



Standard Practice for Selection and Application of Piping System Materials¹

This standard is issued under the fixed designation F1155; 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 (ϵ) 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, 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.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- 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)
- A164 Specification for Electrodeposited Coatings of Zinc on Steel (Withdrawn 1981)³
- 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 Steel, Alloy Steel, and Stainless 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, Studs, and Threaded Rod 60 000 PSI Tensile Strength

¹ 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.

Current edition approved Dec. 1, 2019. Published January 2020. Originally approved in 1988. Last previous edition approved in 2015 as F1155 – 10 (2015). DOI: 10.1520/F1155-10R19.

² 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.

³ The last approved version of this historical standard is referenced on www.astm.org.

- 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
- 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, Socket Head 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 ASME Standards:⁴

ASME Boiler and Pressure Vessel Code, Sections I and VIII

B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

B16.9 Factory-Made Wrought Butt Welding Fittings

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

B16.11 Forged Fittings, Socket-Welding and Threaded

B16.15 Cast Copper Alloy Threaded Fittings: Classes 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 Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500

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: Classes 150 and 300

B16.48 Line Blanks

B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

B18.2.2 Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

B18.21.1 Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

B18.22.1 Plain Washers

B31.1 Power Piping

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

2.3 MSS Standards:⁵

- 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:

- ABS Rules for Building and Classing Steel Vessels⁶
- Title 46 Code of Federal Regulations, Parts 41 to 69⁷
- NVIC 11-86 Guidelines Governing the Use of Fiberglass Pipe (FGP) on Coast Guard Inspected Vessels⁷
- MIL-F-1183 Fittings, Pipe, Cast Bronze, Silver-Brazing⁷

3. General Requirements

3.1 Shipboard piping systems shall be in accordance with ASME 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 ASME B16.34 and shall use the adjusted pressure temperature ratings of ASME 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.

⁵ Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, <http://www.mss-hq.org>.

⁶ Available from American Bureau of Shipping (ABS), ABS Plaza, 16855 Northchase Dr., Houston, TX 77060, <http://www.eagle.org>.

⁷ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

4. List of Tables

4.1 The tables are arranged in the following sequence:

Title	Table
Material Temperature Limitations	Table 1
Steam, Steam Drains, Boiler Blow, and Superheater Safety Valve Escape Piping; 1100°F max	Table 2
Steam, Steam Drains, Feed, Condensate, Boiler Blow, Sampling and Compounding, and Safety Valve Escape Piping; 775°F max	Table 3
Steam, Steam Drains, Feed, Condensate, Boiler Blow, Sampling and Compounding, and Safety Valve Escape Piping; 406°F max	Table 4
Gas Turbine and Diesel Exhaust Piping; 1100°F max	Table 5
Gas Turbine and Diesel Exhaust Piping; 775°F max	Table 6
Fresh Water for Auxiliary Machinery and Engine Cooling; 240°F max	Table 7
Fresh Water, Hot and Cold Domestic, Air Conditioning and Sanitary	Table 8
Seawater Circulating, Wet Firemain, and Distilling Plant Piping	Table 9
Dry Firemain, Foam, Sprinkling, Deckwash, and Tank Cleaning Piping	Table 10
Bilge, Clean Ballast, and Pump Priming Piping	Table 11
Diesel and Lube Oil System Piping, Fuel Oil Filling Transfer, and Service Suction Piping	Table 12

Title	Table
Fuel Oil Service Discharge Piping	Table 13
Cargo Oil (and Vent Piping) and Crude Oil Wash Piping	Table 14
Steering Gear Fill and Drain Piping, and Telemotor Piping	Table 15
Hydraulic Piping	Table 16
Air Piping 150 psi and Below	Table 17
Air Piping Above 150 psi	Table 18
Refrigeration Piping	Table 19
CO ₂ , Halon, and Smoke Detection	Table 20
Sounding Tubes, Vents, and Overflows for Fresh Water, Saltwater and Oil	Table 21
Waste, Soil, and Interior Deck Drains	Table 22
Weather Deck Drains, Main Deck, and Above	Table 23
Inert Gas—Generator or Uptakes to Scrubber	Table 24
Inert Gas—Scrubber to Tanks	Table 25
Liquified Natural Gas Systems Including Vapor Fuel, Inert Gas, and Nitrogen Service	Table 26
Liquified Natural Gas Systems Including Cargo, Inert Gas, Nitrogen, and Cargo Tank Cooldown and Warmup Piping Below 0°F	Table 27
Valve Trim Groups	Table 28

