



Standard Specification for Titanium-Stabilized Carbon Steel Forgings for Glass-Lined Piping and Pressure Vessel Service¹

This standard is issued under the fixed designation A 836/A836M; 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 nonstandard as-forged fittings, valve components, and parts for glass-lined piping and pressure vessel service. Mechanical properties are certified on the basis of test material subjected to heat treatments to simulate glass-coating operations.

1.2 The values stated in either inch-pound units or SI units 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. The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.²

2. Referenced Documents

2.1 ASTM Standards:

A 275/A275M Test Method for Magnetic Particle Examination of Steel Forgings³

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products⁴

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment³

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products⁴

A 788 Specification for Steel Forgings, General Requirements³

E 165 Test Method for Liquid Penetrant Examination⁵

E 709 Guide for Magnetic Particle Examination⁵

2.2 ASME Boiler and Pressure Vessel Code:

Section IX Welding Qualifications⁶

2.3 Military Standard:

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage⁷

3. Ordering Information

3.1 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:

3.1.1 Quantity,

3.1.2 Dimensions (Tolerance and surface finishes should be included),

3.1.3 Specification number and class (The year date should be included),

3.1.4 Supplementary requirements, and

3.1.5 Additional requirements (see 10.1, 13.1, 13.2, 13.3, and 15.2).

4. Materials and Manufacture

4.1 Material for forgings shall consist of ingots, or forged, rolled, or strand cast blooms, billets, slabs, or bars.

4.2 The material shall be forged by hammering, pressing, rolling, extruding, or upsetting, such that the finished product will be a forging as defined in the Terminology Section of Specification A 788.

4.3 A sufficient discard shall be made from the source material to secure freedom from injurious piping and undue segregation.

4.4 When specified in the order, the manufacturer shall submit for approval by the purchaser a sketch showing the shape of the rough forging before machining.

4.5 Forgings shall be protected against sudden or too rapid cooling from the rolling or forging while passing through the critical range.

4.6 Heat treatment of forgings is neither required nor prohibited. However, the test material for qualifying the forging or the welding procedure shall be heat treated to simulate glass-coating operations.

5. Chemical Composition

5.1 *Cast or Heat Analysis*—An analysis of each cast or heat shall be made by the manufacturer to determine the percentages of the elements specified in Table 1. The analysis shall be

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Valves, Fittings, Bolting, and Flanges for High and Subatmospheric Temperatures.

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² *Annual Book of ASTM Standards*, Vol 03.05.

³ *Annual Book of ASTM Standards*, Vol 01.05.

⁴ *Annual Book of ASTM Standards*, Vol 01.03.

⁵ *Annual Book of ASTM Standards*, Vol 03.03.

⁶ Available from American Society of Mechanical Engineers, 345 E. 47 St., New York, NY, 10017.

⁷ Available from U.S. Government Printing Office, Washington, DC 20402.

TABLE 1 Chemical Requirements

Element	Composition, %
Carbon, max	0.20
Manganese, max	0.90
Phosphorus, max	0.05
Silicon, max	0.35
Sulfur, max	0.05
Titanium, min	4× carbon content
Titanium, max.	1.00

made from a test sample, preferably taken during the pouring of the cast or heat. The chemical composition thus determined shall conform to the requirements in Table 1.

5.2 Product Analysis:

5.2.1 The purchaser may make a product analysis on forgings supplied to this specification by any of the commonly accepted methods that will positively identify the material. Samples for analysis may be taken from midway between center and surface of solid forgings, midway between inner and outer surfaces of hollow forgings, midway between center and surface of full-size prolongations, or from broken mechanical test specimens. The chemical composition thus determined shall conform to Table 1 within the permissible variations of Table 2.

