

Standard Specification for Pipes Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

1. Scope :-

- 1.1 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 , 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 according with Supplementary Requirement S58 of Specification A960/A960M.
- 1.2 optional supplementary requirements are provided for fitting where a greater degree of examination is desired . When desired , one of more of these supplementary requirements may be specified in the order.
- 1.3 This specification does not cover cash welding fittings or fittings machined from castings. Cast steel welding fittings are governed by Specification 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 value stated in each system may not be exact equivalents ; therefore ; each system shall be used independently of the order . 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 :-
 - A216/A216N 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 :-

B16.9 Steel Butt-Welding fittings

B16.11 Forged Steel Fittings , Socket Welding and Threaded

2.4 ASME Boiler and Pressure Vessel Code:

Section V Nondestructive Examination

Section VIII , Division 1 , pressure Vessels

Section IX Welding Qualifications

2.5 MSS Standards :-

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

2.6 ASNT Standard :-

SNT-TC-1A Recommended Practice for Nondestructive testing Personal Qualification and Certification

2.7 AWS Specifications :-

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 the supplementary requirements that are including in the purchase order . Failure to comply with this specification . In case of a conflict between the requirement of this specification and specification A960/A960M , this specification shall prevail.

TABLE 1 Chemical Requirements

Composition , %										
Grade and Marking Symbol ^A	carbon	Manganeses	Phosphorus, max	Sulfur, max	Silicon	Chromium	Molybdenum	Nickel	Copper	Others
WPB ^{B-C-D-E-3}	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
WPC ^{C-D-E-3}	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	Vanadium 0.08 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 CL1, WP5 CL3	0.15 max	0.30-0.60	0.040	0.030	0.50 max	4.0-6.0	0.44-0.65	....	....	.....
WP9 CL1, WP9 CL3	0.15 max	0.30-0.60	0.030	0.030	1.00 max	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 Aluminium 0.02 max ^G Titanium 0.01 max ^G Zirconium 0.01 max ^G
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 max	....	Vanadium 0.18-0.25 Columbium 0.060-0.10 Nitrogen 0.04-0.09 Aluminium

										0.02 max ^G Boron 0.0003- 0.006 Tungsten 0.90-1.10 Titanium 0.01 max ^G Zirconium 0.01 max ^G
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TABLE 2 Tensile Requirements

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]	60-90 [415- 655]	70-95 [485-655]	55-80 [380- 585]	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- Under-load)	35 [240]	40 [275]	30 [205]	30 [205]	46 [315]	45 [310]	60 [415]	64 [440]	32 [220]

7. Heat Treatment :-

7.1 Heat Treatment Procedures – fittings , after forming at an elevated 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 temperature specified are metal (part) temperatures . Heat-treatment 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 treatment provided they are cooled in still air .

7.2.2 Hot-formed or forged WPB , WPC , and WPR fitting finished at temperature in excess of 1800 °F [980 °C] shall subsequently be annealed , normalised , 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 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 .

7.2.4 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 shell be stress relieved at 1100 at 1250 °F [595 to 675 °C] .

7.2.5 WPB , WPC , and WPR fittings produced by fusion welding and having a normal wall thickness at the welded joint of $\frac{3}{4}$ in . [19 mm] or greater shall be post-weld heat treated at 1100 to 1250 °F [595 to 675 °C] , or in accordance with 7.2.6 .

7.2.6 At the option of the manufacture , WPB and WPC fittings produced by any of the method in Section 6 may be annealed , normalized , or normalized and tempered .

7.3 Fittings Other than WPB , WPC , and WPR :

7.3.1 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 finished 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 Class3 , 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] .

7.3.2 Fittings of Grades WP1 , WP12 , Class 1 , or WP12 heat treatment at 1200 °F [650 °C] instead of the heat treatment specified in 7.3.1 .

7.3.3 Fittings in all thickness produced by fusion welding after heat treatment specified in 7.3.1 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 normal wall thickness at the welded joint is $\frac{1}{2}$ in . [13 mm] or greater .

7.3.4 Except when Supplementary Requirement SI 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] as a final heat treatment .

7.3.5 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 .

7.4 WPB and WPC Fittings Made from Bar – Cold – finished bars reduced in in cross section 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 . Mechanical testing must be performed subsequent to the final heat-treating operation .

7.5 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 Grade 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 .

8. Chemical Composition :-

8.1 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 , tubes , plate , bar , and forgings) normally used in the manufacturing of fittings to this specification .

8.2 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 .

8.3 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 .

8.4 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. Tensile Requirements :-

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

9.1.1 Specimens cut either longitudinally or transversely shall be acceptable for the tensile test .

9.1.2 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 requirements that is appropriate for the specimen used be applicable .

9.2 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 . The sample thickness shall not vary more than ¼ in . [6 mm] from the fitting wall thickness it represents .

9.3 When cold –formed fittings are furnished , sample of the raw material shall be normalized or stress relieved as required in 7.2.4 . Tensile tests considered to be the tensile properties of the cold-formed fittings .

9.4 Records of the tensile tests shall be certification that the material of the fitting meets the tensile requirements of this specification provided the heat treatment are the same . If the raw material was material was not tested , or the fitting is not in the same condition of heat treatment , the fitting manufacture shall perform the required test on material representative of the finished fitting from each heat of starting material.

12. Dimension :-

12.1 Butt-welding fittings and butt-welding short radius elbows and return purchased in accordance with this specification shall conform to the dimension and tolerances given in the latest revision of ASME B16.9 . Steel socket – welding and threaded fitting purchased in accordance with this specification shall conform to the sizes , shapes , dimensions , and tolerance specified in the latest revision of ASME B 16.11 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 size , shapes , dimension and tolerance specified in the latest revision of MSS-SP-95 or MSS-SP-97 .

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

19. Keywords :-

19.1 pipe fittings – steel ; piping ; application ; pressure containing parts ; pressure vessel service ; temperature service application – elevated .

A1.FITTING DESIGNATION FOR MARKING PURPOSES

TABLE A1.1 Fitting Designation for Marking Purposes



ASTM A234/A234M-10

Grade	Class	Construction	Mandatory Marking
WPB		W(Welded construction) S(Seamless construction)	WPBW WPB
WPC		W(Welded construction) S(Seamless construction)	WPCW WPC
WP1		W(Welded construction) S(Seamless construction)	WP1W WP1
WP12	CL1 CL2	W(Welded construction) S(Seamless construction)	WP12 CL1W WP12 CL1 WP12 CL2W WP12 CL2
WP11	CL1 CL2 CL3	W(Welded construction) S(Seamless construction)	WP11 CL1W WP11 CL1 WP11 CL2W WP11 CL2 WP11 CL3W WP11 CL3
WP22	CL1 CL3	W(Welded construction) S(Seamless construction)	WP22 CL1W WP22 CL1 WP22 CL3W WP22 CL3
WP5	CL1 CL3	W(Welded construction) S(Seamless construction)	WP5 CL1W WP5 CL1 WP5 CL3W WP5 CL3
WP9	CL1 CL3	W(Welded construction) S(Seamless construction)	WP9 CL1W WP9 CL1 WP9 CL3W WP9 CL3
WPR		W(Welded construction) S(Seamless construction)	WPR W WPR
WP91		W(Welded construction) S(Seamless construction)	WP91W WP91

SUPPLEMENTARY REQUIREMENTS

- S1. Alternative Heat Treatment – Grade WP91
- S2. Restricted Vanadium Content
- S3. Carbon Equivalent