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Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings¹

This standard is issued under the fixed designation A 815/A 815M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification covers two general classes, WP and CR, of wrought ferritic, ferritic/austenitic, and martensitic stainless steel fittings of seamless and welded construction covered by the latest revision of Specification A 960/A 960M. Fittings differing from these standards may be furnished in accordance with Supplementary Requirement S58 of Specification A 960/A 960M.

1.1.1 Class WP fittings are subdivided into four subclasses: Classes WP-S, WP-W, WP-WX, and WP-WU. They are manufactured to the requirements of Specification A 960/A 960M, and they shall have pressure ratings compatible with 12.2. Class WP-S fittings are those manufactured from seamless product by a seamless method of manufacture (marked with class symbol WP-S); Class WP-W fittings are those which contain welds where the fitting fabrication or construction welds have been radiographed (marked with class symbol WP-W); and Class WP-WX fittings are those which contain welds where all welds have been radiographed (marked with class symbol WP-WX); and Class WP-WU fittings are those which contain welds where all welds have been ultrasonically tested (marked with class symbol WP-WU).

1.1.2 Class CR fittings are those manufactured to the requirements of MSS SP-43, and they shall have pressure ratings compatible with 12.3.

1.2 This specification does not apply to cast fittings.

1.3 Optional supplementary requirements are provided. When desired, one or more of these may be specified in the order.

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:²

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

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

A 388/A 388M Practice for Ultrasonic Examination of Steel Forgings

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

A 763 Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels

A 923 Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels

A 960/A 960M Specification for Common Requirements for Wrought Steel Piping Fittings

E 165 Test Method for Liquid Penetrant Examination

2.2 ASME Standards:³

B16.9 Factory-Made Wrought Butt-Welding Fittings

B16.11 Forged Fittings, Socket-Welding and Threaded

2.3 MSS Standards:⁴

MSS SP-43 Standard Practice for Light Weight Stainless Steel Butt-Welding Fittings

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 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.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁴ 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

2.4 ASME Boiler and Pressure Vessel Codes:³

Section VIII Division I, Pressure Vessels—

Section IX, Welding and Brazing Qualifications

2.5 ASNT Standard:⁵

SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel Qualification and Certification

3. Common Requirements and Ordering Information

3.1 Material furnished to this specification shall conform to the requirements of Specification A 960/A 960M including any supplementary requirements that are indicated in the purchase order. Failure to comply with the common requirements of Specification A 960/A 960M constitutes nonconformance with this specification. In case of conflict between this specification and Specification A 960/A 960M, this specification shall prevail.

3.2 Specification A 960/A 960M identifies the ordering information that should be complied with when purchasing material to this specification.

4. Materials

4.1 The material for fittings shall consist of forgings, bars, plates, or seamless or welded tubular products that conform to the chemical requirements in Table 1.

4.2 The steel shall be melted by one of the following processes:

4.2.1 Electric furnace (with separate degassing and refining optional),

4.2.2 Vacuum furnace, or

4.2.3 Electric furnace followed by vacuum or electroslag-consumable remelting.

4.3 If secondary melting is employed, the heat shall be defined as all ingots remelted from a primary heat.

5. Manufacture

5.1 *Forming*—Forging or shaping operations may be performed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion welding, machining or by combination of two or more of these operations. The forming procedure shall be so applied that it will not produce surface discontinuities deeper than 5 % of the specified nominal thickness of the fitting.

5.2 All classes of fittings shall be heat treated in accordance with Section 6.

5.3 Fittings ordered as Class WP-S shall be of seamless construction and shall meet all requirements of Specification A 960/A 960M.

5.4 Fittings ordered as Class WP-W shall meet the requirements of Specification A 960/A 960M and (1) shall have all welds made by the fitting manufacturer and all pipe welds made with the addition of filler metal radiographically examined throughout the entire length in accordance with Paragraph UW-51 of Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code; and (2) shall not require radiography of the starting pipe weld if the pipe was welded without the addition of filler metal. In place of radiographic examination, welds made by the fitting manufacturer may be ultrasonically examined in accordance with the code requirements stated in 5.6.

