



Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification² covers wrought carbon steel and alloy steel fittings of seamless and welded construction covered by the latest revision of ANSI B16.9, ANSI B16.11, ANSI B16.28, MSS SP-79, and MSS SP-95. These fittings are for use in pressure piping and in pressure vessel fabrication for service at moderate and elevated temperatures. Fittings differing from these ANSI and MSS standards shall be furnished in accordance with Supplementary Requirement S9.

1.2 Optional supplementary requirements are provided for fittings where a greater degree of examination is desired. When desired, one or more of these supplementary requirements may be specified in the order.

1.3 This specification does not cover cast welding fittings or fittings machined from castings. Cast steel welding fittings are governed by Specifications A 216/A 216M and A 217/A 217M.

1.4 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished to inch-pound units.

1.5 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 ASTM Standards:

A 216/A 216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service³

A 217/A 217M Specification for Steel Castings, Martensi-

tic Stainless and Alloy, for Pressure-Containing Parts Suitable for High-Temperature Service³

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products⁴

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products⁴

E 165 Practice for Liquid Penetrant Inspection Method⁵

E 709 Practice for Magnetic Particle Examination⁵

2.2 ANSI Standards:⁶

B16.9 Steel Butt-Welding Fittings

B16.11 Forged Steel Fittings, Socket Welding and Threaded

B16.28 Wrought Steel Butt-Welding Short Radius Elbows and Returns

2.3 ASME Boiler and Pressure Vessel Code:⁷

Section V Nondestructive Examination

Section VIII, Division 1, Pressure Vessels

Section IX Welding Qualifications

2.4 MSS Standards:⁸

MSS SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions

MSS SP-79 Socket Welding Reducer Inserts

MSS SP-95 Swage(d) Nipples and Bull Plugs

2.5 ASNT Standard:

SNT-TC-1A(1984) Recommended Practice for Nondestructive Testing Personnel Qualification and Certification⁹

3. Ordering Information

3.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to purchase the needed material. Examples of such information include but are not limited to the following:

3.1.1 Quantity,

3.1.2 Description of fitting and nominal dimensions (standard or special),

⁴ Annual Book of ASTM Standards, Vol 01.03.

⁵ Annual Book of ASTM Standards, Vol 03.03.

⁶ Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

⁷ Available from American Society of Mechanical Engineers, 345 E. 47th St. New York, NY 10017.

⁸ Available from Manufacturers Standardization Society of the Valve and Fittings Industry, 1815 N. Fort Myer Drive, Arlington, VA 22209.

⁹ Available from American Society for Nondestructive Testing, 4153 Arlingate Plaza, Columbus, OH 43228-0518.

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Steel Forgings and Wrought Fittings for Piping Applications and Bolting Materials for Piping and Special Purpose Applications.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-234 in Section II of that Code.

³ Annual Book of ASTM Standards, Vol 01.02.

3.1.3 Steel composition by grade and class designation,
 3.1.4 Construction, seamless or welded (unless seamless or welded construction is specified by the purchaser either may be furnished at the option of the supplier),
 3.1.5 Specification number (the year date should be included),
 3.1.6 Supplementary requirements, and
 3.1.7 Additional requirements, if any, (see 4.1, 6.5, 14.2, and 16.1).

4. Materials

4.1 The material for fittings shall consist of killed steel, forgings, bars, plates, seamless or fusion-welded tubular products with filler metal added and shall conform to the chemical requirements of Table 1. Unless otherwise specified for carbon steel plates, the steel may be made to either coarse grain or fine grain practice.

4.2 A starting material specification that specifically requires the addition of any element beyond those listed for the materials in Table 1 and Table 2 for the applicable grade of material is not permitted. This does not preclude the use of deoxidizers or the judicious use of elements for grain size control.

5. Manufacture

5.1 Forging or shaping operations may be performed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion welding, machining, or by a combination of two or more of these operations. The forming procedure shall be so applied that it will not produce injurious imperfections in the fittings.

5.2 Fittings machined from bar shall be restricted to NPS 4 or smaller. Elbows, return bends, tees, and header tees shall not be machined directly from bar stock.

