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## Standard Specification for Common Requirements for Wrought Steel Piping Fittings<sup>1</sup>

This standard is issued under the fixed designation A960/A960M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification covers a group of common requirements that shall apply to wrought steel piping fittings covered in any of the following individual product specifications or any other ASTM specification that invokes this specification or portions thereof:

Title of Specification	ASTM Designation
Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	A234/A234M
Specification for Wrought Austenitic Stainless Steel Piping Fittings	A403/A403M
Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service	A420/A420M
Specification for Butt-Welding, Wrought-Carbon Steel, Piping Fittings with Improved Notch Toughness	A758/A758M
Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures	A774/A774M
Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings	A815/A815M
Specification for Heat-Treated Carbon Steel Fittings for Low-Temperature and Corrosive Service	A858/A858M
Specification for Wrought High-Strength Low-Alloy Steel Butt-Welded Fittings	A860/A860M

1.2 In case of conflict between a requirement of the individual product specification and a requirement of this general requirement specification, the requirements of the individual product specification shall prevail over those of this specification.

1.3 By mutual agreement between the purchaser and the supplier, additional requirements may be specified (See 4.1.74.1.8). The acceptance of any such additional requirements shall be dependent on negotiations with the supplier and must be included in the order as agreed upon by the purchaser and supplier.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text and the tables, 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 specification. The inch-pound units shall apply unless the "M" designation [SI] of the product specification is specified in the order.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

A29/A29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for

A234/A234M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A388/A388M Practice for Ultrasonic Examination of Steel Forgings

A403/A403M Specification for Wrought Austenitic Stainless Steel Piping Fittings

A420/A420M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service

<sup>1</sup> 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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<sup>2</sup> 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.

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

- A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment
- A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- A758/A758M Specification for Wrought-Carbon Steel Butt-Welding Piping Fittings with Improved Notch Toughness
- A763 Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels
- A774/A774M Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
- A815/A815M Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
- A858/A858M Specification for Heat-Treated Carbon Steel Fittings for Low-Temperature and Corrosive Service
- A860/A860M Specification for Wrought High-Strength Ferritic Steel Butt-Welding Fittings
- A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
- A967 Specification for Chemical Passivation Treatments for Stainless Steel Parts
- A1058 Test Methods for Mechanical Testing of Steel Products<sup>Metric</sup>
- E165 Practice for Liquid Penetrant Examination for General Industry
- E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing
- E709 Guide for Magnetic Particle Testing
- E1916 Guide for Identification of Mixed Lots of Metals
- 2.2 *Manufacturer's Standardization Society Standards*:<sup>3</sup>
- MSS-SP-25 The Standard Marking System of Valves, Fittings, Flanges and Unions
- MSS-SP-43 Standard Practice for Light Weight Stainless Steel Butt-Welding Fittings
- MSS-SP-75 Specification for High Test Wrought Butt-Welding Fittings
- MSS-SP-79 Socket Welding Reducer Inserts
- MSS-SP-83 Class 3000 Steel Pipe Unions, Socket Welding and Threaded
- MSS-SP-95 Swage(d) Nipples and Bull Plugs—Swage(d) Nipples and Bull Plugs
- MSS-SP-97 Integrally Reinforced Forged Branch Outlet Fittings—Socket Welding, Threaded and Buttwelding Ends
- 2.3 *American Society of Nondestructive Testing*:<sup>4</sup>
- SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel Qualification and Certification
- 2.4 *ASME Standards*:<sup>5</sup>
- B16.9 Steel Butt-Welding Fittings
- B16.11 Forged Steel Fittings, Socket Welding and Threaded
- Section IX Welding Qualifications

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

- 3.1.1 *bar*—a solid section that is long in relationship to its cross sectional dimensions, with a relatively constant cross section throughout its length. (See Specification A29/A29M for definitions relating to the production of hot wrought and cold finished bars.)
- 3.1.2 *certifying organization*—the company or association responsible for the conformance of, the marking of, and the certification of the product to the specification requirements.
- 3.1.3 *fitting*—a component for non-bolted joints used in piping systems and pressure vessels.
- 3.1.4 *flange*—a component for bolted joints used in piping systems and pressure vessels.
- 3.1.5 *forging*—the product of a substantially compressive hot or cold plastic working operation that consolidates the material and produces the required shape.
- 3.1.6 *Discussion*—The plastic working must be performed by a forging machine, such as a hammer, press, or ring rolling machine and must deform the material to produce an essentially wrought structure throughout the material cross section.
- 3.2 *Definitions*—For definitions of other terms used in this specification, refer to Terminology A941.

