



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

This standard has been approved for use by agencies of the 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 4.2), 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. 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.

1.5 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."

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:

2.2 ASTM Standards:³

A266/A266M Specification for Carbon Steel Forgings for Pressure Vessel Components

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

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

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.

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>.

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

2.4 ASME Standards:

B16.5 Dimensional Standards for Steel Pipe Flanges and Flanged Fittings⁵

B16.9 Wrought Steel Butt-welding 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:

Section IX Welding Qualifications⁵

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. Ordering Information

3.1 See Specification A961/A961M.

3.1.1 Additional requirements (see 12.2).

4. General Requirements

4.1 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.

4.2 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.

5. Heat Treatment

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

5.1.1 Flanges above Class 300,⁷

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

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

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

5.1.5 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.

5.2 Heat treatment, when required by 5.1 shall be annealing, normalizing, or normalizing and tempering or quenching and tempering in accordance with Specification A961/A961M.

6. Chemical Composition

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

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

7. Mechanical Properties

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

7.2 For normalized, normalized and tempered, or quenched and tempered forgings, the central axis of the test specimen shall correspond to the $\frac{1}{4} T$ plane or deeper position, 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 any second heat-treated surface. When section thickness does not permit this positioning, the test specimen shall be positioned as near as possible to the prescribed location.

7.3 Tension Tests:

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

7.3.2 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.

⁵ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three 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>.

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

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

TABLE 1 Chemical Requirements

NOTE—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 1.35 %.

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 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 %.

TABLE 2 Mechanical Requirements^A

Tensile strength, min, psi [MPa]	70 000 [485]
Yield strength, min, psi [MPa] ^B	36 000 [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 gage length or smaller proportionally sized specimen with the gage 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
Reduction of area, min, % ^D	30
Hardness, HB, max	187

^A For small forgings, see 7.3.4.

^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.

TABLE 3 Computed Minimum Values

Wall Thickness		Elongation in 2 in. or 50 mm, min, %
in.	mm	
$\frac{5}{16}$ (0.312)	7.9	30.00
$\frac{9}{32}$ (0.281)	7.1	28.50
$\frac{1}{4}$ (0.250)	6.4	27.00
$\frac{7}{32}$ (0.219)	5.6	25.50
$\frac{3}{16}$ (0.188)	4.8	24.00
$\frac{5}{32}$ (0.156)	4.0	22.50
$\frac{1}{8}$ (0.125)	3.2	21.00
$\frac{3}{32}$ (0.094)	2.4	19.50
$\frac{1}{16}$ (0.062)	1.6	18.00

Note—The above table gives the computed minimum elongation values for each $\frac{1}{32}$ -in. [0.8-mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following equation:

$$E = 48T + 15.00$$

where:

E = elongation in 2 in. or 50 mm, %, and

T = actual thickness of specimen, in. [mm].

7.3.2.1 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.

7.3.3 Testing shall be performed in accordance with Test Methods and Definitions A370. The largest feasible round specimen