NOTE 1—Fittings NPS-4 and under may be machined from hot-forged or rolled, cold-sized, and straightened bar stock having the chemical composition of the Grade in Table 1 and the mechanical properties of the Grade in Table 2. Heat treatment shall be in accordance with Section 6. All caps machined from bar stock shall be examined by liquid penetrant or magnetic particle in accordance with S3 or S4.

5.3 All welds including welds in tubular products from which fittings are made shall be (1) made by welders, welding operators, and welding procedures qualified under the provisions of ASME Section IX, (2) heat treated in accordance with Section 6 of this specification, and (3) radiographically examined throughout the entire length of each weld in accordance with Article 2, ASME Section V with acceptance limits in accordance with Paragraph UW-51 of ASME Section VIII, Division 1 of the ASME Boiler & Pressure Vessel Code. In place of radiographic examination, welds may be ultrasonically examined in accordance with Appendix 12 of Section VIII. The NDE of welds in Grades WPB, WPC, WP1, WP11 Class 1, WP11 Class 2, WP11 Class 3, WP12 Class 1, WP12 Class 2, and WPR may be performed either prior to or after forming. NDE of welds in Grades WP5, WP9, WP91, WP22 Class 1, and WP22 Class 3 shall be done after forming.

5.4 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

5.5 The welded joints of the fittings shall be finished in accordance with the requirements of Paragraph UW-35 (a) of ASME Section VIII, Division 1.

TABLE 1 Chemical Requirements

NOTE 1—All requirements are maximum unless otherwise indicated.

NOTE 2—Where an ellipsis (...) appears in this table, there is no requirement.

Grade and Marking Symbol ^A	Composition, %									
	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon	Chromium	Molybdenum	Nickel	Copper	Others
WPB ^{B,C,D,E,F}	0.30 max	0.29–1.06	0.050	0.058	0.10 min	0.40 max	0.15 max	0.40 max	0.40 max	Vanadium 0.08 max Columbium 0.02 max Vanadium 0.08 max Columbium 0.02 max
WPC ^{C,D,E,F}	0.35 max	0.29–1.06	0.050	0.058	0.10 min	0.40 max	0.15 max	0.40 max	0.40 max	
WP1	0.28 max	0.30–0.90	0.045	0.045	0.10–0.50	...	0.44–0.65	...	...	...
WP12 CL1, WP12 CL2	0.05–0.20	0.30–0.80	0.045	0.045	0.60 max	0.80–1.25	0.44–0.65	...	...	...
WP11 CL1	0.05–0.15	0.30–0.60	0.030	0.030	0.50–1.00	1.00–1.50	0.44–0.65	...	...	...
WP11 CL2, WP11 CL3	0.05–0.20	0.30–0.80	0.040	0.040	0.50–1.00	1.00–1.50	0.44–0.65	...	...	...
WP22 CL1, WP22 CL3	0.05–0.15	0.30–0.60	0.040	0.040	0.50 max	1.90–2.60	0.87–1.13	...	...	...
WP5	0.15 max	0.30–0.60	0.040	0.030	0.50 max	4.0–6.0	0.44–0.65	...	...	...
WP9	0.15 max	0.30–0.60	0.030	0.030	0.25–1.00	8.0–10.0	0.90–1.10	...	...	...
WPR	0.20 max	0.40–1.06	0.045	0.050	...	...	...	1.60–2.24	0.75–1.25	...
WP91	0.08–0.12	0.30–0.60	0.020	0.010	0.20–0.50	8.0–9.5	0.85–1.05	0.40 max	...	Vanadium 0.18–0.25 Columbium 0.06–0.10 Nitrogen 0.03–0.07 Aluminum 0.04 max

^A When fittings are of welded construction, the grade and marking symbol shown above shall be supplemented by letter "W".

^B Fittings made from bar or plate may have 0.35 max carbon.

^C Fittings made from forgings may have 0.35 max carbon and 0.35 max silicon with no minimum.

^D For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted, up to a maximum of 1.35 %.

^E The sum of Copper, Nickel, Chromium, and Molybdenum shall not exceed 1.00 %.

^F The sum of Chromium and Molybdenum shall not exceed 0.32 %.

TABLE 2 Tensile Requirements

NOTE 1—Where an ellipsis (...) appears in this table, there is no requirement.

