



# Standard Practice for Selection and Application of Piping System Materials<sup>1</sup>

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## 1. Scope

1.1 This practice is intended as a guide to shipbuilders, shipowners, and design agents for use in the preparation of piping system material schedules for commercial ship design and construction.

1.2 The materials and limitations listed in **Tables 1-28** meet the minimum requirements of the U.S. Coast Guard and the American Bureau of Shipping and, except for titanium, should be considered to be the minimum acceptable materials in regard to material, design, and testing. This document is not intended to limit the selection of material strictly to those listed. Other equal or superior materials may be used provided that they are acceptable to the regulatory bodies and classification societies.

NOTE 1—Titanium has been added as its use in fresh and sea water systems is becoming more common.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- [A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless](#)
- [A105/A105M Specification for Carbon Steel Forgings for Piping Applications](#)
- [A106/A106M Specification for Seamless Carbon Steel Pipe for High-Temperature Service](#)
- [A134 Specification for Pipe, Steel, Electric-Fusion \(Arc\)-Welded \(Sizes NPS 16 and Over\)](#)
- [A139/A139M Specification for Electric-Fusion \(Arc\)-Welded Steel Pipe \(NPS 4 and Over\)](#)
- [A178/A178M Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes](#)
- [A179/A179M Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes](#)

- [A181/A181M Specification for Carbon Steel Forgings, for General-Purpose Piping](#)
- [A182/A182M Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service](#)
- [A192/A192M Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service](#)
- [A193/A193M Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications](#)
- [A194/A194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both](#)
- [A213/A213M Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes](#)
- [A214/A214M Specification for Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes](#)
- [A216/A216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service](#)
- [A234/A234M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service](#)
- [A242/A242M Specification for High-Strength Low-Alloy Structural Steel](#)
- [A249/A249M Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes](#)
- [A283/A283M Specification for Low and Intermediate Tensile Strength Carbon Steel Plates](#)
- [A307 Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength](#)
- [A320/A320M Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service](#)
- [A335/A335M Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service](#)
- [A351/A351M Specification for Castings, Austenitic, for Pressure-Containing Parts](#)
- [A387/A387M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum](#)
- [A395/A395M Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures](#)

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**A515/A515M** Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

**A536** Specification for Ductile Iron Castings

**A563** Specification for Carbon and Alloy Steel Nuts

**B61** Specification for Steam or Valve Bronze Castings

**B62** Specification for Composition Bronze or Ounce Metal Castings

**B88** Specification for Seamless Copper Water Tube

**B265** Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate

**B338** Specification for Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers

**B348** Specification for Titanium and Titanium Alloy Bars and Billets

**B363** Specification for Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings

**B367** Specification for Titanium and Titanium Alloy Castings

**B381** Specification for Titanium and Titanium Alloy Forgings

**B466/B466M** Specification for Seamless Copper-Nickel Pipe and Tube

**B467** Specification for Welded Copper-Nickel Pipe

**B861** Specification for Titanium and Titanium Alloy Seamless Pipe

**B862** Specification for Titanium and Titanium Alloy Welded Pipe

**B863** Specification for Titanium and Titanium Alloy Wire

**B898** Specification for Reactive and Refractory Metal Clad Plate

**D2996** Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

**D2997** Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

**D4024** Specification for Machine Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges

**F467** Specification for Nonferrous Nuts for General Use

**F468** Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

**F682** Specification for Wrought Carbon Steel Sleeve-Type Pipe Couplings

**F683** Practice for Selection and Application of Thermal Insulation for Piping and Machinery

**F704** Practice for Selecting Bolting Lengths for Piping System Flanged Joints

**F722** Specification for Welded Joints for Shipboard Piping Systems

**F1476** Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

**F1548** Specification for Performance of Fittings for Use with Gasketed Mechanical Couplings Used in Piping Applications

## 2.2 ANSI Standards:<sup>3</sup>

**B16.5** Steel Pipe Flanges and Flanged Fittings

**B16.9** Factor Made Wrought Steel Butt welding Fittings

**B16.10** Face to Face and End to End Dimensions of Valves

**B16.11** Forged Steel Fittings, Socket Welding and Threaded

**B16.15** Cast Bronze Threaded Fittings Class 125 and 250

**B16.18** Cast Copper Alloy Solder Joint Pressure Fittings

**B16.22** Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

**B16.24** Bronze Flanges and Flanged

**B16.28** Wrought Steel Butt welding Short Radius Elbows and Returns

**B16.34** Valves Flanged, Threaded and Welding End

**B16.42** Ductile Iron Pipe Flanges and Flanged Fittings

**B18.2.1** Square and Hex Bolts and Screws Inch Series

**B18.2.2** Square and Hex Nuts (Inch Series)

**B18.21.1** Lock Washers (Inch Series)

**B18.22.1** Plain Washers

**B16.48** Steel Line Blanks

**B31.1** Power Piping

**B36.10** Welded and Seamless Wrought Steel Pipe

**B36.19** Stainless Steel Pipe

## 2.3 Manufacturer’s Standardization Society of the Valve and Fitting Industry Standards:<sup>4</sup>

**SP-43** Wrought Stainless Steel Butt welding Fittings

**SP-44** Steel Pipeline Flanges

**SP-67** Butterfly Valves

**SP-72** Ball Valves with Flanged or Butt-Welding Ends for General Service

**SP-80** Bronze Gate, Globe, Angle and Check Valves

**SP-83** Class 300 Steel Pipe Unions Socket Welding and Threaded

**SP-97** Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded, and Butt welding Ends

**SP-119** Factory Made Belled End Socket-Welding Fittings

## 2.4 Other Documents:

**ASME** Boiler and Pressure Vessel Code, Sections I and VIII<sup>5</sup>

**ABS’** Rules for Building and Classing Steel Vessels<sup>6</sup>

**Title 46**, Code of Federal Regulations, Parts 41 to 69<sup>7</sup>

**NVIC 11-86**; Guidelines Governing the Use of Fiberglass Pipe (FGP) on Coast Guard Inspected Vessels<sup>7</sup>

**MIL-F-1183** Fittings, Pipe, Cast Bronze, Silver-Brazing<sup>7</sup>

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>4</sup> Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602.

<sup>5</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

<sup>6</sup> Available from American Bureau of Shipping (ABS), ABS Plaza, 16855 Northchase Dr., Houston, TX 77060.

<sup>7</sup> Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

### 3. General Requirements

3.1 Shipboard piping systems shall be in accordance with ANSI B31.1 except as modified by 46 CFR Part 56 of the U.S. Coast Guard regulations and Sections 36 and 44 of the ABS' Rules.

3.2 Piping systems shall be classed in accordance with 46 CFR 56.04.

3.3 Valves shall be in accordance with 46 CFR 56.20.

3.4 Valves for Class I systems shall be in accordance with 46 CFR 56.20-9(b) and if larger than 2-in. NPS shall not have socket weld ends.

