



Designation: **A960/A960M – 19 A960/A960M – 19a**

Standard Specification for Common Requirements for Wrought Steel Piping Fittings¹

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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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 High Temperature Service	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 Wrought-Carbon Steel Butt-Welding 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 Ferritic Steel Butt-Welding 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 4.1.8). 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.

1.5 *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 *ASTM Standards:*²

[A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought](#)

[A234/A234M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service](#)

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.

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

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
A700 Guide 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/A967M Specification for Chemical Passivation Treatments for Stainless Steel Parts
A1058 Test Methods for Mechanical Testing of Steel Products—Metric
E165/E165M Practice for Liquid Penetrant Testing 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:*³

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
MSS-SP-97 Integrally Reinforced Forged Branch Outlet Fittings—Socket Welding, Threaded and Buttwelding Ends

2.3 *American Society of Nondestructive Testing:*⁴

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

2.4 *ASME Standards:*⁵

B16.9 Steel Butt-Welding Fittings
B16.11 Forged Steel Fittings, Socket Welding and Threaded
Boiler and Pressure Vessel Code Section IX

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.

³ 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>.

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

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

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),
- 4.1.5 Specification number (including the year/date of issue),
- 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 *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 (or Solution Treat or Treatment)*—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, held long enough to reduce stresses and then cooled at a rate that will result in the properties required for the material grade and minimize the development of new residual stresses. The temperature shall not vary from the selected temperature by more than ± 25 °F [± 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** of this specification.

8.3.1 Limits on formula calculations involving elemental contents shall apply only to the heat analysis, unless agreed upon between supplier and purchaser. Where limits on formula calculations involving elemental contents apply to product analysis by such agreement, permissible variations in the formula calculation results beyond the limits for the heat analysis shall also be agreed upon between supplier and purchaser. Examples of such formula calculations include, but are not limited to, the following: carbon equivalent $CE = C + Mn/6 + (Cr + Mo + V) / 5 + (Ni + Cu) / 15$; J factor $= (Mn + Si) \times (P + Sn) \times 10^4$; or requirements for specific elemental balance or sufficiency, typically related to Ti, Nb, or Al and interstitials C and N, such as $Nb = 5 \times C$ minimum.

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 1/4 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 ± 25 °F [± 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. 19a

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 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 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 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.

TABLE 1 Product Analysis Tolerances^A

Element	Limit or Maximum of Specified Range, Wt %	Tolerance Over the Maximum Limit or Under the 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
	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
Phosphorous	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
	over 0.20 to 0.50, incl	0.020
Silicon	to 1.00, incl	0.05
	over 1.00 to 3.00, incl	0.10
	over 3.00 to 7.00, incl	0.15
Chromium	0.90 and under	0.03
	over 0.90 to 2.10, incl	0.05
	over 2.10 to 4.00, incl	0.07
	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
	over 20.00 to 30.00, incl	0.20
Molybdenum	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
	to 1.15, incl	0.05
Niobium (Columbium)	to 0.14, incl	0.02
	over 0.14 to 5.50	0.05
Tantalum	to 0.10 incl	0.02
Copper	to 0.50, incl	0.03
	over 0.50 to 1.00, incl	0.05
	over 1.00 to 5.00, incl	0.10
Cobalt	0.05 to 0.25, incl	0.01 ^B
	0.25 to 5.00, incl	0.05
Nitrogen	to 0.02, incl	0.005
	over 0.02 to 0.19, incl	0.01
	over 0.19 to 0.25	0.02
	over 0.25 to 0.35	0.03
	over 0.35 to 0.45	0.04
	over 0.45	0.05
Aluminum	to 0.15, incl	-0.005
		+0.01
	over 0.15 to 0.50, incl	0.05
Vanadium	over 0.50 to 0.80, incl	0.07
	to 0.10 incl	0.01
	over 0.10 to 0.25, incl	0.02
	over 0.25 to 0.50, incl	0.03
	minimum value specified, under minimum limit only	0.01
Cerium	to 0.20, incl	0.01
Selenium	to 0.35, incl	0.001
Tungsten	to 0.50, incl	0.02
	over 0.50 to 1.00, incl	0.03
	over 1.00 to 2.00, incl	0.05
	over 2.00 to 4.00, incl	0.06
Lead	to 0.35, incl	0.03
Zirconium	to 0.01, incl	0.005
Boron	to 0.015 incl	0.0005
Tin	to 0.010, incl	c
Arsenic	to 0.010, incl	c
Antimony	to 0.003, incl	c

^AThis table does not apply to heat analysis.

^BProduct analysis limits for cobalt under 0.05 % have not been established and the producer should be consulted for those limits.

^CNo over tolerance allowed.

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. 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 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.

12.3 Notched-bar impact specimens shall be simple-beam, Charpy-type A with a V-notch 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. Standard specimens 10 by 10 mm in cross section shall be used unless the material to be tested is of insufficient thickness, in which case the largest obtainable standard subsize impact specimens shall be used. When the size or shape of the finished fittings is insufficient to permit obtaining the smallest standard subsize impact specimens, an impact test by the fitting manufacturer will not be required.

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. Surface Finish, Appearance, and Corrosion Protection

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

15.2 The finished parts shall be cleaned to remove all 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.

15.2.1 The surface finish shall allow the detection of imperfections that can be disclosed by visual inspection.

15.2.2 The cleaned parts shall be protected to prevent recontamination.

15.2.2.1 Exterior and interior surfaces of carbon, low, and intermediate alloy steel fittings shall have a corrosion protective coating. Unless otherwise specified by the purchaser, the type of surface protection shall be at the option of the manufacturer.

15.2.2.2 Stainless steel and nickel alloy fittings need not be coated. Unmachined surfaces of stainless steel fittings shall be passivated by exposure to an acid bath, or electropolished.

15.2.3 Protective coatings on parts subsequently subjected to socket welds or butt welds shall be suitable for welding without removal of the coating. Threaded fittings shall be capable of installation without the removal of the coating.

15.2.4 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, 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, 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**. Fittings conforming to MSS-SP-75 shall be free of surface discontinuities that penetrate more than 6½ % of the specified nominal wall thickness.