5.5 Fittings ordered as Class WP-WX shall meet the requirements of Specification A 960/A 960M and shall have all welds, whether made by the fitting manufacturer or the starting material manufacturer, radiographically examined throughout their entire length in accordance with Paragraph UW-51 of Section VIII, Division I of the ASME Boiler and Pressure Vessel Code. The radiography of welds for this class of fittings can be done either prior to or after forming at the option of the manufacturer.

5.6 Fittings ordered as Class WP-WU shall meet the requirements of Specification A 960/A 960M and shall have all welds, whether made by the fitting manufacturer or the starting material manufacturer, ultrasonically examined throughout their entire length in accordance with Appendix 12 of Section VIII, Division 1 of ASME Boiler and Pressure Vessel Code.

5.7 The radiography or ultrasonic examination for this class of fittings may be done at the option of the manufacturer, either prior to or after forming.

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

5.9 Fittings covered in Specification A 960/A 960M and ordered as CR shall meet the requirements of Specification A 960/A 960M and do not require nondestructive examination.

5.10 ~~All classes of fittings shall have the welders, welding operators, and welded procedures qualified under the provisions of Specification A 960/A 960M.~~ All classes of fittings shall have the welders, welding operators, and welding procedures qualified under the provisions of Section IX of the ASME Boiler and Pressure Vessel Code except that starting pipe welds made without the addition of filler metal do not require such qualification.

5.11 All joints welded with filler metal shall be finished in accordance with the requirements of Paragraph UW-35 (a) of Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code.

⁵ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlington Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

TABLE 1 Chemical Requirements

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

Composition, %														
Grade ^A			C, max	Mn ^B	P, max	S, max	Si, max	Ni ^B	Cr	Mo	Cu ^B	N ^B	Ti	Other
Ferritic Steels														
WP27	CR27	S44627	0.010	0.75	0.020	0.020	0.40	0.50	25.0–27.5	0.75–1.50	0.20	0.015	...	Cb 0.05–0.20
WP33	CR33	S44626	0.06	0.75	0.040	0.020	0.75	0.50	25.0–27.0	0.75–1.50	0.20	0.040	0.20–1.00 (7×(C+N)) min	...
WP429	CR429	S42900	0.12	1.0	0.040	0.030	0.75	0.50	14.0–16.0	...	...	...	...	...
WP430	CR430	S43000	0.12	1.00	0.040	0.030	1.00	0.50	16.0–18.0	...	...	...	...	...
WP430Ti	CR430Ti	S43036	0.10	1.00	0.040	0.030	1.00	0.75	16.0–19.5	...	...	...	(5×C) min max	0.75
WP446	CR446	S44600	0.20	1.50	0.040	0.030	0.75	0.50	23.0–27.0	...	...	0.25	...	...
Ferritic/Austenitic Steels														
WPS31803	CRS31803	S31803	0.030	2.00	0.030	0.020	1.0	4.5–6.5	21.0–23.0	2.5–3.5	...	0.08–0.20	...	...
WPS32101	CRS32101	S32101	0.040	4.0–6.0	0.040	0.030	1.00	1.35–1.70	21.0–22.0	0.10–0.80	0.10–0.80	0.20–0.25	...	...
WPS32202	CRS32202	S32202	0.030	2.00	0.040	0.010	1.00	1.00–2.80	21.5–24.0	0.45	...	0.18–0.26	...	...
WPS32750	CRS32750	S32750	0.030	1.20	0.035	0.020	0.8	6.0–8.0	24.0–26.0	3.0–5.0	0.5	0.24–0.32	...	...
WPS32950	CRS32950	S32950	0.030	2.00	0.035	0.010	0.60	3.5–5.2	26.0–29.0	1.00–2.50	...	0.15–0.35	...	...
WPS32760	CRS32760	S32760	0.030	1.00	0.030	0.010	1.00	6.0–8.0	24.0–26.0 ^C	3.0–4.0 ^C	0.50–1.00	0.20–0.30 ^C	...	W 0.50–1.00
WPS39274	CRS39274	S32974	0.030	1.00	0.030	0.020	0.80	6.0–8.0	24.0–26.0	2.50–3.50 ^C	0.20–0.80	0.24–0.32	...	W 1.50–2.50
WPS32550	CRS32550	S32550	0.04	1.50	0.040	0.030	1.00	4.5–6.5	24.0–27.0	2.9–3.9	1.50–2.50	0.10–0.25	...	...
WPS32205	CRS32205	S32205	0.030	2.00	0.030	0.020	1.00	4.5–6.5	22.0–23.0	3.0–3.5	...	0.14–0.20	...	...
Martensitic Steels														
WP410	CR410	S41000	0.15	1.00	0.040	0.030	1.00	0.50 max	11.5–13.5	...	...	...	...	...
WPS41008	CRS41008	S41008	0.08	1.00	0.040	0.030	1.00	0.60	11.5–13.5	...	...	...	...	...
WPS41500	CRS41500	S41500	0.05	0.50–1.00	0.030	0.030	0.60	3.5–5.5	11.5–14.0	0.50–1.00	...	...	...	W 0.50–1.00

