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Endorsed by
Manufacturers Standardization Society
of the Valve and Fittings Industry
Used in USDOE-NE Standards

Standard Specification for Carbon Steel Forgings for Piping Applications¹

This standard is issued under the fixed designation A105/A105M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification² covers forged carbon steel piping components for ambient- and higher-temperature service in pressure systems. Included are flanges, fittings, valves, and similar parts ordered either to dimensions specified by the purchaser or to dimensional standards such as the MSS, ASME, and API specifications referenced in Section 2. Forgings made to this specification are limited to a maximum weight of 10 000 lb [4540 kg]. Larger forgings may be ordered to Specification **A266/A266M**. Tubesheets and hollow cylindrical forgings for pressure vessel shells are not included within the scope of this specification. Although this specification covers some piping components machined from rolled bar and seamless tubular products (see 5.2), it does not cover raw material produced in these product forms.

1.2 Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order.

1.3 Specification **A266/A266M** covers other steel forgings and Specifications **A675/A675M** and **A696** cover other steel bars.

1.4 This specification is expressed in both inch-pound units and SI units. However, unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished to inch-pound units. The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as “nominal diameter,” “size,” and “nominal size.”

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 In addition to those reference documents listed in Specification **A961/A961M**, the following list of standards apply to this specification:

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 ASME Boiler and Pressure Vessel Code applications see related Specification SA-105 in Section II of that Code.

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



2.2 *ASTM Standards:*³

- A266/A266M Specification for Carbon Steel Forgings for Pressure Vessel Components
- A675/A675M Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
- A696 Specification for Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality, for Pressure Piping Components
- A788/A788M Specification for Steel Forgings, General Requirements
- A961/A961M Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications

2.3 *MSS Standards:*

- SP 44 Standard for Steel Pipe Line Flanges⁴

2.4 *ASME Standards:*

- B16.5 Dimensional Standards for Steel Pipe Flanges and Flanged Fittings⁵
- B16.9 Wrought Steel Buttwelding Fittings⁵
- B16.10 Face-to-Face and End-to-End Dimensions of Ferrous Valves⁵
- B16.11 Forged Steel Fittings, Socket Weld, and Threaded⁵
- B16.34 Valves-Flanged, Threaded and Welding End⁵
- B16.47 Large Diameter Steel Flanges⁵

2.5 *ASME Boiler and Pressure Vessel Code:*⁵

Section IX

2.6 *API Standards:*

- API-600 Flanged and Butt-Welding-End Steel Gate Valves⁶
- API-602 Compact Design Carbon Steel Gate Valves for Refinery Use⁶

3. Terminology

3.1 *Definitions*—For definitions of other terms used in this specification, refer to Specification A961/A961M.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *heaviest cross-section, n*—maximum heat treated thickness of the production forging.

4. Ordering Information

4.1 See Specification A961/A961M.

4.1.1 Additional requirements (see 14.2).

5. General Requirements

5.1 Product furnished to this specification shall conform to the requirements of Specification A961/A961M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the requirements of Specification A961/A961M constitutes nonconformance with this specification. In case of a conflict between the requirements of this specification and Specification A961/A961M, this specification shall prevail.

5.2 Except as permitted by Section 6 in Specification A961/A961M, the finished product shall be a forging as defined in the Terminology Section of Specification A788/A788M.

6. Heat Treatment

6.1 Heat treatment is not a mandatory requirement of this specification except for the following piping components:

³ 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.

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

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

⁶ Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://www.api.org.

6.1.1 Flanges above Class 300,⁷

6.1.2 Flanges of special design where the design pressure at the design temperature exceeds the pressure-temperature ratings of Class 300, Group 1.1,

6.1.3 Flanges of special design where the design pressure or design temperature are not known,

6.1.4 Piping components other than flanges which meet both of the following criteria: (1) over NPS 4 and (2) above Class 300, and

6.1.5 Piping components of Special Class⁸ other than flanges which meet both of the following criteria: (1) over NPS 4 and (2) when the working pressure at the operating temperature exceeds the tabulated values for Special Class 300, Group 1.1.

6.2 Heat treatment, when required by 6.1 shall be annealing, normalizing, or normalizing and tempering or quenching and tempering in accordance with Specification A961/A961M. After hot working and before reheating for heat treatment, the forging shall be allowed to cool substantially below the transformation range.

6.2.1 Quenching shall consist of either (1) fully austenitizing the forgings followed by quenching in a suitable liquid medium or (2) using a multiple stage procedure whereby the forgings are first fully austenitized and rapidly cooled, then reheated to partially reaustenitize, followed by quenching in a suitable liquid medium. All quenched forgings shall be tempered as prescribed in Specification A961/A961M.