3.5 Resilient seated valves shall be in accordance with 46 CFR 56.20-15.

3.6 Dimensions of ductile iron gate, globe, angle, and check valves shall be in accordance with ANSI B16.34 and shall use the adjusted pressure temperature ratings of ANSI B31.1, Appendix E.

3.7 Flanges for flanged valves and fittings and their companion flanges shall be in accordance with 46 CFR 56.25 and 56.30-10.

3.8 Bolting shall be in accordance with 46 CFR 56.25-20. Practice **F704** shall be used as a guide for determining flange bolting lengths.

3.9 Socket weld joints shall be in accordance with 46 CFR 56.30-5(c) and 56.30-10(b), Method 4, and shall not exceed 3-in. NPS for Class I and II-L service.

3.10 Threaded joints shall be in accordance with 46 CFR 56.30-20 and shall not exceed 2-in. NPS for Class I systems.

3.11 Flared, flareless, and compression tube fittings shall be limited to 2-in. OD or below and shall be in accordance with 46 CFR 56.30-25.3.12

3.12 Brazed socket type joints shall be in accordance with 46 CFR 56.30-30 and 56.75.

3.13 Gasketed mechanical couplings and fittings for use with gasketed mechanical couplings shall be in accordance with 46 CFR 56.30-35.

3.14 Flexible pipe couplings of the compression or slip-on types shall be in accordance with 46 CFR 56.30-40.

3.15 For restrictions on the use of welded tube and pipe, see 46 CFR 56.60-2(b).

3.16 Ferrous pipe used for saltwater service shall be protected against corrosion in accordance with 46 CFR 56.60-3(a).

3.17 All welding of Class I and II piping shall be in accordance with 46 CFR 56.70 and Specification **F722**.

3.18 Thermal insulation for piping systems shall be in accordance with Practice **F683**.

3.19 Fiberglass reinforced thermosetting epoxy resin pipe and fittings shall be in accordance with 46 CFR 56.60-25 and U.S. Coast Guard Navigation and Vessel Inspection Circular (NVIC) 11-86.

3.20 Fiberglass pipe shall not be used outboard of skin valves.

### 4. List of Tables

4.1 The tables are arranged in the following sequence:

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| Steam, Steam Drains, Feed, Condensate, Boiler Blow, Sampling and Compounding, and Safety Valve Escape Piping; 406°F max | 4     |
| Gas Turbine and Diesel Exhaust Piping; 1100°F max   | 5     |
| Gas Turbine and Diesel Exhaust Piping; 775°F max  | 6     |
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| Seawater Circulating, Wet Firemain, and Distilling Plant Piping   | 9     |
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**TABLE 1 Material Temperature Limitations<sup>A</sup>**

| Material                  | Material Specifications                          | Temperature Limit, °F, max |
|---------------------------|--|----------------------------|
| Corrosion resistant steel | ASTM <b>A194/A194M</b> GR <sup>B</sup> 8, 8C, 8T | 1200                       |
|                           | ASTM <b>A194/A194M</b> GR 8F                     | 800                        |
|                           | ASME SA312 TP <sup>C</sup> 316L                  | 850                        |
|                           | ASME SA312 TP 304L                               | 800                        |
|                           | ASTM <b>A351/A351M</b> GR CF3M                   | 850                        |
| Chrome-molybdenum steel   | ASTM <b>A182/A182M</b> GR F6a, F11               | 1100                       |
|                           | ASTM <b>A193/A193M</b> GR B16                    | 1100                       |
|                           | ASTM <b>A193/A193M</b> GF B7                     | 1000                       |
|                           | ASTM <b>A194/A194M</b> GR 4                      | 900                        |

**TABLE 1** *Continued*

| Material                                       | Material Specifications                     | Temperature Limit, °F, max |
|--|---|----------------------------|
| Carbon steel                                   | ASME SA217 GR WC6                           | 1100                       |
|  | ASTM <b>A234/A234M</b> GR WP11              | 1100                       |
|  | ASTM <b>A335/A335M</b> GR P11               | 1100                       |
|  | ASTM <b>A387/A387M</b>                      | 1000                       |
|  | ASTM <b>A53/A53M</b> TY <sup>D</sup> S      | 800 <sup>E</sup>           |
|  | ASTM <b>A53/A53M</b> TY E                   | 650                        |
|  | ASTM <b>A105/A105M</b>                      | 800 <sup>E</sup>           |
|  | ASTM <b>A106/A106M</b>                      | 800 <sup>E</sup>           |
|  | ASTM <b>A134</b> GR 285C (straight seam)    | 300                        |
|  | ASTM <b>A134</b> GR 285C (spiral seam)      | 200                        |
|  | ASTM <b>A139/A139M</b> GR B (straight seam) | 300                        |
|  | ASTM <b>A139/A139M</b> GR B (spiral seam)   | 200                        |
|  | ASTM <b>A181/A181M</b>                      | 800 <sup>E</sup>           |
|  | ASTM <b>A194/A194M</b> GR 2H                | 800                        |
|  | ASTM <b>A216/A216M</b> GR WCB               | 1000                       |
|  | ASTM <b>A234/A234M</b> GR WPB               | 800                        |
|  | ASTM <b>A307</b>                            | 400                        |
| Ductile iron                                   | ASTM <b>A515/A515M</b> GR 70                | 800                        |
|  | ASTM <b>A395/A395M</b>                      | 650                        |
| Bronze   | <b>A536</b>                                 | 450                        |
|  | ASME SB61                                   | 550                        |
| Copper nickel alloy                            | ASME SB62                                   | 406                        |
|  | ASME SB466 C70600                           | 600                        |
| Copper   | ASME SB467 C70600                           | 600                        |
|  | ASTM <b>B88</b> TY K or L                   | 400                        |
| Glass reinforced plastic                       | ASME SB75                                   | 400                        |
|  | ASTM <b>D2996</b> GR 1                      | 225                        |
|  | ASTM <b>D2997</b> GR 1                      | 225                        |
| CP Titanium<br>Grades 1, 2, 3, 4, 7,<br>11, 12 | ASTM <b>D4024</b> GR 1                      | 225                        |
|  | ASTM <b>B367</b> (Castings)                 | 600                        |
|  | ASTM <b>B381</b> (Forgings)                 | 600                        |
|  | ASTM <b>B861</b> (Seamless Pipe)            | 600                        |
|  | ASTM <b>B338</b> (Seamless & Welded Tube)   | 600                        |
|  | ASTM <b>B862</b> (Welded Pipe)              | 600                        |
|  | ASTM <b>B265</b> (Strip, Sheet and Plate)   | 600                        |
|  | ASTM <b>B348</b> (Bar and Billet)           | 600                        |

<sup>A</sup> Maximum temperature limits per ANSI B31.1 for all material, except glass reinforced plastic, which is per NVIC 11-86 and Specification **A536** which is per 46 CFR 56.

<sup>B</sup> GR—grade.

<sup>C</sup> TP—tubular product.

