



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

This standard is issued under the fixed designation F 1155; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 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 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.

### 2. Referenced Documents

#### 2.1 *ASTM Standards:*

- A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless<sup>2</sup>
- A 105/A105M Specification for Carbon Steel Forgings for Piping Applications<sup>2</sup>
- A 106 Specification for Seamless Carbon Steel Pipe for High-Temperature Service<sup>2</sup>
- A 134 Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)<sup>2</sup>
- A 139/A 139M Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)<sup>2</sup>
- A 178/A 178M Specification for Electric-Resistance Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes<sup>2</sup>
- A 179/A 179M Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes<sup>2</sup>
- A 181/A 181M Specification for Carbon Steel Forgings, for General-Purpose Piping<sup>2</sup>
- A 182/A 182M Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service<sup>2</sup>
- A 192/A 192M Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service<sup>2</sup>

- A 193/A 193M Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service<sup>2</sup>
- A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service<sup>2</sup>
- A 213/A 213M Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes<sup>2</sup>
- A 214/A 214M Specification for Electric-Resistance Welded Carbon Steel Heat-Exchanger and Condenser Tubes<sup>2</sup>
- A 216/A 216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service<sup>3</sup>
- A 234/A 234M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service<sup>2</sup>
- A 242/A 242M Specification for High-Strength Low-Alloy Structural Steel<sup>4</sup>
- A 249/A 249M Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes<sup>2</sup>
- A 283/A 283M Specification for Low and Intermediate Tensile Strength Carbon Steel Plates<sup>4</sup>
- A 307 Specification for Carbon Steel Bolts and Studs, 60 000 Psi Tensile Strength<sup>5</sup>
- A 320/A 320M Specification for Alloy Steel Bolting Materials for Low-Temperature Service<sup>2</sup>
- A 335/A 335M Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service<sup>2</sup>
- A 351/A 351M Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts<sup>3</sup>
- A 387/A 387M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum<sup>4</sup>
- A 395 Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures<sup>3</sup>
- A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service<sup>4</sup>
- A 536 Specification for Ductile Iron Castings<sup>3</sup>
- A 563 Specification for Carbon and Alloy Steel Nuts<sup>5</sup>

<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> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 01.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 01.04.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 15.08.

- B 61 Specification for Steam or Valve Bronze Castings<sup>6</sup>
- B 62 Specification for Composition Bronze or Ounce Metal Castings<sup>6</sup>
- B 88 Specification for Seamless Copper Water Tube<sup>6</sup>
- B 466 Specification for Seamless Copper-Nickel Pipe and Tube<sup>6</sup>
- B 467 Specification for Welded Copper-Nickel Pipe<sup>6</sup>
- D 2996 Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe<sup>7</sup>
- D 2997 Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe<sup>7</sup>
- D 4024 Specification for Machine Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges<sup>7</sup>
- F 682 Specification for Wrought Carbon Steel Sleeve-Type Pipe Couplings<sup>8</sup>
- F 683 Practice for Selection and Application of Thermal Insulation for Piping and Machinery<sup>8</sup>
- F 704 Practice for Selecting Bolting Lengths for Piping System Flanged Joints<sup>8</sup>
- F 722 Specification for Welded Joints for Shipboard Piping Systems<sup>8</sup>
- F 1476 Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications<sup>8</sup>
- F 1548 Specification for the Performance of Fittings for Use with Gasketed Mechanical Couplings Used in Piping Applications<sup>8</sup>

2.2 *ANSI Standards:*<sup>9</sup>

- B16.5 Steel Pipe Flanges and Flanged Fittings
- B16.9 Factor Made Wrought Steel Buttwelding 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 Buttwelding 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)
- 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>10</sup>

- 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 Carbon Steel Pipe Unions, Socket-Welding and Threaded

2.4 *Other Documents:*

- ASME Boiler and Pressure Vessel Code, Sections I and VIII<sup>11</sup>
- ABS’ Rules for Building and Classing Steel Vessels<sup>12</sup>
- Title 46, Code of Federal Regulations, Parts 41 to 69<sup>13</sup>
- NVIC 11-86; Guidelines Governing the Use of Fiberglass Pipe (FGP) on Coast Guard Inspected Vessels<sup>13</sup>
- MIL-F-1183 Fittings, Pipe, Cast Bronze, Silver-Brazing<sup>13</sup>

**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 F 704 F 704 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).