^A Naming system developed and applied by ASTM International.

^B Maximum unless otherwise indicated.

^C % Cr + 3.3 × % Mo + 16 × % N = 40 min.

5.12 Fittings machined from bar shall be restricted to NPS 4 or smaller.

5.12.1 All caps machined from bar shall be examined by liquid penetrant in accordance with Practice E 165.

5.13 Weld buildup is permitted to dimensionally correct unfilled areas produced during cold forming of stub ends. Radiographic examination of the weld buildup shall not be required provided that all of the following steps are adhered to:

5.13.1 The weld procedure and welders or welding operators meet the requirements of 5.10,

5.13.2 Heat-treatment is performed after welding and prior to machining,

5.13.3 All weld surfaces are liquid penetrant examined in accordance with Appendix 8 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, and

5.13.4 Repair of areas in the weld is permitted, but 5.13.1, 5.13.2, and 5.13.3 must be repeated.

5.14 Stub ends may be produced with the entire lap added as weld metal to a straight pipe section provided the welding satisfies the requirements of 5.10 for qualifications and 6.3 for qualifications and Section 6 for post weld heat treatment.

5.14.1 Class WP-W—Radiographic inspection of the weld is required (see 5.4).

5.14.2 Class WP-WX—Radiographic inspection of all welds is required (see 5.5).

5.14.3 Class WP-WU—Ultrasonic inspection of all welds is required (see 5.6).

5.14.4 *Class CR*—Nondestructive examination is not required (see 5.9).

5.15 Stub ends 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 5.10 for qualifications and 6.3 for qualifications and Section 6 for post weld heat treatment.

5.15.1 *Class WP-W*—Radiographic inspection of all welds, made with the addition of filler metal is required (see 5.4).

5.15.2 *Class WP-WX*—Radiographic inspection of all welds, made with or without the addition of filler metal, is required (see 5.5).

5.15.3 *Class WP-WU*—Ultrasonic inspection of all welds, made with or without the addition of filler metal, is required (see 5.6).

5.15.4 *Class CR*—Nondestructive examination is not required (see 5.9).

6. Heat Treatment

6.1 Unless otherwise stated herein, heat treatment shall be performed after welding and in accordance with the requirements of Table 2.

6.1.1 No final heat treatment of welded fittings (HT-O) fabricated from ferritic/austenitic plate that has been heat treated as required by Table 2 for the particular grade, is required, provided material representative of the fittings, including base metal, weld metal, and heat affected zone, passes a Test Methods A 923 Method B or C (See Note 1) corrosion evaluation per heat. Each fitting supplied under this requirement shall be stenciled with the suffix HT-O.

6.1.2 For materials not listed in Table 3 of Test Methods A 923, the HT-O provision does not apply.

~~6.2 All fittings shall be heat treated in accordance with the requirements specified in Table 2.~~ the HT-O provision does not apply.

NOTE 1—The Test Methods A 923 test method (B or C) is at the manufacturer's option, unless otherwise specified by the purchaser.

~~6.3 All welding shall be done prior to the heat treatment specified in Table 2.~~

~~6.4 All fittings machined directly from forgings or bars (see~~

~~6.2 All fittings machined directly from forgings or bars (see 5.12), previously heat treated in accordance with the requirements specified in Table 2, need not be reheat treated.~~

7. Chemical Composition

7.1 The chemical composition of each cast or heat shall be determined and shall conform to the requirements of the chemical composition for the respective grades of materials listed in Table 1. Methods and practices relating to chemical analyses required by this specification shall be in accordance with Methods, Practices, and Definitions A 751. Product analysis tolerances in accordance with Table 3 are applicable.

