



Designation: A960/A960M – 23

## 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 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:<sup>2</sup>

- 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
- 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 and Practices 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

<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](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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

- [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:*<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
  - [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 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.)

<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.msshq.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, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

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.

3.1.5.1 *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.

3.1.6 *longitudinal axis*—an axis along the lengthwise direction of the part, bar, pipe or tubing parallel to the direction of the greatest extension of the steel during rolling, extruding or forging.

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),
- 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 Parts up to and including NPS 4 may be machined from bar or seamless tubular material provided the longitudinal axis of the part is parallel to the longitudinal axis of the bar or tubular material. 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  $\pm 25$  °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** 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 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**.

**TABLE 1 Product Analysis Tolerances<sup>A</sup>**

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
Phosphorous	over 6.00 to 10.00, incl	0.06
	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
	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
Nickel	over 10.00 to 15.00, incl	0.15
	over 15.00 to 20.00, incl	0.20
	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
Molybdenum	over 10.00 to 20.00, incl	0.15
	over 20.00 to 30.00, incl	0.20
	over 30.00 to 40.00, incl	0.25
	to 0.20, incl	0.01
Titanium	over 0.20 to 0.60, incl	0.03
	over 0.60 to 2.00, incl	0.05
	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
Cobalt	over 1.00 to 5.00, incl	0.10
	0.05 to 0.25, incl	0.01 <sup>B</sup>
Nitrogen	0.25 to 5.00, incl	0.07
	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
Aluminum	over 0.35 to 0.45	0.04
	over 0.45	0.05
	to 0.15, incl	-0.005
Vanadium		+0.01
	over 0.15 to 0.50, incl	0.05
	over 0.50 to 0.80, incl	0.07
	to 0.10 incl	0.01
Cerium	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
Selenium	to 0.20, incl	0.01
Tungsten	to 0.35, incl	0.001
	to 0.50, incl	0.02
	over 0.50 to 1.00, incl	0.03
Lead	over 1.00 to 2.00, incl	0.05
	over 2.00 to 4.00, incl	0.06
Zirconium	to 0.35, incl	0.03
Boron	to 0.01, incl	0.005
Tin	to 0.015 incl	0.0005
Arsenic	to 0.010, incl	<sup>C</sup>
Antimony	to 0.010, incl	<sup>C</sup>
	to 0.003, incl	<sup>C</sup>

<sup>A</sup>This table does not apply to heat analysis.

<sup>B</sup>Product analysis limits for cobalt under 0.05 % have not been established and the producer should be consulted for those limits.

<sup>C</sup>No over tolerance allowed.

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.

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  $\frac{1}{16}$  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  $6\frac{1}{2}$  % 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. Surface discontinuities on fittings conforming to MSS-SP-75 shall be removed or repaired in accordance with the requirements of that standard. Except for fittings conforming to MSS-SP-75, the wall thickness at all points shall be at least the specified minimum wall thickness, or  $87\frac{1}{2}$  % of the specified nominal wall thickness and the diameters shall be within the limits specified in the applicable dimensional standards.

15.3.3 Surface checks (fish scale) deeper than  $\frac{1}{64}$  in. [0.4 mm] shall be removed.

15.3.4 Mechanical marks deeper than  $\frac{1}{16}$  in. [1.6 mm] shall be removed.

15.3.5 When the removal of a surface discontinuity reduces the wall thickness below the specified minimum wall thickness at any point, the fitting shall be subject to rejection or to repair as provided in Section **16**, or in accordance with MSS-SP-75 for fittings conforming to that standard.

### 16. Repair by Welding

16.1 The purchaser may require the supplier to submit proposed weld repairs for approval by invoking the appropriate Supplementary Requirement in the purchase order.

16.2 If the purchaser does not require prior approval of the proposed weld repairs, these repairs shall be permitted at the discretion of the supplier. All weld repairs shall be performed in accordance with the following limitations and requirements.

16.2.1 The welding procedure, welders and operators shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. The composition of the weld deposit shall be compatible with the composition of the material being welded.

16.2.2 Defects shall be completely removed prior to welding by machining, chipping or grinding to sound metal. Removal of these defects shall be verified by magnetic particle examination in accordance with Guide **E709** or liquid penetrant inspection in accordance with Test Method **E165/E165M**, as applicable.