<sup>6</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>7</sup> Annual Book of ASTM Standards, Vol 08.04.

<sup>8</sup> Annual Book of ASTM Standards, Vol 01.07.

<sup>9</sup> Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

<sup>10</sup> Available from Manufacturer’s Standardization Society of the Valve and Fittings Industry, 127 Park St., N.E. Vienna, VA 22180.

<sup>11</sup> Available from American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

<sup>12</sup> Available from American Bureau of Shipping, Book Order, 45 Eisenhower Dr., Paramus, NJ 07652.

<sup>13</sup> Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

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 F 722F 722.

3.18 Thermal insulation for piping systems shall be in accordance with Practice F 683F 683.

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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#### 5. Keywords

5.1 materials; piping systems; piping systems materials; ship construction; ship design

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**TABLE 1 Material Temperature Limitations<sup>A</sup>**

Material	Material Specifications	Temperature Limit, °F, max
Corrosion resistant steel	ASTM A 194/A 194MA 194/A 194M GR <sup>B</sup> 8, 8C, 8T	1200
	ASTM A 194/A 194MA 194/A 194M GR 8F ASME SA312 TP <sup>C</sup> 316L ASME SA312 TP 304L	800 850 800
Chrome-molybdenum steel	ASTM A 351/A 351MA 351/A 351M GR CF3M	850
	ASTM A 182/A 182MA 182/A 182M GR F6a, F11	1100
	ASTM A 193/A 193MA 193/A 193M GR B16	1100
	ASTM A 193/A 193MA 193/A 193M GF B7	1000
	ASTM A 194/A 194A 194/A 194M GR 4	900
	ASME SA217 GR WC6	1100
	ASTM A 234/A 234MA 234/A 234M GR WP11	1100
	ASTM A 335/A 335MA 335/A 335M GR P11	1100
	ASTM A 387/A 387MA 387/A 387M	1000
	Carbon steel	ASTM A 53A 53 TY <sup>D</sup> S
ASTM A 53A 53 TY E		650
ASTM A 105/A 105MA 105/A105M		800 <sup>E</sup>
ASTM A 106A 106		800 <sup>E</sup>
ASTM A 134A 134 GR 285C (straight seam)		300
ASTM A 134A 134 GR 285C (spiral seam)		200
ASTM A 139/A 139MA 139/A 139M GR B (straight seam)		300
ASTM A 139/A 139MA 139/A 139M GR B (spiral seam)		200
ASTM A 181/A 181MA 181/A 181M		800 <sup>E</sup>
ASTM A 194/A 194MA 194/A 194M GR 2H		800
ASTM A 216/A 216MA 216/A 216M GR WCB		1000
ASTM A 234/A 234MA 234/A 234M GR WPB		800
ASTM A 307A 307		400
ASTM A 515/A 515MA 515/A 515M GR 70		800
ASTM A 395A 395		650
A 536A 536		450
Bronze		ASME SB61
	ASME SB62	406
Copper nickel alloy	ASME SB466 C70600	600
	ASME SB467 C70600	600
Copper	ASTM B 88B 88 TY K or L	400
	ASME SB75	400
Glass reinforced plastic	ASTM D 2996D 2996 GR 1	225
	ASTM D 2997D 2997 GR 1	225
	ASTM D 4024D 4024 GR 1	225

<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 A 536A 536 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.

