be commercial standard weight for Schedule 40 pipe and commercial extra heavy weight for Schedule 80 pipe, black carbon steel where threaded, and 14 or 21 megapascal 2,000-or 3,000-psi wog forged carbon steel, conforming to ASTM A105/A105M and ASME B16.11, where welded.]

[Flanges DN65 and over 2-1/2 inches and over shall be 1035 kilopascal, 150-pound, forged carbon-steel welding neck, with raised face or flat face and concentric serrated finish, conforming to ASTM A105/A105M and ASME B16.5.]

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

2.2.3 Type GCS, Galvanized Carbon Steel

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

Pipe DN15 through DN250, and where indicated 1/2 through 10 inches, and where indicated shall be Schedule 40 seamless or electric-resistance welded galvanized steel conforming to ASTM A53/A53M, Type E, Grade B (electric-resistance welded) or Type S (seamless).

Pipe DN300 and over 12 inches and over shall be 9.52 millimeter 0.375-inch wall, seamless, galvanized steel, conforming to ASTM A53/A53M, Grade B.

Fittings DN50 and under 2 inches and under shall be 1034 kilopascal 150-psig wsp banded galvanized malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.

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

Fittings DN65 and over 2-1/2 inches and over shall be 862 kilopascal 125-psig wsp cast-iron flanges and flanged fittings, conforming to ASTM A126, Class A and ASME B16.1.

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

Contractor has the option of using 1034 kilopascal 150-psig wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A197/A197M and ASME B16.3.

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

NOTE: Nonferrous piping exposed to view in finished spaces and normally chrome plated is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE Select A53 pipe where bending and flattening tests are required.

Pipe (all sizes) shall be Schedule 40 [seamless] [electric-resistance welded] galvanized carbon steel, conforming to ASTM A53/A53M, Grade A.

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

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

[Fittings shall be galvanized, [coated] [uncoated], screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A126.]

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

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

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

Provide soil pipe drain, waste, and vent bell-and-spigot type pipe cast iron, conforming to ASTM A74. Caulk and lead all joints in lines where necessary to provide proper leaktight support and alignment; other-wise joints may be two-gasket system type chloroprene, conforming to ASTM C564. Pipe class shall be extra heavy (CISP-DWV-XH).

2.2.6 Type CPR, Copper

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

2.2.6.1 Type CPR-A, Copper Above Ground

Tubing DN50 and under 2 inches and under shall be seamless copper tubing, conforming to ASTM B88M, ASTM B88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).

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

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

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

[Solder must be 60-40 tin-antimony, alloy Sb-5, conforming to ASTM B32.]

2.2.6.2 Type CPR-U, Copper Under Ground

NOTE: For sizes under DN80 3 inches.

Provide Type K seamless copper tube piping, conforming to ASTM B88M ASTM B88. Socket-joint fittings shall be wrought copper, conforming to ASME B16.22. Fittings for connection to corporation cocks shall be cast bronze, flared-type, conforming to ASME B16.26. Joints shall be brazed.

2.2.6.3 Type CPR-INS, Copper Under Ground Insulated

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

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

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

Provide insulated Type K seamless copper tube piping conforming to ASTM B88M ASTM B88. Socket-joint fittings shall be wrought copper, conforming to ASME B16.22. Joints shall be brazed.

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

2.2.7 Grooved Pipe Couplings and Fittings

Provide housing for all couplings, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Coupling gasket shall be molded synthetic rubber, conforming to ASTM D2000. Coupling bolts shall be oval-neck, track-head type, with hexagonal heavy nuts conforming to ASTM A183.

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

Fabricate fittings from Schedule 40 or 19 millimeter 0.75-inch wall ASTM A53/A53M, Grade B seamless steel pipe; long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

2.3 PIPING SPECIALTIES

2.3.1 Air Separator

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

[Commercially constructed separator shall be designed and certified to separate not less than 80 percent of entrained air on the first passage of water and not less than 80 percent of residual on each successive pass. Provide shop drawings detailing all piping connections proposed for this work.]