5. Keywords

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

TABLE 1 Material Temperature Limitations^A

Material	Material Specifications	Temperature Limit, °F, max
Corrosion resistant steel	ASTM A194/A194M GR ^B 8, 8C, 8T	1200
	ASTM A194/A194M GR 8F	800
	ASME SA312 TP ^C 316L	850
	ASME SA312 TP 304L	800
	ASTM A351/A351M GR CF3M	850
Chrome-molybdenum steel	ASTM A182/A182M GR F6a, F11	1100
	ASTM A193/A193M GR B16	1100
	ASTM A193/A193M GF B7	1000
	ASTM A194/A194M GR 4	900
	ASME SA217 GR WC6	1100
	ASTM A234/A234M GR WP11	1100
	ASTM A335/A335M GR P11	1100
	ASTM A387/A387M	1000
Carbon steel	ASTM A53/A53M TY ^D S	800 ^E
	ASTM A53/A53M TY E	650
	ASTM A105/A105M	800 ^E
	ASTM A106/A106M	800 ^E
	ASTM A134 GR 285C (straight seam)	300
	ASTM A134 GR 285C (spiral seam)	200
	ASTM A139/A139M GR B (straight seam)	300
	ASTM A139/A139M GR B (spiral seam)	200
	ASTM A181/A181M	800 ^E
	ASTM A194/A194M GR 2H	800
	ASTM A216/A216M GR WCB	1000
	ASTM A234/A234M GR WPB	800
	ASTM A307	400
	ASTM A515/A515M GR 70	800
Ductile iron	ASTM A395/A395M	650
	ASTM A536	450

TABLE 1 Continued

Material	Material Specifications	Temperature Limit, °F, max
Bronze	ASME SB61	550
	ASME SB62	406
Copper nickel alloy	ASME SB466 C70600	600
	ASME SB467 C70600	600
Copper	ASTM B88 TY K or L	400
	ASME SB75	400
Glass reinforced plastic	ASTM D2996 GR 1	225
	ASTM D2997 GR 1	225
	ASTM D4024 GR 1	225
CP Titanium Grades 1, 2, 3, 4, 7, 11, 12	ASTM B367 (Castings)	600
	ASTM B381 (Forgings)	600
	ASTM B861 (Seamless Pipe)	600
	ASTM B338 (Seamless & Welded Tube)	600
	ASTM B862 (Welded Pipe)	600
	ASTM B265 (Strip, Sheet and Plate)	600
	ASTM B348 (Bar and Billet)	600

^A Maximum temperature limits in accordance with ASME B31.1 for all material, except glass reinforced plastic, which is in accordance with NVIC 11-86 and Specification A536 which is in accordance with 46 CFR 56.

^B GR—grade.

^C TP—tubular product.

^D TY—type.

^E 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 ^A Remarks/Limitations
Pipe	Seamless	CrMo ^B steel	ASTM A335/A335M GR ^C P11	ASME B36.10	...
Takedown joints	Flanges: weld neck or socket weld	CrMo steel	ASTM A182/A182M GR F11	ASME B16.5	...
Bolting	Bolts/bolt studs Nuts	CrMoV ^D steel	ASTM A193/A193M GR B16	ASME B18.2.1	...
		CMo ^E steel	ASTM A194/A194M GR 4	ASME B18.2.2	...
Fittings	Flanged	CrMo steel	ASME SA217 GR WC6 or ASTM A182/A182M GR F11	ASME B16.5	...
	Buttweld	CrMo steel	ASTM A234/A234M GR WP11	ASME B16.9 or B16.28	...
	Socket weld	CrMo steel	ASTM A182/A182M GR F11	ASME B16.11	...
Valves: gate, globe, angle, check	Flanged or buttweld	CrMo steel	ASME SA217 GR WC6 or ASTM A182/A182M GR F11	ASME B16.34	Trim group 1 ^F
	Socket weld	CrMo steel	ASTM A182/A182M GR F6a or GR F11	ASME B16.34	...

^A Consult applicable material and design specifications, and Table 1 where indicated, to establish pressure/temperature ratings.

^B CrMo—chromium-molybdenum.

