Designation: A216/A216M – 18

Endorsed by Manufacturers Standardization Society of the Valve and Fittings Industry
Endorsed by American Foundrymen's Society
Used in USDOE-NE Standards

Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service[1]

This standard is issued under the fixed designation A216/A216M; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification[2] covers carbon steel castings for valves, flanges, fittings, or other pressure-containing parts for high-temperature service and of quality suitable for assembly with other castings or wrought steel parts by fusion welding.

1.2 Three grades, WCA, WCB, and WCC, are covered in this specification. Selection will depend upon design and service conditions, mechanical properties, and the high-temperature characteristics.

1.3 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 nonconformance with the standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A488/A488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel

A703/A703M Specification for Steel Castings, General Requirements, for Pressure-Containing Parts

A985/A985M Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts

2.2 *Manufacturers Standardization Society of the Valve and Fittings Industry Standard:*[4]

SP 55 Steel Castings for Valve, Flanges, and Fittings, and Other Components (Visual Method)

3. General Conditions for Delivery

3.1 Except for investment castings, castings furnished to this specification shall conform to the requirements of Specification A703/A703M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A703/A703M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A703/A703M, this specification shall prevail.

3.2 Steel investment castings furnished to this specification shall conform to the requirements of Specification A985/A985M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A985/A985M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A985/A985M, Specification A985/A985M 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),

[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 A01.18 on Castings.

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[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-216/SA-216M 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**

TABLE 1 Chemical Requirements[A]

Material Grade UNS	Element, %									
	Carbon	Manganese	Phosphorus	Sulfur[B]	Silicon	Nickel[C]	Chromium[C]	Molybdenum[C]	Copper[C]	Vanadium[C]
WCA[D] J02502	0.25	0.70	0.035	0.035	0.60	0.50	0.50	0.20	0.30	0.03
WCB[D] J03002	0.30	1.00	0.035	0.035	0.60	0.50	0.50	0.20	0.30	0.03
WCC[D] J02503	0.25	1.20	0.035	0.035	0.60	0.50	0.50	0.20	0.30	0.03

[A] All values are maximums.
[B] For lower maximum sulfur content, see Supplementary Requirement S52.
[C] Specified Residual Elements—Except when Supplementary Requirement S50 is specified, the total content of these elements is 1.00 % maximum.
[D] For each reduction of 0.01 % below the specified maximum carbon content, an increase of 0.04 % manganese above the specified maximum will be permitted up to a maximum of 1.10 % for WCA, 1.28 % for WCB, and 1.40 % for WCC.

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 annealed, or normalized, or normalized and tempered condition unless Supplementary Requirement S15 is specified.

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

6. Temperature Control

6.1 Furnace temperatures for heat treating shall be effectively controlled by pyrometer.

7. Chemical Composition

7.1 The steel shall be in accordance with the requirements as to chemical composition prescribed in Table 1.

8. Tensile Requirements

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

TABLE 2 Tensile Requirements[A]

Material Grade	Tensile Strength, ksi [MPa]	Yield Strength,[B] ksi [MPa]	Elongation in 2 in. [50 mm], %[C]	Reduction of Area, %
WCA	60 – 85 [415 – 585]	30 [205]	24	35
WCB	70 – 95 [485 – 655]	36 [250]	22	35
WCC	70 – 95 [485 – 655]	40 [275]	22	35

[A] All values are minimums, except where a range is provided.
[B] Determine by either 0.2 % offset method or 0.5 % extension-under-load method.
[C] When ICI test bars are used in tensile testing as provided for in Specification A703/A703M, the gage length to reduced section diameter ratio shall be 4 to 1.

9. Quality

9.1 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. Visual Method SP-55 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.

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

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

10. Repair by Welding

10.1 Repairs shall be made using procedures and welders qualified under Practice A488/A488M.

10.2 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.

10.3 Castings containing any repair weld that exceeds 20 % of the wall thickness or 1 in. [25 mm], whichever is smaller, or that exceeds approximately 10 in.^{2} [65 cm^2] in area, or that was made to correct hydrostatic test defects, shall be stress relieved or heat treated after welding. This mandatory stress relief or heat treatment shall be in accordance with the procedure qualification used.

11. Keywords

11.1 carbon steel; high temperature; pressure-containing parts; steel castings

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall not apply unless specified in the purchase order. Lists of standardized supplementary requirements for use at the option of the purchaser are included in Specifications A703/A703M and A985/A985M. Those which are ordinarily considered suitable for use with this specification are given below. Others enumerated in Specifications A703/A703M and A985/A985M may be used with this specification upon agreement between the manufacturer and purchaser.

S1. Unspecified Elements

S2. Destruction Tests

S3. Bend Test

S4. Magnetic Particle Inspection

S5. Radiographic Inspection

S10. Examination of Weld Preparation

S15. Quench and Temper Heat Treatment

S50. Carbon Equivalent

S50.1 When specified in the order, the maximum carbon equivalent shall be:

Grade	Carbon Equivalent, max
WCA	0.50
WCB	0.50
WCC	0.55

S50.2 Carbon equivalent (*CE*) shall be determined as follows:

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

S51. Requirements for Carbon Steel Castings for Hydrofluoric Acid Alkylation Service

S51.1 The maximum carbon equivalent shall be as follows:

	CE maximum
Maximum specified section thickness less than or equal to 1 in. [25 mm]	0.43
Maximum specified section thickness greater than 1 in. [25 mm]	0.45

S51.2 Determine the carbon equivalent (*CE*) as follows:

$$CE = C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$$

S51.3 Vanadium and niobium maximum content based upon heat analysis shall be:

NOTE 1—Niobium = columbium

Maximum vanadium	0.02 wt %
Maximum niobium	0.02 wt %
Maximum vanadium plus niobium	0.03 wt %

S51.4 The sum of the nickel and copper contents, based upon heat analysis, shall not exceed 0.15 wt %.

S51.5 The minimum carbon content shall be 0.18 wt %. The maximum carbon content shall be as required for the appropriate grade.

S51.6 Welding consumables for repair welds shall be of the low-hydrogen type. E60XX electrodes shall not be used and the resulting weld chemistry shall meet the same chemistry requirements as the base metal.

S51.7 In addition to the requirements for product marking in the specification, an "HF-N" stamp or marking shall be provided on each casting to identify that the casting complies with this supplementary requirement.

S52. Lower Sulfur Maximum

S52.1 When specified in the order, the maximum sulfur content of Grade WCA, or Grade WCB, or Grade WCC shall not exceed 0.030.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A216/A216M – 16) that may impact the use of this standard. (Approved Jul. 1, 2018.)

(1) Updated formatting of Tables 1 and 2 to be more consistent with other A01.18 material specifications.
(2) Renumbered S11 to S50 and S16 to S51, as these supplementary requirements are specific to this product specification and do not match S11 and S16 in the general specifications referenced (A703/A703M and A985/A985M).