### 4. Ordering Information

- 4.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to purchase the needed material. Examples of such information include but are not limited to the following:
  - 4.1.1 Quantity,
  - 4.1.2 Description of fitting and nominal dimensions (standard or special),
  - 4.1.3 Steel composition by grade and class designation,
  - 4.1.4 Construction, seamless or welded (unless seamless or welded construction is specified by the purchaser, either may be furnished at the option of the supplier),

<sup>3</sup> 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>.

<sup>4</sup> Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

<sup>5</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

4.1.5 Specification number (including the year/date of issue),

4.1.6 ~~Supplementary requirements, and~~

4.1.7

4.1.6 Choice of testing track from the options listed in Test Methods A1058 when material is ordered to an M suffix (SI units) product standard. If the choice of test track is not specified in the order, then the default ASTM track shall be used as noted in Test Methods A1058.

4.1.7 Supplementary requirements, and

4.1.8 Additional requirements.

## 5. Material

5.1 The material for fittings shall consist of forgings, bars, plates and seamless or welded tubular products.

5.2 The steel shall conform to the chemical requirements of the individual product specification and may be made from any process.

5.3 Ferritic steels shall be fully killed.

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

## 6. Manufacture

6.1 Forging or shaping operations may be performed by any of the methods included in the individual product specification.

6.2 Hollow cylindrically shaped parts up to and including NPS 4 may be machined from bar or seamless tubular material provided the axial length of the part is approximately parallel to the axial length of the fitting. Elbows, return bends, tees and header tees shall not be machined directly from bar stock.

6.3 Fittings, after forming at an elevated temperature, shall be cooled to a temperature below the critical range under suitable conditions to prevent injury by cooling too rapidly.

6.4 All classes of fittings shall have the welders, welding operators, and welding procedures qualified under the provision of Section IX of the ASME Boiler and Pressure Vessel Code except that welds from the original pipe manufacturer made without the addition of filler metal do not require such qualification.

## 7. Heat Treatment

7.1 Fittings requiring heat treatment shall be treated as specified in the individual product specification using the following procedures:

7.1.1 *Full Annealing*—Fittings shall be uniformly reheated to a temperature above the transformation range and, after holding for a sufficient time at this temperature, cooled slowly to a temperature below the transformation range.

7.1.2 *Solution Annealing*—Fittings shall be heated to a temperature that causes the carbides to go into solution and then quenched in water or rapidly cooled by other means to prevent reprecipitation.

7.1.3 *Isothermal Annealing*—Isothermal annealing shall consist of austenitizing a ferrous alloy and then cooling to and holding within the range of temperature at which the austenite transforms to a relatively soft ferrite-carbide aggregate.

7.1.4 *Normalizing*—Fittings shall be uniformly reheated to a temperature above the transformation range and subsequently cooled in air at room temperature.

7.1.5 *Tempering and Post-Weld Heat Treatment*—Fittings shall be reheated to the prescribed temperature below the transformation range, held at temperature for the greater of ½ h or 1 h/in. [25.4 mm] of thickness at the thickest section and cooled in still air.

7.1.6 *Stress Relieving*—Fittings shall be uniformly heated to the selected stress relieving temperature. The temperature shall not vary from the selected temperature by more than  $\pm 25$  °F [ $\pm 14$  °C].

7.1.7 *Quench and Temper*—Fittings shall be fully austenitized and immediately quenched in a suitable liquid medium. The quenched fittings shall be reheated to a minimum temperature of 1100 °F [590 °C] and cooled in still air.

## 8. Chemical Requirements

8.1 *Chemical Analysis*—Samples for chemical analysis and methods of analysis shall be in accordance with Test Methods, Practices and Terminology A751 for Chemical Analysis of Steel Products.