^C GR—grade.

^D CrMoV—chromium-molybdenum-vanadium.

^E CMo—carbon-molybdenum.

^F 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 775°F ^A Remarks/Limitations
Pipe	Seamless or electric resistance welded	Carbon steel	ASTM A106/A106M GR ^B B or A53/A53M GR B TY S or E	ASME B36.10	A53/A53M GR B TY ^C E Limited to a design pressure of 350 psig. See also Table 1.
Takedown joints	Flanges: weld neck, socket weld or slip-on	Carbon steel	ASTM A105/A105M	ASME B16.5	...
	Unions: socket weld	Carbon steel	ASTM A105/A105M	MSS-SP-83	...

TABLE 3 *Continued*

Item	Type/Style	Material	Material Specification	Design Specification	Maximum Temperature 775°F ^A Remarks/Limitations
Bolting	Bolts/bolt studs	CrMo ^D steel	ASTM A193/A193M GR B7	ASME B18.2.1	...
	Nuts	Carbon steel	ASTM A194/A194M GR 2H	ASME B18.2.2	...
Fittings	Flanged	Carbon steel	ASTM A216/A216M GR WCB or A105/A105M	ASME B16.5	...
	Butt weld	Carbon steel	ASTM A234/A234M GR WPB	ASME B16.9 or B16.28	...
	Socket weld	Carbon steel	ASTM A234/A234M GR WPB or A105/A105M	ASME B16.11	...
Valves: gate, globe, angle, check	Flanged or butt weld	Carbon steel	ASTM A216/A216M GR WCB or A105/A105M	ASME B16.34	Trim group 2 ^E
	Socket weld	Carbon steel	ASTM A234/A234M GR WPB or A105/A105M	ASME B16.34	...

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

^B GR—grade.

^C TY—type.

^D CrMo—chromium-molybdenum

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

^A When combining dissimilar materials, galvanic corrosion can occur, especially in seawater systems, and should be considered.

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

^C GR—grade.

^D TY—type.

^E For trim group definition, refer to **Table 28**.

^F 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 ^A Remarks/Limitations
Pipe	Seamless	CrMo steel ^B	ASTM A335/A335M GR ^C P11	ASME B36.10	...
	Plate formed	CrMo steel	ASTM A387/A387M	Commercial ^D	...

TABLE 5 Continued

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

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

^B CrMo—chromium-molybdenum.

^C GR—grade.

^D Specific Coast Guard and ABS approval for design required.

^E CrMoV—chromium-molybdenum-vanadium.

^F CMo—carbon-molybdenum.

TABLE 6 Gas Turbine and Diesel Exhaust Piping

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

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

^B GR—grade.

^C Specific Coast Guard and ABS approval required.

^D CrMo—chromium-molybdenum.

TABLE 7 Fresh Water for Auxiliary Machinery and Engine Cooling

Item	Type/Style	Material	Material Specification ^A	Design Specification	Maximum Temperature 240°F ^B Remarks/Limitations
Pipe	Seamless or electric resistance welded	Carbon steel	ASTM A106/A106M GR ^C B or A53/A53M GR B TY ^D S or E	ASME B36.10	...
		CP Titanium Grade 2	ASTM B861 / ASME SB861 ASTM B862 / ASME SB862		
	Filament wound Centrifugally cast	FGP ^E FGP ^E	ASTM D2996 GR 1 ASTM D2997 GR1	Commercial ^F Commercial ^F	See Table 1 and NVIC 11-86 ^G
Takedown joints	Flanges: socket weld or slip-on	Carbon steel	ASTM A105/A105M	ASME B16.5	...
	Unions: socket weld or threaded	Carbon steel	ASTM A105/A105M	MSS-SP-83	...
	Unions: threaded or brazed	Bronze	ASME SB61 or SB62	MIL-F-1183	...
	Flanges: adhesive bonded	GRP ^H	ASTM D4024 GR 1	ASTM D4024	...
	Gasketed mechanical couplings	Ductile iron	ASTM A536	ASTM F1476	...
	Flanges: Blind, Weld Neck Slip-On, Threaded Pipe Figure 8 Blanks	CP Titanium	ASTM B381 / ASME SB381	ASME B16.5 (Dimensions only)	
	Spectacle Blinds	CP Titanium		ASME B16.5 ASME B16.48 (Dimensions only) Pipe Fitters Bluebook (Dimensions only)	
Bolting	Bolts/bolt studs	Carbon steel	ASTM A307 GR B	ASME B18.2.1	...
		CP Titanium	ASTM B348 / ASME SB348		
		2, 3, 4, 7, 12	ASTM B381 / ASME SB381		

