# SPECIFICATION FOR STEEL CASTINGS, MARTENSITIC STAINLESS AND ALLOY, FOR PRESSURE-CONTAINING PARTS, SUITABLE FOR HIGH-TEMPERATURE SERVICE

**SA-217/SA-217M**

(Identical with ASTM Specification A217/A217M-07.)

# SPECIFICATION FOR STEEL CASTINGS, MARTENSITIC STAINLESS AND ALLOY, FOR PRESSURE-CONTAINING PARTS, SUITABLE FOR HIGH-TEMPERATURE SERVICE

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(Identical with ASTM Specification A 217/A 217M-07.)

## 1. Scope

**1.1** This specification covers martensitic stainless steel and alloy steel castings for valves, flanges, fittings, and other pressure-containing parts (Note 1) intended primarily for high-temperature and corrosive service (Note 2).

**1.2** One grade of martensitic stainless steel and nine grades of ferritic alloy steel are covered. Selection will depend on design and service conditions, mechanical properties, and the high-temperature and corrosion-resistant characteristics (Note 3).

NOTE 1 — Carbon steel castings for pressure-containing parts are covered by Specification A 216/A 216M. Low alloy quench-and-tempered grades equivalent to Specification A 217/A 217M grades may be found in both Specifications A 352/A 352M and A 487/A 487M.

NOTE 2 — The grades covered by this specification represent materials that are generally suitable for assembly with other castings or wrought steel parts by fusion welding. It is not intended to imply that these grades possess equal degrees of weldability; therefore, it is the responsibility of the purchaser to establish for himself a suitable welding technique. Since these grades possess varying degrees of suitability for high-temperature and corrosion-resistant service, it is also the responsibility of the purchaser to determine which grade shall be furnished, due consideration being given to the requirements of the applicable construction codes.

NOTE 3 — The committee formulating this specification has included nine grades of materials that are considered to represent basic types of ferritic alloy steels suitable for valves, flanges, fittings, and other pressure-containing parts. Additional alloy steels that may better fulfill certain types of service will be considered for inclusion in this specification by the committee as the need becomes apparent.

**1.3** 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. Inch-pound units are applicable for material ordered to Specification A 217 and SI units for materials ordered to Specification A 217M.

## 2. Referenced Documents

**2.1** *ASTM Standards:*

A 216/A 216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

A 352/A 352M Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service

A 487/A 487M Specification for Steel Castings Suitable for Pressure Service

A 488/A 488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel

A 703/A 703M Specification for Steel Castings, General Requirements, for Pressure-Containing Parts

A 802/A 802M Practice for Steel Castings, Surface Acceptance Standards, Visual Examination

A 985/A 985M Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts

E 165 Test Method for Liquid Penetrant Examination

E 709 Guide for Magnetic Particle Examination

## 3. General Conditions for Delivery

**3.1** Except for investment castings, castings furnished to this specification shall conform to the requirements of Specification A 703/A 703M including any supplementary

requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A 703/A 703M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 703/A 703M, this specification shall prevail.

**3.2** Steel investment castings furnished to this specification shall conform to the requirements of Specification A 985/A 985M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A 985/A 985M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 985/A 985M, Specification A 985/A 985M shall prevail.

## 4. Ordering Information

**4.1** The inquiry and order should include or indicate the following:

**4.1.1** A description of the casting by pattern number or drawing (dimensional tolerances shall be included on the casting drawing),

**4.1.2** Grade of steel,

**4.1.3** Options in the specification,

**4.1.4** Whether the castings are to be produced using the investment casting process, and

**4.1.5** The supplementary requirements desired including the standards of acceptance.

## 5. Heat Treatment

**5.1** All castings shall receive a heat treatment proper to their design and chemical composition.

**5.2** Castings shall be furnished in the normalized and tempered conditions; Grades WC1, WC4, WC5, WC6, and CA15 shall be tempered at 1100°F [595°C] min; Grades WC9, C5, C12, and WC11 shall be tempered at 1250°F [675°C] min; Grade C12A shall be normalized at 1900-1975°F [1040–1080°C] and tempered at 1350–1470°F [730–800°C].

**5.3** Heat treatment shall be performed after castings have been allowed to cool below the transformation range.

## 6. Chemical Composition

**6.1** The steel shall be in accordance with the requirements as to chemical composition prescribed in Table 1 (Note 4).

