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Used in 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.

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.

1.6 *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 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]

A105/A105M Specification for Carbon Steel Forgings for Piping Applications

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 III

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

[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**

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

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. Terminology

3.1 *Definitions*—For definitions of terms used in this specification refer to Specification A960/A960M.

4. Ordering Information

4.1 See Specification A960/A960M.

5. General Requirements

5.1 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.

6. Materials

6.1 The starting material for fittings shall be killed steel, consisting of 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.

6.2 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.

7. Manufacture

7.1 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.

7.2 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 8. 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.

7.3 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 8 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 Types 1 and 2, WP911, WP92, WP22 Class 1, WP22 Class 3, and WP24 shall be done after forming.

7.3.1 All welds in WP91 Types 1 and 2 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 Type 1 and Type 2 fittings shall not exceed 1.0 %.

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

7.3.3 All welds in WP115 shall be made using deposited filler metal suitable for the composition being welded. Any defects shall be thoroughly chipped or ground out before welding and each welded length shall be re-heat treated or stress relieved as required by the application specification. Alternately, the weld shall be made with the welding products and procedures of 7.3.1.

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

7.5 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.

7.6 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

[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 Type 1	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[G] 0.06–0.10 Nitrogen 0.03–0.07 Aluminum 0.02[F] Titanium 0.01[F] Zirconium 0.01[F]
WP91 Type 2	0.08–0.12	0.30–0.50[F]	0.020[F]	0.005[F]	0.20–0.40[F]	8.0–9.5[F]	0.85–1.05	0.20[F]	0.10[F]	Vanadium 0.18–0.25 Columbium[G] 0.06–0.10 Nitrogen 0.035–0.070[F] Aluminum 0.020[F] N/Al ratio ≥4.0 Boron 0.001[F] Zirconium 0.01[F] Titanium 0.01[F] Arsenic 0.010[F] Tin 0.010[F] Antimony 0.003[F] Tungsten 0.05[F]
WP115	0.08–0.13	0.20–0.50	0.020	0.005	0.15–0.45	10.0–11.0	0.40–0.60	0.25	0.10	Vanadium 0.18–0.25 Niobium 0.02–0.06 Nitrogen 0.030–0.070 Aluminum 0.02 Titanium 0.01 Boron 0.001 Zirconium 0.01 Tungsten 0.05 Arsenic 0.010 Tin 0.010 Antimony 0.003 N/Al ratio 4.0 min CNB[H] 10.5
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[G] 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[G] 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.
[G] Columbium (Cb) and Niobium (Nb) are alternate names for element 41 in the Periodic Table of the Elements.
[H] Chromium Nickel Balance is defined as CNB = (Cr + 6Si + 4Mo + 1.5W + 11V + 5Nb + 9Ti + 12Al) – (40C + 30N + 4Ni + 2Mn + 1Cu)

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 15 on Surface Finish, Appearance, and Corrosion Protection. 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.

NOTE 1—The examination described in 7.6 exists because the great bulk of cold-forming strain-induced imperfections are detected in the area described. Subsection 7.6 does not waive other areas of a tee from meeting the requirements of Section 15 on Surface Finish, Appearance, and Corrosion Protection.

7.7 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 7.3 for qualifications and 8.3.4 for post weld heat treatment.

8. Heat Treatment

8.1 *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 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 Section 7 in Specification A960/A960M.

8.2 *WPB, WPC, and WPR Fittings:*

8.2.1 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.

8.2.2 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.

8.2.3 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 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.

8.2.4 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].

8.2.5 WPB, WPC, and WPR fittings produced by fusion welding and having a nominal wall thickness at the welded joint of ¾ in. [19 mm] or greater shall be post-weld heat treated at 1100 to 1250 °F [595 to 675 °C], or in accordance with 8.2.6.

8.2.6 At the option of the manufacturer, WPB and WPC fittings produced by any of the methods in Section 7 may be annealed, normalized, or normalized and tempered.

8.3 *Fittings Other than WPB, WPC, and WPR:*

8.3.1 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 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].

8.3.2 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 8.3.1.

8.3.3 Fittings of WP24 either hot formed or cold formed shall be furnished in the normalized and tempered condition. The normalizing temperature range shall be 1800 to 1975 °F [980 to 1080 °C]. The tempering temperature range shall be 1350 to 1470 °F [730 to 800 °C].

8.3.4 Fittings in all thicknesses produced by fusion welding after the heat treatment specified in 8.3.1 shall be post-weld heat treated at a temperature not less than prescribed above for tempering except that Grade WP1 Type 1 and Type 2 are required to be post-weld heat treated only when the nominal wall thickness at the welded joint is ½ in. [13 mm] or greater, and except that preheat and post weld heat treatment are not required for WP24 fittings whose section thickness does not exceed 0.500 in. [12.7 mm].

8.3.5 Except when Supplementary Requirement S1 is specified by the purchaser, Grade WP91 Type 1 and Type 2 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.

8.3.6 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.

