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Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications[1]

This standard is issued under the fixed designation A961/A961M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers a group of common requirements that shall apply to steel flanges, forged fittings, valves, and parts for piping applications under any of the following individual product specifications:

Title of Specification	ASTM Designation
Forgings, Carbon Steel, for Piping Components	A105/A105M
Forgings, Carbon Steel, for General-Purpose Piping	A181/A181M
Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service	A182/A182M
Forgings, Carbon and Low Alloy Steel, Requiring Notch Toughness Testing for Piping Components	A350/A350M
Forged or Rolled 8 and 9 % Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service	A522/A522M
Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service	A694/A694M
Flanges, Forged, Carbon and Alloy Steel for Low Temperature Service	A707/A707M
Forgings, Carbon Steel, for Piping Components with Inherent Notch Toughness	A727/A727M
Forgings, Titanium-Stabilized Carbon Steel, for Glass-Lined Piping and Pressure Vessel Service	A836/A836M

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 Section 4.1.2). 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 between 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 standard. 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]

A105/A105M Specification for Carbon Steel Forgings for Piping Applications

A181/A181M Specification for Carbon Steel Forgings, for General-Purpose Piping

[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**

A182/A182M Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
A275/A275M Practice for Magnetic Particle Examination of Steel Forgings
A350/A350M Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A522/A522M Specification for Forged or Rolled 8 and 9% Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service
A694/A694M Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment
A707/A707M Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
A727/A727M Specification for Carbon Steel Forgings for Piping Components with Inherent Notch Toughness
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
A836/A836M Specification for Titanium-Stabilized Carbon Steel Forgings for Glass-Lined Piping and Pressure Vessel Service
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
A967/A967M Specification for Chemical Passivation Treatments for Stainless Steel Parts
A991/A991M Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products
A1058 Test Methods for Mechanical Testing of Steel Products—Metric
B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys
E165/E165M Practice for Liquid Penetrant Testing for General Industry
E381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings
E709 Guide for Magnetic Particle Testing
E1916 Guide for Identification of Mixed Lots of Metals

2.2 *ASME Standard:*[3]

ASME Boiler and Pressure Vessel Code–Section IX

2.3 *Manufacturer's Standardization Society Standard:*[4]

SP 25 Standard Marking System of Valves, Fittings, Flanges and Unions

3. Terminology

3.1 *Definitions*—For definitions of other terms used in this specification, refer to Terminology A941.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bar, n*—a solid rolled or forged section that is long in relationship to its cross sectional dimensions, with a relatively constant cross section throughout its length and a wrought microstructure.

3.2.2 *certifying organization, n*—the company or association responsible for the conformance of, the marking of, and the certification of the product to the specification requirements.

3.2.3 *fitting, n*—a component for non-bolted joints in piping systems.

3.2.4 *flange, n*—a component for bolted joints used in piping systems.

3.2.5 *forging, n*—the product of a substantially compressive hot or cold plastic working operation that consolidates the material and produces the required shape.

3.2.5.1 *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 a wrought structure throughout the material cross section.

3.2.6 *seamless tubing, n*—a tubular product made without a welded seam.

3.2.6.1 *Discussion*—

It is manufactured usually by hot working the material, and if necessary, by subsequently cold finishing the hot worked tubular product to produce the desired shape, dimensions and properties.

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

[4] Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, http://www.mss-hq.com.

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 Size and pressure class or dimensions, (tolerances and surface finishes should be included),

4.1.3 Specification number with grade or class, or both, as applicable, and year/date,

4.1.4 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,

4.1.5 Supplementary requirements, and

4.1.6 Additional requirements.

5. Melting Process

5.1 Unless otherwise specified in the individual Product Specification, the steel shall be fully killed.

5.2 If a specific type of melting is required by the purchaser, it shall be stated on the purchase order.

5.3 The primary melting may incorporate separate degassing or refining and may be followed by secondary melting, such as electroslag remelting or vacuum remelting. If secondary melting is employed, the heat shall be defined as all of the ingot remelted from a single primary heat.

5.4 Steel may be cast in ingots or may be strand cast. When steel of different grades is sequentially strand cast, identification of the resultant transition material is required. The steel producer shall remove the transition material by an established procedure that positively separates the grades.

5.5 A sufficient discard shall be made from the source material to secure freedom from injurious porosity and shrinkage, and undue segregation.

6. Manufacture

6.1 The finished part shall be manufactured from a forging that is as close as practicable to the finished size or shape. Alternative starting materials may be used, but with the following exceptions and requirements.

6.1.1 *Bar*—Flanges, elbows, return bends, tees, and header tees shall not be machined directly from bar. Other hollow cylindrical shaped parts up to, and including, NPS 4 can be machined from bar provided that the axial length of the part is approximately parallel to the metal flow lines of the starting stock.

6.1.2 *Wrought Seamless Pipe and Tubing*—Flanges shall not be machined directly from seamless pipe or tubing. Other hollow cylindrical shaped parts can be machined from seamless pipe and tubing provided that the axial length of the part is approximately parallel to the metal flow lines of the starting stock.

7. Heat Treatment

7.1 Material requiring heat treatment shall be treated as specified in the individual product specification using the following procedures that are defined in more detail in Terminology A941.