TABLE 7 *Continued*

Item	Type/Style	Material	Material Specification ^A	Design Specification	Maximum Temperature 240°F ^B Remarks/Limitations
	Nuts	CP Titanium	ASTM A563 GR A	ASME B18.2.2	...
	Washers	2, 3, 4, 7, 12 CP Titanium	ASTM B348 / ASME SB348 ASTM B381 / ASME SB381 ASTM B265 / ASME SB265		
	Bolt/Bolt Studs	2, 3, 4, 7, 12 CP Titanium	Per Request Only: ASTM F468 (Bolts)		
	Nuts	2, 3, 4, 7, 12 CP Titanium	ASTM F467 (Nuts)		
	Plain Washers and Lock Washers	1, 2, 3, 4, 7, 11, 12 CP Titanium		ASME B18.21.1 ASME B18.22.1	
Fittings	Flanged	Carbon steel	ASTM A216/A216M GR WCB or A105/A105M	ASME B16.5	...
	Buttweld	Carbon steel	ASTM A234/A234M GR WPB	ASME B16.9 or B16.28	...
	Socket weld or threaded	Carbon steel	ASTM A234/A234M GR WPB	ASME B16.9	...
	Sleeve couplings	Carbon steel	ASTM A234/A234M GR WPB	or B16.28 ASTM F682	...
	Threaded or brazed	Bronze	ASME SB61 or SB62	MIL-F-1183	...
	Adhesive bonded	GRP ^H	Commercial	Commercial ^F	...
	Used with gasketed mechanical couplings	Ductile iron	A536	F1548	...
	Buttweld	CP Titanium	ASTM B363 / ASME SB363	ASME B16.9	
	Elbows, Tees, Caps, & Reducers	1, 2, 3, 4, 7, 12 CP Titanium		MSS SP-43 (Dimensions only)	
	Socket-Welding or Threaded Elbows, Tees, Couplings, Bushings	1, 2, 3, 4, 7, 12 CP Titanium	ASTM B381 / ASME SB381	ASME B16.11 MSS SP-97 (Dimensions only)	
	Plugs	CP Titanium	ASTM B381 / ASME SB381	ASME B16.11 (Dimensions only) MSS SP-97	
	Unions	CP Titanium	ASTM B381 / ASME SB381	MSS SP-83 (Dimensions only)	
	Nipples	CP Titanium	ASTM B861 / ASME SB861 ASTM B862 / ASME SB862	MSS SP-83 (Dimensions only)	
	Belled End Socket- Welding Elbows, Tees, Couplings, Reducers, Caps	CP Titanium	ASTM B363 / ASME SB363	MSS SP-119 (Dimensions only)	
	Threaded, Socket- Welding, and Buttwelding Outlets	CP Titanium	ASTM B381 / ASME SB381	MSS SP-97 (Dimensions only)	
Valves	Butterfly wafer or lug type	Ductile iron	ASTM A395/A395M	MSS-SP-67	Trim group 4 ^I
	Butterfly grooved end	Ductile iron	ASTM A536	...	Trim group 4 ^I
Valves: gate, globe, angle, check	Flanged	Ductile iron	ASTM A395/A395M	ASME B16.34	Trim group 4 ^I
	Flanged or buttweld	Carbon steel	ASTM A216/A216M GR WCB or A105/A105M	ASME B16.34	Trim group 3 and 4 ^I
	Socket weld	Carbon steel	ASTM A105/A105M	ASME B16.34	Trim group 3 and 4 ^I
	Threaded or brazed	Bronze	ASME SB61 or SB62	MSS-SP-80 ^J	Trim group 3 and 4 ^I
	Grooved end	Ductile iron	ASTM A536	...	Trim group 3 and 4 ^I
Valves: ball	Flanged or buttweld	Carbon steel	ASTM A216/A216M GR WCB or A105/A105M or A181/A181M	MSS-SP-72	Trim group 3 and 4 ^I

^A When combining dissimilar materials, galvanic corrosion can occur especially in seawater systems, and should be considered.