<sup>D</sup> TY—type.

<sup>E</sup> Upon prolonged exposure to temperatures above 775°F, the carbide phase or carbon steel may be converted to graphite.

<https://standards.iteh.ai/catalog/standards/sist/5d863e1a-0594-49b1-b987-a950d7666f85/astm-f1155-10>

**TABLE 2 Steam, Steam Drains, Boiler Blow, Superheater Safety Valve Escape Piping**

| Item                                 | Type/Style                        | Material                 | Material Specification                     | Design Specification | Maximum Temperature<br>1100°F <sup>A</sup><br>Remarks/Limitations |
|--------------------------------------|-----------------------------------|--------------------------|--|----------------------|---|
| Pipe                                 | Seamless                          | CrMo <sup>B</sup> steel  | ASTM <b>A335/A335M</b> GR <sup>C</sup> P11 | ANSI B36.10          | ...   |
| Takedown joints                      | Flanges: weld neck or socket weld | CrMo steel               | ASTM <b>A182/A182M</b> GR F11              | ANSI B16.5           | ...   |
| Bolting                              | Bolts/bolt studs                  | CrMoV <sup>D</sup> steel | ASTM <b>A193/A193M</b> GR B16              | ANSI B18.2.1         | ...   |
|                                      | Nuts                              | CMo <sup>E</sup> steel   | ASTM <b>A194/A194M</b> GR 4                | ANSI B18.2.2         | ...   |
| Fittings                             | Flanged                           | CrMo steel               | ASME SA217 GR WC6 or                       | ANSI B16.5           | ...   |
|                                      |                                   |                          | ASTM <b>A182/A182M</b> GR F11              |                      |   |
| Valves: gate, globe,<br>angle, check | Buttweld                          | CrMo steel               | ASTM <b>A234/A234M</b> GR WP11             | ANSI B16.9 or B16.28 | ...   |
|                                      | Socket weld                       | CrMo steel               | ASTM <b>A182/A182M</b> GR F11              | ANSI B16.11          | ...   |
|                                      | Flanged or buttweld               | CrMo steel               | ASME SA217 GR WC6 or                       | ANSI B16.34          | Trim group 1 <sup>F</sup>   |
|                                      |                                   |                          | ASTM <b>A182/A182M</b> GR F11              |                      |   |
|                                      | Socket weld                       | CrMo steel               | ASTM <b>A182/A182M</b> GR F6a or GR F11    | ANSI B16.34          | ...   |

<sup>A</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>B</sup> CrMo—chromium-molybdenum.

<sup>C</sup> GR—grade.

<sup>D</sup> CrMoV—chromium-molybdenum-vanadium.

<sup>E</sup> CMo—carbon-molybdenum.

<sup>F</sup> For trim group definition, refer to **Table 28**.

**TABLE 3 Steam, Steam Drains, Feed, Condensate Boiler Blow Sampling and Compounding, Safety Valve Escape Piping**

| Item                              | Type/Style  | Material                | Material Specification   | Design Specification | Maximum Temperature<br>775°F <sup>A</sup><br>Remarks/Limitations   |
|-----------------------------------|---|-------------------------|--|----------------------|--|
| Pipe                              | Seamless or electric resistance welded                            | Carbon steel            | ASTM <b>A106/A106M</b> GR <sup>B</sup> B<br>or<br><b>A53/A53M</b> GR B TY S or E | ANSI B36.10          | <b>A53/A53M</b> GR B TY <sup>C</sup> E<br>Limited to a design pressure of 350 psig.<br>See also <b>Table 1</b> . |
| Takedown joints                   | Flanges: weld neck, socket weld or slip-on<br>Unions: socket weld | Carbon steel            | ASTM <b>A105/A105M</b>   | ANSI B16.5           | ...  |
| Bolting                           | Bolts/bolt studs  | Carbon steel            | ASTM <b>A105/A105M</b>   | MSS-SP-83            | ...  |
|                                   | Nuts  | CrMo <sup>D</sup> steel | ASTM <b>A193/A193M</b> GR B7   | ANSI B18.2.1         | ...  |
| Fittings                          | Nuts  | Carbon steel            | ASTM <b>A194/A194M</b> GR 2H   | ANSI B18.2.2         | ...  |
|                                   | Flanged   | Carbon steel            | ASTM <b>A216/A216M</b> GR<br>WCB or <b>A105/A105M</b>                            | ANSI B16.5           | ...  |
|                                   | Butt weld   | Carbon steel            | ASTM <b>A234/A234M</b> GR<br>WPB   | ANSI B16.9 or B16.28 | ...  |
| Valves: gate, globe, angle, check | Socket weld   | Carbon steel            | ASTM <b>A234/A234M</b> GR<br>WPB or <b>A105/A105M</b>                            | ANSI B16.11          | ...  |
|                                   | Flanged or butt weld  | Carbon steel            | ASTM <b>A216/A216M</b> GR<br>WCB or <b>A105/A105M</b>                            | ANSI B16.34          | Trim group 2 <sup>E</sup>  |
|                                   | Socket weld   | Carbon steel            | ASTM <b>A234/A234M</b> GR<br>WPB or <b>A105/A105M</b>                            | ANSI B16.34          | ...  |

<sup>A</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>B</sup> GR—grade.

<sup>C</sup> TY—type.

<sup>D</sup> CrMo—chromium-molybdenum

<sup>E</sup> For trim group definition, refer to **Table 28**.

