Designation: A 351/A 351M – 06

Standard Specification for Castings, Austenitic, for Pressure-Containing Parts[1]

This standard is issued under the fixed designation A 351/A 351M; 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 Department of Defense.

1. Scope*

1.1 This specification[2] covers austenitic steel castings for valves, flanges, fittings, and other pressure-containing parts (Note 1).

NOTE 1—Carbon steel castings for pressure-containing parts are covered by Specification A 216/A 216M, low-alloy steel castings by Specification A 217/A 217M, and duplex stainless steel castings by Specification A 995/A 995M.

1.2 A number of grades of austenitic steel castings are included in this specification. Since these grades possess varying degrees of suitability for service at high temperatures or in corrosive environments, it is the responsibility of the purchaser to determine which grade shall be furnished. Selection will depend on design and service conditions, mechanical properties, and high-temperature or corrosion-resistant characteristics, or both.

1.2.1 Because of thermal instability, Grades CE20N, CF3A, CF3MA, and CF8A are not recommended for service at temperatures above 800°F [425°C].

1.2.2 Because of embrittlement phases, Grade CD4MCu is not recommended for service at temperatures above 600°F [316°C].

1.3 Supplementary requirements of an optional nature are provided for use at the option of the purchaser. The Supplementary requirements shall apply only when specified individually by the purchaser in the purchase order or contract.

1.4 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply. 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 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.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

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

A 217/A 217M Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature 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 985/A 985M Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts

A 995/A 995M Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts

E 165 Test Method for Liquid Penetrant Examination

E 709 Guide for Magnetic Particle Examination

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

SP-55 Quality Standard for Steel Castings for Valves, Flanges, and Fittings and Other Components (Visual Method)

3. General Conditions for Delivery

3.1 Other than investment castings – Material 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/

[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-351/SA-351M 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.

***A Summary of Changes section appears at the end of this standard.**

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 Investment Castings – Material 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.

3.3 The post weld heat treatment requirements of Supplementary Requirement S11 may be specified when austenitic castings other than HK, HT, or CT15C are to be subjected to severe corrosive service.

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, and

4.1.4 Supplementary requirements desired, including the standards of acceptance.

5. Process

5.1 The steel shall be made by the electric furnace process with or without separate refining such as argon-oxygen decarburization (AOD).

6. Heat Treatment

6.1 All castings shall receive a heat treatment at the temperature specified in Table 1, followed by a quench in water or rapid cool by other means except as noted.

TABLE 1 Heat-Treatment Requirements

Grade	Temperature, min	
	°F	°C
HK30, HK40, HT30, CT15C	as-cast	as-cast
CF3, CF3A, CF8, CF8A, CF3M, CF3MA, CF8M, CF3MN, CG3M, CF10, CF10M, CG8M	1900	1040
CF10SMnN, CF8C, CF10MC	1950	1065
CN7M, CG6MMN, CE8MN	2050	1120
CK3MCuN, CN3MN, CH8, CH10, CH20, CK20	2100	1150
CE20N[A]	2225	1220

[A] Grade shall be quenched in water or the castings may be furnace cooled to 2050°F [1120°C] minimum, held for 15 min minimum and then quenched in water or rapidly cooled by other means.

NOTE 2—Proper heat treatment of these alloys is usually necessary to enhance corrosion resistance and in some cases to meet mechanical properties. Minimum heat-treat temperatures are specified; however, it is sometimes necessary to heat-treat at higher temperatures, hold for some minimum time at temperature, and then rapidly cool the castings in order to enhance the corrosion resistance and meet mechanical properties.

7. Chemical Composition

7.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 2.

8. Tensile Properties

8.1 Steel used for the castings shall conform to the requirements as to tensile properties prescribed in Table 3.

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 S5, S6, 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 A 488/A 488M.

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 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. When castings are produced with Supplementary Requirement S6 specified, weld repairs shall be inspected by liquid penetrant examination to the same standards that are used to inspect the castings.

NOTE 3—When austenitic steel castings are to be used in services where they will be subject to stress corrosion, the purchaser should so indicate in his order and such castings should be solution-heat treated following all weld repairs.