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

^C GR—grade.

^D TY—type.

^E FGP—fiberglass pipe.

^F Specific Coast Guard and ABS approval required.

^G For U.S. flag vessels in addition to classification society requirements.

^H GRP—glass reinforced plastic.

^I For trim group definition, refer to **Table 28**.

^J 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 ^A	Design Specification	Maximum Temperature 240°F ^B Remarks/Limitations	
Pipe	Seamless	Copper	ASTM B88 TY ^C K or L	ASTM B88	Hard drawn. Must be annealed for pressures greater than 225 psig. See Table 1 and NVIC 11-86 ^G . See Table 1 and NVIC 11-86 ^G .	
	Filament wound	FGP ^D	ASTM D2996 GR ^E 1	Commercial ^F		
	Centrifugally cast	FGP ^D	ASTM D2997 GR 1	Commercial ^F		
	Seamless or electric Resistance welded	CP Titanium Grade 2	ASTM B861 / ASME SB861 ASTM B862 / ASME SB862			
Takedown joints	Flanges: silbraze	Bronze	ASME SB862	ASME B16.24	...	
	Unions: brazed or threaded	Bronze	ASME SB861 or SB862	MIL-F-1183	...	
	Flanges: adhesive bonded	GRP ^H	ASTM D4024 GR 1	ASTM D4024	...	
	Gasketed mechanical couplings	Ductile iron ^I	ASTM A536	ASTM F1476	...	
	Flanges: Blind, Weld Neck Slip-On, Threaded Pipe Figure 8 Blanks	CP Titanium	ASTM B381 / ASME SB381	ASME B16.5 (Dimensions only)		
		CP Titanium		ASME B16.5 ASME B16.48 (Dimensions only) Pipe Fitters Bluebook (Dimensions only)		
	Spectacle Blinds	CP Titanium				
Bolting	Bolts/bolt studs	Carbon steel	ASTM A307 GR B	ASME B18.2.1	...	
	Nuts	Carbon steel	ASTM A563 GR A	ASME B18.2.2	...	
	Bolts/Bolt Studs	CP Titanium	ASTM B348 / ASME SB348			
	Nuts	2, 3, 4, 7, 12	CP Titanium	ASTM B381 / ASME SB381		
		2, 3, 4, 7, 12	CP Titanium	ASTM B348 / ASME SB348		
	Washers	2, 3, 4, 7, 12	CP Titanium	ASTM B381 / ASME SB381		
		1, 2, 3, 4, 7, 11, 12	CP Titanium	ASTM B265 / ASME SB265		
	Bolts/Bolt Studs	CP Titanium	Per Request only: ASTM F468 (Bolts)			
	Nuts	CP Titanium	ASTM F467 (Nuts)			
	Plain Washers & Lock Washers	CP Titanium		ASME B18.21.1 ASME B18.22.1		
Fittings	Silbraze	Copper	ASME SB88 TY K or L	ASME B16.22	...	
	Adhesive bonded	GRP ^H	Commercial	Commercial ^F	...	
	Used with gasketed mechanical couplings	Bronze	ASTM B61 or B62	ASTM F1476	...	
	Buttweld Elbows, Tees, Caps, & Reducers	CP Titanium	ASTM B363 / ASME SB363	ASME B16.9 MSS SP-43 (Dimensions only)		
	Socket-Welding or Threaded Elbows, Tees Couplings, Bushings (Dimensions only)	CP Titanium	ASTM B381 / ASME SB381	ASME B16.11 MSS SP-97		
	Plugs	CP Titanium	ASTM B381 / ASME SB381	ASME B16.11 MSS SP-97 (Dimensions only)		
	Unions	CP Titanium	ASTM B381 / ASME SB381	MSS SP-83 (Dimensions only)		
	Nipples	CP Titanium	ASTM B861 / ASME SB861 ASTM B862 / ASME SB862	MSS SP-83 (Dimensions only)		
	Belled End Socket-Welding Elbows, Tees, Couplings, Reducers, Caps	CP Titanium	ASTM B363 / ASME SB363	MSS SP-119 (Dimensions only)		
	Threaded, Socket-Welding, and Buttwelding Outlets	CP Titanium	ASTM B381 / ASME SB381	MSS SP-97 (Dimensions only)		
	Valves	Butterfly wafer or lug	Ductile iron	ASTM A395/A395M	MSS-SP-67	Trim group 4 ^J
		Butterfly grooved end	Bronze	ASTM B61 or B62	...	Trim group 4 ^J

