

## SECTION 23 05 15

## COMMON PIPING FOR HVAC

## PART 1 GENERAL

## 1.1 REFERENCES

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; Amendment 2012) 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 (2012) Plumbing Supply Fittings

ASME A112.19.2/CSA B45.1 (2013) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals

ASME B1.20.7 (1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)

ASME B1.21M (1997; R 2013) Standard for Metric Screw Threads - MJ Profile

ASME B16.1 (2015) 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 (2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.25 (2012) Standard for Buttwelding Ends

ASME B16.26 (2013) 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 (2014) 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            | (2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9            | (2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings                   |
| ASME B31.3            | (2014) Process Piping                                                                 |
| ASME B36.10M          | (2015) Standard for Welded and Seamless Wrought Steel Pipe                            |
| ASME B40.100          | (2013) 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 | (2014) Standard Specification for Carbon Steel Forgings for Piping Applications                                                             |
| ASTM A106/A106M | (2014) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service                                                   |
| ASTM A126       | (2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings                                         |
| ASTM A183       | (2014) Standard Specification for Carbon Steel Track Bolts and Nuts                                                                         |
| ASTM A197/A197M | (2000; R 2011) Standard Specification for Cupola Malleable Iron                                                                             |
| ASTM A216/A216M | (2014; E 2015) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service                 |
| ASTM A234/A234M | (2013; E 2014) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A276/A276M | (2016) 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       | (2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength                                        |
| ASTM A312/A312M | (2016) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes                       |
| ASTM A480/A480M | (2014b) 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       | (2015) Standard Specification for Carbon and Alloy Steel Nuts                                                                      |
| ASTM A563M      | (2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)                                                     |
| ASTM A6/A6M     | (2014) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling          |
| ASTM A74        | (2016) Standard Specification for Cast Iron Soil Pipe and Fittings                                                                 |
| ASTM B117       | (2011) Standard Practice for Operating Salt Spray (Fog) Apparatus                                                                  |
| ASTM B32        | (2008; R 2014) Standard Specification for Solder Metal                                                                             |
| ASTM B370       | (2012) Standard Specification for Copper Sheet and Strip for Building Construction                                                 |
| ASTM B62        | (2015) Standard Specification for Composition Bronze or Ounce Metal Castings                                                       |
| ASTM B749       | (2014) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products                                              |
| ASTM B88        | (2014) Standard Specification for Seamless Copper Water Tube                                                                       |
| ASTM B88M       | (2013) Standard Specification for Seamless Copper Water Tube (Metric)                                                              |
| ASTM C109/C109M | (2013; E 2015) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)   |

|            |                                                                                                                             |
|------------|-----------------------------------------------------------------------------------------------------------------------------|
| ASTM C404  | (2011) Standard Specification for<br>Aggregates for Masonry Grout                                                           |
| ASTM C476  | (2010) Standard Specification for Grout<br>for Masonry                                                                      |
| ASTM C553  | (2013) Standard Specification for Mineral<br>Fiber Blanket Thermal Insulation for<br>Commercial and Industrial Applications |
| ASTM C564  | (2014) Standard Specification for Rubber<br>Gaskets for Cast Iron Soil Pipe and<br>Fittings                                 |
| ASTM C67   | (2014) Standard Test Methods for Sampling<br>and Testing Brick and Structural Clay Tile                                     |
| ASTM C920  | (2014a) Standard Specification for<br>Elastomeric Joint Sealants                                                            |
| ASTM D2000 | (2012) Standard Classification System for<br>Rubber Products in Automotive Applications                                     |
| ASTM D2308 | (2007; R 2013) Standard Specification for<br>Thermoplastic Polyethylene Jacket for<br>Electrical Wire and Cable             |
| ASTM E1    | (2014) Standard Specification for ASTM<br>Liquid-in-Glass Thermometers                                                      |
| ASTM E814  | (2013a) Standard Test Method for Fire<br>Tests of Through-Penetration Fire Stops                                            |
| ASTM E84   | (2015b) Standard Test Method for Surface<br>Burning Characteristics of Building<br>Materials                                |
| ASTM F104  | (2011) Standard Classification System for<br>Nonmetallic Gasket Materials                                                   |
| ASTM F2389 | (2010) Standard Specification for<br>Pressure-rated Polypropylene (PP) Piping<br>Systems                                    |
| ASTM F568M | (2007) Standard Specification for Carbon<br>and Alloy Steel Externally Threaded Metric<br>Fasteners                         |