16.2.3 After repair welding, the welded area shall be machined or ground smooth to the original contour and shall be completely free of defects as verified by magnetic particle examination in accordance with Guide E709 or liquid penetrant inspection in accordance with Test Method E165/E165M, as applicable.

16.2.4 Repair welding shall not exceed 10 % of the external surface area of the part, or 33 $\frac{1}{3}$  % of the wall thickness of the finished product, or  $\frac{3}{8}$  in. [10 mm] deep maximum at the location of the repair, without prior approval of the purchaser.

16.2.5 Weld repaired material or parts, or both, shall be marked “RW” when required by the product specification.

16.3 The weld repair shall conform to the additional requirements, if any, invoked in the product specification.

## 17. Inspection

17.1 The supplier shall provide the purchaser’s inspector with all reasonable facilities necessary to satisfy him that the material is being produced and furnished in accordance with this specification and the applicable product specification. Site inspection by the purchaser shall not interfere unnecessarily with the supplier’s operations.

## 18. Rejection and Rehearing

18.1 Samples representing material rejected by the purchaser shall be preserved until disposition of the claim has been agreed to between the supplier and the purchaser.

## 19. Marking

19.1 Each piece shall be legibly marked in a position as not to injure the usefulness of the fitting with the product specification number, grade or marking symbol, class, certifying organization’s name or symbol, the heat number or heat identification, size, and schedule number or wall thickness, if applicable. Dual or multiple marking with the product specification number, grade or marking symbol, and class is acceptable provided the material meets all the requirements with which it is marked. It is not required to mark the product with the specification year and date of issue. When size or shape does not permit the inclusion of all the required marking as described, see 19.2. Manufacturer can also choose the use of

tags, box labels, etc. for identification when per piece marking is not practical due to size or shape.

19.2 The Standard Marking System of Valves, Fittings, Flanges and Unions MSS-SP-25 shall be followed except the word “steel” shall not be substituted for the specification grade.

19.3 Product marking shall conform to the additional requirements, if any, invoked in the product specification or purchase order.

## 20. Certification

20.1 A test report and certificate of compliance are required.

20.2 Test reports shall include the product specification number and year/date of issue, the results of all tests required by this specification, and the purchaser order, and shall be traceable to the part represented.

20.3 A single document containing the test report information and certificate of compliance information may be used.

20.4 A certificate printed from or used in electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier’s facility. The content of the EDI transmitted document shall conform to any existing EDI agreement between the purchaser and the supplier.

20.5 Notwithstanding the absence of a signature, the organization submitting either a printed certificate or an EDI transmitted certificate is responsible for the content of the report.

## 21. Packaging, Marking and Loading for Shipment

21.1 Packaging, marking, and loading for shipment shall be in accordance with Practices A700.

## 22. Keywords

22.1 austenitic stainless steel; corrosive service applications; ferritic/austenitic stainless steel; ferritic stainless steel; high strength low alloy steel; martensitic stainless steel; piping applications; pressure containing parts; pressure vessel service; stainless steel fittings; temperature service applications-elevated; temperature service applications-low; temperature service applications-moderate

## SUPPLEMENTARY REQUIREMENTS

These requirements shall not be considered unless specified in the order, in which event, the supplementary requirements specified shall be made at the place of manufacture, unless otherwise agreed upon, at the purchaser’s expense. The test specified shall be witnessed by the purchaser’s inspector before shipment of material, if so specified in the order. The rationale for beginning the section numbering with S50 is to eliminate the possibility of confusion with supplementary requirements existing in individual product specifications.

**S50. Product Analysis (see Note S50.1)**

S50.1 A product analysis shall be made from each heat of base metal and, if of welded construction, from each lot number of welding material of the fittings offered for delivery. The analysis shall conform to the requirements specified in Section 8.

**S51. Tension Test (see Note S50.1)**

S51.1 One tension test shall be made on one fitting or representative test piece (See Note S50.2) per lot (See Note S50.3) of fittings. If the fittings are of welded construction, the tension specimen shall include the weld and shall be prepared so that the weld is at the midlength location of the specimen. However, in no case shall the tensile properties of the finished fitting be less than the requirements listed in the individual product specification.

NOTE S50.1—If the result of any of the tests specified in Supplementary Requirements S50, S51, or S63 do not conform to requirements, retests may be made at the manufacturer's expense on additional fittings or representative test pieces of double the original number from the same heat or lot as defined in Supplementary Requirements S50, S51, or S63, each of which shall conform to the requirements specified.