TABLE 8 *Continued*

Item	Type/Style	Material	Material Specification ^A	Design Specification	Maximum Temperature 240°F ^B Remarks/Limitations
Valves: gate, globe, angle, check	Flanged or brazed	Bronze	ASME SB61 or SB62	MSS-SP-80 ^K	Trim group 4 ^J
Valves: ball	Flanged	Bronze	ASME SB61 or SB62	MSS-SP-72	Trim group 4 ^J

^A When combining dissimilar materials galvanic corrosion can occur, especially in seawater systems, and should be considered.

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

^C TY—type.

^D FGP—fiberglass pipe.

^E GR—grade.

^F Specific Coast Guard and ABS approval required.

^G For U.S. flag vessels in addition to classification society requirements.

^H GRP—glass reinforced plastic.

^I Acceptable when gasket isolates coupling housings from fluid.

^J For trim group definition, refer to **Table 28**.

^K 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 ^A	Design Specification	Maximum Temperature 150°F ^B Remarks/Limitations
Pipe	Seamless or welded	CNA ^C 90:10	ASME SB466 or SB467	ASME SB466 or SB467	
	Filament wound	FGP ^D	ASTM D2996 GR ^E 1	Commercial ^F	See NVIC 11-86 ^G
	Centrifugally cast	FGP ^D	ASTM D2997 GR 1	Commercial ^F	See NVIC 11-86 ^G
	Seamless or electric Resistance welded	CP Titanium Grade 2	ASTM B861 / ASME SB861 ASTM B862 / ASME SB862		
Takedown joints	Flanges: brazed	Bronze	ASME SB62	ASME B16.24	...
	Unions: brazed	Bronze	ASME SB61 or SB62	MIL-F-1183	...
	Flanges: adhesive bonded	GRP ^H	ASTM D4024 GR 1	ASTM D4024	...
	Gasketed mechanical couplings	Ductile iron ^I	ASTM A536	ASTM F1476	...
	Flanges: Blind, Weld Neck Slip-On, Threaded Pipe Figure 8 Blanks	CP Titanium	ASTM B381 / ASME SB381	ASME B16.5 (Dimensions only)	
		CP Titanium		ASME B16.5 ASME B16.48 (Dimensions only)	
	Spectacle Blinds	CP Titanium		Pipe Fitters Bluebook (Dimensions only)	
Bolting	Bolts/bolt studs	Carbon steel	ASTM A307 GR B	ASME B18.2.1	...
	Nuts	Carbon steel	ASTM A563 GR A	ASME B18.2.2	...
	Bolts/Bolt Studs	CP Titanium	ASTM B348 / ASME SB348		
		2, 3, 4, 7, 12	CP Titanium	ASTM B381 / ASME SB381	
	Nuts	CP Titanium	ASTM B348 / ASME SB348		
		2, 3, 4, 7, 12	CP Titanium	ASTM B381 / ASME SB381	
	Washers	CP Titanium	ASTM B265 / ASME SB265		
		1, 2, 3, 4, 7, 11, 12		Per Request only: ASTM F468 (Bolts)	
	Bolts/Bolt Studs	CP Titanium	2, 3, 4, 7, 12		
	Nuts	CP Titanium	2, 3, 4, 7, 12	ASTM F467 (Nuts)	
Plain Washers & Lock Washers	CP Titanium	1, 2, 3, 4, 7, 12		ASME B18.21.1 ASME B18.22.1	
Fittings	Flanged	Bronze	ASME SB61 or SB62	ASME 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 ^H	Commercial	Commercial ^F	...
	Used with gasketed mechanical couplings	Bronze	ASTM B61 or B62	ASTM F1548	...
		CNA	ASTM B466/B466M or B467	ASTM F1548	...
	Buttweld Elbows, Tees, Caps, & Reducers	CP Titanium	ASTM B363 / ASME SB363	ASME B16.9 MSS SP-43 (Dimensions only)	
	Socket-Welding or Threaded Elbows, Tees	CP Titanium	ASTM B381 / ASME SB381	ASME B16.11 MSS SP-97	
		CP Titanium	1, 2, 3, 4, 7, 12		