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

Item	Type/Style	Material	Material Specification	Design Specification	Maximum Temperature 1100°F <sup>A</sup> Remarks/Limitations
Pipe	Seamless	CrMo <sup>B</sup> steel	ASTM A 335/A 335M <b>A 335/A 335M</b> GR <sup>C</sup> P11	ANSI <b>B36.10</b>	...
Takedown joints	Flanges: weld neck or socket weld	CrMo steel	ASTM A 182/A 182M <b>A 182/A 182M</b> F11	GR ANSI <b>B16.5</b>	...
Bolting	Bolts/bolt studs	CrMoV <sup>D</sup> steel	ASTM A 193/A 193M <b>A 193/A 193M</b> B16	GR ANSI <b>B18.2.1</b>	...
	Nuts	CMo <sup>E</sup> steel	ASTM A 194/A 194M <b>A 194/A 194M</b> 4	GR ANSI <b>B18.2.2</b>	...
Fittings	Flanged	CrMo steel	ASME SA217 GR WC6 or ASTM A 182/A 182M <b>A 182/A 182M</b> GR F11	ANSI B16.5	...
	Buttweld	CrMo steel	ASTM A 234/A 234M <b>A 234/A 234M</b> WP11	GR ANSI <b>B16.9</b> or <b>B16.28</b>	...
	Socket weld	CrMo steel	ASTM A 182/A 182M <b>A 182/A 182M</b> F11	GR ANSI <b>B16.11</b>	...
Valves: gate, globe, angle, check	Flanged or buttweld	CrMo steel	ASME SA217 GR WC6 or ASTM A 182/A 182M <b>A 182/A 182M</b> GR F11	ANSI <b>B16.34</b>	Trim group 1 <sup>F</sup>
	Socket weld	CrMo steel	ASTM A 182/A 182M <b>A 182/A 182M</b> F6a or GR F11	GR ANSI <b>B16.34</b>	...

<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**.

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**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 775°F <sup>A</sup> Remarks/Limitations
Pipe	Seamless or electric resistance welded	Carbon steel	ASTM A 106/A 106 GR <sup>B</sup> B or A 53A 53 GR B TY S or E	ANSI B36.10	A 53A 53 GR B TY <sup>C</sup> E Limited to a design pressure of 350 psig. See also Table 1.
Takedown joints	Flanges: weld neck, socket weld or slip-on Unions: socket weld	Carbon steel	ASTM A 105/A 105MA 105/A 105M	ANSI B16.5	...
		Carbon steel	ASTM A 105/A 105MA 105/A 105M	MSS-SP-83	...
Bolting	Bolts/bolt studs	CrMo <sup>D</sup> steel	ASTM A 193/A 193MA 193/A 193M GR B7	ANSI B18.2.1	...
	Nuts	Carbon steel	ASTM A 194/A 194MA 194/A 194M GR 2H	ANSI B18.2.2	...
Fittings	Flanged	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR WCB or A 105/A 105MA 105/A 105M	ANSI B16.5	...
	Butt weld	Carbon steel	ASTM A 234/A 234MA 234/A 234M GR WPB	ANSI B16.9 or B16.28	...
	Socket weld	Carbon steel	ASTM A 234/A 234MA 234/A 234M GR WPB or A 105/A 105MA 105/A 105M	ANSI B16.11	...
Valves: gate, globe, angle, check	Flanged or butt weld	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR	ANSI B16.34	Trim group 2 <sup>E</sup>
	Socket weld	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR WCB or A 105/A 105MA 105/A 105M	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.

