

ASTM - A234/A234M

SPECIFICATION FOR PIPING FITTINGS OF WROUGHT CARBON STEEL AND ALLOY STEEL FOR MODERATE AND HIGH-TEMPERATURE SERVICE

This specification covers wrought carbon steel and alloy steel fittings of seamless and welded construction covered by the latest revision of ASME B16.9, B16.11, MSS-SP-79, MSS-SP-83, and MSS-SP-95.

These fittings are for use in pressure piping and in pressure vessel fabrication for service at moderate and elevated temperatures.

A. Heat Treatment :-

1. Heat-treated fittings shall be treated according to paragraph 7 in Specification A 960/A 960M.
2. WPB, WPC, and WPR Fittings:
 - i. Hot-formed WPB, WPC, and WPR fittings upon which the final forming operation is completed at a temperature above 1150°F [620°C] and below 1800°F [980°C] need not be heat treated provided they are cooled in still air.
 - ii. Hot-formed or forged WPB, WPC, and WPR fittings finished at temperature in excess of 1800°F [980°C] shall subsequently be annealed, normalized, or normalized and tempered. Hotformed fittings NPS 4 or smaller need not be heat treated.
 - iii. WPB, WPC, and WPR fittings over NPS 12, produced by locally heating a portion of the fitting stock to any temperature for forming, shall be subsequently annealed, normalized, or normalized and tempered.
 - iv. Fittings such as elbows, tees, header tees, reducers and lap joint stub ends with a carbon content less than 0.26%, NPS 12 and under, shall not require heat treatment after forming a locally heated portion of the fitting.
 - v. Cold-formed WPB, WPC, and WPR fittings, upon which the final forming operation is completed at a temperature below 1150°F [620°C], shall be normalized, or shall be stress relieved at 1100 to 1275°F [595 to 690°C].
 - vi. WPB, WPC, and WPR fittings produced by fusion welding and having a nominal wall thickness at the welded joint of 3/4 in. [19 mm] or greater shall be post weld heat treated at 1100 to 1250°F [595 to 675°C].
3. Fittings Other than WPB, WPC, and WPR:
 - i. Fittings of Grades WP1, WP11 Class 1, WP11 Class 2, WP11 Class 3, WP12 Class 1, WP12 Class 2, WP22 Class 1, WP22 Class 3, WP5, and WP9 shall be furnished in the full-annealed, isothermal-annealed, or normalized and tempered condition. If normalized and tempered, the tempering temperature for WP11 Class 1, WP11 Class 2, WP11 Class 3, WP12 Class 1, and WP12 Class 2 shall not be less than 1150°F [620°C]; for Grades WP5, WP9, WP22 Class 1, and WP22 Class 3 the tempering temperature shall not be less than 1250°F [675°C].
 - ii. Fittings of Grades WP1, WP12 Class 1, or WP12 Class 2 either hot formed or cold formed may be given a final heat treatment at 1200°F [650°C] instead of the heat treatment specified in point A.3.i.
 - iii. Fittings in all thicknesses produced by fusion welding after the heat treatment specified in point A.3.i shall be post-weld heat treated at a temperature not less than prescribed above for tempering except that Grade WP1 is required to be post-weld heat treated only when the nominal wall thickness at the welded joint is 1/2 in. [13 mm] or greater.
 - iv. Except when Supplementary Requirement 'F.1' is specified by the purchaser, Grade WP91 shall be normalized at 1900°F [1040°C] minimum, and 1975°F [1080°C] maximum, and tempered in the temperature range of 1350°F [730°C] to 1470°F [800°C] as a final heat treatment.
 - v. Grade WP911 shall be normalized in the temperature range of 1900 to 1975°F [1040 to 1080°C], and tempered in the temperature range of 1365 to 1435°F [740 to 780°C] as a final heat treatment.
4. WPB and WPC Fittings Made from Bar:

- i. Cold finished bars reduced in cross-sectional area more than 10% by cold drawing or cold rolling are not acceptable for use in the manufacture of these fittings unless the bars have been either stress relieved in the temperature range of 1100 to 1250°F [595 to 675°C], normalized, normalized and tempered, or fully annealed.
5. Liquid quenching followed by tempering shall be permitted for all grades when approved by the purchaser. Minimum tempering temperature shall be 1100°F [595°C] for WPB, WPC, and WPR, 1150°F [620°C] for Grades WP1, WP11 Class 1, WP11 Class 2, WP11 Class 3, WP 12 Class 1, and WP12 Class 2 and 1250°F [675°C] for Grades WP5, WP9, WP22 Class 1, and WP22 Class 3, and 1350°F [730°C] for Grade WP91 and WP911.

B. Chemical Composition :-

The chemical composition for the respective materials listed in Table 1.