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

2.3.2 Air Vents

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

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

[Automatic air vents on pumps, mains, and where indicated shall be of ball-float construction. Vent inlet shall be not less than DN20 3/4-inch ips and the outlet not less than 8 millimeter 1/4-inch ips. Orifice shall be 3 millimeter 1/8 inch. Provide corrosion-resistant steel trim conforming to [ASTM A276] [ASTM A480/A480M]. Vent shall be fitted with try-cock. Vent shall discharge air at any pressure up to 1034 kilopascal 150 psi. Outlet shall be copper tube routed.]

2.3.3 Compression Tank

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

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

2.3.4 Dielectric Connections

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

2.3.5 Expansion Vibration Isolation Joints

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

This joint may also serve as a dielectric connector.

Single or multiple arch-flanged expansion vibration isolation joints shall be constructed of steel-ring reinforced chloroprene-impregnated cloth materials. Design joint to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Back flanges with ferrous-metal backing rings. Provide control rod assemblies to restrict joint movement. All nonmetallic exterior surfaces of the joint shall be coated with chlorosulphinated polyethylene. Provide grommets in limit bolt hole to absorb noise transmitted through the bolts.

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

Joints shall be suitable for continuous-duty working temperature of at least 121 degrees C 250 degrees F.

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

Fill arches with soft chloroprene.

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

2.3.6 Flexible Pipe

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

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

Flexible pipe may also serve as a dielectric connector.

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

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

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

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

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

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

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

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

2.3.7 Flexible Metallic Pipe

Flexible pipe shall be the bellows-type with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of [ASME B31.3](#).

Working pressure minimum rating shall be [\[345\] \[690\] kilopascal at 149 degrees C](#) [\[50\] \[100\] psi at 300 degrees F](#).

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

[Welded end connections shall be Schedule 80 carbon steel pipe, conforming to [ASTM A106/A106M](#), Grade [B] [C].]

[Threaded end connections shall be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to [ASTM A312/A312M](#).]

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

2.3.8 Flexible Metal Steam Hose

Hose shall be bellows type with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of [ASME B31.3](#).

Working steam pressure rating shall be [862 kilopascal at 260 degrees C](#) [125 psi at 500 degrees F](#).

[Minimum burst pressure shall be nine times working steam pressure at [149 degrees C](#) [300 degrees F](#).]

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

[Welded end connections shall be Schedule 80 carbon steel pressure tube, conforming to [ASTM A106/A106M](#), Grade [B] [C].]

[Threaded end connections shall be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to [ASTM A312/A312M](#).]

[Flanged end connection rating and materials shall conform to

specifications for system primary-pressure rating.]

2.3.9 Metallic Expansion Joints

[Expansion joints shall be metallic-bellows-type, conforming to MIL-DTL-17813.]

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

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

Rate, design, and construct joints for pressures to 862 kilopascal 125 psig and temperatures to 260 degrees C 500 degrees F.

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

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

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

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

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

End connections shall require no field preparation other than cleaning.

[Butt weld end preparation of expansion joints shall 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 shall conform to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.]

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

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

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

[Expansion joints shall 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 shall be included in shop drawings. Overall dimension after joint installation shall be subject to approval.]

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

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

Permanently and legibly mark each joint with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

2.3.10 Hose Faucets

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

Construct hose faucets with 15 millimeter 1/2 inch male inlet threads, hexagon shoulder, and 20 millimeter 3/4 inch hose connection, conforming to ASME A112.18.1/CSA B125.1. Hose-coupling screw threads shall conform to ASME B1.21M ASME B1.20.7.

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

2.3.11 Pressure Gages

Pressure gages shall conform to ASME B40.100 and to requirements specified herein. Pressure-gage size shall be 90 millimeter 3-1/2 inches nominal diameter. Case shall be corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A6/A6M, with an ASM No. 4 standard commercial polish or better. Equip gages with adjustable red marking pointer and damper-screw adjustment in inlet connection. Service-pressure reading shall be at midpoint of gage range. All gages shall be Grade B or better and be equipped with gage isolators.

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

[Fit steam gages with black steel syphons and steam service pressure-rated gage cocks or valves.]

2.3.12 Sight-Flow Indicators

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

2.3.13 Sleeve Couplings

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

2.3.14 Thermometers

Thermometers shall conform to ASTM E1, except for being filled with a red organic liquid. Thermometers shall be an industrial pattern armored glass model, (well-threaded and seal-welded). Thermometers installed 1800 millimeter 6 feet or higher above the floor shall have an adjustable angle body. Scale shall be not less than 180 millimeter 7 inches long. Case face shall be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range shall be [____]. Provide thermometers with nonferrous separable wells. Provide lagging extension to accommodate insulation thickness.

