



## Standard Specification for Carbon Steel Forgings for Piping Applications<sup>1</sup>

This standard is issued under the fixed designation A 105/A 105M; 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.

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

### 1. Scope

1.1 This specification<sup>2</sup> 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 ANSI 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 A 266. 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 A 266/A 266M covers other steel forgings and Specifications A 675, A 695, and A 696 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.

1.5 The values stated in either inch-pound units or SI are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

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 A 961, the following list of standards apply to this specification:

#### 2.2 ASTM Standards:

A 266/A 266M Specification for Carbon Steel Forgings for Pressure Vessel Components<sup>3</sup>

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>3,4,5</sup>

A 675 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties<sup>3</sup>

A 695 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, for Fluid Power Applications<sup>3</sup>

A 696 Specification for Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality, for Pressure Piping Components<sup>3</sup>

A 788 Specification for Steel Forgings, General Requirements<sup>3</sup>

A 961 Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications<sup>4</sup>

E 340 Test Method for Macroetching Metals and Alloys<sup>6</sup>

#### 2.3 MSS Standards:

SP 44 Standard for Steel Pipe Line Flanges<sup>7</sup>

#### 2.4 ASME Standards:

B16.5 Dimensional Standards for Steel Pipe Flanges and Flanged Fittings<sup>8</sup>

B16.9 Wrought Steel Butt-welding Fittings<sup>8</sup>

B16.10 Face-to-Face and End-to-End Dimensions of Ferrous Valves<sup>8</sup>

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

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.05.

<sup>4</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.03.

<sup>6</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>7</sup> Available from Manufacturers' Standardization Society of the Valve and Fittings Industry, 127 Park Street, NE Vienna, VA 22180-4602.

<sup>8</sup> Available from ASME International, Three Park Avenue, New York, NY 10016-5990.

B16.11 Forged Steel Fittings, Socket Weld, and Threaded<sup>8</sup>  
 B16.34 Valves-Flanged, Threaded and Welding End<sup>8</sup>  
 B16.47 Large Diameter Steel Flanges<sup>8</sup>

2.5 API Standards:

API-600 Flanged and Butt-Welding-End Steel Gate Valves<sup>9</sup>  
 API-602 Compact Design Carbon Steel Gate Valves for Refinery Use<sup>9</sup>

2.6 AWS Standard:

AWSA 5.1 Mild Steel Covered Arc-Welding Electrodes<sup>10</sup>

**3. Ordering Information**

3.1 See Specification A 961.

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 A 961, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the requirements of Specification A 961 constitutes nonconformance with this specification. In case of a conflict between the requirements of this specification and Specification A 961, this specification shall prevail.

4.2 Except as permitted by Section 6 in Specification A 961, the finished product shall be a forging as defined in the Terminology Section of Specification A 788.

**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,<sup>11</sup>

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 Class<sup>12</sup> 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 A 961.

**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.

<sup>9</sup> Available from American Petroleum Institute, 2101 L St. N.W., Washington, DC 20037.

<sup>10</sup> Available from American Welding Society, 550 LeJeune Rd., P.O. Box 351040, Miami, FL 33135.

<sup>11</sup> For definition of Class 300, see ASME B16.5.

<sup>12</sup> 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 <sup>A</sup>
Nickel	0.40 max <sup>A</sup>
Chromium	0.30 max <sup>A,B</sup>
Molybdenum	0.12 max <sup>A,B</sup>
Vanadium	0.05 max
Columbium	0.02 max

<sup>A</sup> The sum of copper, nickel, chromium and molybdenum shall not exceed 1.00 %.

<sup>B</sup> The sum of chromium and molybdenum shall not exceed 0.32 %.

**TABLE 2 Mechanical Requirements<sup>A</sup>**

Tensile strength, min, psi [MPa]	70 000 [485]
Yield strength, min, psi [MPa] <sup>B</sup>	36 000 [250]
Elongation in 2 in. or 50 mm, min, %:	
Basic minimum elongation for walls <sup>5</sup> / <sub>16</sub> 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 <sup>1</sup> / <sub>32</sub> -in. [0.8-mm] decrease in wall thickness below <sup>5</sup> / <sub>16</sub> in. [7.9 mm] from the basic minimum elongation of the percentage points of Table 3	1.50 <sup>C</sup>
Reduction of area, min, % <sup>D</sup>	30
Hardness, HB, max	187

<sup>A</sup> For small forgings, see 7.3.4.

<sup>B</sup> Determined by either the 0.2 % offset method or the 0.5 % extension-under-load method.

<sup>C</sup> See Table 3 for computed minimum values.

<sup>D</sup> For round specimens only.

**TABLE 3 Computed Minimum Values**

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

Note—The above table gives the computed minimum elongation values for each <sup>1</sup>/<sub>32</sub>-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. 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