TABLE 2 Heat Treatment

Stainless Steel	All WP and CR Grades	Temperature	Cooling	Tempering Temperature
Ferritic Ferritic/Austenitic	All	≥ 1200 °F [650 °C]	As appropriate for grade	Not specified
	S31803	1870–2010 °F [1020–1100 °C]	Water quench or rapidly cooled by other means	Not required
	S32101	1870 °F [1020 °C] min	Water quench or rapidly cooled by other means	Not required
	S32202	1800–1975 °F [980–1080 °C]	Water quench or rapidly cooled by other means	Not required
	S32205	1870–2010 °F [1020–1100 °C]	Water quench	Not required
	S32750	1920–2060 °F [1025–1125 °C]	Water quench or rapidly cooled by other means	Not required
	S32760	2010–2085 °F [1100–1140 °C]	Water quench or rapidly cooled by other means	Not required
	S39274	1920–2060 °F [1025–1125 °C]	Water quench or rapidly cooled by other means	Not required
	S32550	1950–1975 °F [1065–1080 °C]	Water quench	Not required
	Martensitic	S32950	Not specified	Not specified	Not required
S41000		≥ 1200 °F [650°C]	Not specified	Not specified
S41008		>1200°F [650°C]	In still air as appropriate for grade	Not specified
S41500		≥ 1750 °F [955 °C]	Air cool to ≤ 200 °F [95 °C] prior to any optional intermediate temper and prior to final temper.	1050–1150 °F [565–620 °C]

**TABLE 3 Product Analysis Tolerances for Higher Alloy and Stainless Steels^A**

Elements	Limit or Maximum of Specified Range, %	Tolerance Over the Maximum Limit or Under the Minimum Limit
Carbon	0.030, incl over 0.030 to 0.20, incl	0.005 0.01
Manganese	to 1.00, incl over 1.00 to 3.00, incl over 3.00 to 6.00 over 6.00 to 10.00	0.03 0.04 0.05 0.06
Phosphorus	to 0.040, incl	0.005
Sulfur	to 0.030, incl	0.005
Silicon	to 1.00, incl over 1.00 to 1.40, incl	0.05 0.10
Chromium	over 4.00 to 10.00, incl over 10.00 to 15.00, incl over 15.00 to 20.00, incl over 20.00 to 27.50, incl	0.10 0.15 0.20 0.25
Nickel	to 1.00, incl over 1.00 to 5.00, incl over 5.00 to 10.00, incl over 10.00 to 20.00, incl over 20.00 to 22.00, incl	0.03 0.07 0.10 0.15 0.20
Molybdenum	over 0.20 to 0.60, incl over 0.60 to 2.00, incl over 2.00 to 7.00, incl	0.03 0.05 0.10
Titanium	all ranges	0.05
Copper	to 0.50	0.03
Nitrogen	to 0.19, incl over 0.19 to 0.25 over 0.25 to 0.35 over 0.35 to 0.45	0.01 0.02 0.03 0.04
Columbium	0.05 to 0.20, incl	0.01
Tungsten	to 1.00	0.04

^A This table does not apply to heat analysis.

7.2 Except as listed below, in fittings of welded construction, the composition of the deposited weld shall conform to the same requirements as the base metal.

7.2.1 Welds on S32950 base metal shall be made with nominal 26 % Cr, 8 % Ni, 2 % Mo weld metal.

7.2.2 Welds on S31803 base metal shall conform to the same requirements as the base metal or shall be made with nominal 22 % Cr, 8 to 10%9 % Ni, 3 % Mo weld metal.

7.2.3 Welds on S32202 base metal shall be made with nominal 22 % Cr, 8 to 10%9 % Ni, 3 % Mo or nominal 23.5 % Cr, 12.00 % Ni weld metal.

8. Tensile Requirements

8.1 The tensile properties of the fitting material shall conform to the requirements of Table 4. The testing and reporting shall be performed in accordance with Test Methods and Definitions A 370.

8.2 At least one tension test per heat shall be made on material representative of the fitting, including weld metal when filler metal is added, and in the same condition of heat treatment as the finished fitting it represents.