**TABLE 4 Steam, Steam Drains, Feed, Condensate, Boiler Blow Sampling and Compounding, and Safety Valve Escape Piping**

| Item                              | Type                                       | Style        | Material Specification <sup>A</sup>  | Design Specification   | Maximum Temperature 406°F <sup>B</sup><br>Remarks/Limitations                      |
|-----------------------------------|--|--------------|--|------------------------|--|
| Pipe                              | Seamless or electric resistance welded     | Carbon steel | ASTM <b>A106/A106M</b> GR <sup>C</sup> B<br>or <b>A53/A53M</b> GR B TY S<br>or E | ANSI B36.10            | <b>A53/A53M</b> GR B TY <sup>D</sup> E<br>limited to a design pressure of 350 psig |
| Takedown joints                   | Flanges: weld neck, socket weld or slip-on | Carbon steel | ASTM <b>A105/A105M</b>   | ANSI B16.5             | ...  |
|                                   | Unions: socket weld or threaded            | Carbon steel | ASTM <b>A105/A105M</b>   | MSS-SP-83              | ...  |
|                                   | Unions: threaded or brazed                 | Bronze       | ASME SB61 or SB62  | MIL-F-1183             | ...  |
| Bolting                           | Bolts/bolt studs                           | Carbon steel | ASTM <b>A307</b> GR B  | ANSI B18.2.1           | ...  |
|                                   | Nuts                                       | Carbon steel | ASTM <b>A563</b> GR A  | ANSI B18.2.2           | ...  |
| Fittings                          | Flanged                                    | Carbon steel | ASTM <b>A216/A216M</b> GR<br>WCB or <b>A105/A105M</b>                            | ANSI B16.5             | ...  |
|                                   | Buttweld                                   | Carbon steel | ASTM <b>A234/A234M</b> GR<br>WPB   | ANSI B16.9 or B16.28   | ...  |
|                                   | Socket weld                                | Carbon steel | ASTM <b>A234/A234M</b> GR<br>WPB or <b>A105/A105M</b>                            | ANSI B16.11            | ...  |
|                                   | Sleeve couplings                           | Carbon steel | ASTM <b>A234/A234M</b> GR<br>WPB   | ASTM <b>F682</b>       | ...  |
|                                   | Threaded or brazed                         | Bronze       | ASME SB61 or SB62  | MIL-F-1183             | ...  |
| Valves: gate, globe, angle, check | Flanged                                    | Ductile iron | ASTM <b>A395/A395M</b>   | ANSI B16.34            | Trim group 3 and 4 <sup>E</sup>  |
|                                   | Flanged or butt weld                       | Carbon steel | ASTM <b>A216/A216M</b> GR<br>WCB or <b>A105/A105M</b>                            | ANSI B16.34            | ...  |
|                                   | Socket weld                                | Carbon steel | ASTM <b>A105/A105M</b>   | ANSI B16.34            | ...  |
|                                   | Threaded or brazed                         | Bronze       | ASME SB61 or SB62  | MSS-SP-80 <sup>F</sup> | ...  |

<sup>A</sup> When combining dissimilar materials, galvanic corrosion can occur, especially in seawater systems, and should be considered.

<sup>B</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>C</sup> GR—grade.

<sup>D</sup> TY—type.

<sup>E</sup> For trim group definition, refer to **Table 28**.

<sup>F</sup> MSS-SP-80 valves limited to 75 % of valve design pressure.

**TABLE 5 Gas Turbine and Diesel Exhaust Piping**

| Item | Type/Style   | Material                | Material Specification                        | Design Specification    | Maximum Temperature<br>1100°F <sup>A</sup><br>Remarks/Limitations |
|------|--------------|-------------------------|---|-------------------------|---|
| Pipe | Seamless     | CrMo steel <sup>B</sup> | ASTM <b>A335/A335M</b> GR <sup>C</sup><br>P11 | ANSI B36.10             | ...   |
|      | Plate formed | CrMo steel              | ASTM <b>A387/A387M</b>                        | Commercial <sup>D</sup> | ...   |

**TABLE 5** *Continued*

| Item            | Type/Style                        | Material                 | Material Specification        | Design Specification    | Maximum Temperature<br>1100°F <sup>A</sup><br>Remarks/Limitations |
|-----------------|-----------------------------------|--------------------------|-------------------------------|-------------------------|---|
| Takedown joints | Flanges: weld neck or socket weld | CrMo steel               | ASTM <b>A182/A182M</b> GR F11 | ANSI B16.5              | ...   |
|                 | Flanges: plate                    | CrMo steel               | ASTM <b>A387/A387M</b>        | Commercial <sup>D</sup> | ...   |
| Bolting         | Bolts/bolt studs                  | CrMoV <sup>E</sup> steel | ASTM <b>A193/A193M</b> GR B16 | ANSI B18.2.1            | ...   |
|                 | Nuts                              | CMo <sup>F</sup> steel   | ASTM <b>A194/A194M</b> GR 4   | ANSI B18.2.2            | ...   |

<sup>A</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>B</sup> CrMo—chromium-molybdenum.

<sup>C</sup> GR—grade.

<sup>D</sup> Specific Coast Guard and ABS approval for design required.

<sup>E</sup> CrMoV—chromium-molybdenum-vanadium.

<sup>F</sup> CMo—carbon-molybdenum.

**TABLE 6 Gas Turbine and Diesel Exhaust Piping**

| Item            | Type/Style                                 | Material                | Material Specification   | Design Specification    | Maximum Temperature<br>775°F <sup>A</sup><br>Remarks/Limitations |
|-----------------|--|-------------------------|--|-------------------------|--|
| Pipe            | Seamless or electric resistance welded     | Carbon steel            | ASTM <b>A106/A106M</b> GR <sup>B</sup> B or <b>A53/A53M</b> GR B TY S or E | ANSI B36.10             | See <b>Table 1</b>   |
| Takedown joints | Flanges: weld neck, socket weld or slip-on | Carbon steel            | ASTM <b>A105/A105M</b>   | ANSI B16.5              | ...  |
|                 | Flanges: plate                             | Carbon steel            | ASTM <b>A515/A515M</b> GR 70   | Commercial <sup>C</sup> | ...  |
| Bolting         | Bolts/bolt studs                           | CrMo <sup>D</sup> steel | ASTM <b>A193/A193M</b> GR B7   | ANSI B18.2.1            | ...  |
|                 | Nuts                                       | Carbon steel            | ASTM <b>A194/A194M</b> GR 2H   | ANSI B18.2.2            | ...  |
| Fittings        | Flanged                                    | Carbon steel            | ASTM <b>A216/A216M</b> GR WCB or <b>A105/A105M</b>                         | ANSI B16.5              | ...  |
|                 | Buttweld                                   | Carbon steel            | ASTM <b>A234/A234M</b> GR WPB  | ANSI B16.9 or B16.28    | ...  |

<sup>A</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>B</sup> GR—grade.

<sup>C</sup> Specific Coast Guard and ABS approval required.

<sup>D</sup> CrMo—chromium-molybdenum.