2.3.15 Pump Suction Strainers

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

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

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

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

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

Provide manual air vent cocks in cap of each strainer.

2.3.16 Line Strainers, Water Service

Strainers shall be Y-type with removable basket. Strainers in sizes DN50 2-inch ips and smaller shall have screwed ends. In sizes DN65 2-1/2-inch ips and larger, strainers shall have flanged ends. Body working-pressure rating shall exceed maximum service pressure of system in which installed by at least 50 percent. Body shall have cast-in arrows to indicate direction of flow. All strainer bodies fitted with screwed screen retainers shall have straight threads and gasketed with nonferrous metal. Strainer bodies DN65 2-1/2-inches and larger, fitted with bolted-on screen retainers, shall have offset blowdown holes. All strainers larger than DN65 2-1/2-inches shall be fitted with manufacturer's standard ball-type blowdown valve. Body material shall be [cast bronze conforming to ASTM B62] [cast iron conforming to Class 30 ASTM A278/A278M]. Where system material is nonferrous, metal strainer body material shall be nonferrous metal.

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

2.3.17 Line Strainers, Steam Service

Strainers shall be Y-type with removable strainer element.

Body end connections shall be flanged for all valves larger than DN50 2 inches, unless butt weld ends are specified. [Screwed] [Socket] weld shall be used for sizes DN50 2 inches and under to suit specified piping system end connection and maintenance requirements [or be welded].

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

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

Body materials shall be [cast steel conforming to ASTM A216/A216M, Grade WCB] [forged carbon steel conforming to ASTM A105/A105M] [manufacturer's standard metallurgical equivalents for service pressures of 1035 kilopascal 150-psi wsp and greater, and for lower pressure ratings where welding is required] [cast iron conforming to ASTM A126, Class B, for service pressures 862 kilopascal 125-psi wsp and less].

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

backup screens where necessary to prevent collapse.

2.4 VALVES

NOTE: Figure 1A is a one piece body.

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

Figure 1C is a top entry.

Figure 1D is a three piece body.

2.4.1 Ball and Butterfly Valves

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

Butterfly valves shall conform to MSS SP-67. Valves shall be wafer type for mounting between specified flanges and shall be rated for 1034 kilopascal 150-psig shutoff and nonshock working pressure. Bodies shall be cast ferrous metal conforming to ASTM A126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals shall be of the resilient elastomer type designed for field removal and replacement.

2.4.2 Drain, Vent, and Gage Cocks

Drain, vent, and gage cocks shall be [T-head] [lever handle], ground key type, with washer and screw, constructed of polished ASTM B62 bronze, and rated 862 kilopascal 125-psi wsp. End connections shall be rated for specified service pressure.

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

2.4.3 Gate Valves (GAV)

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

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

2.4.4 Globe and Angle Valves (GLV-ANV)

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

Globe and angle valves DN65 2-1/2 inches and larger, shall be cast iron with bronze trim. Valve bodies shall be cast iron conforming to ASTM A126, Class A, as specified for Class 1 valves under MSS SP-70. Valve ends shall be flanged in conformance with ASME B16.1. Valve construction shall be outside screw and yoke (OS&Y) type. Make packing of non-asbestos type materials.

2.4.5 Standard Check Valves (SCV)

Standard check valves in sizes DN50 2 inches and smaller shall be 862 kilopascal 125-psi swing check conforming to MSS SP-71, except as otherwise specified. Provide lift checks where indicated. Swing-check pins shall be nonferrous and suitably hard for the service. Discs shall be composition type. Swing-check angle of closure shall be manufacturer's standard unless a specific angle is needed.

Check valves in sizes DN65 2-1/2 inches and larger shall be cast iron, bronze trim, swing type. Valve bodies shall be cast iron, conforming to ASTM A126, Class A. Valve ends shall be flanged in conformance with ASME B16.1. Swing-check pin shall be AISI Type or approved equal corrosion-resistant steel. Angle of closure shall be manufacturer's standard unless a specific angle is needed. Valves shall have bolted and gasketed covers.