7. Chemical Composition

7.1 The steel shall conform to the chemical requirements specified in Table 1.

7.2 Steels to which lead has been added shall not be used.

8. Mechanical Properties

8.1 The material shall conform to the mechanical property requirements prescribed in Table 2 and Table 3.

8.2 For normalized, normalized and tempered, or quenched and tempered forgings, the central axis of the test specimen shall be taken at least $\frac{1}{4} T$ from the nearest surface as-heat-treated, where T is the maximum heat-treated thickness of the represented forging. In addition, for quenched and tempered forgings, the midlength of the test specimen shall be at least T from all other

TABLE 1 Chemical Requirements

NOTE 1—For each reduction of 0.01 % below the specified carbon maximum (0.35 %), an increase of 0.06 % manganese above the specified maximum (1.05 %) will be permitted up to a maximum of 1.65 %.

Element	Composition, %
Carbon	0.35 max
Manganese	0.60–1.05
Phosphorus	0.035 max
Sulfur	0.040 max
Silicon	0.10–0.35
Copper	0.40 max ^A
Nickel	0.40 max ^A
Chromium	0.30 max ^{A,B}
Molybdenum	0.12 max ^{A,B}
Vanadium	0.08 max ^A

^A The sum of copper, nickel, chromium, molybdenum and vanadium shall not exceed 1.00 %.

^B The sum of chromium and molybdenum shall not exceed 0.32 %.

⁷ For definition of Class 300, see ASME B16.5.

⁸ For definition of special class, see ASME B16.34.

TABLE 2 Mechanical Requirements^A

Tensile strength, min, ksi [MPa]	70 [485]
Yield strength, min, ksi [MPa] ^B	36 [250]
Elongation in 2 in. or 50 mm, min, %:	
Basic minimum elongation for walls $\frac{5}{16}$ in. [7.9 mm] and over in thickness, strip tests.	30
When standard round 2-in. or 50-mm gauge length or smaller proportionally sized specimen with the gauge length equal to 4D is used	22
When standard round 2-in. or 50-mm gauge length or smaller proportionally sized specimen with the gauge length equal to 4D is used	22
For strip tests, a deduction for each $\frac{1}{32}$ in. [0.8 mm] decrease in wall thickness below $\frac{5}{16}$ in. [7.9 mm] from the basic minimum elongation of the percentage points of Table 3	1.50 ^C
Strip specimens for wall thickness $\frac{5}{16}$ in. [7.94 mm] and over and for small sizes tested in full section.	30
Formula for calculating min elongation for strip specimens thinner than $\frac{5}{16}$ in. [7.94 mm]; min % in 2 in. [50 mm]: t = actual thickness	
Inch-pound units (in.)	$48t + 15$
SI units (mm)	$1.9t + 15$
Reduction of area, min, % ^D	30
Reduction of area, min, % ^C	30
Hardness, HBW, max	197

^A For small forgings, see 8.3.4.

^B Determined by either the 0.2 % offset method or the 0.5 % extension-under-load method.

^C See Table 3 for computed minimum values.

^D For round specimens only.

surfaces as-heat-treated, exclusive of the T dimension surfaces. When section thickness does not permit this positioning, the test specimen shall be positioned as near as possible to the prescribed location.

8.3 Tension Tests:

8.3.1 One tension test shall be made for each heat of as-forged components.

8.3.2 One tension test shall be made from each heat-treating charge. If more than one heat is included in such a charge, each heat shall be tested.

8.3.2.1 When forgings of different shapes are included in the same heat-treating charge, the test specimen shall be obtained from the heaviest cross-section of the thickest forging, except for hubbed flanges (see 8.3.3). The test specimen shall represent all forgings from the same heat and heat-treating charge whose maximum thicknesses do not exceed the thickness of the test forging.

8.3.2.2 When the heat-treating temperatures are the same and the furnaces (either batch or continuous type), are controlled within ± 25 °F [± 14 °C] and equipped with recording pyrometers so that complete records of heat treatment are available, then one tension test from each heat is required instead of one test from each heat in each heat-treatment charge. The test specimen material shall be included with a furnace charge.

8.3.3 Testing shall be performed as specified in Specification A961/A961M. The largest feasible round specimen shall be used except when hollow cylindrically shaped parts are machined from seamless tubulars. When hollow cylindrically shaped parts are machined from seamless tubular materials, strip tests may be used. The tension test specimen shall be obtained from a production forging, or from an integral prolongation representative of the hub location of a flange, or the heaviest cross section of a fitting, valve, or other part within the scope of this specification. Alternatively, the test specimen may be taken from a separately forged test block which has been taken from the same heat of steel as the production forgings, and which has been reduced by forging in a manner similar to that for the forgings it represents.