**TABLE 7 Fresh Water for Auxiliary Machinery and Engine Cooling**

| Item                       | Type/Style   | Material                   | Material Specification <sup>A</sup>   | Design Specification   | Maximum Temperature<br>240°F <sup>B</sup><br>Remarks/Limitations |
|----------------------------|--|----------------------------|---|--|--|
| Pipe                       | Seamless or electric resistance welded                           | Carbon steel               | ASTM <b>A106/A106M</b> GR <sup>C</sup> B or <b>A53/A53M</b> GR B TY <sup>D</sup> S or E | ANSI B36.10  | ...  |
|                            |  | CP Titanium Grade 2        | ASTM <b>B861</b> / ASME SB861   |  |  |
| Takedown joints            | Filament wound   | FGP <sup>E</sup>           | ASTM <b>D2996</b> GR 1  | Commercial <sup>F</sup>  | See <b>Table 1</b> and NVIC 11-86 <sup>G</sup>                   |
|                            | Centrifugally cast   | FGP <sup>E</sup>           | ASTM <b>D2997</b> GR 1  | Commercial <sup>F</sup>  |  |
|                            | Flanges: socket weld or slip-on                                  | Carbon steel               | ASTM <b>A105/A105M</b>  | ANSI B16.5   | ...  |
|                            | Unions: socket weld or threaded                                  | Carbon steel               | ASTM <b>A105/A105M</b>  | MSS-SP-83  | ...  |
|                            | Unions: threaded or brazed                                       | Bronze                     | ASME SB61 or SB62   | MIL-F-1183   | ...  |
|                            | Flanges: adhesive bonded   | GRP <sup>H</sup>           | ASTM <b>D4024</b> GR 1  | ASTM <b>D4024</b>  | ...  |
|                            | Gasketed mechanical couplings                                    | Ductile iron               | ASTM <b>A536</b>  | ASTM <b>F1476</b>  | ...  |
|                            | Flanges: Blind, Weld Neck Slip-On, Threaded Pipe Figure 8 Blanks | CP Titanium                | ASTM <b>B381</b> / ASME SB381   | ANSI B16.5 (Dimensions only)   |  |
|                            | Spectacle Blinds   | CP Titanium                |   | ANSI B16.5 ASME B16.48 (Dimensions only) Pipe Fitters Bluebook (Dimensions only) |  |
|                            | Bolting  | Bolts/bolt studs           | Carbon steel  | ASTM <b>A307</b> GR B  | ANSI B18.2.1   |
| CP Titanium 2, 3, 4, 7, 12 |  |                            | ASTM <b>B348</b> / ASME SB348<br>ASTM <b>B381</b> / ASME SB381                          |  |  |
| Nuts                       |  | CP Titanium 2, 3, 4, 7, 12 | ASTM <b>A563</b> GR A<br>ASTM <b>B348</b> / ASME SB348<br>ASTM <b>B381</b> / ASME SB381 | ANSI B18.2.2   | ...  |
| Washers                    |  | CP Titanium                | ASTM <b>B265</b> / ASME SB265   |  |  |

**TABLE 7** *Continued*

| Item                              | Type/Style  | Material                    | Material Specification <sup>A</sup>   | Design Specification                          | Maximum Temperature<br>240°F <sup>B</sup><br>Remarks/Limitations |
|-----------------------------------|---|-----------------------------|---|---|--|
| Fittings                          |   | 1, 2, 3, 4, 7, 11, 12       |   |   |  |
|                                   | Bolt/Bolt Studs   | CP Titanium                 | Per Request Only:<br>ASTM <b>F468</b> (Bolts)                                 |   |  |
|                                   | Nuts  | CP Titanium                 |   |   |  |
|                                   | Plain Washers and Lock Washers                                    | CP Titanium                 | ASTM <b>F467</b> (Nuts)   | ASME B18.21.1<br>ASME B18.22.1                |  |
|                                   | Flanged   | Carbon steel                | ASTM <b>A216/A216M</b> GR WCB<br>or <b>A105/A105M</b>                         | ANSI B16.5                                    | ...  |
|                                   | Buttweld  | Carbon steel                | ASTM <b>A234/A234M</b> GR WPB   | ANSI B16.9 or B16.28                          | ...  |
|                                   | Socket weld or threaded   | Carbon steel                | ASTM <b>A234/A234M</b> GR WPB<br>or <b>A105/A105M</b>                         | ANSI B16.9 or B16.28                          | ...  |
|                                   | Sleeve couplings  | Carbon steel                | ASTM <b>A234/A234M</b> GR WPB   | ASTM <b>F682</b>                              | ...  |
|                                   | Threaded or brazed  | Bronze                      | ASME SB61 or SB62   | ML-F-1183                                     | ...  |
|                                   | Adhesive bonded   | GRP <sup>H</sup>            | Commercial  | Commercial <sup>F</sup>                       | ...  |
|                                   | Used with gasketed mechanical couplings                           | Ductile iron                | <b>A536</b>   | <b>F1548</b>                                  | ...  |
|                                   | Buttweld  | CP Titanium                 | ASTM <b>B363</b> / ASME SB363   | ANSI B16.9<br>MSS SP-43<br>(Dimensions only)  |  |
|                                   | Elbows, Tees, Caps, & Reducers                                    | 1, 2, 3, 4, 7, 12           |   |   |  |
|                                   | Socket-Welding or Threaded Elbows, Tees, Couplings, Bushings      | CP Titanium                 | ASTM <b>B381</b> / ASME SB381   | ANSI B16.11<br>MSS SP-97<br>(Dimensions only) |  |
|                                   | Plugs   | CP Titanium                 | ASTM <b>B381</b> / ASME SB381   | ANSI B16.11<br>(Dimensions only)              |  |
|                                   | Unions  | CP Titanium                 | ASTM <b>B381</b> / ASME SB381   | MSS SP-97<br>MSS SP-83<br>(Dimensions only)   |  |
|                                   | Nipples   | CP Titanium                 | ASTM <b>B861</b> / ASME SB861<br>ASTM <b>B862</b> / ASME SB862                | MSS SP-83<br>(Dimensions only)                |  |
|                                   | Belled End Socket-Welding Elbows, Tees, Couplings, Reducers, Caps | CP Titanium                 | ASTM <b>B363</b> / ASME SB363   | MSS SP-119<br>(Dimensions only)               |  |
|                                   | Threaded, Socket-Welding, and Buttwelding Outlets                 | CP Titanium                 | ASTM <b>B381</b> / ASME SB381   | MSS SP-97<br>(Dimensions only)                |  |
|                                   | Valves  | Butterfly wafer or lug type | Ductile iron  | ASTM <b>A395/A395M</b>                        | MSS-SP-67  |
| Butterfly grooved end             |   | Ductile iron                | ASTM <b>A536</b>  | ...   | Trim group 4 <sup>I</sup>  |
| Valves: gate, globe, angle, check | Flanged   | Ductile iron                | ASTM <b>A395/A395M</b>  | ANSI B16.34                                   | Trim group 4 <sup>I</sup>  |
|                                   | Flanged or buttweld   | Carbon steel                | ASTM <b>A216/A216M</b> GR WCB<br>or <b>A105/A105M</b>                         | ANSI B16.34                                   | Trim group 3 and 4 <sup>I</sup>                                  |
| Valves: ball                      | Socket weld   | Carbon steel                | ASTM <b>A105/A105M</b>  | ANSI B16.34                                   | Trim group 3 and 4 <sup>I</sup>                                  |
|                                   | Threaded or brazed  | Bronze                      | ASME SB61 or SB62   | MSS-SP-80 <sup>J</sup>                        | Trim group 3 and 4 <sup>I</sup>                                  |
|                                   | Grooved end   | Ductile iron                | ASTM <b>A536</b>  | ...   | Trim group 3 and 4 <sup>I</sup>                                  |
|                                   | Flanged or buttweld   | Carbon steel                | ASTM <b>A216/A216M</b> GR WCB<br>or <b>A105/A105M</b> or<br><b>A181/A181M</b> | MSS-SP-72                                     | Trim group 3 and 4 <sup>I</sup>                                  |

<sup>A</sup> When combining dissimilar materials, galvanic corrosion can occur especially in seawater systems, and should be considered.

<sup>B</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>C</sup> GR—grade.