Grade and Marking Symbol	WPB	WPC, WP11 CL2, WP12 CL2	WP1	WP11 CL1, WP22 CL1, WP5, WP9	WPR	WP11 CL3, WP22 CL3	WP91	WP12 CL1
Tensile strength, range ksi [MPa]	60–85 [415–585]	70–95 [485–655]	55–80 [380–550]	60–85 [415–585]	63–88 [435–605]	75–100 [520–690]	85–110 [585–760]	60–85 [415–585]
Yield strength, min, ksi [MPa] (0.2 % offset or 0.5 % extension-under-load)	35 [240]	40 [275]	30 [205]	30 [205]	46 [315]	45 [310]	60 [415]	32 [220]

Elongation Requirements						
Grades						
All Grades except WPR and WP91		WPR		WP91		
Longi- tudinal	Trans- verse	Longi- tudinal	Trans- verse	Longi- tudinal	Trans- verse	
Elongation:						
Standard round specimen, or small proportional specimen, min % in 4 D		22	14	20	...	20
Rectangular specimen for wall thickness $\frac{5}{16}$ in. [7.94 mm] and over, and for all small sizes tested in full section; min % in 2 in. [50 mm]		30	20 ^A	28	...	...
Rectangular specimen for wall thickness less than $\frac{5}{16}$ in. [7.94 mm]; min % in 2 in. [50 mm] ($\frac{1}{2}$ -in. [12.7-mm] wide specimen)		B	B	B	...	...

^A WPB and WPC fittings manufactured from plate shall have a minimum elongation of 17 %.

^B For each $\frac{1}{32}$ in. [0.79 mm] decrease in wall thickness below $\frac{5}{16}$ in. [7.94 mm], a deduction of 1.5 % for longitudinal and 1.0 % for transverse from the values shown above is permitted. The following table gives the minimum value for various wall thicknesses.

Wall Thickness		Grades			
		All Grades except WPR		WPR	
in.	[mm]	Longitudinal	Transverse	Longitudinal	Transverse
$\frac{5}{16}$ (0.312)	7.94	30.0	20.0	28.0	...
$\frac{9}{32}$ (0.281)	7.14	28.5	19.0	26.5	...
$\frac{1}{4}$ (0.250)	6.35	27.0	18.0	25.0	...
$\frac{7}{32}$ (0.219)	5.56	25.5	...	23.5	...
$\frac{3}{16}$ (0.188)	4.76	24.0	...	22.0	...
$\frac{5}{32}$ (0.156)	3.97	22.5	...	20.5	...
$\frac{1}{8}$ (0.125)	3.17	21.0	...	19.0	...
$\frac{3}{32}$ (0.094)	2.38	19.5	...	17.5	...
$\frac{1}{16}$ (0.062)	1.59	18.0	...	16.0	...

NOTE—This table gives the computed minimum % elongation value for each $1/32$ in. [0.79 mm] decrease in wall thickness. Where the wall thickness lies between two values above, the minimum elongation value is determined by the following equations:

Direction of Test

Longitudinal
Transverse

Equation

$$E = 48t + 15.00$$

$$E = 32t + 10.00$$

where:

E = elongation in 2 in. or [50 mm], %, and
 t = actual thickness of specimen, in. [mm].

5.6 All butt-weld tees manufactured by cold-forming method(s) shall be liquid penetrant or magnetic particle examined by one of the methods specified in Supplementary Requirement S3 or S4. This examination shall be performed after final heat treat. Only the side wall area of the tees need be examined. This area is defined by a circle that covers the area from the weld bevel of the branch outlet to the center line of the body or run. Internal and external surfaces shall be examined when size permits accessibility. No cracks shall be permitted. Other imperfections shall be treated in accordance with Section 12 on Surface Quality. After the removal of any crack, the tee(s) shall be re-examined by the original method. Acceptable

tees shall be marked with the symbol PT or MT, as applicable, to indicate compliance.

6. Heat Treatment

6.1 *Heat Treatment Procedures*—Fittings, after forming at an elevated temperature, shall be cooled to a temperature below the critical range under suitable conditions to prevent injuries by too rapid cooling, but in no case more rapidly than the cooling rate in still air. Heat-treated fittings shall be treated according to the following procedures:

NOTE 2—Heat treatment temperatures shall be in Fahrenheit temperatures.