## FLUID SEALING ASSOCIATION (FSA)

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

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

|          |                                                                                                                        |
|----------|------------------------------------------------------------------------------------------------------------------------|
| IEEE 515 | (2011) Standard for the Testing, Design,<br>Installation, and Maintenance of<br>Electrical Resistance Heat Tracing for |
|----------|------------------------------------------------------------------------------------------------------------------------|

## Industrial Applications

IEEE C2 (2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015) 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 (1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-67 (2011) Butterfly Valves

MSS SP-70 (2011) Gray Iron Gate Valves, Flanged and Threaded Ends

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

MSS SP-80 (2013) Bronze Gate, Globe, Angle and Check Valves

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2014) Motors and Generators

NEMA MG 10 (2013) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors

NEMA MG 11 (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

## NSF INTERNATIONAL (NSF)

NSF/ANSI 14 (2014) Plastics Piping System Components and Related Materials

## 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; Notice 1 2013)

Expansion Joints, Pipe, Metallic Bellows,  
General Specification for

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

|               |                                                                                                     |
|---------------|-----------------------------------------------------------------------------------------------------|
| CID A-A-1922  | (Rev A; Notice 2) Shield, Expansion<br>(Caulking Anchors, Single Lead)                              |
| CID A-A-1923  | (Rev A; Notice 2) Shield, Expansion (Lag,<br>Machine and Externally Threaded Wedge Bolt<br>Anchors) |
| CID A-A-1924  | (Rev A; Notice 2) Shield, Expansion (Self<br>Drilling Tubular Expansion Shell Bolt<br>Anchors)      |
| CID A-A-1925  | (Rev A; Notice 2) Shield Expansion (Nail<br>Anchors)                                                |
| CID A-A-55614 | (Basic; Notice 2) Shield, Expansion<br>(Non-Drilling Expansion Anchors)                             |
| CID A-A-55615 | (Basic; Notice 2) Shield, Expansion (Wood<br>Screw and Lag Bolt Self-Threading Anchors)             |

UNDERWRITERS LABORATORIES (UL)

|         |                                                       |
|---------|-------------------------------------------------------|
| UL 1479 | (2015) Fire Tests of Through-Penetration<br>Firestops |
|---------|-------------------------------------------------------|

## 1.2 GENERAL REQUIREMENTS

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 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.

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

Government approval is required for submittals. 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.

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-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-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. Provide standard products in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has 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 are 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

Ensure the equipment items are supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. Select service organizations that are 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

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not 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 are considered mandatory, the word "should" is interpreted as "shall." Reference to the "code official" is interpreted to mean the "Contracting Officer." For Navy owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, references to the "owner" is interpreted to mean the "lessor." References to the "permit holder" are 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, are applied as appropriate by the Contracting Officer and 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.

## 1.6 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Ensure motors, controllers, disconnects and contactors 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 is not permitted. Provide controllers and contactors with a maximum of 120 volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of additional electrical service and related work under the section that specified that motor or equipment. Provide power wiring and conduit for field installed equipment under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 1.7 ELECTRICAL INSTALLATION REQUIREMENTS

Ensure electrical installations 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. Provide under Division 26, 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, except internal wiring for components of package equipment is 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, provide high efficiency single-phase fractional-horsepower alternating-current motors 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, ensure polyphase squirrel-cage medium induction motors with continuous ratings 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 one 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. Provide instructors 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 is 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

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 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. Obtain approval before used directly on plastic pipe. Heater shall be covered with a radiation cross-linked modified polyolefin dielectric jacket in accordance with ASTM D2308.

NOTE: Self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40 degrees F pipe

temperature operation to 150 degrees F pipe temperature operation.

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

Heater shall operate on existing line voltages without the use of transformers.

Size Heater according to the following table:

| Pipe Size<br>(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 40 degrees F either directly or through an appropriate contactor.

## 2.2 PIPE AND FITTINGS

Submit equipment and performance data for pipe and fittings consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations 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.

