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Usedin USDOE-NE Standards

Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service[1]

This standard is issued under the fixed designation A234/A234M; 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.

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

ε[1] NOTE—Table 2 editorially corrected in January 2014.

1. Scope*

1.1 This specification[2] 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, MSS-SP-95, and MSS-SP-97. These fittings are for use in pressure piping and in pressure vessel fabrication for service at moderate and elevated temperatures. Fittings differing from these ASME and MSS standards shall be furnished in accordance with Supplementary Requirement S58 of Specification A960/A960M.

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 A216/A216M and A217/A217M.

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

2. Referenced Documents

2.1 In addition to those reference documents listed in Specification A960/A960M, the following list of standards apply to this specification.

2.2 *ASTM Standards:*[3]

A216/A216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

A217/A217M Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service

A960/A960M Specification for Common Requirements for Wrought Steel Piping Fittings

2.3 *ASME Standards:*[4]

B16.9 Steel Butt-Welding Fittings

B16.11 Forged Steel Fittings, Socket Welding and Threaded

2.4 *ASME Boiler and Pressure Vessel Code:*[4]

Section V

Section VIII, Division 1

Section IX

2.5 *MSS Standards:*[5]

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

MSS-SP-79 Socket Welding Reducer Inserts

MSS-SP-83 Steel Pipe Unions, Socket-Welding and Threaded

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

MSS-SP-97 Integrally Reinforced Forged Branch Outlet Fittings—Socket Welding, Threaded and Buttwelding Ends

[1] This specification is under the jurisdiction of ASTM Committee A01 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] 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.

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

[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.com.

***A Summary of Changes section appears at the end of this standard**

2.6 *ASNT Standard:*[6]
SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel Qualification and Certification
2.7 *AWS Specifications*[7]
A5.5/A5.5M Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
A5.23/A5.23M Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
A5.28/A5.28M Specification for Low-Alloy Steel Electrodes for Gas Shielded Arc Welding
A5.29/A5.29M Low-Alloy Steel Electrodes for Flux Cored Arc Welding

3. Ordering Information

3.1 See Specification A960/A960M.

4. General Requirements

4.1 Product furnished to this specification shall conform to the requirements of Specification A960/A960M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the requirements of Specification A960/A960M constitutes non-conformance with this specification. In case of a conflict between the requirements of this specification and Specification A960/A960M, this specification shall prevail.

5. Materials

5.1 The material for fittings shall consist of killed steel, forgings, bars, plates, sheet, and 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 and sheet, the steel may be made to either coarse grain or fine grain practice. Grade WP9 shall be made to fine grain practice.

5.2 A starting material specification that specifically requires the addition of any element beyond those listed for the materials in Table 1 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.

6. Manufacture

6.1 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.

6.2 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 7. All caps machined from bar stock shall be examined by liquid penetrant or magnetic particle in accordance with S52 or S53 in Specification A960/A960M.

6.3 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 7 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, WP911, WP92, WP22 Class 1, WP22 Class 3, and WP24 shall be done after forming.

6.3.1 All welds in WP91 shall be made with one of the following welding processes and consumables: SMAW, A5.5/A5.5M E90XX-B9; SAW, A5.23/A5.23M EB9 + flux; GTAW, A5.28/A5.28M ER90S-B9; and FCAW A5.29/A5.29M E91T1-B9. In addition, the Ni+Mn content of all welding consumables used to fabricate WP91 fittings shall not exceed 1.0 %.

6.3.2 All welds in WP92 and WP911 shall be made using welding consumables meeting the chemical requirements for the grade in Table 1.

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

6.5 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.

6.6 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 S52 or S53 in Specification A960/A960M. 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 14 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.

6.7 Stubends may be produced with the entire lap added by the welding of a ring, made from plate or bar of the same alloy grade and composition, to the outside of a straight section of pipe, provided the weld is double welded, is a full penetration joint, satisfies the requirements of 6.3 for qualifications and 7.3.4 for post weld heat treatment.

7. Heat Treatment

7.1 *Heat Treatment Procedures*—Fittings, after forming at an elevated temperature, shall be cooled to a temperature

[6] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.
[7] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

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 and analysis for the element need not be determined or reported.