NOTE S50.2—Where the test specimen for the tension or intergranular corrosion bend test cannot be taken from a fitting due to size limitations, a representative test piece shall be obtained. The test piece shall be from the same lot it represents and shall have approximately the same amount of working. In addition, these pieces representing fittings manufactured from bars, plate, or forgings shall have a cross section equal to the greatest cross section of the fitting, and test pieces representing fittings manufactured from pipe shall have an outside diameter and wall thickness equal to those of the fitting. The test piece for fittings of welded construction shall be prepared to the same weld procedures and from the same heat of materials as the fittings it represents.

NOTE S50.3—A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material (and, if fabrication welding is performed using one lot number of electrode or one heat of weld wire), and heat treated using the same heat-treat cycle in either a continuous or batch-type furnace controlling within a range of 50 °F [28 °C] and equipped with recording pyrometers so that complete records of heat treatment are available.

**S52. Liquid Penetrant Examination**

S52.1 All surfaces shall be liquid penetrant examined in accordance with Test Method E165/E165M. Acceptance limits shall be specified by the purchaser. Personnel performing the examination shall be qualified in accordance with SNT-TC-1A-1988 or later.

**S53. Magnetic-Particle Examination**

S53.1 All accessible surfaces shall be magnetic particle examined in accordance with Guide E709. Acceptance limits shall be specified by the purchaser. Personnel performing the examination shall be qualified in accordance with SNT-TC-1A-1988 or later.

**S54. Hydrostatic Test**

S54.1 A hydrostatic test shall be applied as agreed upon between the manufacturer and purchaser.

**S55. Bar Stock Fittings**

S55.1 Bar stock fittings shall not be permitted.

**S56. Special Heat Treatment**

S56.1 A special heat treatment shall be applied as agreed upon between the manufacturer and the purchaser.

**S57. Hardness Test**

S57.1 If actual hardness testing of fittings is required, the frequency and the method used shall be as agreed upon between the manufacturer and the purchaser.

**S58. Special Fittings**

S58.1 Partial compliance fittings of size or shape not conforming to the dimensional requirements of ASME B16.9, B16.11, MSS-SP-79, MSS-SP-83, MSS-SP-95, and MSS-SP-97 shall meet all other requirements of the individual product specification. In addition to the marking required by Section 19, the grade designation symbol of the individual product specification shall be followed by the symbol "S58".

**S59. Heat Treatment of Concentric Reducers**

S59.1 Concentric reducers formed by local heating of the fitting shall be subsequently annealed, normalized, or normalized and tempered.

**S60. Marking Small Fittings**

S60.1 For small products where the space for marking is less than 1 in. [25 mm] in any direction, test reports are mandatory and marking may be restricted to only such symbols or codes as are necessary to identify the parts with test reports.

S60.2 When the configuration or size does not permit marking directly on the fitting, the marking method shall be a matter of agreement between the manufacturer and the purchaser.

**S61. Phosphorous and Sulphur Content**

S61.1 The phosphorous and sulphur contents of the fittings shall not exceed 0.025 %.

**S62. Ultrasonic Test**

S62.1 Each fitting or the raw material from which the fitting is made shall be ultrasonically tested to determine its soundness. The method, where applicable, shall be in accordance with Practice A388/A388M. Acceptance limits shall be specified by the purchaser. Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A-1988 or later.

S62.2 Each fitting or the raw material from which each fitting is made shall be ultrasonically tested to determine its soundness. The method, where applicable, shall be in accordance with Practice E213. Acceptable limits shall be specified by the purchaser. Personnel performing the examination shall be qualified in accordance with SNT-TC-1A-1988 or later.

**S63. Intergranular Corrosion Bend Test (see Note S50.1)**

S63.1 An intergranular corrosion bend test shall be made on one fitting or representative test piece (See Note S50.2) per lot (See Note S50.3) of fittings. If the fittings are of welded construction, the bend specimen shall include the weld and be prepared so that the weld is at the midlength location of the

specimen. Specimens containing a weld shall be bent so that the location of weld is at the point of maximum bend. The method of testing shall be in accordance with Practice E of Practices **A262** (rapid screening is not allowed) or Practice Z of Practices **A763**, as applicable.