### 2.2.1 Type BCS, Black Carbon Steel

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

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

Pipe 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) or Type S (seamless). Grade A should be used for permissible field bending, in both cases.

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

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

#### 2.2.2 Type BCS-125, 125-psi Service

NOTE: This pipe is typically applicable for steam and condensate piping systems at pressures less than 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 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 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) or Type S (seamless) and ASME B36.10M.

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

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

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

Fittings 1 through 2 inches shall be 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 2 inches and under shall be 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.

Fittings 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 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 2,000-or 3,000-psi wog forged carbon steel, conforming to ASTM A105/A105M and ASME B16.11, where welded.

Flanges 2-1/2 inches and over shall be 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 in accordance with paragraph GROOVED PIPE COUPLINGS AND FITTINGS.

#### 2.2.3 Type GCS, Galvanized Carbon Steel

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

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

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

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

Conform grooved pipe couplings and fittings in accordance with paragraph GROOVED PIPE COUPLINGS AND FITTINGS.

As an option, use 150-psig wall 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

Ensure pipe (all sizes) is Schedule 40 seamless or electric-resistance welded galvanized carbon steel, conforming to ASTM A53/A53M, Grade A.

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

Risers 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

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; otherwise joints may be two-gasket system type chloroprene, conforming to ASTM C564. Select the extra heavy (CISP-DWV-XH) pipe class.

#### 2.2.6 Type CPR, Copper

Copper pipe above ground and below ground is typically required for chilled, hot, dual-temperature, cooling-tower water, and potable-water systems unless specified otherwise.

#### 2.2.6.1 Type CPR-A, Copper Above Ground

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

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

Unions 2 inches and under shall be 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.

Use solder, alloy Sb-5, conforming to ASTM B32.

#### 2.2.6.2 Type CPR-U, Copper Under Ground

Provide Type K seamless copper tube piping, conforming to ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Ensure fittings for connection to corporation cocks are cast bronze, flared-type, conforming to ASME B16.26. Braze the joints.

#### 2.2.6.3 Type CPR-INS, Copper Under Ground Insulated

Provide insulated Type K seamless copper tube piping conforming to ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Braze the joints.

Provide insulation not less than 2 inches thick, suitable for continuous service temperatures of not less than 250 degrees F. Use factory-molded, closed-cell polyurethane foam insulation of not less than 2.5 pounds per cubic foot density. Waterproof insulation with an extruded rigid Type II virgin polyvinylchloride, with minimum wall thickness of 60 mils through 4 inches outside diameter, 85 mils through 6.625 inches and 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 NOT USED.

#### 2.2.8 Grooved Pipe Couplings and Fittings

Provide housing for all couplings, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Ensure coupling gasket is molded synthetic rubber, conforming to ASTM D2000. Ensure coupling bolts are 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 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

Submit equipment and performance data for piping specialties consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations 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.

### 2.3.1 Air Separator

Air separated from converter discharge water is 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 125 psi.

### 2.3.2 Air Vents

Unless specified otherwise or where the vent is required to pass more than 20 cubic feet of free air per minute at a system pressure of 125 psi, Manual air vents shall be 3/8-inch globe valves.

Where a system shall be filled at a more rapid rate, or for larger systems requiring large volumes, larger vents and or a multiple vent assembly with safety features shall be used.

Automatic air vents on pumps, mains, and where indicated shall be of ball float construction. Vent inlet shall be not less than 3/4-inch ips and the outlet not less than 1/4-inch ips. Orifice shall be 1/8 inch. Provide corrosion-resistant steel trim conforming to ASTM A276 or ASTM A480/A480M. Vent shall be fitted with try-cock. Vent shall discharge air at any pressure up to 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 125 psi in accordance with ASME BPVC SEC VIII D1. Ensure tank is hot-dip galvanized after fabrication to produce not less than 1.5 ounces of zinc coating per square foot of single-side surface.

Tank accessories 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

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. Coat all nonmetallic exterior surfaces of the joint with chlorosulphinated polyethylene. Provide grommets in limit bolt hole to absorb noise transmitted through the bolts.

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

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

Construct flexible pipe vibration and pipe-noise eliminators of wire-reinforced, rubber-impregnated cloth and cord materials and be flanged. Back the flanges with ferrous-metal backing rings. Service pressure-rating shall be a minimum 1.5 times actual service, with surge pressure at 180 degrees F.