Grade and Marking Symbol[A]	Composition, %									
	Carbon	Manganese	Phospho-rus	Sulfur	Silicon	Chromium	Molybdenum	Nickel	Copper	Others
WPB[B,C,D,E,]	0.30	0.29–1.06	0.050	0.058	0.10 min	0.40	0.15 max	0.40	0.40	Vanadium 0.08
WPC[C,D,E,]	0.35	0.29–1.06	0.050	0.058	0.10 min	0.40	0.15 max	0.40	0.40	Vanadium 0.08
WP1	0.28	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	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	1.90–2.60	0.87–1.13	. . .	. . .	. . . . . .
WP24	0.05–0.10	0.30–0.70	0.020	0.010	0.15–0.45	2.20–2.60	0.90–1.10	. . .	0.75–1.25	Aluminum 0.020 Boron 0.0015–0.0070 Nitrogen 0.12 Titanium 0.06–0.10 Vanadium 0.20–0.30
WP5 CL1, WP5 CL3	0.15	0.30–0.60	0.040	0.030	0.50	4.0–6.0	0.44–0.65	. . .	. . .	. . . . . .
WP9 CL1, WP9 CL3	0.15	0.30–0.60	0.030	0.030	1.00	8.0–10.0	0.90–1.10	. . .	. . .	. . .
WPR	0.20	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	. . .	Vanadium 0.18–0.25 Columbium 0.06–0.10 Nitrogen 0.03–0.07 Aluminum 0.02[F] Titanium 0.01[F] Zirconium 0.01[F]
WP911	0.09–0.13	0.30–0.60	0.020	0.010	0.10–0.50	8.5–9.5	0.90–1.10	0.40	. . .	Vanadium 0.18–0.25 Columbium 0.060–0.10 Nitrogen 0.04–0.09 Aluminum 0.02 max[F] Boron 0.0003–0.006 Tungsten 0.90–1.10 Titanium 0.01 max[F] Zirconium 0.01 max[F]
WP92	0.07–0.13	0.30–0.60	0.020	0.010	0.50	8.50–9.50	0.30–0.60	0.40	. . .	Aluminum 0.02[F] Boron 0.001–0.006 Columbium 0.04–0.09 Nitrogen 0.030–0.070 Titanium 0.01[F] Tungsten 1.50–2.00 Vanadium 0.15–0.25 Zirconium 0.01[F]

[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 1.65 %.
[E] The sum of Copper, Nickel, Chromium, and Molybdenum shall not exceed 1.00 %.
[F] Applies both to heat and product analyses.

below the critical range under suitable conditions to prevent injurious defects caused by too rapid cooling, but in no case more rapidly than the cooling rate in still air. Heat treatment temperatures specified are metal (part) temperatures. Heat-treated fittings shall be treated according to paragraph 7 in Specification A960/A960M.

7.2 *WPB, WPC, and WPR Fittings :*

7.2.1 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.

7.2.2 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. Hot-forged fittings NPS 4 or smaller need not be heat treated.

7.2.3 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. Fittings such as elbows, tees, header tees, reducers and lap joint stub ends with

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 CL1 WP9 CL1	WPR	WP11 CL3, WP22 CL3 WP5 CL3 WP9 CL3	WP24	WP91	WP92 WP911	WP12 CL1
Tensile strength, minimum unless a range is given ksi [MPa]	60 [415]	70 [485]	55–80 [380–550]	60 [415]	63–88 [435–605]	75 [520]	85 [585]	90 [620]	90–120 [620–840]	60 [415]
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]	60 [415]	64 [440]	32 [220]

	Elongation Requirements					
	Grades					
	All Grades except WPR, WP91, and WP911		WPR and WP24		WP91 WP92 WP911	
	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	13
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] (½-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, WP92, and WP911
in.		[mm]	Longitudinal	Transverse	Longitudinal	Longitudinal
5⁄16	(0.312)	7.94	30.0	20.0	28.0	20
9⁄32	(0.281)	7.14	28.5	19.0	26.5	19
1⁄4	(0.250)	6.35	27.0	18.0	25.0	18
7⁄32	(0.219)	5.56	25.5	. . .	23.5	17
3⁄16	(0.188)	4.76	24.0	. . .	22.0	16
5⁄32	(0.156)	3.97	22.5	. . .	20.5	15
1⁄8	(0.125)	3.17	21.0	. . .	19.0	14
3⁄32	(0.094)	2.38	19.5	. . .	17.5	13
1⁄16	(0.062)	1.59	18.0	. . .	16.0	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].