NOTE 4 — The role of alloying elements in the development of Grade C12A has been extensively investigated. V and Cb contribute to precipitation strengthening by forming fine and coherent precipitation of M(C,N)X carbo-nitrides in the ferrite matrix. V also precipitates as VN during tempering or during creep. The two elements are more effective in combination. Therefore, the addition of strong nitride-forming elements, those with a stronger affinity for nitrogen than Cb and V, as deoxidation agents, interferes with these high-temperature strengthening mechanisms.

## 7. Tensile Requirements

**7.1** Steel used for the castings shall be in accordance with the requirements as to tensile properties prescribed in Table 2.

## 8. Quality

**8.1** The surface of the casting shall be examined visually and shall be free of adhering sand, scale, cracks, and hot tears. Other surface discontinuities shall meet the visual acceptance standards specified in the order. Practice A 802/A 802M or other visual standards may be used to define acceptable surface discontinuities and finish. Unacceptable visual surface discontinuities shall be removed and their removal verified by visual examination of the resultant cavities. When methods involving high temperature are used in the removal of discontinuities, castings shall be preheated to at least the minimum temperatures in Table 3.

**8.2** When additional inspection is desired, Supplementary Requirements S4, S5, and S10 may be ordered.

**8.3** The castings shall not be peened, plugged, or impregnated to stop leaks.

## 9. Repair by Welding

**9.1** Repairs shall be made using procedures and welders qualified under Practice A 488/A 488M.

**9.2** Weld repaired Grade C12A castings shall be postweld heat treated at 1350-1470°F [730-800°C].

**9.3** Weld repairs shall be inspected to the same quality standards that are used to inspect the castings. When castings are produced with Supplementary Requirement S4 specified, weld repairs shall be inspected by magnetic particle examination to the same standards that are used to inspect the castings. When castings are produced with Supplementary Requirement S5 specified, weld repairs on castings that have leaked on hydrostatic test, or on castings in which the depth of any cavity prepared for repair welding exceeds 20% of the wall thickness or 1 in. [25 mm], whichever is smaller, or on castings in which any cavity prepared for welding is greater than approximately 10 in.$^2$ [65 cm$^2$], shall be radiographed to the same standards that are used to inspect the castings.

**9.4** Weld repairs shall be considered major in the case of a casting that has leaked on hydrostatic test, or when

the depth of the cavity prepared for welding exceeds 20% of the wall thickness or 1 in. [25 mm], whichever is smaller, or when the extent of the cavity exceeds approximately 10 in.$^2$ [65 cm$^2$]. All castings with major repair welds shall be thermally stress relieved or completely reheat-treated. This mandatory stress relief or reheat-treatment shall be in accordance with the qualified procedure used. Major repairs shall be inspected to the same quality standards that are used to inspect the castings.