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

2.4.6 Nonslam Check Valves (NSV)

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

Check valves at pump discharges in sizes DN50 2 inches and larger shall be

nonslam or silent-check type conforming to MSS SP-125. Valve disc or plate shall close before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Valve shall be Class 125 rated for 1379 kilopascal 200-psi maximum, nonshock pressure at 66 degrees C 150 degrees F in sizes to DN300 12 inches. Valves shall be [wafer type to fit between flanges conforming to ASME B16.1] [fitted with flanges conforming to ASME B16.1]. Valve body may be cast iron, conforming to ASTM A278/A278M, Class 40 or equivalent strength ductile iron. Disks shall be manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Pins, springs, and miscellaneous trim shall be manufacturer's standard corrosion-resistant steel. Disk and shaft seals shall be Buna-N elastomer tetrafluoroethylene.

2.5 MISCELLANEOUS MATERIALS

2.5.1 Bituminous Coating

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

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

2.5.2 Bolting

Flange and general purpose bolting shall be hex-head and must conform to ASTM F568M, Class 4.8 or above ASTM A307, Grade B (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts shall conform to ASTM A563M ASTM A563. Square-head bolts and nuts are not acceptable. Threads shall be coarse-thread series.

2.5.3 Elastomer Caulk

Polysulfide- or polyurethane-base elastomer caulking material shall be two-component type, conforming to ASTM C920.

2.5.4 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall conform to ASME A112.19.2/CSA B45.1.

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

2.5.5 Flashing

Sheet lead shall conform to ASTM B749, [UNS Alloy Number L50049 (intended for use in laboratories and shops in general application)] [UNS Alloy Number L51121 (for use where lead sheet of high purity and improved structural strength is indicated)].

Sheet copper shall conform to ASTM B370 and be of not less than 4.88 kilogram per square meter 16 ounces per square foot weight.

2.5.6 Flange Gaskets

Compressed non-asbestos sheet, conforming to **ASTM F104**, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to **399 degrees C** **750 degrees F**.

2.5.7 Grout

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

Shrink-resistant grout shall be a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to **ASTM C404** and **ASTM C476**.

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

For service with acids, polyester grouts should be specified.

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

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

Tensile strength		13.100 Megapascal, minimum
Compressive strength	ASTM C109/C109M	96.527 Megapascal, minimum
Shrinkage, linear		0.003 mm per millimeter, maximum
Water absorption	ASTM C67	0.1 percent, maximum
Bond strength to		6.895 Megapascal, minimum steel in shear minimum
Tensile strength		1,900 psi, minimum
Compressive strength	ASTM C109/C109M	14,000 psi, minimum
Shrinkage, linear		0.00012 inch per inch, maximum
Water absorption	ASTM C67	0.1 percent, maximum
Bond strength to		1,000 psi, minimum steel in shear minimum

2.5.8 Pipe Thread Compounds

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

2.6 SUPPORTING ELEMENTS

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

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

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

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

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

2.6.1 Building Structure Attachments

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

2.6.1.1 Anchor Devices, Concrete and Masonry

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

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

[Masonry anchor devices shall be built-in.]

Powder-actuated anchoring devices shall not be used to support any

mechanical systems components.

2.6.1.2 Beam Clamps

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

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

2.6.1.3 C-Clamps

Do not use C-clamps.

2.6.1.4 Inserts, Concrete

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

2.6.2 Horizontal Pipe Attachments

2.6.2.1 Single Pipes

Support piping in sizes to and including DN50 2-inch ips by MSS SP-58 Type 6 solid malleable iron pipe rings, except that split-band-type rings shall be used in sizes up to DN25 1-inch ips.

Support piping in sizes through DN200 8-inch ips inclusive by MSS SP-58 Type [1] [3] [4] attachments.

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

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

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

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

Provide insulated piping without vapor barrier on roll supports with MSS SP-58 Type 39 saddles.

Spring supports shall be as indicated.

2.6.2.2 Parallel Pipes

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

2.6.3 Vertical Pipe Attachments

Vertical pipe attachments shall be [MSS SP-58](#) Type 8.

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

2.6.4 Hanger Rods and Fixtures

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

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

2.6.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design and fabricate such supplementary steel in accordance with [AISC 325](#).

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Submit certificates for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Certificates shall verify [Surface Resistance](#), [Shear and Tensile Strengths](#), [Temperature Ratings](#), [Bending Tests](#), [Flattening Tests](#) and [Transverse Guided Weld Bend Tests](#).

