# SPECIFICATION FOR FORGINGS, TITANIUM-STABILIZED CARBON STEEL, FOR GLASS-LINED PIPING AND PRESSURE VESSEL SERVICE

SA-836/SA-836M

(Identical with ASTM Specification A 836/A 836M-95b.)

## 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. Referenced Documents

**2.1** *ASTM Standards:*

A 275/A 275M Test Method for Magnetic Particle Examination of Steel Forgings

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

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

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

A 788 Specification for Steel Forgings, General Requirements

E 165 Practice for Liquid Penetrant Inspection Method

E 709 Practice for Magnetic Particle Examination

**2.2** *ASME Boiler and Pressure Vessel Code:*

Section IX Welding Qualifications

**2.3** *Military Standard:*

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

## 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 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. Test Specimens

**7.1** 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.

**7.2** The tension test specimens shall be machined to the form and dimensions of the standard 2 in. [50 mm] gage length tension test specimen shown in Fig. 4 of Test Methods and Definitions A 370, except as specified in 7.3.

**7.3** In the case of small sections that will not permit taking standard test specimens as specified in 7.2, the tension test specimen shall be as large as feasible and its dimensions shall be proportional to those shown in Fig. 4 of Test Methods and Definitions A 370. The gage length for measuring elongation shall be four times the diameter of the specimen.

**7.4** For the purpose of determining conformance to Table 3, specimens shall be obtained from the production forgings, or from separately forged test blanks prepared from the stock used to make the finished product. Such test blanks shall receive approximately the same working as the finished product.

## 8. Workmanship, Finish, and Appearance

**8.1** 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.

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

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

**8.3.1** 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.

**8.3.2** 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.

**8.3.3** 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.

## 9. Number of Tests and Retests

**9.1** One tension test shall be made from each heat.

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

**9.3** 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.

## 10. Repair by Welding

**10.1** Approval by the purchaser shall be required prior to weld repair.

**10.2** The welding procedure and welders shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. The welded test plate used to qualify the procedure shall be normalized three times at 1550°F [845°C] prior to testing to simulate glass-coating operations.

**10.3** The composition of the weld deposits shall be similar to the base metal and in accordance with the procedure qualification for the applicable material. Welding shall be accomplished with a weld procedure designed to produce low hydrogen in the weldment. Short-circuit gas metal arc welding is permissible only with the approval of the purchaser.

**10.4** Unacceptable imperfections shall be removed by mechanical means or thermal cutting or gouging methods. Cavities prepared for welding shall be examined by one of the following methods to verify removal of the imperfection:

**10.4.1** Magnetic particle examination in accordance with Test Method A 275/A 275M or Practice E 709, or

**10.4.2** Liquid penetrant examination in accordance with Practice E 165.

**10.5** Weld repaired area(s) shall be blended uniformly to the base metal and shall be examined by the method used in 10.4.

**10.6** Repair by welding shall neither exceed 10% of the surface area of the part, nor $33^{1}/_{3}$% of the wall thickness of the finished product at the location of repair, without prior approval by the purchaser.

## 11. Inspection

**11.1** The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being produced and furnished in accordance with this specification. Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

## 12. Rejection and Rehearing

**12.1** Each forging that develops injurious defects during shop working or application shall be rejected and the manufacturer notified.

**12.2** Samples representing material rejected by the purchaser shall be preserved until disposition of the claim has been agreed upon by the manufacturer and the purchaser.

## 13. Certification

**13.1** When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. The specification designation included on test reports shall include year of issue and revision letter, if any.

**13.2** When specified in the purchase order or contract, a report of the test results shall be furnished.

**13.3** Upon request of the purchaser in the contract or order, a report of the test results and chemical analyses shall be furnished.

## 14. Marking of Forgings

**14.1** Identification marks consisting of the manufacturer's symbol or name (Note), designation of service rating, this specification number, class, and size shall be legibly forged or stamped on each forging, and in such a position as not to injure the usefulness of the forgings. The specification number marked on the forgings need not include specification year of issue and revision letter.

NOTE—For purposes of identification marking, the manufacturer is considered the organization that certifies the piping component was manufactured, sampled, and tested in accordance with this specification and the results have been determined to meet the requirements of this specification.

**14.2** *Bar Coding* — In addition to the requirements in 14.1, bar coding is acceptable as a supplementary identification method. The bar coding system, if applied at the discretion of the supplier, should be consistent with one of the published industry standards for bar coding. If used on small parts, the bar code may be applied to the box or a substantially applied tag.

## 15. Packaging, Marking, and Loading for Shipment

**15.1** Packaging, marking, and loading for shipment shall be in accordance with Practices A 700.

**15.2** When specified in the contract or order, and for direct procurement by or direct shipment to the government, when level A is specified, preservation, packaging, and packing shall be in accordance with the Level A requirements of MIL-STD-163.

## 16. Keywords

**16.1** pipe fittings, steel; piping applications; pressure containing parts; pressure vessel service; steel flanges; steel forgings-carbon; steel valves

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 |

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 including 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 |

[A] Product cross-sectional area is defind 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.

[B] Area 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 |

[A] Determined by either 0.2% offset method or the 0.5% extension-under-load method.