#### **S64. Photomicrographs**

S64.1 Photomicrographs at 100 diameters shall be made for information only of the actual base metal structure from one fitting as furnished in each lot. The photomicrographs shall be identified as to fitting size, wall thickness, lot identification, and heat. The definition of “lot” shall be as specified by the purchaser.

#### **S65. Surface Finish**

S65.1 Machined surfaces shall have a maximum roughness of 250  $\mu\text{in}$ . AARH [6.3  $\mu\text{m}$ ]. All other surfaces shall be suitable for ultrasonic testing.

#### **S66. Repair Welding**

S66.1 No weld repair shall be permitted without prior approval of the purchaser.

#### **S67. Charpy V-Notch Test**

S67.1 Charpy V-notch test shall be made as specified on the order. The test temperature, acceptance criteria, number of tests, and location of tests (whether from base metal, weld metal, or heat affected zone of welds) shall be specified.

#### **S68. Special Notch Toughness**

S68.1 The impact test temperature or acceptance values, or both, shall be as agreed upon, but only with respect to lower temperatures or higher energy values.

#### **S69. Magnetic Particle Examination—Weld Metal**

S69.1 All accessible welds shall be examined in accordance with Guide **E709**. Accessible is defined as all outside surfaces, all inside fitting surfaces 24 in. [610 mm] in diameter and greater, and inside fitting surfaces less than 24 in. [610 mm] in diameter, for a distance of one diameter from the ends.

S69.2 *Acceptance Criteria*—The following indications are unacceptable:

S69.2.1 Any cracks and linear indications,

S69.2.2 Rounded indications with dimensions greater than  $\frac{3}{16}$  in. [4.8 mm],

S69.2.3 Four or more indications in any line separated by  $\frac{1}{16}$  in. [1.6 mm],

S69.2.4 Ten or more indications located in any 6 in.<sup>2</sup> [4000 mm<sup>2</sup>] of surface, with the major dimensions not to exceed 6 in. [150 mm] when the major dimension is oriented so that the area includes the maximum number of indications being evaluated.

S69.3 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A-1988 or later.

#### **S70. Liquid Penetrant Examination of Weld Metal**

S70.1 All accessible surfaces of fittings shall be examined in accordance with Test Method **E165/E165M**. Accessible is defined in S69.

S70.2 Acceptance criteria shall be in accordance with S69.2.

S70.3 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A-1988 or later.

#### **S71. Product Marking**

S71.1 Weld repaired parts shall be marked “S71”.

#### **S72. Nondestructive Electromagnetic (Eddy-Current) Test**

S72.1 For eddy-current testing, the calibration tube shall contain, at the option of the manufacturer, any one of the following discontinuities placed in the weld to establish a minimum sensitivity level for rejection.

S72.2 *Drilled Hole*—A hole not larger than 0.031 in. [0.79 mm] in diameter shall be drilled radially and completely through the tube wall, with care being taken to avoid distortion of the tube while drilling.

S72.3 *Transverse Tangential Notch*—Using a round tool or file with a  $\frac{1}{4}$ -in. [6-mm] diameter, a notch shall be filed or milled tangential to the surface and transverse to the longitudinal axis of the tube. The notch shall have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.004 in. [0.102 mm], whichever is greater.

S72.4 *Longitudinal Notch*—A notch 0.031 in. [0.79 mm] or less in width shall be machined in a radial plane parallel to the tube axis on the outside surface of the tube, to have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.004 in. [0.102 mm], whichever is greater. The length of the notch shall be compatible with the testing method.

S72.5 Fittings producing a signal equal to or greater than the calibration defect shall be subject to rejection. To be accepted, after rework, the fittings must pass the same test to which it was originally subjected.

S72.6 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A-1988 or later.

#### **S73. Weld Metal Analysis**

S73.1 Analysis of weld metal shall be reported.

#### **S74. Welding Procedure Test Record**

S74.1 A welding procedure test record shall be furnished.

#### **S75. Chemical Analysis of Remelted Steel**

S75.1 Each remelted ingot shall be assigned a unique identification number.

S75.2 A chemical analysis shall be made from each remelted ingot.

#### **S76. Electropolished Austenitic Grades**

S76.1 All electropolished austenitic fittings shall be of a cleanliness according to Specification **A967/A967M**.

S76.2 Details concerning which test method of Specification **A967/A967M** are to be a matter of agreement between the manufacturer and the purchaser.