8.2 *Heat Analysis*—An analysis of each heat of steel shall be made by the manufacturer to determine the percentages of those elements specified in the individual product specification. If secondary melting processes are employed, the heat analysis shall be obtained from one remelted ingot of each primary melt. The chemical analysis thus determined shall conform to the requirements of the individual product specification. Note that the product analysis (check analysis) tolerances are not to be applied to the heat analysis requirements.

8.2.1 For steels ordered under product specifications referencing this specification of general requirements, the steel shall not contain an unspecified element, other than nitrogen for stainless steels, for the ordered grade to the extent that the steel conforms to the requirements of another grade for which that element is a specified element having a required minimum content. For this requirement, a grade is defined as an alloy described individually and identified by its own UNS or grade designation in a table of chemical requirements within any specification listed within the scope as being covered by this specification.

8.3 *Product Analysis*—If a product analysis is performed it shall be in accordance with Test Methods, Practices, and Terminology A751. The chemical composition thus determined shall conform to limits of the product specification, within the permissible variations of Table 1 or Table 2 of this specification, as appropriate for the grade being supplied.

## 9. Mechanical Requirements

9.1 *Method of Mechanical Test*—All tests shall be conducted in accordance with Test Methods and Definitions A370 ~~if the inch-pound units are specified~~ or Test Methods A1058 if the M suffix (SI Units) standard is specified.

9.2 The test specimen shall represent all material from the same heat and heat treatment load whose maximum thicknesses do not exceed the thickness of the test specimen or blank by more than ¼ in. [6 mm].

9.3 One tension test at room temperature shall be made in accordance with 9.2 from each heat in each heat treatment load.

9.3.1 If heat treatment is performed in either a continuous or batch type furnace controlled within  $\pm 25$  °F [ $\pm 14$  °C] of the required heat treatment temperature and equipped with recording pyrometers so that complete records of heat treatment are available, and if the same heat treating cycles are used on the material represented by the tension test, then one tension test from each heat shall be required, instead of one tension test from each heat in each heat treatment load in accordance with 9.2.

9.4 *Retest*—When a retest is permitted by the product specification, it shall be performed on twice the number of representative specimens that were originally nonconforming. When any retest specimen does not conform to the product specification

**TABLE 1 Product Analysis Tolerances for Low Alloy and Carbon Steels<sup>A</sup>**

Elements	Limit, or Maximum of Specified Range, %	Permissible Variations Over Maximum Limit or Under Minimum Limit, %
Carbon	to 0.010, incl	0.002
	over 0.010 to 0.030, incl	0.005
	over 0.030 to 0.20, incl	0.01
Manganese	over 0.20 to 0.80, incl	0.02
	to 1.00, incl	0.03
Phosphorus	over 1.00 to 3.00, incl	0.04
	to 0.040, incl	0.005
Sulfur	over 0.040 to 0.20, incl	0.010
	to 0.040, incl	0.005
Silicon	over 0.040 to 0.20, incl	0.010
	to 1.00, incl	0.02
Nickel	over 1.00 to 3.00, incl	0.10
	to 1.00, incl	0.03
	over 1.00 to 5.00	0.07
	over 5.00 to 10.00, incl	0.10
Chromium	over 10.00 to 20.00, incl	0.15
	0.90 and under	0.03
	over 0.90 to 2.10, incl	0.05
Molybdenum	over 2.10 to 4.00, incl	0.07
	over 4.00 to 10.00, incl	0.10
	0.20 and under	0.01
Vanadium	over 0.20 to 0.60, incl	0.03
	over 0.60 to 2.00, incl	0.05
	0.10 and under	0.01
	over 0.10 to 0.25, incl	0.02
Columbium (Niobium)	over 0.25 to 0.50, incl	0.03
	minimum value specified, under minimum limit only	0.01
	to 1.50, incl	0.05
Titanium	to 1.00, incl	0.05
Aluminum	to 0.15, incl	-0.005
	over 0.15 to 0.50, incl	+0.01
Lead <sup>B</sup>	over 0.50 to 0.80, incl	0.05
	0.15 to 0.35, incl	0.03
Copper	to 0.50, incl	0.03
	over 0.50 to 1.00, incl	0.05
Nitrogen	over 1.00 to 3.00, incl	0.10
	to 0.02, incl	0.005
Tungsten	over 0.02 to 0.19, incl	0.01
	to 0.50, incl	0.02
	over 0.50 to 1.00, incl	0.03
Zirconium	over 1.00 to 2.00, incl	0.05
	over 2.00 to 4.00, incl	0.06
Boron	to 0.01, incl	0.005
	to 0.01, incl	0.0005

<sup>A</sup> Chrome content less than 4.00.