<sup>D</sup> TY—type.

<sup>E</sup> FGP—fiberglass pipe.

<sup>F</sup> Specific Coast Guard and ABS approval required.

<sup>G</sup> For U.S. flag vessels in addition to classification society requirements.

<sup>H</sup> GRP—glass reinforced plastic.

<sup>I</sup> For trim group definition, refer to **Table 28**.

<sup>J</sup> MSS-SP-80 valves limited to 75 % of valve design pressure.

**TABLE 8** **Fresh Water, Hot and Cold Domestic, Air Conditioning, Sanitary**

| Item | Type/Style | Material | Material Specification <sup>A</sup>    | Design Specification | Maximum Temperature 240°F <sup>B</sup><br>Remarks/Limitations     |
|------|------------|----------|--|----------------------|---|
| Pipe | Seamless   | Copper   | ASTM <b>B88</b> TY <sup>C</sup> K or L | ASTM <b>B88</b>      | Hard drawn. Must be annealed for pressures greater than 225 psig. |

**TABLE 8** *Continued*

| Item            | Type/Style  | Material                             | Material Specification <sup>A</sup>                            | Design Specification                           | Maximum Temperature 240°F <sup>B</sup><br>Remarks/Limitations |                           |
|-----------------|---|--------------------------------------|--|--|---|---------------------------|
| Takedown joints | Filament wound  | FGP <sup>D</sup>                     | ASTM <b>D2996</b> GR <sup>E</sup> 1                            | Commercial <sup>F</sup>                        | See <b>Table 1</b> and NVIC 11-86 <sup>G</sup>                |                           |
|                 | Centrifugally cast  | FGP <sup>D</sup>                     | ASTM <b>D2997</b> GR 1   | Commercial <sup>F</sup>                        | See <b>Table 1</b> and NVIC 11-86 <sup>G</sup>                |                           |
|                 | Seamless or electric Resistance welded  | CP Titanium Grade 2                  | ASTM <b>B861</b> / ASME SB861<br>ASTM <b>B862</b> / ASME SB862 |  |   |                           |
|                 | Flanges: silbrazed  | Bronze                               | ASME SB862   | ANSI B16.24                                    | ...   |                           |
|                 | Unions: brazed or threaded  | Bronze                               | ASME SB861 or SB862  | MIL-F-1183                                     | ...   |                           |
|                 | Flanges: adhesive bonded  | GRP <sup>H</sup>                     | ASTM <b>D4024</b> GR 1   | ASTM <b>D4024</b>                              | ...   |                           |
|                 | Gasketed mechanical couplings   | Ductile iron <sup>I</sup>            | ASTM <b>A536</b>   | ASTM <b>F1476</b>                              | ...   |                           |
|                 | Flanges: Blind, Weld Neck Slip-On, Threaded Pipe Figure 8 Blanks              | CP Titanium                          | ASTM <b>B381</b> / ASME SB381                                  | ANSI B16.5<br>(Dimensions only)                |   |                           |
|                 |   | CP Titanium                          |  | ANSI B16.5<br>ASME B16.48<br>(Dimensions only) |   |                           |
|                 |   | Spectacle Blinds                     | CP Titanium  |  | Pipe Fitters Bluebook<br>(Dimensions only)                    |                           |
| Bolting         | Bolts/bolt studs  | Carbon steel                         | ASTM <b>A307</b> GR B  | ANSI B18.2.1                                   | ...   |                           |
|                 | Nuts  | Carbon steel                         | ASTM <b>A563</b> GR A  | ANSI B18.2.2                                   | ...   |                           |
|                 | Bolts/Bolt Studs  | CP Titanium<br>2, 3, 4, 7, 12        | ASTM <b>B348</b> / ASME SB348<br>ASTM <b>B381</b> / ASME SB381 |  |   |                           |
|                 | Nuts  | CP Titanium<br>2, 3, 4, 7, 12        | ASTM <b>B348</b> / ASME SB348<br>ASTM <b>B381</b> / ASME SB381 |  |   |                           |
|                 | Washers   | CP Titanium<br>1, 2, 3, 4, 7, 11, 12 | ASTM <b>B265</b> / ASME SB265                                  |  |   |                           |
|                 |   | Bolts/Bolt Studs                     | CP Titanium<br>2, 3, 4, 7, 12                                  | Per Request only:<br>ASTM <b>F468</b> (Bolts)  |   |                           |
|                 | Nuts  | CP Titanium<br>2, 3, 4, 7, 12        | ASTM <b>F467</b> (Nuts)  |  |   |                           |
| Fittings        | Plain Washers & Lock Washers  | CP Titanium<br>1, 2, 3, 4, 7, 12     |  | ASME B18.21.1<br>ASME B18.22.1                 |   |                           |
|                 | Silbrazed   | Copper                               | ASME SB88 TY K or L  | ANSI B16.22                                    | ...   |                           |
|                 | Adhesive bonded   | GRP <sup>H</sup>                     | Commercial   | Commercial <sup>F</sup>                        | ...   |                           |
|                 | Used with gasketed mechanical couplings                                       | Bronze                               | ASTM <b>B61</b> or <b>B62</b>                                  | ASTM <b>F1476</b>                              | ...   |                           |
|                 | Buttweld Elbows, Tees, Caps, & Reducers                                       | CP Titanium<br>1, 2, 3, 4, 7, 12     | ASTM <b>B363</b> / ASME SB363                                  | ANSI B16.9<br>MSS SP-43<br>(Dimensions only)   |   |                           |
|                 | Socket-Welding or Threaded Elbows, Tees Couplings, Bushings (Dimensions only) | CP Titanium<br>1, 2, 3, 4, 7, 12     | ASTM <b>B381</b> / ASME SB381                                  | ANSI B16.11<br>MSS SP-97                       |   |                           |
|                 | Plugs   | CP Titanium                          | ASTM <b>B381</b> / ASME SB381                                  | ANSI B16.11<br>MSS SP-97<br>(Dimensions only)  |   |                           |
|                 | Unions  | CP Titanium                          | ASTM <b>B381</b> / ASME SB381                                  | MSS SP-83<br>(Dimensions only)                 |   |                           |
|                 | Nipples   | CP Titanium                          | ASTM <b>B861</b> / ASME SB861<br>ASTM <b>B862</b> / ASME SB862 | MSS SP-83<br>(Dimensions only)                 |   |                           |
|                 | Belled End Socket-Welding Elbows, Tees, Couplings, Reducers, Caps             | CP Titanium                          | ASTM <b>B363</b> / ASME SB363                                  | MSS SP-119<br>(Dimensions only)                |   |                           |
| Valves          | Threaded, Socket-Welding, and Buttwelding Outlets                             | CP Titanium                          | ASTM <b>B381</b> / ASME SB381                                  | MSS SP-97<br>(Dimensions only)                 |   |                           |
|                 | Butterfly wafer or lug end  | Ductile iron<br>Bronze               | ASTM <b>A395/A395M</b><br>ASTM <b>B61</b> or <b>B62</b>        | MSS-SP-67<br>...                               | Trim group 4 <sup>J</sup><br>Trim group 4 <sup>J</sup>        |                           |
|                 | Valves: gate, globe, angle, check   | Flanged or brazed                    | Bronze   | ASME SB61 or SB62                              | MSS-SP-80 <sup>K</sup>  | Trim group 4 <sup>J</sup> |
|                 | Valves: ball  | Flanged                              | Bronze   | ASME SB61 or SB62                              | MSS-SP-72   | Trim group 4 <sup>J</sup> |

<sup>A</sup> When combining dissimilar materials galvanic corrosion can occur, especially in seawater systems, and should be considered.