Construct flexible pipe vibration and pipe noise eliminators of wire-reinforced chloroprene-impregnated cloth and cord materials. Ensure the pipe is flanged. Provide all flanges backed with ferrous-metal backing rings. Coat nonmetallic exterior surfaces of the flexible pipe with an acid- and oxidation-resistant chlorosulphinated polyethylene. Flexible pipe shall be rated for continuous duty at 130 psi and 250 degrees F.

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

| <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               |
| 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 100 psi at 300 degrees F.

Minimum burst pressure shall be four times working pressure at 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 or 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

Provide a bellows type hose with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Ensure the working steam pressure rating is 125 psi at 500 degrees F.

Ensure minimum burst pressure is nine times working steam pressure at 300 degrees F.

Ensure bellows material is AISI Type 316L corrosion-resistant steel. Braid is 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 or 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. 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 125 psig and temperatures to 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.

Provide bellows and internal sleeve material of 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.

Provide joints, 2-1/2 inches and smaller, with internal guides and limit stops.

Provide joints, 3 inches and larger, with removable external covers, internal sleeves, and purging connection. Size sleeves to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, provide the gasket used 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 with the sleeve. Expansion joints shall have four, equidistant, permanent tram points clearly marked on each joint end. Locate points to prevent obliteration during installation. Include distance between tram points indicating installed lengths in shop drawings. Overall dimension after joint installation is 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.

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

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

Provide vandal proof, atmospheric-type vacuum breaker 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 3-1/2 inches nominal diameter. Case shall be constructed of 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. Align service-pressure reading at midpoint of gage range. Ensure all gages are Grade B or better and be equipped with gage isolators.

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

#### 2.3.12 Sight-Flow Indicators

Construct sight-flow indicators for pressure service on 3-inch ips and

smaller 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 or 316 corrosion-resistant steel shaft. Body may have screwed or flanged end. Provide pressure- and temperature-rated assembly for the applied service. Flapper flow-type indicators are not acceptable.

#### 2.3.13 Sleeve Couplings

Sleeve couplings for plain-end pipe 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. Provide an industrial pattern armored glass thermometer, (well-threaded and seal-welded). Thermometer installed 6 feet or higher above the floor shall have an adjustable angle body. Scale shall be not less than 7 inches long and the case face shall be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. . Provide thermometers with nonferrous separable wells. Provide lagging extension to accommodate insulation thickness.

#### 2.3.15 Pump Suction Strainers

Provide a cast iron strainer body, rated for not less than 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction is 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. Provide a basket with 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 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Provide reducing fittings from strainer-flange size to pipe size.

Provide a differential-pressure gage or a pressure gage with 0.25-pound graduations fitted with a two-way brass cock 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 2-inch ips and smaller shall have screwed ends; in sizes 2-1/2-inch ips and larger, strainers shall have flanged ends. Body working-pressure rating shall exceed maximum service pressure of installed system 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. DStrainer bodies 2-1/2-inches and larger, fitted with bolted-on screen retainers, shall have offset blowdown holes. All strainers larger than 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 or cast iron

conforming to Class 30 ASTM A278/A278M. Where system material is nonferrous, use nonferrous metal for the metal strainer body material.

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 perforation size is not to exceed 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 or 316 corrosion-resistant steel or alternatively may be made of 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 2 inches, unless butt weld ends are specified. Use socket weld for sizes 2 inches and under to suit specified piping system end connection and maintenance requirements.

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

Body working steam pressure rating is 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. D 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 150-psi wsp and greater, and for lower pressure ratings where welding is required, or cast iron conforming to ASTM A126, Class B, for service pressures 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 0.020 inch or equivalent wire mesh. Strainer screens have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material is AISI Type 304 or 316 corrosion-resistant steel and fitted with backup screens where necessary to prevent collapse.