<sup>B</sup> Product analysis tolerance for lead applies both over and under to a specified range of 0.15 to 0.35 %.

**TABLE 2 Product Analysis Tolerances for Higher Alloy and Stainless Steels<sup>A</sup>**

Element	Upper Limit of Maximum of Specified Range, %	Tolerances Over the Maximum (Upper Limit) or Under the Minimum (Lower Limit)
Carbon	to 0.010, incl	0.002
	over 0.010 to 0.030, incl	0.005
	over 0.030 to 0.20, incl	0.01
	over 0.20 to 0.80, incl	0.02
Manganese	to 1.00, incl	0.03
	over 1.00 to 3.00, incl	0.04
	over 3.00 to 6.00, incl	0.05
	over 6.00 to 10.00, incl	0.06
Phosphorus	to 0.040, incl	0.005
	over 0.040 to 0.20, incl	0.010
Sulfur	to 0.040, incl	0.005
	over 0.040 to 0.20, incl	0.010
Silicon	over 0.20 to 0.50, incl	0.020
	to 1.00, incl	0.05
	over 1.00 to 3.00, incl	0.10
Chromium	over 3.00 to 7.00, incl	0.15
	over 4.00 to 10.00, incl	0.10
	over 10.00 to 15.00, incl	0.15
	over 15.00 to 20.00, incl	0.20
Nickel	over 20.00 to 30.00, incl	0.25
	to 1.00, incl	0.03
	over 1.00 to 5.00, incl	0.07
	over 5.00 to 10.00, incl	0.10
	over 10.00 to 20.00, incl	0.15
Molybdenum	over 20.00 to 30.00, incl	0.20
	over 30.00 to 40.00, incl	0.25
	to 0.20, incl	0.01
	over 0.20 to 0.60, incl	0.03
	over 0.60 to 2.00, incl	0.05
Titanium	over 2.00 to 7.00, incl	0.10
Columbium	to 1.00, incl	0.05
Tantalum	to 1.50, incl	0.05
Copper	to 0.10, incl	0.02
	to 0.50, incl	0.03
	over 0.50 to 1.00, incl	0.05
Aluminum	over 1.00 to 3.00, incl	0.10
	to 0.15, incl	-0.005
	over 0.15 to 0.50, incl	+0.01
Nitrogen	to 0.02, incl	0.005
	over 0.02 to 0.19, incl	0.01
	over 0.19 to 0.25, incl	0.02
	over 0.25 to 0.35, incl	0.03
	over 0.35 to 0.45, incl	0.04
	over 0.45	0.05
Vanadium	to 0.10, incl	0.01
	over 0.10 to 0.25, incl	0.02
Cerium	to 0.20, incl	0.01
Tungsten	to 0.50, incl	0.02
	over 0.50–1.00, incl	0.03
	over 1.00–2.00, incl	0.05
	over 2.00–4.00, incl	0.06
Cobalt	to 0.20, incl	0.01

<sup>A</sup> Chrome content 4.00 or greater.

requirements for the characteristic in question, the lot represented by that specimen shall be rejected or reworked in accordance with Section 14.

9.4.1 If the results of the tension test do not conform to the requirements specified in the product specification, retests are permitted as outlined in ~~Test Methods and Definitions A370~~ the test methods specified herein. If the results of any tension test specimen are less than specified because a flaw becomes evident in the test specimen during testing, a retest shall be allowed provided that the defect is not attributable to ruptures, cracks, or flakes in the steel.

9.4.2 If the average impact energy value meets the product specification requirements, but one energy value is below the specified minimum value for individual specimens, a retest is permitted. The retest shall be conducted in accordance with ~~Test Methods and Definitions A370~~ the test methods specified herein.

9.5 For the purpose of determining conformance to the product specification requirements, specimens shall be obtained from a finished product, or from production material that is in the same condition of working and heat treatment as the production material.

## 10. Hardness Requirements

- 10.1 The part shall conform to the hardness requirements prescribed in the product specification.
- 10.2 Sampling for hardness testing shall conform to the product specification.