<sup>B</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>C</sup> TY—type.

<sup>D</sup> FGP—fiberglass pipe.



<sup>E</sup> GR—grade.

<sup>F</sup> Specific Coast Guard and ABS approval required.

<sup>G</sup> For U.S. flag vessels in addition to classification society requirements.

<sup>H</sup> GRP—glass reinforced plastic.

<sup>I</sup> Acceptable when gasket isolates coupling housings from fluid.

<sup>J</sup> For trim group definition, refer to [Table 28](#).

<sup>K</sup> MSS-SP-80 valves limited to 75 % of valve design pressure.

**TABLE 9 Sea Water Circulating, Wet Firemain, and Distilling Plant Piping**

| Item             | Type/Style  | Material                  | Material Specification <sup>A</sup>                            | Design Specification   | Maximum Temperature<br>150°F <sup>B</sup><br>Remarks/Limitations |     |
|------------------|---|---------------------------|--|--|--|-----|
| Pipe             | Seamless or welded  | CNA <sup>C</sup> 90:10    | ASME SB466 or SB467  | ASME SB466 or SB467  |  |     |
|                  | Filament wound  | FGP <sup>D</sup>          | ASTM <b>D2996</b> GR <sup>E</sup> 1                            | Commercial <sup>F</sup>  | See NVIC 11-86 <sup>G</sup>                                      |     |
|                  | Centrifugally cast  | FGP <sup>D</sup>          | ASTM <b>D2997</b> GR 1   | Commercial <sup>F</sup>  | See NVIC 11-86 <sup>G</sup>                                      |     |
| Takedown joints  | Seamless or electric  | CP Titanium               | ASTM <b>B861</b> / ASME SB861                                  |  |  |     |
|                  | Resistance welded   | Grade 2                   | ASTM <b>B862</b> / ASME SB862                                  |  |  |     |
|                  | Flanges: brazed   | Bronze                    | ASME SB62  | ANSI B16.24  | ...  |     |
|                  | Unions: brazed  | Bronze                    | ASME SB61 or SB62  | MIL-F-1183   | ...  |     |
|                  | Flanges: adhesive bonded  | GRP <sup>H</sup>          | ASTM <b>D4024</b> GR 1   | ASTM <b>D4024</b>  | ...  |     |
|                  | Gasketed mechanical couplings                                     | Ductile iron <sup>I</sup> | ASTM <b>A536</b>   | ASTM <b>F1476</b>  | ...  |     |
|                  | Flanges: Blind, Weld Neck Slip-On, Threaded Pipe Figure 8 Blanks  | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  | ANSI B16.5<br>(Dimensions only)  |  |     |
|                  | Spectacle Blinds  | CP Titanium               |  | ANSI B16.5<br>ASME B16.48<br>(Dimensions only)<br>Pipe Fitters Bluebook<br>(Dimensions only) |  |     |
|                  | Bolting   | Bolts/bolt studs          | Carbon steel   | ASTM <b>A307</b> GR B  |  | ... |
|                  |   | Nuts                      | Carbon steel   | ASTM <b>A563</b> GR A  |  | ... |
| Bolts/Bolt Studs |   | CP Titanium               | ASTM <b>B348</b> / ASME SB348                                  |  |  |     |
| Nuts             |   | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  |  |  |     |
| Washers          |   | CP Titanium               | ASTM <b>B348</b> / ASME SB348                                  |  |  |     |
|                  |   | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  |  |  |     |
|                  |   | CP Titanium               | ASTM <b>B265</b> / ASME SB265                                  |  |  |     |
|                  |   | CP Titanium               | Per Request only:<br>ASTM <b>F468</b> (Bolts)                  |  |  |     |
|                  |   | CP Titanium               | ASTM <b>F467</b> (Nuts)  |  |  |     |
|                  |   | CP Titanium               | ASTM <b>F1155-10</b>   |  |  |     |
| Fittings         | Plain Washers & Lock Washers                                      | CP Titanium               |  | ASME B18.21.1<br>ASME B18.22.1   |  |     |
|                  | Flanged   | Bronze                    | ASME SB61 or SB62  | ANSI B16.24  | ...  |     |
|                  | Buttweld or welding sleeve  | CNA 90:10                 | ASME SB466 or SB467  | 810-1385880  | ...  |     |
|                  | Brazed  | Bronze                    | ASME SB61 or SB62  | MIL-F-1183   | ...  |     |
|                  | Adhesive bonded   | GRP <sup>H</sup>          | Commercial   | Commercial <sup>F</sup>  | ...  |     |
|                  | Used with gasketed mechanical couplings                           | Bronze                    | ASTM <b>B61</b> or <b>B62</b>                                  | ASTM <b>F1548</b>  | ...  |     |
|                  |   | CNA                       | ASTM <b>B466/B466M</b> or ASTM <b>B467</b>                     | ASTM <b>F1548</b>  | ...  |     |
|                  | Buttweld Elbows, Tees, Caps, & Reducers                           | CP Titanium               | ASTM <b>B363</b> / ASME SB363                                  | ANSI B16.9<br>MSS SP-43<br>(Dimensions only)   |  |     |
|                  | Socket-Welding or Threaded Elbows, Tees                           | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  | ANSI B16.11<br>MSS SP-97<br>(Dimensions only)  |  |     |
|                  | Couplings, Bushings   | CP Titanium               |  | ANSI B16.11<br>MSS SP-97<br>(Dimensions only)  |  |     |
|                  | Plugs   | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  | ANSI B16.11<br>MSS SP-97<br>(Dimensions only)  |  |     |
|                  | Unions  | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  | MSS SP-83<br>(Dimensions only)   |  |     |
|                  | Nipples   | CP Titanium               | ASTM <b>B861</b> / ASME SB861<br>ASTM <b>B862</b> / ASME SB862 | MSS SP-83<br>(Dimensions only)   |  |     |
|                  | Belled End Socket-Welding Elbows, Tees, Couplings, Reducers, Caps | CP Titanium               | ASTM <b>B363</b> / ASME SB363                                  | MSS SP-119<br>(Dimensions only)  |  |     |
|                  | Threaded, Socket-Welding, and Buttwelding Outlets                 | CP Titanium               | ASTM <b>B381</b> / ASME SB381                                  | MSS SP-97<br>(Dimensions only)   |  |     |