Table 1

Grade and Marking Symbol ^A	C	Mn	P, max	S, max	Si	Cr, max	Mo	Ni, max	Other Elements
WPB ^{B,C,D,E,F}	0.30 max	0.29–1.06	0.05	0.058	0.10 min	0.4	0.15 max	0.4	V [0.08 max], Cu [0.4 max]
WPC ^{C,D,E,F}	0.35 max	0.29–1.06	0.05	0.058	0.10 min	0.4	0.15 max	0.4	V [0.08 max], Cu [0.4 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	0.03	0.03	0.50–1.00	1.00–1.50	0.44–0.65	...	...
WP11 CL2, WP11 CL3	0.05–0.20	0.30–0.80	0.04	0.04	0.50–1.00	1.00–1.50	0.44–0.65	...	...
WP22 CL1, WP22 CL3	0.05–0.15	0.30–0.60	0.04	0.04	0.50 max	1.90–2.60	0.87–1.13	...	...
WP5 CL1, WP5 CL3	0.15 max	0.30–0.60	0.04	0.03	0.50 max	4.0–6.0	0.44–0.65	...	...
WP9 CL1, WP9 CL3	0.15 max	0.30–0.60	0.03	0.03	1.00 max	8.0–10.0	0.90–1.10	...	...
WPR	0.20 max	0.40–1.06	0.045	0.05	...	...	...	1.60–2.24	Cu [0.75-1.25]
WP91	0.08–0.12	0.30–0.60	0.02	0.01	0.20–0.50	8.0–9.5	0.85–1.05	0.4	V [0.18–0.25], Cb [0.06–0.10], N [0.03–0.07], Al [0.02 max] ^G , Ti [0.01 max] ^G , Zr [0.01 max] ^G
WP911	0.09–0.13	0.30–0.60	0.02	0.01	0.10–0.50	8.5–9.5	0.90–1.10	0.4	V [0.18–0.25], Cb [0.06–0.10], N [0.04–0.09], Al [0.02 max] ^G , Ti [0.01 max] ^G , Zr [0.01 max] ^G , B [0.0003–0.006], W [0.90–1.10]

NOTE 1 — All requirements are maximum unless otherwise indicated.

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

^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%. ^G Applies both to heat and product analyses.

C. Tensile Requirements :-

1. The tensile properties of the fitting material shall conform to the requirements listed in Table 2.
2. While Table 3 specifies elongation requirements for both longitudinal and transverse specimens.

Table 2

Grade and Marking Symbol	WPB	WPC, WP11 CL2, WP12 CL2	WP1	WP11 CL1, WP22 CL1, WP5 CL1, WP9 CL1	WPR	WP11 CL3, WP22 CL3, WP5 CL3, WP9 CL3	WP91	WP911	WP12 CL1
Tensile strength range, ksi [MPa]	60–95 [415–655]	70–95 [485–655]	55–80 [380–550]	60–85 [415–585]	63–88 [435–605]	75–100 [520–690]	85–110 [585–760]	90–120 [620–840]	60–85 [415–585]
Yield strength, min, ksi [MPa] (0.2% offset or 0.5% extension underload)	35 [240]	40 [275]	30 [205]	30 [205]	46 [315]	45 [310]	60 [415]	64 [440]	32 [220]

Table 3

	Elongation Requirements					
	All Grades except WPR, WP91, and WP911		WPR		WP91, WP911	
	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
Standard round specimen, or small proportional specimen, min % in 4 D	22	14	20	...	20	...
Rectangular specimen for wall thickness 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 5/16 in. [7.94 mm]; min % in 2 in. [50 mm] (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 1/32 in. [0.79 mm] decrease in wall thickness below 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, WP91, and WP911		WPR	WP91, WP911
in.	mm.	Longitudinal	Transverse	Longitudinal	Longitudinal
5/16 (0.312)	7.94	30	20	28	20
9/32 (0.281)	7.14	28.5	19	26.5	19
1/4 (0.250)	6.35	27	18	25	18
7/32 (0.219)	5.56	25.5	...	23.5	17
3/16 (0.188)	4.76	24	...	22	16
5/32 (0.156)	3.97	22.5	...	20.5	15
1/8 (0.125)	3.17	21	...	19	14
3/32 (0.094)	2.38	19.5	...	17.5	13
1/16 (0.062)	1.59	18	...	16	12

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	Equation
Longitudinal	$E = 48t + 15.00$
Transverse	$E = 32t + 10.00$

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

D. Hardness :-

1. Fittings shall be capable of meeting the following hardness requirements, if tested:

Grades	HB
WP5, WP9, and WPR and WP911	217 max. WP91 248 max.
all other grades	197 max.

E. Hydrostatic Tests :- See Specification A 960/A 960M.

F. Supplementary Requirements :-

1. Alternative Heat Treatment :- Grade WP91

- Grade WP91 shall be normalized in accordance with 7 and tempered at a temperature, to be specified by the purchaser, less than 1350°F [730°C]. It shall be the purchaser's responsibility to subsequently temper the entire fitting in the temperature range of 1350°F [730°C] to 1470°F [800°C] as a final heat treatment.

2. Restricted Vanadium Content :-

- The vanadium content of the fittings shall not exceed 0.03%.

3. Carbon Equivalent :-

□ For grades WPB and WPC, the maximum carbon equivalent (C.E.), based on heat analysis and the following formula, shall be 0.50.

$$C.E. = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

- A lower maximum carbon equivalent may be agreed upon between the purchaser and the supplier.

Keyword

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