## 11. Tensile Requirements

- 11.1 The part shall conform to the tensile property requirements prescribed in the product specification.
- 11.2 Sampling for tensile testing shall conform to the product specification.
- 11.3 When the dimensions of the material to be tested will permit, the tension test specimens shall be machined to the form and dimensions of the standard 2-in. [50-mm] gage length tension test specimens described in Test Methods and Definitions A370. When the dimensions of the material to be tested will permit, the tension test specimens shall be machined to the form and dimensions of the standard 2-in. gauge length tension test specimens described in Test Methods and Definitions A370 if inch-pound units are specified or the standard 62.5 mm gauge length tension test specimens described in the applicable track of Test Methods A1058 if SI units are specified.

11.3.1 In the case of small sections, which will not permit taking the standard test specimen described in 11.3, the subsize round or strip specimen shall be machined as described in Test Methods and Definitions A370, the test methods being used. The tension test specimen shall be as large as feasible.

## 12. Impact Requirements

- 12.1 The part shall conform to the impact requirements prescribed in the product specification.
- 12.2 Sampling for impact testing shall conform to the product specification.

## 13. Hydrostatic Test Requirements

13.1 Parts manufactured under this specification shall be capable of passing a hydrostatic test compatible with the rating of the specified matching pipe of equivalent material. Such a test shall be conducted only when specified in the purchase order or when the hydrostatic test Supplementary Requirement is invoked by the purchaser.

## 14. Rework

14.1 When one or more representative test specimens or retest specimens do not conform to the requirements specified in the product specification for the tested characteristic, the lot of material represented by the test specimen may be reworked according to the following requirements.

14.1.1 If previously tested in the untreated condition, the product may be reworked by heat treatment, and subsequently retested, in accordance with the product specification.

14.1.2 If previously tested in the heat treated condition, the product may be reworked by reheat treatment, and subsequently retested, in accordance with the product specification.

## 15. Finish and Appearance

15.1 The parts shall conform to the dimensions, tolerances and finish as specified in the purchaser's order. Parts ordered to the requirements of an ASTM specification shall conform to the requirements of the individual product specification.

15.2 The surface finish shall allow the detection of imperfections that can be disclosed by visual inspection. Where necessary the finished parts shall be cleaned to remove all loose scale and processing compounds prior to the final surface examination. The cleaning process shall not injure the surface finish, material properties, or the metallurgical structure. The cleaned parts shall be protected to prevent recontamination. Protective coatings on parts subsequently subjected to socket welds or butt welds shall be suitable for welding without removal of the coating. When specified in the purchase order, parts may be furnished in the as-formed condition.

15.3 Fittings supplied under this specification shall be examined visually. Selected typical surface discontinuities shall be explored for depth. Unless otherwise specified in the purchase order, the following shall apply.

15.3.1 ~~Fittings conforming to ASME B16.9 and MSS-SP-43, MSS-SP-43, and MSS-SP-95 shall be free of surface discontinuities that penetrate more than 5 % of the specified nominal wall thickness, except as defined in 15.3.3 and 15.3.4. Fittings conforming to ASME B16.11 and MSS-SP-79, MSS-SP-79, MSS-SP-83, and MSS-SP-97 shall be free of surface discontinuities that penetrate more than 5 % of the actual wall thickness at the point of interest, or 1/16 in. [1.6 mm], whichever is less, except as defined in 15.3.4.~~

15.3.2 Surface discontinuities deeper than 5% of the specified nominal wall thickness, except as defined in . Fittings conforming to MSS-SP-75 shall be free of surface discontinuities that penetrate more than 6½ % of the specified nominal wall thickness.

15.3.2 Surface discontinuities deeper than 5 % of the specified nominal or actual wall thickness as applicable, except as defined in 15.3.3 and 15.3.4, shall be removed by the manufacturer by machining or grinding to sound metal, and the repaired areas shall blend smoothly into the contour of the finished fitting. Except for fittings conforming to MSS-SP-75, shall be removed by the manufacturer by machining or grinding to sound metal, and the repaired areas shall blend smoothly into the contour of the finished fitting. Surface discontinuities on fittings conforming to MSS-SP-75 shall be removed or repaired in accordance with the