#### 2.4 VALVES

Submit equipment and performance data for valves consisting of corrosion resistance and life expectancy. Submit design analysis and calculations consisting of rates of flow, head losses, inlet and outlet design, and pressure calculations. Also include in data, pipe dimensions, as well as temperature ratings, vibration and thrust limitations, minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

#### 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 are rated for service at not less than 175 psig at 200 degrees F. Valve bodies in sizes 2 inches and smaller shall be screwed-end connection-type constructed of Class A copper alloy. Valve bodies in sizes 2-1/2 inches and larger shall be flanged-end connection type, constructed of Class D, E or F material. Balls and stems of valves 2 inches and smaller shall be manufacturer's standard with hard chrome plating finish. Balls and stems of valves 2-1/2 inches and larger shall be manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Valves shall be suitable for flow from either direction and 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 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 fabricated from resilient elastomer designed for field removal and replacement.

#### 2.4.2 Drain, Vent, and Gage Cocks

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

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

#### 2.4.3 Gate Valves (GAV)

Gate valves 2 inches and smaller shall conform to MSS SP-80. 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 2-1/2 inches and larger, shall be Type I, (solid wedge disc, tapered seats, steam rated); Class 125 (125-psig steam-working pressure at 353 degrees F saturation); and 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 2 inches and smaller shall be 125-pound, 125-psi conforming to MSS SP-80 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, 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-80. Select flanged valves 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 2 inches and smaller shall be 125-psi swing check valves except as otherwise specified. Provide lift checks where indicated. Swing-check pins shall be nonferrous and suitably hard for the service. Disks shall be composition type. Swing-check angle of closure is manufacturer's standard unless a specific angle is needed.

Check valves in sizes 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 and valve ends are 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 or lever-weighted, positive-closure devices and valve ends are mechanical joint or flanged.

#### 2.4.6 Nonslam Check Valves (NSV)

Provide check valves at pump discharges in sizes 2 inches and larger with nonslam or silent-check operation conforming to MSS SP-125. Select a valve disc or plate that closes before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Ensure valve is Class 125 rated for 200-psi maximum, nonshock pressure at 150 degrees F in sizes to 12 inches. Use valves that are Valves shall be wafer type to fit between flanges conforming to ASME B16.1 or fitted with flanges conforming to ASME B16.1.. Valve body may be cast iron, or equivalent strength ductile iron. Select disks using manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Ensure pins, springs, and miscellaneous trim are manufacturer's standard corrosion-resistant steel. Disk and shaft seals are Buna-N elastomer tetrafluoroethylene.

### 2.5 MISCELLANEOUS MATERIALS

Submit equipment and performance data for miscellaneous materials consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

#### 2.5.1 Bituminous Coating

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

For previously coal-tar coated and uncoated ferrous surfaces underground, use bituminous coating 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 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 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 have provisions consisting of 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) or 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 not less than 16 ounces per square foot weight.

### 2.5.6 Flange Gaskets

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

### 2.5.7 Grout

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

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

|                      |                 |                                              |
|----------------------|-----------------|----------------------------------------------|
| 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<br>minimum |

### 2.5.8 Pipe Thread Compounds

Use polytetrafluoroethylene tape not less than 2 to 3 mils thick in potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Use polytetrafluoroethylene dispersions and other suitable compounds for all other applications upon approval by the Contracting Officer; however, do not use lead-containing compounds in potable water systems.

## 2.6 SUPPORTING ELEMENTS

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

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. Ensure supporting elements are 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, and MSS SP-58, 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. Select materials of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Electroplate supporting elements in contact with copper tubing with copper.

Type designations specified herein are based on MSS SP-58. 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

#### 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, 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, or 30.

When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, MSS SP-58 Type 19, 20, 25, or 27 may be used for piping sizes 2 inches and less and for piping sizes 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 2 inches ips and larger and where otherwise required by imposed loads, insert and wire a 1-foot length of 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 2-inch ips by MSS SP-58 Type 6 solid malleable iron pipe rings, except that, use split-band-type rings in sizes up to 1-inch ips.

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

MSS SP-58 Type 1 and Type 6 assemblies shall be used on vapor-sealed insulated piping and 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 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 1/2 inch, use MSS SP-58 Type 41, 44 through 46, or 49 pipe rolls.

Support piping in sizes larger than 8-inch ips with MSS SP-58 Type 41, 44 through 46, or 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 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

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-58, and AWS WHB-2.9.

Submit Installation Drawings for pipes, valves and specialties. Drawings 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), or flanged with gaskets rated for the service.

