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Standard Specification for Wrought High-Strength Ferritic Steel Butt-Welding Fittings¹

This standard is issued under the fixed designation A860/A860M; 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.

1. Scope*

1.1 This specification covers wrought high-strength ferritic steel butt-welding fittings of seamless and electric fusion-welded construction covered by the latest revisions of ASME B16.9 and MSS-SP-75. Butt-welding fittings differing from these ASME and MSS standards shall be furnished in accordance with Supplementary Requirement S58 of Specification A960/A960M. These fittings are for use in high-pressure gas and oil transmission and distribution systems.

1.2 Optional supplementary requirements are provided for fittings when a greater degree of examination is desired. One or more of the supplementary requirements may be specified in the order.

1.3 This specification does not cover cast-welding fittings or fittings machined from castings.

1.4 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. Unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished to inch-pound units.

2. Referenced Documents

2.1 *ASTM Standards:*² ~~A370 Test Methods and Definitions for Mechanical Testing of Steel Products~~

A751 *Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products*

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

2.2 *ASME Standards:*³

B16.9 *Steel Butt-Welding Fittings*

2.3 *ASME Boiler and Pressure Vessel Code:*³

Section V *Nondestructive Examination*

Section VIII Division 1, *Pressure Vessels*

Section IX *Welding and Brazing Qualifications*

2.4 *MSS Standards:*⁴

MSS SP-25 *The Standard Marking System of Valves, Fittings, Flanges and Unions*

MSS-SP-75 *Specification for High Test Wrought Butt-Welding Fittings*

2.5 *American Society of Nondestructive Testing:*⁵

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

3. Ordering Information

3.1 In addition to the requirements of Specification A960/A960M, the following ordering information applies:

3.1.1 Grade Symbol,

3.1.2 Requirements for certification of test report.

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 general requirements of

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.

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

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

Specification A960/A960M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A960/A960M, this specification shall prevail.

5. Materials and Manufacture

5.1 The material for fittings shall be fully killed fine-grain material made by a melting process that is intended to produce rounded, well dispersed, fine sulphide inclusions, that promote good notch toughness, assists in the resistance to hydrogen induced cracking, and for weldability suitable for field welding.

5.2 Starting materials shall consist of plate, sheet, forgings, forging quality bar, and seamless or fusion-welded tubular products with filler metal added. The chemical composition shall conform to Table 1.

5.3 A starting material that specifically requires the addition of any element beyond those listed in Table 1 is not permitted. This does not preclude the use of deoxidizers.

5.4 Starting material shall not require a preheat for field welding provided that the restrictions of ASME Boiler and Pressure Vessel Code, Section VIII, Paragraph UW-30 are complied with.

5.5 Forging or shaping operations may be performed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion, welding, machining, or by a combination of these operations.

5.6 All welds including welds in tubular products from which the fittings are made shall be:

5.6.1 Made by welders, welding operators, and welding procedures qualified under the provisions of ASME Boiler and Pressure Vessel Code, Section IX.

5.6.2 Heat treated in accordance with Section 6 of this specification, and

5.6.3 Radiographically examined throughout the entire length of each weld in accordance with Articles 1 and 2 of ASME Boiler and Pressure Vessel Code, Section V with acceptance limits in accordance with Paragraph UW-51 of ASME Boiler and Pressure Vessel Code, Section VIII.

5.7 The welded joints of the fittings shall be furnished in accordance with the requirements of Paragraph UW-35(a) of ASME Boiler and Pressure Vessel Code, Section VIII.

5.8 All butt-weld tees manufactured by cold-forming methods shall be liquid penetrant or magnetic particle examined by one of the methods specified in Supplementary Requirements S69 or S70 of Specification A960/A960M. This examination shall be performed in accordance with a written procedure and shall be performed after final heat treatment. 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 12.1 on finish. After the removal of any cracks, the tees shall be re-examined by the original method. Acceptable tees shall be marked with the symbol PT or MT, as applicable, to indicate compliance. NDE personnel shall be qualified in accordance with SNT-TC-1A.

5.9 All caps machined from bar stock shall be examined by liquid penetrant or magnetic particle in accordance with Supplementary Requirements S69 or S70 of Specification A960/A960M, and with personnel qualifications, acceptance criteria, and marking as in 5.8.