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

Fabricate and install piping systems in accordance with [ASME B31.3](#), [MSS SP-69](#), and [AWS WHB-2.9](#).

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

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

Make final connections to equipment with [unions] [flanges] provided every 30480 millimeter 100 feet of straight run. Provide unions in the line downstream of screwed- and welded-end valves.

Ream all pipe ends before joint connections are made.

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

Apply joint compounds to the male thread only and exercise care to prevent compound from reaching the unthreaded 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 for maintenance.

Securely support piping systems with due allowance for thrust forces, thermal expansion and contraction, and shall not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

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

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

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

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

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

3.2 VALVES

Provide valves in piping mains and all branches and at equipment where indicated and as specified.

Provide valves to permit isolation of branch piping and each equipment item from the balance of the system.

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

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

3.3 SUPPORTING ELEMENTS INSTALLATION

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

Support piping from building structure. No piping shall be supported from roof deck or from other pipe.

Piping shall run 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 shall be no less than DN15 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

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

Load rating for all pipe-hanger supports shall be based on insulated weight of lines filled with water and forces imposed. Deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span must be reduced proportionately:

<u>PIPE SIZE (DN)</u> <u>MILLIMETER</u>	<u>ROD SIZE</u> <u>MILLIMETER</u>	<u>STEEL PIPE</u> <u>MILLIMETER</u>	<u>COPPER PIPE</u> <u>MILLIMETER</u>
25 and smaller	10	2500	1850
32 to 40	10	3050	2500
50	10	3050	3050
65 to 90	13	3700	3700
100 to 125	16	5000	4300
150	20	5000	5000
200 to 300	22	6100	6100
356 to 457	25	6100	6100
508 and over	32	6100	6100
<u>PIPE SIZE</u> <u>INCHES</u>	<u>ROD SIZE</u> <u>INCHES</u>	<u>STEEL PIPE</u> <u>FEET</u>	<u>COPPER PIPE</u> <u>FEET</u>
1 and smaller	3/8	8	6

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

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

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

3.4 PENETRATIONS

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

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

3.5 SLEEVES

Provide sleeves where piping passes through roofs, masonry, concrete walls

and floors.

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

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

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with a mineral fiber conforming to ASTM C553 Type V (flexible blanket), (to 538 degrees C) (to 1,000 degrees F). Provide this packing wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration shall be filled with an elastomer caulk to a depth of 13 millimeter 1/2 inch. All surfaces to be caulked shall be oil- and grease-free.

Through-Penetration fire stop materials and methods shall be in accordance with ASTM E814 and UL 1479.

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

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

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

3.6 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. For insulated pipes, the plates shall be large enough to fit around the insulation. Escutcheons shall be chrome-plated in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Firmly attach escutcheons with setscrews.

3.7 FLASHINGS

NOTE: Review roof flooding provisions.

[Provide flashings at penetrations of building boundaries by mechanical systems and related work.]

3.8 UNDERGROUND PIPING INSTALLATION

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

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

Distinctly mark defective materials found using a road-traffic quality yellow paint; promptly remove defective material from the site.

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

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

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

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

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

Make changes in direction with long sweep fittings.

Necessary socket clamping, piers, bases, anchors, and thrust blocking shall be provided. Protect rods, clamps, and bolting with a coating of bitumen.

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

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

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

[Provide cleanout, flushing, and observation risers.]

3.9 HEAT TRACE CABLE INSTALLATION

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

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

3.10 DISINFECTION

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

[Flush piping with potable water until visible grease, dirt and other contaminants are removed (visual inspection).]

3.11 HEAT TRACE CABLE TESTS

Test heat trace cable system in accordance with IEEE 515 after installation and before and after installation of the thermal insulation. Test heater cable using a [1000] [] vdc megger. Minimum insulation resistance shall be [20 to 1000] [] megohms regardless of cable length.

3.12 OPERATION AND MAINTENANCE

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

NOTE: For SOUTHNAVFACENGCOM projects, delete all
painting requirements and specify as follows: "PART
3 EXECUTION, Not Used."

3.13 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.13.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, design the factory painting system for the temperature service.

3.13.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

- a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat.
- b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F shall receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.
- c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F shall receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

-- End of Section --