8.3.7 Grade WP92 shall be normalized at 1900 °F [1040 °C] minimum, and 1975 °F [1080 °C] maximum, and tempered in

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 Types 1 and 2	WP92 WP911	WP115	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]	90 [620]	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]	65 [450]	32 [220]

	Elongation Requirements					
	Grades					
	All Grades except WPR, WP91 Type 1 and Type 2, WP115 and WP911		WPR and WP24		WP91 Types 1 and 2 WP92 WP115 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 Type 1 and Type 2, WP115, and WP911		WPR	WP91 Types 1 and 2, WP92, WP115, 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].

the temperature range of 1350 °F [730 °C] to 1470 °F [800 °C] as a final heat treatment.

8.3.8 Grade WP115 shall be normalized in the temperature range of 1920 °F [1050 °C] to 2010 °F [1100 °C].

8.4 *WPB and WPC Fittings Made from Bar*—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 annealed. Mechanical testing must be performed subsequent to the final heat-treating operation.

8.5 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 Type 1 and Type 2, WP11 Class 1, WP11 Class 2, WP 12 Class 1, and WP12 Class 2 and 1250 °F [675 °C] for Grades WP5, WP9, WP22 Class 1, 1350 °F [730 °C] for both Grade WP91 Type 1 and Type 2 and WP911 and 1380 °F [750 °C] for Grade WP115. The tempering temperature range for WP24 shall be as in 8.3.3.

8.5.1 Liquid quenching followed by tempering for grades WP11 Class 3 and WP22 Class 3 shall be permitted at the manufacturer's option unless otherwise provided in the purchase order. The minimum tempering temperature for WP11 Class 3 shall be 1150 °F [620 °C] and for WP22 Class 3 shall be 1250 °F [675 °C].

9. Chemical Composition

9.1 The chemical composition of each cast or heat used shall be determined and shall conform to the requirements of the chemical composition for the respective materials listed in Table 1. The ranges as shown have been expanded to include variations of the chemical analysis requirements that are listed in the various specifications for the starting materials (pipe, tube, plate, bar, and forgings) normally used in the manufacturing of fittings to this specification.

9.2 The steel shall not contain any unspecified elements for the ordered grade to the extent that it conforms to the requirements of another grade for which that element is a specified element having a required minimum content.

9.3 Weld metal used in the construction of carbon-steel fittings shall be mild steel analysis No. A1 of Table QW-442, Section IX of the ASME Boiler and Pressure Vessel Code, No. A2 may be used for Grade WPCW.

9.4 The molybdenum and chromium content of the deposited weld metal of alloy steel fittings shall be within the same percentage range as permitted for the base metal.

9.5 Weld metal used in the construction of WP24 fittings shall be of the composition: 2.25 % Cr, 1 % Mo, 0.25 % V.

10. Tensile Requirements

10.1 The tensile properties of the fitting material shall conform to the requirements listed in Table 2.

10.1.1 Longitudinal or transverse specimens cut from either a fitting or from the starting plate or pipe they were manufactured from shall be acceptable for the tension test. For fittings made from forgings, the test specimen shall meet the requirements of Specification A105/A105M for the tension test.

10.1.2 While Table 2 specifies elongation requirements for both longitudinal and transverse specimens, it is not the intent that both requirements apply simultaneously. Instead, it is intended that only the elongation requirement that is appropriate for the specimen used be applicable.

10.2 One tension test shall be made on each heat of material and in the same condition of heat treatment as the finished fittings it represents. Where plate or pipe is used for the test specimen, the specimen thickness tested shall represent all fittings made from the same heat of material in the same heat treat condition in any thickness up to and including the tested thickness. Same heat treatment condition means that the same type of heat treatment (for example, stress relieve, normalize) and the same heat treating cycles (temperatures, time at temperature (minimum), temperature uniformity of ±25 °F [±14 °C], cooling method, etc.) are used (see 9.3 of Specification A960/A960M for furnace uniformity requirement).

10.3 When cold-formed fittings are furnished, samples of the raw material shall be normalized or stress relieved as required in 8.2.4. Tension tests conducted on these heat-treated samples shall be considered to be the tensile properties of the cold-formed fittings.

10.4 Records of raw material test report of the tension tests shall be certification that the material of the fitting meets the tensile requirements of this specification provided the heat treatments of the finished fitting are the same as the raw material test report. If the raw material was not tested, or the fitting is not in the same condition of heat treatment, the fitting manufacturer shall perform the required test on material representative of the finished fitting from each heat of starting material. For fittings that are not heat treated in accordance with 8.2.1 or 8.2.3, the raw material test report data can be used to represent the fitting properties provided the heat treatments are the same.

10.5 When testing of the finished fittings is requested by the purchaser, see Supplementary Requirement S51 in Specification A960/A960M.

11. Hardness

11.1 Except when only one fitting is produced, and except for Grade WP91 Type 1 and Type 2, a minimum of two pieces per batch or continuous run shall be hardness tested to ensure the fittings are within the following limits for each grade in Table 2. The purchaser may verify that the requirement has been met by testing at any location on the fitting provided such testing does not render the fitting useless.