7.1.1 *Annealing*—Material 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)*—Material shall be heated to a temperature that causes the chromium carbides to go into solution, and then, quenched in water or rapidly cooled by other means to prevent re-precipitation.

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*—Material 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*—Material shall be reheated to the prescribed temperature below the transformation range, held at temperature for the greater of 30 min or 1 h/in. [25.4 mm] of thickness at the thickest section and cooled in still air.

7.1.6 *Stress Relieving*—Material 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*—Material shall be fully austenitized and quenched immediately in a suitable liquid medium. The quenched material shall be reheated to a minimum temperature of 1100 °F [590 °C] and cooled in still air.

7.1.8 *Same Heat Treat Cycle*—Heat treat loads at the same temperature, equivalent soak times as appropriate for the maximum section size on the respective load and equivalent cooling methods.

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.

8.2 *Heat Analysis*—An analysis of each heat of steel shall be made by the steel 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, or the product of one remelted ingot, from 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.

8.3 *Product Analysis*—If a product analysis is performed it shall be in accordance with Test Methods, Practices, and Terminology A751. Samples for analysis shall be taken from midway between center and surface of solid parts, midway between inner and outer surfaces of hollow parts, midway between center and surface of full-size prolongations or from broken mechanical test specimens. The chemical composition thus determined shall conform to the 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) × (P + Sn) × 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 × C minimum.

9. Mechanical Requirements

9.1 *Method of Mechanical Tests*—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) is specified.

9.2 For the purpose of determining conformance to the product specification requirements, specimens shall be obtained from the production forgings, or from separately forged test blanks prepared from the stock used to make the finished product. In either case, mechanical test specimens shall not be removed until after all heat treatment is complete. If repair welding is performed, test specimens shall not be removed until after post-weld heat treatment is complete, unless permitted by the product specification. The locations from which test specimens are removed shall be in accordance with the Product Specification.

9.3 If separately forged test blanks are used, they shall be of the same heat of steel, be subjected to substantially the same reduction and working as the production forging they represent, be heat treated in the same furnace charge except as provided for in the reduced testing provisions of the product specification, under the same conditions as the production forging, and be of the same nominal thickness as the maximum heat treated thickness of the production forging.

9.4 When parts are machined from bar or seamless tubing, as permitted in 6.1.1 and 6.1.2, the mechanical properties may be determined for the parts from the starting material, if the parts have not been subjected to any subsequent thermal processing since the time of mechanical test.

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 Sampling for tensile testing shall conform to the Product Specification.

11.2 When the dimensions of the material to be tested will permit, the tension test specimens shall be machined to standard round 2-in. gauge length tension test specimen described in Test Methods and Definitions A370 if inch-pound units are specified or the standard gauge length tension test specimens described in the applicable track of Test Methods A1058 if SI units are specified.

11.3 In the case of small sections, which will not permit taking of the standard test specimen described in 11.2, the subsize round specimen shall be machined. The tension test specimen shall be as large as feasible.

11.4 The results of the tensile tests shall conform to the tensile property requirements prescribed in the product specification.

11.5 If the results of tension tests 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.

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
	over 20.00 to 30.00 incl.	0.25
Nickel	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
	over 30.00 to 40.00, incl.	0.25
Molybdenum	to 0.20 incl.	0.01
	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
Titanium	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.	0.07
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
	over 0.50 to 0.80, incl.	0.07
Vanadium	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]

[A] This table does not apply to heat analysis.
[B] Product analysis limits for cobalt under 0.05 % have not been established and the producer should be consulted for those limits.

[C] No over tolerance allowed.

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 part is insufficient to permit obtaining the smallest standard subsize impact specimens, an impact test by the part manufacturer will not be required.

12.4 If the average impact energy value meets the product specification requirements, but the energy value for one specimen is below the specified minimum value for individual specimens, a retest is permitted. This shall consist of two impact specimens from a location adjacent to, and on either side of, the specimen that failed. Each of the retested specimens must exhibit an energy value equal to or greater than the minimum average value required by 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 finished part. Such tests shall be conducted by the supplier only when the hydrostatic test supplementary requirement in the product specification 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 product may be reworked according to the following requirements:

14.1.1 If previously tested in the unheat treated 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 on the purchaser's drawing or order and 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 or as-forged condition.

15.3 The parts shall be free of injurious imperfections as defined below. At the discretion of the inspector representing the purchaser, finished parts shall be subject to rejection if surface imperfections acceptable under 15.5 are not scattered, but appear over a large area.

15.4 *Depth of Injurious Imperfections*—Selected typical linear and other typical surface imperfections shall be explored for depth. When the depth encroaches on the minimum specified wall thickness of the finished part, such imperfections shall be considered injurious.

15.5 *Imperfections Not Classified as Injurious*—Surface imperfections not classified as injurious shall be treated as follows:

15.5.1 Seams, laps, tears, or slivers not deeper than 5 % of the actual wall thickness at the point of interest or 1⁄16 in. [1.6 mm], whichever is less, are acceptable. If deeper, these imperfections require removal, and shall be removed by machining or grinding.

15.5.2 Mechanical marks or abrasions and pits shall be acceptable without grinding or machining provided the depth does not exceed 1⁄16 in. [1.6 mm]. If such imperfections are deeper than 1⁄16 in. [1.6 mm] but do not encroach on the minimum wall thickness of the forging they shall be removed by machining or grinding to sound metal.