5.2.2 Test Methods, Practices, and Terminology A 751 apply.

6. Mechanical Properties

6.1 The test material shall conform to the requirements as to tensile properties prescribed in Table 3.

6.2 Testing shall be performed in accordance with Test Methods and Definitions A 370.

7. Workmanship, Finish, and Appearance

7.1 The forgings shall be free of injurious imperfections as defined below and shall have a workmanlike finish. At the discretion of the inspector representing the purchaser, finished forgings shall be subject to rejection if surface imperfections acceptable under 8.3 are not scattered but appear over a large area in excess of what is considered a workmanlike finish.

7.2 Depth of Injurious Imperfections—Selected typical linear and other typical surface imperfections shall be explored

TABLE 2 Permissible Variations in Product Analysis

	Permissible Variations over the Maximum Limit or Under the Minimum Limit, % ^{A,B}				
	200 in. ² [1290 cm ²] and under	Over 200 to 400 in. ² [1290 to 2580 cm ²], incl	Over 400 to 800 in. ² [2580 to 5160 cm ²], incl	Over 800 to 1600 in. ² [5160 to 10 320 cm ²]	Over 1600 in. ² [10 320 cm ²]
Manganese Up to and in- cluding 0.90	0.04	0.05	0.06	0.07	0.08
Phosphorus	0.008	0.010	0.010	0.015	0.015
Sulfur	0.010	0.010	0.010	0.015	0.015
Silicon	0.03	0.04	0.04	0.05	0.06

^AProduct cross-sectional area is defined as (a) maximum cross-sectional area of rough machined forging (excluding boring), (b) maximum cross-sectional area of the unmachined forging, or (c) maximum cross-sectional area of the billet, bloom or slab.

^BArea taken at right angles to the axis of the original ingot or billet.

TABLE 3 Tensile Requirements

	Class I
Tensile strength, min, ksi [MPa]	55[380]
Yield strength, ^A min, ksi [MPa]	25[175]
Elongation in 2 in. or 50 mm, min, %	22
Reduction of area, min, %	35

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

for depth. When the depth encroaches on the minimum wall thickness of the finished forging, such imperfections shall be considered injurious.

7.3 Machining or Grinding Imperfections Not Classified as Injurious—Surface imperfections not classified as injurious shall be treated as follows:

7.3.1 Forgings showing seams, laps, tears, or slivers not deeper than 5 % of the nominal wall thickness or 1/16 in. [2 mm], whichever is less, need not have these imperfections removed. If the imperfections require removal, they shall be removed by machining or grinding.

7.3.2 Mechanical marks or abrasions and pits shall be acceptable without grinding or machining provided the depth does not exceed the limitations set forth in 8.2 and if not deeper than 1/16 in. [2 mm]. If such imperfections are deeper than 1/16 in. but do not encroach on the minimum wall thickness of the forging they shall be removed by grinding to sound metal.

7.3.3 When imperfections have been removed by grinding or machining, the outside dimension at the point of grinding or machining may be reduced by the amount removed. When impracticable to secure a direct measurement, the wall thickness at the point of grinding, or at imperfections not required to be removed, shall be determined by deducting the amount removed by grinding, from the nominal finished wall thickness of the forging; the remainder shall not be less than the minimum specified or required wall thickness.

8. Number of Tests and Retests

8.1 One tension test shall be made from each heat.

8.2 If any test specimen is defectively machined, it may be discarded and another specimen substituted.

8.3 When one or more representative test specimens do not conform to specification requirements for the tested characteristic, only a single retest for each nonconforming characteristic may be performed to establish product acceptability. Retests shall be performed on twice the number of representative specimens that were originally nonconforming. When any retest specimen does not conform to specification requirements for the characteristic in question, the lot represented by that specimen shall be rejected, or the test material shall be reheat-treated in accordance with 4.6 and 7.1, and tested in accordance with Sections 6, 7, and 9.

9. Test Specimens

9.1 The test material to be used for qualifying the forgings shall be heat treated with the forgings represented by the test material, if the forgings are heat treated, then, the test material shall be normalized three times from a minimum temperature of 1550°F [845°C] prior to testing. This heat treatment simulates glass-coating operations.