**TABLE 9** *Continued*

| Item                                 | Type/Style               | Material   | Material Specification <sup>A</sup>   | Design Specification   | Maximum Temperature<br>150°F <sup>B</sup><br>Remarks/Limitations |
|--------------------------------------|--------------------------|--|---|------------------------|--|
| Valves                               | Butterfly water or lug   | Ductile iron <sup>J</sup><br>Carbon steel <sup>J</sup> | ASTM <b>A395/A395M</b><br>ASTM <b>A216/A216M</b> GR<br>WCB or <b>A105/A105M</b> | MSS-SP-67              | Trim group 6 <sup>K</sup>  |
|                                      | Butterfly grooved<br>end | Bronze   | ASTM <b>B61</b> or <b>B62</b>   | ...                    | Trim group 4 <sup>K</sup>  |
| Valves: gate, globe,<br>angle, check | Flanged<br>Brazed        | Bronze   | ASME SB61 or SB62   | MSS-SP-80 <sup>L</sup> | Trim group 6 <sup>K</sup>  |

<sup>A</sup> When combining dissimilar materials, galvanic corrosion can occur, especially in seawater systems, and should be considered.

<sup>B</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>C</sup> CNA—copper nickel alloy.

<sup>D</sup> FGP—fiberglass pipe.

<sup>E</sup> GR—grade.

<sup>F</sup> Specific Coast Guard and ABS approval required.

<sup>G</sup> For U.S. flag vessels in addition to classification society requirements.

<sup>H</sup> GRP—glass reinforced plastic.

<sup>I</sup> Acceptable when gasket isolates coupling housings from fluid.

<sup>J</sup> Not permitted with CNA piping.

<sup>K</sup> For trim group definition, refer to **Table 28**.

<sup>L</sup> MSS-SP-80 valves limited to 75 % of valve design pressure.

**TABLE 10 Dry Fire Main, Foam, Sprinkling, Deckwash, Tank Cleaning Piping**

| Item                                 | Type/Style                                       | Material     | Material Specification <sup>A</sup>   | Design Specification   | Maximum Temperature<br>200°F <sup>B</sup><br>Remarks/Limitations |
|--------------------------------------|--|--------------|---|------------------------|--|
| Pipe                                 | Seamless or electric<br>resistance welded        | Carbon steel | ASTM <b>A106/A106M</b> GR <sup>C</sup> B or <b>A53/</b><br><b>A53M</b><br>GR B TY <sup>D</sup> S or E | ANSI B36.10            | ...  |
| Takedown joints                      | Flanges: socket weld or<br>slip-on               | Carbon steel | ASTM <b>A105/A105M</b>  | ANSI B16.5             | ...  |
|                                      | Unions: socket weld or<br>threaded               | Carbon steel | ASTM <b>A105/A105M</b>  | MSS-SP-83              | ...  |
|                                      | Gasketed<br>mechanical<br>couplings              | Ductile iron | ASTM <b>A536</b>  | ASTM <b>F1476</b>      | ...  |
| Bolting                              | Bolts/bolt studs                                 | Carbon steel | ASTM <b>A307</b> GR B   | ANSI B18.2.1           | ...  |
|                                      | Nuts   | Carbon steel | ASTM <b>A563</b> GR A   | ANSI B18.2.2           | ...  |
| Fittings                             | Buttweld   | Carbon steel | ASTM <b>A234/A234M</b> GR WPB   | ANSI B16.9 or B16.28   | ...  |
|                                      | Socket weld                                      | Carbon steel | ASTM <b>A234/A234M</b> GR WPB<br>or <b>A105/A105M</b>   | ANSI B16.11            | ...  |
|                                      | Sleeve coupling                                  | Carbon steel | ASTM <b>A234/A234M</b> GR WPB   | ASTM <b>F682</b>       | ...  |
|                                      | Threaded   | Bronze       | ASME SB61 or SB62   | ANSI B16.15            | ...  |
|                                      | Used with<br>Gasketed<br>mechanical<br>couplings | Ductile iron | ASTM <b>A536</b>  | ASTM <b>F1548</b>      | ...  |
| Valves                               | Butterfly wafer or lug type                      | Ductile iron | ASTM <b>A395/A395M</b>  | MSS-SP-67              | ...  |
|                                      | Butterfly grooved<br>end                         | Ductile iron | ASTM <b>A536</b>  | ...                    | Trim group 4 <sup>E</sup>  |
| Valves: gate, globe,<br>angle, check | Flanged  | Ductile iron | ASTM <b>A395/A395M</b>  | ANSI B16.34            | Trim group 4 <sup>E</sup>  |
|                                      | Flanged or buttweld                              | Carbon steel | ASTM <b>A216/A216M</b> GR WCB<br>or <b>A105/A105M</b>   | ANSI B16.34            | Trim group 3 <sup>E</sup>  |
|                                      | Socket weld                                      | Carbon steel | ASTM <b>A234/A234M</b> GR WPB<br>or <b>A105/A105M</b>   | ANSI B16.34            | ...  |
|                                      | Flanged or threaded                              | Bronze       | ASME SB61 or SB62   | MSS-SP-80 <sup>F</sup> | ...  |
|                                      | Grooved end                                      | Ductile iron | ASTM <b>A536</b>  | ...                    | Trim group 3 and 4 <sup>E</sup>                                  |

<sup>A</sup> When combining dissimilar materials, galvanic corrosion can occur, especially in seawater systems, and should be considered.

<sup>B</sup> Consult applicable material and design specifications, and **Table 1** where indicated, to establish pressure/temperature ratings.

<sup>C</sup> GR—grade.

<sup>D</sup> TY—type.

<sup>E</sup> For trim group definition, refer to **Table 28**.

<sup>F</sup> MSS-SP-80 valves limited to 75 % of valve design pressure.

**TABLE 11 Bilge, Clean Ballast, and Pump Priming Piping**

| Item | Type/Style                              | Material         | Material Specification <sup>A</sup>   | Design Specification    | Maximum Temperature<br>100°F <sup>B</sup><br>Remarks/Limitations |
|------|---|------------------|---|-------------------------|--|
| Pipe | Seamless or electric<br>resistance weld | Carbon steel     | ASTM <b>A106/A106M</b> GR <sup>C</sup> B or<br><b>A53/A53M</b><br>GR B TY <sup>D</sup> S or E | ANSI B36.10             | ...  |
|      | Filament wound                          | FGP <sup>E</sup> | ASTM <b>D2996</b> GR 1  | Commercial <sup>F</sup> | See NVIC 11-86 <sup>G</sup>                                      |
|      | Centrifugally cast                      | FGP <sup>E</sup> | ASTM <b>D2997</b> GR 1  | Commercial <sup>F</sup> | See NVIC 11-86 <sup>G</sup>                                      |