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**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> Remarks/Limitations
Pipe	Seamless or electric resistance welded	Carbon steel	ASTM A 106/A 106 GR <sup>C</sup> B or A 53/A 53 GR B TY S or E	ANSI B36.10	A 53A 53 GR B TY <sup>D</sup> E limited to a design pressure of 350 psig
Takedown joints	Flanges: weld neck, socket weld or slip-on	Carbon steel	ASTM A 105/A 105MA 105/ A105M	ANSI B16.5	...
	Unions: socket weld or threaded	Carbon steel	ASTM A 105/A 105MA 105/ A105M	MSS-SP-83	...
	Unions: threaded or brazed	Bronze	ASME SB61 or SB62	MIL-F-1183	...
Bolting	Bolts/bolt studs	Carbon steel	ASTM A 307/A 307 GR B	ANSI B18.2.1	...
	Nuts	Carbon steel	ASTM A 563/A 563 GR A	ANSI B18.2.2	...
Fittings	Flanged	Carbon steel	ASTM A 216/A 216MA 216/ A 216M GR WCB or	ANSI B16.5	...
		Carbon steel	ASTM A 234/A 234MA 234/ A 234M GR WPB	ANSI B16.9 or B16.28	...
	Buttweld	Carbon steel	ASTM A 234/A 234MA 234/ A 234M GR WPB	ANSI B16.11	...
		Carbon steel	ASTM A 234/A 234MA 234/ A 105MA 105/A105M	ANSI B16.11	...
	Sleeve couplings	Carbon steel	ASTM A 234/A 234MA 234/ A 234M GR WPB	ASTM F 682F 682	...
		Carbon steel	ASTM A 234/A 234MA 234/ A 105MA 105/A105M	ASTM F 682F 682	...
Valves: gate, globe, angle, check	Threaded or brazed	Bronze	ASME SB61 or SB62	MIL-F-1183	...
	Flanged	Ductile iron	ASTM A 395/A 395	ANSI B16.34	Trim group 3 and 4 <sup>E</sup>
		Carbon steel	ASTM A 216/A 216MA 216/ A 216M GR WCB or A 105/ A 105MA 105/A105M	ANSI B16.34	...
	Socket weld	Carbon steel	ASME SB61 or SB62	MSS-SP-80 <sup>F</sup>	...
	Threaded or brazed	Bronze			...

<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 1100°F <sup>A</sup> Remarks/Limitations
Pipe	Seamless	CrMo steel <sup>B</sup>	ASTM A 335/A 335MA 335/ A 335M GR <sup>C</sup> P11	ANSI B36.10	...
	Plate formed	CrMo steel	ASTM A 387/A 387MA 387/ A 387M	Commercial <sup>D</sup>	...
Takedown joints	Flanges: weld neck or socket weld	CrMo steel	ASTM A 182/A 182MA 182/ A 182M GR F11	ANSI B16.5	...
	Flanges: plate	CrMo steel	ASTM A 387/A 387MA 387/ A 387M	Commercial <sup>D</sup>	...
Bolting	Bolts/bolt studs	CrMoV <sup>E</sup> steel	ASTM A 193/A 193MA 193/ A 193M GR B16	ANSI B18.2.1	...
	Nuts	CMo <sup>F</sup> steel	ASTM A 194/A 194MA 194/ A 194M 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 775°F <sup>A</sup> Remarks/Limitations
Pipe	Seamless or electric resistance welded	Carbon steel	ASTM A 106/A 106 GR <sup>B</sup> B or A 53A 53 GR B TY S or E	ANSI B36.10	See Table 1
Takedown joints	Flanges: weld neck, socket weld or slip-on	Carbon steel	ASTM A 105/A 105MA 105/A 105M	ANSI B16.5	...
	Flanges: plate	Carbon steel	ASTM A 515/A 515MA 515/A 515M GR 70	Commercial <sup>C</sup>	...
Bolting	Bolts/bolt studs	CrMo <sup>D</sup> steel	ASTM A 193/A 193MA 193/A 193M GR B7	ANSI B18.2.1	...
	Nuts	Carbon steel	ASTM A 194/A 194MA 194/A 194M GR 2H	ANSI B18.2.2	...
Fittings	Flanged	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR WCB or A 105/A 105MA 105/A 105M	ANSI B16.5	...
	Buttweld	Carbon steel	ASTM A 234/A 234MA 234/A 234M 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.