#### **S77. Positive Material Identification Examination**

S77.1 Fittings shall be examined to assure that the purchaser is receiving fittings of the correct material grade prior to shipment of the fittings. This examination is to assure that no



material grade mix-up has happened during manufacturing and marking of the fittings.

S77.2 Fittings shall receive a Positive Material Identification examination using the methods of Guide E1916.

S77.3 The quantity examined shall be 100 % of the fittings.

S77.4 All fittings that are not of the correct material grade shall be rejected.

S77.5 The method of fitting marking after this examination shall be agreed upon between the manufacturer and purchaser.

### **S78. Requirements for Carbon Steel Products for Concentrated Hydrofluoric Acid Service**

S78.1 The maximum carbon equivalent based on heat analysis shall be as follows:

Maximum section thickness less than or equal to 1 in. CE maximum = 0.43

Maximum section thickness greater than 1 in. CE maximum = 0.45

S78.2 Determine the carbon equivalent (CE) as follows:

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

S78.3 Vanadium and Niobium maximum content based on heat analysis shall be:

Maximum Vanadium = 0.02 wt %

Maximum Niobium = 0.02 wt %

Maximum Vanadium plus Niobium = 0.03 wt %

(Note Niobium = Columbium)

S78.4 The maximum composition based on heat analysis of Ni + Cu shall be 0.15 wt %.

S78.5 The minimum C content based on heat analysis shall be 0.18 wt %. The maximum C content shall be as specified in the appropriate material specification.

S78.6 Repair welds shall not be made with E60XX electrodes. Use of E70XX electrodes is recommended and the resulting weld chemistry should meet the same chemistry criteria as the base metal as listed above.

S78.7 In addition to the requirements of product marking of the specification, an "HF" stamp or marking shall be provided on each component to identify that component complies with this supplementary requirement.

### **S79 Pressure Equipment Directive—Mechanical Testing**

S79.1 Charpy impact testing shall be done at the lowest scheduled operating temperature, but not higher than 68 °F [20 °C].

S79.2 The frequency of impact testing shall be the same as that specified in the product specification for the tension test, with three individual Charpy test specimens for each required tension test.

S79.3 The minimum impact absorption energy for the Charpy test specimen shall be at least 20 ft-lb [27 J].

S79.4 The minimum elongation in the tension test shall be measured on a gauge length of five times the diameter of the test specimen, and shall not be less than 14 %.

S79.5 Impact and tension test results shall be included in the product certification.

## **ANNEXES**

### **(Mandatory Information)**

#### **A1. REQUIREMENTS FOR THE INTRODUCTION OF NEW MATERIALS**

A1.1 New materials may be proposed for inclusion in specifications referencing this specification of general requirements subject to the following conditions:

A1.1.1 Application for the addition of a new grade to a specification shall be made to the chair of the subcommittee that has jurisdiction over that specification.

A1.1.2 The application shall be accompanied by a statement from at least one user indicating that there is a need for the new grade to be included in the applicable specification.

A1.1.3 The application shall be accompanied by test data as required by the applicable specification. Test data from a minimum of three test lots, as defined by the specification, each from a different heat, shall be furnished.

A1.1.4 The application shall provide recommendations for all requirements appearing in the applicable specification.

A1.1.5 The application shall state whether the new grade is covered by patent.

## A2. REQUIREMENTS FOR THE INTRODUCTION OF MATERIALS FROM OTHER A01 OR B02.07 SPECIFICATIONS

A2.1 Wrought materials that are already covered by another A01 or B02.07 specification may be proposed for inclusion in specifications referencing this specification of general requirements subject to the following conditions:

A2.1.1 Application for the addition of a grade that is already covered in another A01 or B02.07 specification shall be made to the chair of the subcommittee that has jurisdiction over that specification.

A2.1.2 The chemical requirements, the specified mechanical properties, and the heat treatment requirements of the grade being added shall be the same as those for the grade in the A01 or A01 specification in which the grade is presently covered.

A2.1.3 The application shall provide recommendations for all requirements appearing in the applicable specification.

A2.1.4 The application shall state whether or not the grade is covered by patent.

## SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A960/A960M – 20) that may impact the use of this standard. (Approved May 1, 2023.)

- (1) Added definition of longitudinal axis to 3.1.6.
- (2) Revised 6.2 to clarify what parts may be machined directly from bar or seamless tubular material.

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