Make final connections to equipment with unions or flanges provided every 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 with not

more than three threads showing 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. Do not subject the system 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.

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

### 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 2-1/2 inches and larger shall be provided. Tap and fit shutoff valve body with a 1/2-inch plugged globe valve.

Provide valves unavoidably located in furred or other normally inaccessible places 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. Do not support piping 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 is no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangars on different adjacent service lines running parallel with each other 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 3 feet from the ends of each runout, and not over 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 is 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, reduce the allowable span proportionately:

| <u>PIPE SIZE</u><br><u>INCHES</u> | <u>ROD SIZE</u><br><u>INCHES</u> | <u>STEEL PIPE</u><br><u>FEET</u> | <u>COPPER PIPE</u><br><u>FEET</u> |
|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|
| 1 and smaller                     | 3/8                              | 8                                | 6                                 |
| 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.

Support vertical risers 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 15-foot intervals for pipe 2 inches and smaller and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

### 3.4 PENETRATIONS

Provide effective sound stopping and adequate operating clearance to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceilings where no special acoustic treatment of ceiling is provided. Finish penetrations 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 120 degrees F, by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Foam shall be finished with a rasp. Vapor barrier shall

be not less than 1/8-inch thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, use only mineral wool shall be used and openings must also be covered with 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 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 provides a minimum 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 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, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer caulk to a depth of 1/2 inch. All caulked surfaces 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.

Sleeve height above roof surface shall be a minimum of 12 and a maximum of 18-inches, unless the roof deck insulation system already meets minimum code and/or TAFB Standards for insulation thickness, in which the sleeve height shall be a minimum of 4 and maximum of 6 inches above the roof surface.

### 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, select plates large enough to fit around the insulation. Use chrome-plated escutcheons in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Firmly attach escutcheons with setscrews.

### 3.7 FLASHINGS

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, clean all piping, visually inspected for apparent defects, and tapped with a hammer to audibly detect hidden defects.

Further inspect suspect cast-ferrous piping 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, coat all external surfaces of cast ferrous conduit with a compatible bituminous coating for protection against brackish ground water. Apply a single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 12 mils.

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

Use wheel cutters for cutting of piping or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting is not permitted.

Begin laying of pipe at the low point of a system. When in final acceptance position, ensure it is true to the grades and alignment indicated, with unbroken continuity of invert. Blocking and wedging is not permitted.

Bell or grooved ends of piping shall point upstream. Make changes in direction with long sweep fittings.

Provide necessary socket clamping, piers, bases, anchors, and thrust blocking. Protect rods, clamps, and bolting with a coating of bitumen.

Support underground piping below supported or suspended slabs 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, provide backfilling material consisting of 2,000-psi cured compressive-strength concrete poured or pressure-grouted up to the level of the footing.

Properly support vertical downspouts; soil, waste, and vent stacks; water risers; and similar work 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

Field apply heater tape 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 fiberglass tape. Label thermal insulation on the outside, "Electrical Heat Trace."

Install power connection, end seals, splice kits and tee kit components in accordance with IEEE 515 to provide a complete workable system. Terminate connection to the thermostat and ends of the heat tape in a junction box. Ensure cable and conduit connections are raintight.

### 3.10 DISINFECTION

Water piping, including all valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water. Ensure the solution contains 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 contains not less than 10 ppm of available chlorine or redisinfect the piping. After successful sterilization, thoroughly flush the piping before placing into service. Flushing is 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 approve 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 is 20 to 1000 megohms regardless of cable length.

### 3.12 OPERATION AND MAINTENANCE

Provide Operation and Maintenance Manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Submit test data that is clear and readily legible.

### 3.13 PAINTING OF NEW EQUIPMENT

Factory or shop apply new equipment painting, 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 withstands 125 hours in a salt-spray fog test, except that equipment located outdoors withstand 500 hours in a salt-spray fog test. Conduct salt-spray fog test is in accordance with ASTM B117, and for that test the acceptance criteria is as follows: immediately after completion of the test, the inspected paint shows no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shows no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

Ensure the film thickness of the factory painting system applied on the equipment is not 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 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 clean to bare metal, surfaces subject to temperatures in excess of 120 degrees F.

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. Selected color of finish coat is aluminum or light gray.

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

-- End of Section --