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

Item	Type/Style	Material	Material Specification <sup>A</sup>	Design Specification	Maximum Temperature 240°F <sup>B</sup> Remarks/Limitations
Pipe	Seamless or electric resistance welded	Carbon steel	ASTM A 106A 106 GR <sup>C</sup> B or A 53A 53 GR B TY <sup>D</sup> S or E	ANSI B36.10	...
	Filament wound	FGP <sup>E</sup>	ASTM D 2996D 2996 GR 1	Commercial <sup>F</sup>	See Table 1 and NVIC
Takedown joints	Centrifugally cast	FGP <sup>E</sup>	ASTM D 2997D 2997 GR1	Commercial <sup>F</sup>	11-86 <sup>G</sup>
	Flanges: socket weld or slip-on	Carbon steel	ASTM A 105/A 105MA 105/A105M	ANSI B16.5	...
	Unions: socket weld or threaded	Carbon steel	ASTM A 105/A 105MA 105/A105M	MSS-SP-83	...
	Unions: threaded or brazed	Bronze	ASME SB61 or SB62	MIL-F-1183	...
	Flanges: adhesive bonded	GRP <sup>H</sup>	ASTM D 4024D 4024 GR 1	ASTM D 4024D 4024	...
	Gasketed mechanical couplings	Ductile iron	ASTM A 536A 536	ASTM F 1476F 1476	...
Bolting	Bolts/bolt studs	Carbon steel	ASTM A 307A 307 GR B	ANSI B18.2.1	...
	Nuts	Carbon steel	ASTM A 563A 563 GR A	ANSI B18.2.2	...
Fittings	Flanged	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR WCB or A 105/A 105MA 105/A105M	ANSI B16.5	...
	Buttweld	Carbon steel	ASTM A 234/A 234MA 234/A 234M GR WPB	ANSI B16.9 or B16.28	...
	Socket weld or threaded	Carbon steel	ASTM A 234/A 234MA 234/A 234M GR WPB or A 105/A 105MA 105/A105M	ANSI B16.9 or B16.28	...
	Sleeve couplings	Carbon steel	ASTM A 234/A 234MA 234/A 234M GR WPB	ASTM F 682F 682	...
	Threaded or 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	Ductile iron	A 536A 536	F 1548F 1548	...
Valves	Butterfly wafer or lug type	Ductile iron	ASTM A 395A 395	MSS-SP-67	Trim group 4 <sup>I</sup>
	Butterfly grooved end	Ductile iron	ASTM A 536A 536	...	Trim group 4 <sup>I</sup>
Valves: gate, globe, angle, check	Flanged	Ductile iron	ASTM A 395A 395	ANSI B16.34	Trim group 4 <sup>I</sup>
	Flanged or buttweld	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR WCB or A 105/A 105MA 105/A105M	ANSI B16.34	Trim group 3 and 4 <sup>I</sup>
Valves: ball	Socket weld	Carbon steel	ASTM A 105/A 105MA 105/A105M	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 A 536A 536	...	Trim group 3 and 4 <sup>I</sup>
	Flanged or buttweld	Carbon steel	ASTM A 216/A 216MA 216/A 216M GR WCB or A 105/A 105MA 105/A105M or A 181/A 181MA 181/A 181M	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> Remarks/Limitations
Pipe	Seamless	Copper	ASTM B 88B 88 TY <sup>C</sup> K or L	ASTM B 88B 88	Hard drawn. Must be annealed for pressures greater than 225 psig. See Table 1 and NVIC 11-86 <sup>G</sup> . See Table 1 and NVIC 11-86 <sup>G</sup> .
	Filament wound	FGP <sup>D</sup>	ASTM D 2996D 2996 GR <sup>E</sup> 1	Commercial <sup>F</sup>	
	Centrifugally cast	FGP <sup>D</sup>	ASTM D 2997D 2997 GR 1	Commercial <sup>F</sup>	
Takedown joints	Flanges: silbrazed	Bronze	ASME SB62	ANSI B16.24	...
	Unions: brazed or threaded	Bronze	ASME SB61 or SB62	MIL-F-1183	...
	Flanges: adhesive bonded	GRP <sup>H</sup>	ASTM D 4024D 4024 GR 1	ASTM D 4024D 4024	...
	Gasketed mechanical couplings	Ductile iron <sup>I</sup>	ASTM A 536A 536	ASTM F 1476F 1476	...
Bolting	Bolts/bolt studs	Carbon steel	ASTM A 307A 307 GR B	ANSI B18.2.1	...
	Nuts	Carbon steel	ASTM A 563A 563 GR A	ANSI B18.2.2	...
Fittings	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 61B 61 or B 62B 62	ASTM F 1476F 1476	...
Valves	Butterfly wafer or lug	Ductile iron	ASTM A 395A 395	MSS-SP-67	Trim group 4 <sup>J</sup>
	Butterfly grooved end	Bronze	ASTM B 61B 61 or B 62B 62	...	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.

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