## 10. Keywords

**10.1** alloy steel; high temperature; martensitic stainless steel; pressure containing; steel castings

TABLE 1
CHEMICAL REQUIREMENTS

| | Composition, % | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Carbon Molybdenum | Nickel Chromium Molybdenum | Nickel Chromium Molybdenum | Chromium Molybdenum | Chromium Molybdenum | Chromium Molybdenum | Chromium Molybdenum | Chromium Molybdenum | Chromium Molybdenum Vanadium | Chromium |
| Grade Identification Symbol UNS Number | WC1 J12524 | WC4 J12082 | WC5 J22000 | WC6 J12072 | WC9 J21890 | WC11 J11872 | C5 J42045 | C12 J82090 | C12A J84090 | CA15 J91150 |
| Carbon | 0.25 | 0.05–0.20 | 0.05–0.20 | 0.05–0.20 | 0.05–0.18 | 0.15–0.21 | 0.20 | 0.20 | 0.08–0.12 | 0.15 |
| Manganese | 0.50–0.80 | 0.50–0.80 | 0.40–0.70 | 0.50–0.80 | 0.40–0.70 | 0.50–0.80 | 0.40–0.70 | 0.35–0.65 | 0.30–0.60 | 1.00 |
| Phosphorus | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.020 | 0.04 | 0.04 | 0.030 | 0.040 |
| Sulfur | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 | 0.015 | 0.045 | 0.045 | 0.010 | 0.040 |
| Silicon | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.30–0.60 | 0.75 | 1.00 | 0.20–0.50 | 1.50 |
| Nickel | ... | 0.70–1.10 | 0.60–1.00 | ... | ... | ... | ... | ... | 0.40 | 1.00 |
| Chromium | ... | 0.50–0.80 | 0.50–0.90 | 1.00–1.50 | 2.00–2.75 | 1.00–1.50 | 4.00–6.50 | 8.00–10.00 | 8.0–9.5 | 11.5–14.0 |
| Molybdenum | 0.45–0.65 | 0.45–0.65 | 0.90–1.20 | 0.45–0.65 | 0.90–1.20 | 0.45–0.65 | 0.45–0.65 | 0.90–1.20 | 0.85–1.05 | 0.50 |
| Columbium | ... | ... | ... | ... | ... | ... | ... | ... | 0.060–0.10 | ... |
| Nitrogen | ... | ... | ... | ... | ... | ... | ... | ... | 0.030–0.070 | ... |
| Vanadium | ... | ... | ... | ... | ... | ... | ... | ... | 0.18–0.25 | ... |
| Specified Residual Elements | | | | | | | | | | |
| Aluminum | ... | ... | ... | ... | ... | 0.01 | ... | ... | 0.02 | ... |
| Copper | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.35 | 0.50 | 0.50 | ... | ... |
| Nickel | 0.50 | ... | ... | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | ... | ... |
| Chromium | 0.35 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Titanium | ... | ... | ... | ... | ... | ... | ... | ... | 0.01 | ... |
| Tungsten | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | ... | 0.10 | 0.10 | ... | ... |
| Vanadium | ... | ... | ... | ... | ... | 0.03 | ... | ... | ... | ... |
| Zirconium | ... | ... | ... | ... | ... | ... | ... | ... | 0.01 | ... |
| Total content of these residual elements | 1.00 | 0.60 | 0.60 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | |

NOTE — All values are maximum unless otherwise indicated.

TABLE 2
TENSILE REQUIREMENTS

| Grade | Tensile Strength, ksi [MPa] | Yield Strength,[A] min, ksi [MPa] | Elongation in 2 in. [50 mm], min, %[B] | Reduction of Area, min, % |
|---|---|---|---|---|
| WC1 | 65 [450] to 90 [620] | 35 [240] | 24 | 35 |
| WC4, WC5, WC6, WC9 | 70 [485] to 95 [655] | 40 [275] | 20 | 35 |
| WC11 | 80 [550] to 105 [725] | 50 [345] | 18 | 45 |
| C5, C12 | 90 [620] to 115 [795] | 60 [415] | 18 | 35 |
| C12A | 85 [585] to 110 [760] | 60 [415] | 18 | 45 |
| CA15 | 90 [620] to 115 [795] | 65 [450] | 18 | 30 |

[A] Determine by either 0.2% offset method or 0.5% extension-under-load method.
[B] When ICI test bars are used in tensile testing as provided for in Specification A 703/A 703M, the gage length to reduced section diameter ratio shall be 4 to 1.

TABLE 3
MINIMUM PREHEAT TEMPERATURES

| Grade | Thickness, in. [mm] | Minimum Preheat Temperature, °F [°C] |
|---|---|---|
| WC1 | $\frac{5}{8}$ and under | 50 [10] |
| | Over $\frac{5}{8}$ [15.9] | 250 [120] |
| WC4 | All | 300 [150] |
| WC5 | All | 300 [150] |
| WC6 | All | 300 [150] |
| WC9 | All | 400 [200] |
| WC11 | All | 300 [150] |
| C5 | All | 400 [200] |
| C12 | All | 400 [200] |
| C12A | All | 400 [200] |
| CA15 | All | 400 [200] |

# SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall not apply unless specified in the purchase order. A list of standardized supplementary requirements for use at the option of the purchaser is included in Specification A 703/A 703M. Those which are ordinarily considered suitable for use with this specification are given below. Others enumerated in Specification A 703/A 703M may be used with this specification upon agreement between the manufacturer and purchaser.

**S1. Unspecified Elements**

**S2. Destruction Tests**

**S3. Bend Tests**

**S4. Magnetic Particle Inspection**

**S5. Radiographic Inspection**

**S10. Examination of Weld Preparation**

**S10.1** The method of performing the magnetic particle or liquid penetrant test shall be in accordance with Test Method E 165 or Guide E 709.

**S13. Hardness Test**

**S21. Heat Treatment Furnace Record**

**S22. Heat Treatment**

**S51. Mandatory Postweld Heat Treatment**

**S51.1** All castings with repair welds shall receive a mandatory thermal stress relief or complete reheat treatment in accordance with the qualified procedure after all weld repairs.

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