8.3 The fittings manufacturer shall perform a tensile test on material representative of the finished fitting. Records of the tensile test made on the starting material may be certification that the material of hot-finished fittings meets the tensile requirements of this specification provided the heat treatments are the same.

9. Hardness Requirements

9.1 Fittings shall not exceed the maximum hardness shown in Table 4.

10. Dimensions

10.1 The sizes, shapes, and dimensions of the fittings covered by ASME B16.9, ASME B16.11, MSS SP-43, MSS SP-79,



TABLE 4 Tensile and Hardness Requirements

All WP and CR Grades	Yield Strength, min, ksi [MPa]	Tensile Strength, ^A ksi [MPa]	Elongation in 2 in. [50 mm] or 4D, min, %	HB max
<i>Ferritic Steels:</i>				
S44627	40 [275]	65 [450]–90 [620]	20.0	190
S44626	45 [310]	68 [470]–93 [640]	20.0	241
S42900	35 [240]	60 [415]–85 [585]	20.0	190
S43000	35 [240]	65 [450]–90 [620]	20.0	190
S43036	35 [240]	60 [415]–85 [585]	20.0	190
S44600	40 [275]	70 [485]–95 [655]	18.0	207
<i>Ferritic/Austenitic Steels:</i>				
S31803	65 [450]	90 [620]	20.0	290
S32101	65 [450]	94 [650]	30.0	290
S32202	65 [450]	94 [650]	30.0	290
S32205	65 [450]	95 [655]	20.0	290
S32750	80 [550]	116 [800]–140 [965]	15.0	310
S32760	80 [550]	109 [750]–130 [895]	25.0	270
S32950	70 [485]	100 [690]	15.0	290
S39274	80 [550]	116 [800]	15.0	310
S32550	80 [550]	110 [760]	15.0	302
<i>Martensitic Steels:</i>				
S41000	30 [205]	70 [485]–95 [655]	20.0	207
S41008	30 [205]	60 [415]	22.0	183
S41500	90 [620]	110 [760]–135 [930]	15.0	295

^AMinimum unless otherwise indicated.

MSS-SP-83, or MSS-SP-95 shall be as specified in those standards.

10.2 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 of Specification A 960/A 960M.

11. Workmanship, Finish, and Appearance

11.1 Fittings supplied under this specification shall be examined visually. Selected typical surface discontinuities shall be explored for depth. The fittings shall be free from surface discontinuities that penetrate more than 5 % of the specified nominal wall thickness, except as defined in 11.3 and 11.4, and shall have a workmanlike finish.

11.2 Surface discontinuities deeper than 5 % of the specified nominal wall thickness, except as defined in 11.3 and 11.4, shall be removed by the manufacturer by machining or grinding to sound metal, and the repaired areas shall be well faired. The wall thickness at all points shall be at least 87½ % of the specified nominal wall thickness, and the diameters at all points shall be within the specified limits.

11.3 Surface checks (fish scale) deeper than ¼ in. [0.4 mm] shall be removed.

11.4 Mechanical marks deeper than ¼ in. [1.6 mm] shall be removed.

11.5 When the removal of a surface discontinuity reduces the wall thickness below 87½ % of the specified nominal wall thickness at any point, the fitting shall be subject to rejection or to repair as provided in 11.6.

11.6 *Repair by Welding:*

11.6.1 Repair welding, of the base metal by the manufacturer, is permissible for fittings made to the dimensional standards listed in 10.1 or for other standard fittings made for stock. Prior approval of the purchaser is required to repair special fittings made to the purchaser's requirements. Repair by welding shall neither exceed 10 % of the outside surface area of the fitting nor 33⅓ % of the nominal wall thickness.

11.6.2 The welding procedure and welders shall be qualified in accordance with Specification A 960/A 960M.

11.6.3 The alloy content (carbon, chromium, nickel, molybdenum, columbium, and titanium) of the deposited weld metal shall be within the same percentage range as permitted for the base metal. (**Warning**—When selecting the filler metal and welding procedure, consideration should be given to their effect on corrosion resistance in service.)

11.6.4 Surface discontinuities deeper than 5 % of the specified nominal wall thickness shall be removed by mechanical means or thermal cutting or gouging methods. Cavities prepared for welding shall be examined by the liquid penetrant method of Practice E 165. No cracks shall be permitted in the prepared cavities.