TABLE 1 Chemical Requirements

	Composition %	
	Heat Analysis	
Carbon	0.20 ^A	
Manganese	1.00–1.45	All values are maximum unless a range is stated
Phosphorus	0.030	
Sulfur	0.010	
Silicon	0.15–0.40 ^B	
Nickel	0.50 ^C	
Chromium	0.30 ^C	
Molybdenum	0.25 ^C	
Copper	0.35 ^C	
Titanium	0.05	
Vanadium	0.10	
Columbium	0.04	
Vanadium plus Columbium	0.12	
Aluminum	0.06	

^A The carbon equivalent, as calculated by the following formula, shall not exceed 0.42 %:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

^B If vacuum carbon deoxidation is used, silicon shall not exceed 0.10 % by heat analysis and 0.12 % by product analysis.

^C The sum of Ni + Cr + Mo + Cu shall not exceed 1.0 %.

6. Heat Treatment

6.1 All fittings shall be furnished in the heat-treated condition. Fittings formed above the transformation temperature or upon which welding is performed, shall be cooled to below the lower critical temperature prior to heat treatment. Fittings shall subsequently be heat treated by normalizing, quenching, and tempering or stress relieving in accordance with Specification A960/A960M.

7. Chemical Composition

7.1 The chemical composition of the steel shall conform to the requirements prescribed in Table 1.

7.2 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.

7.3 Analysis of each heat of steel shall be made from a sample taken preferably during the pouring of the heat. The results shall conform to Table 1 for either heat or Specification A960/A960M for product analysis limits as applicable.

7.4 The fittings manufacturer shall make a product analysis per heat from either the starting material or from a fitting. The chemical composition thus determined shall conform to Table 1. The product analysis shall be the basis for rejection. For referee purposes, Test Methods, Practices, and Terminology A751 shall apply.

7.5 The carbon equivalent of the base metal, as determined by the following formula, shall not exceed 0.42 % for the product analysis:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

7.6 Weld metal used in the construction of the fittings shall conform to the tensile and impact requirements of 9.4 and 8.1 after heat treatment in accordance with Section 6. A chemical analysis shall be performed on deposited weld metal for each heat of filler metal or, for submerged arc welding, each heat of filler metal and batch of flux. The weld metal shall be deposited in accordance with the qualified weld procedure.

7.7 Only the carbon content of the deposited weld-metal composition need comply with the requirements of Table 1. The nickel content of the deposited weld metal shall not exceed 1.0 %.

8. Notch Toughness Properties

8.1 The notch toughness properties of the fittings shall conform to the requirements listed in Table 2. The testing shall be performed in accordance with Test Methods and Definitions as specified in Specification A370/A960/A960M. Full size Charpy,

TABLE 2 Mechanical Requirements

Property	Grade					
	WPHY 42	WPHY 46	WPHY 52	WPHY 60	WPHY 65	WPHY 70
Yield strength, min ^A 0.2 % offset, ksi [MPa]	42 [290]	46 [315]	52 [360]	60 [415]	65 [450]	70 [485]
Tensile strength, ksi [MPa]	60 [415]	63 [435]	66 [455]	75 [515]	77 [530]	80 [550]
	-85 [585]	- 88 [605]	- 91 [625]	- 100 [690]	- 102 [705]	-105 [725]
<i>Elongation:</i>						
Standard round specimen, or small-size proportional specimen, min, % in 4D	25	25	25	20	20	20
Rectangular specimen, for section thickness $\frac{5}{16}$ in. [7.94 mm] and over, and for all small sizes tested in full section; min, % in 2 in. [50 mm].	32	32	32	28	28	28
Rectangular specimen for thickness less than $\frac{5}{16}$ in. [7.94 mm]; min, % 2 in. [50 mm]. Width of specimen $1\frac{1}{2}$ in. [40 mm].	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
<i>Toughness:</i>						
<i>C_v</i> energy absorption ^C ; measured at -50 °F [-46 °C].	Size, mm		Average/min, ft-lbs[J]		Lateral Expansion min, MLS[mm]	
	10× 10		30/25 [40/34]		25 [0.64]	
	10× 7.5		25/21 [34/28]		21 [0.53]	
	10× 5		20/17 [27/23]		13 [0.33]	

^A Actual yield strength shall not exceed specified minimum by more than 15 ksi [105 MPa].

^B For each $\frac{1}{32}$ -in. [0.79 mm] decrease in section thickness below $\frac{5}{16}$ in. [7.94 mm], a deduction of 1.5 % from the elongation value of specimens above $\frac{5}{16}$ in. [7.94 mm] is permitted. When the section thickness lies between two values defined above, the minimum elongation value is determined by the following equation:

$$E = 48t + 15.00$$

where:

E = elongation % in 2 in. [50 mm], and

t = actual thickness of specimen.

^C These requirements are intended to minimize fracture initiation. The requirements are not intended to give assurance against fracture propagation.