11.1.1 Fittings of Grades WP5, WP9, and WPR—217 HBW maximum.

11.1.2 Fittings of Grade WP24 and WP911—248 HBW maximum.

11.1.3 Fittings of Grade WP92—269 HBW maximum.

11.1.4 Fittings of all other grades—197 HBW maximum.

11.2 All fittings of Grade WP91 Type 1 and Type 2 and WP115 shall be hardness tested and shall have a hardness of 190 HBW-250 HBW.

11.3 When additional hardness testing of the fittings is required, see Supplementary Requirement S57 in Specification A960/A960M.

12. Hydrostatic Tests

12.1 See Specification A960/A960M.

13. Nondestructive Examination

13.1 For WP91 Type 1 and Type 2 and WP92 fittings, one of the following examinations, as found in the Supplementary Requirements of Specification A960/A960M, shall be performed: S52 Liquid Penetrant Examination, S53 Magnetic Particle Examination, S62 Ultrasonic Test, or S72 Nondestructive Electromagnetic (Eddy-Current) Test.

14. Dimensions

14.1 Butt-welding fittings and butt-welding short radius elbows and returns purchased in accordance with this specification shall conform to the dimensions and tolerances given in the latest revision of ASME B16.9. Steel socket-welding and threaded fittings purchased in accordance with this specification shall conform to the sizes, shapes, dimensions, and tolerances specified in the latest revision of ASME B16.11, MSS-SP-79, or MSS-SP-83. Swage(d) Nipples, Bull Plugs, and Integrally Reinforced Forged Branch Outlet Fittings purchased in accordance with this specification shall conform to the sizes, shapes, dimensions, and tolerances specified in the latest revision of MSS-SP-95 or MSS-SP-97.

14.2 Fittings of size or shape differing from these standards, but meeting all other requirements of this specification may be furnished in accordance with Supplementary Requirement S58 in Specification A960/A960M.

15. Surface Finish, Appearance, and Corrosion Protection

15.1 The requirements of Specification A960/A960M apply.

16. Repair by Welding

16.1 See Specification A960/A960M.

16.2 In addition to the requirements for weld repair of Specification A960/A960M, weld repairs to WP91 Type 1 and Type 2 fittings shall meet the requirements of 7.3.1.

16.3 In addition to the requirements for weld repair of Specification A960/A960M, weld repairs to WP24 fittings shall meet the requirements of 9.5. The recommended preheat and interpass temperature ranges are 200 to 400 °F [95 to 205 °C]. Weld repairs to WP24 fittings shall be post weld heat treated at 1350 to 1470 °F [730 to 800 °C], except that preheat and post weld heat treatment are not required for WP24 fittings whose section thickness does not exceed 0.500 in. [12.7 mm].

17. Inspection

17.1 See Specification A960/A960M.

17.2 Other tests, when required by agreement, shall be made from material of the lots covered in the order.

18. Rejection and Rehearing

18.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly in writing. In case of dissatisfaction with the results of the tests, the producer or supplier may make claim for a rehearing.

18.2 Fittings that develop defects in shopworking or application operations may be rejected. Upon rejection, the manufacturer shall be notified promptly in writing.

19. Certification

19.1 Test reports are required for all fittings covered by this specification. Each test report shall meet the requirements for certification in A960/A960M as well as include the following information specific to this specification:

19.1.1 Chemical analysis results, Section 9 (Table 1), reported results shall be to the same number of significant figures as the limits specified in Table 1 for that element.

19.1.2 Tensile property results, Section 10 (Table 2), report the yield strength and tensile strength in ksi [MPa] and elongation in percent,

19.1.3 Hardness results, Section 11,

19.1.4 Type heat treatment, if any, Section 8,

19.1.5 Seamless or welded,

19.1.6 Starting material, specifically pipe, plate, etc.,

19.1.7 Statement regarding radiographic or ultrasonic examination, Section 7.3, and

19.1.8 Any supplementary testing required by the purchase order.

20. Product Marking

20.1 In addition to marking requirements of A960/A960M, the following marking requirements shall apply:

20.1.1 Butt-welding fittings shall be marked with the fitting designation for marking in accordance with Annex A1.

20.1.2 Butt-welding fittings containing welds that have been ultrasonically examined instead of radiography shall be marked U after heat identity.

20.1.3 Threaded or socket-welding fittings shall be marked with the pressure class and fitting designation for marking in accordance with Annex A1. Plugs and bushings furnished to ASME B16.11 requirements are not required to be marked.

20.1.4 When agreed upon between the purchaser and manufacturer, and specified in the order, the markings shall be painted or stenciled on the fitting or stamped on a metal or plastic tag which shall be securely attached to the fitting.

20.1.5 WP91 material shall additionally be marked with the appropriate Type.

20.2 *Bar Coding*—In addition to the requirements in 20.1, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used. The bar coding system, if applied at the discretion of the supplier, should be consistent with one of the published industry standards for bar coding. If used on