11. Keywords

11.1 austenitic stainless steel; pressure containing parts; stainless steel; steel castings

TABLE 2 Chemical Requirements

NOTE—CD4MCu and CD3MWCuN have been deleted from this specification and added to Specification A 995/A 995M. They may now be supplied and purchased in compliance with Specification A 995/A 995M as grades 1B and 6A respectively.

Element, % (max, except where range is given)	CF3, CF3A J92700	CF8, CF8A J92600	CF3M, CF3MA J92800	CF8M J92900	CF3MN J92804	CF8C J92710	CF10 J92950	CF10M J92901	CH8 J93400	CH10 J93401	CH20 J93402	CK20 J94202	HK30 J94203	HK40 J94204
Carbon	0.03	0.08	0.03	0.08	0.03	0.08	0.04–0.10	0.04–0.10	0.08	0.04–0.10	0.04–0.20	0.04–0.20	0.25–0.35	0.35–0.45
Manganese	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Silicon	2.00	2.00	1.50	1.50	1.50	2.00	2.00	1.50	1.50	2.00	2.00	1.75	1.75	1.75
Sulfur	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
Phosphorus	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
Chromium	17.0–21.0	18.0–21.0	17.0–21.0	18.0–21.0	17.0–21.0	18.0–21.0	18.0–21.0	18.0–21.0	22.0–26.0	22.0–26.0	22.0–26.0	23.0–27.0	23.0–27.0	23.0–27.0
Nickel	8.0–12.0	8.0–11.0	9.0–13.0	9.0–12.0	9.0–13.0	9.0–12.0	8.0–11.0	9.0–12.0	12.0–15.0	12.0–15.0	12.0–15.0	19.0–22.0	19.0–22.0	19.0–22.0
Molybdenum	0.50	0.50	2.0–3.0	2.0–3.0	2.0–3.0	0.50	0.50	2.0–3.0	0.50	0.50	0.50	0.50	0.50	0.50
Columbium (niobium)	. . .	. . .	. . .	. . .	. . .	[A]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Vanadium	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Nitrogen	. . .	. . .	. . .	. . .	0.10–0.20	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Copper	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Element, % (max, except where range is given)	HT30 N08030	CF10MC	CN7M N08007	CN3MN J94651	CE8MN	CG-6MMN J93790	CG8M J93000	CF10S-MnN J92972	CT15C N08151	CK-3MCuN J93254	CE20N J92802	CG3M J92999
Carbon	0.25–0.35	0.10	0.07	0.03 max	0.08	0.06	0.08	0.10	0.05–0.15	0.025	0.20	0.03
Manganese	2.00	1.50	1.50	2.00 max	1.00	4.00–6.00	1.50	7.00–9.00	0.15–1.50	1.20	1.50	1.50
Silicon	2.50	1.50	1.50	1.00 max	1.50	1.00	1.50	3.50–4.50	0.50–1.50	1.00	1.50	1.50
Sulfur	0.040	0.040	0.040	0.010 max	0.040	0.030	0.04	0.030	0.03	0.010	0.040	0.04
Phosphorus	0.040	0.040	0.040	0.040 max	0.040	0.040	0.04	0.060	0.03	0.045	0.040	0.04
Chromium	13.0–17.0	15.0–18.0	19.0–22.0	20.0–22.0	22.5–25.5	20.50–23.50	18.0–21.0	16.0–18.0	19.0–21.0	19.5–20.5	23.0–26.0	18.0–21.0
Nickel	33.0–37.0	13.0–16.0	27.5–30.5	23.5–25.5	8.0–11.0	11.50–13.50	9.0–13.0	8.0–9.0	31.0–34.0	17.5–19.5	8.0–11.0	9.0–13.0
Molybdenum	0.50	1.75–2.25	2.0–3.0	6.0–7.0	3.0–4.5	1.50–3.00	3.0–4.0	. . .	. . .	6.0–7.0	0.50	3.0–4.0
Columbium (niobium)	. . .	[B]	. . .	. . .	. . .	0.10–0.30	. . .	. . .	0.50–1.50	. . .	. . .	. . .
Vanadium	. . .	. . .	. . .	. . .	. . .	0.10–0.30	. . .	. . .	. . .	. . .	. . .	. . .
Nitrogen	. . .	. . .	. . .	0.18–0.26	0.10–0.30	0.20–0.40	. . .	0.08–0.18	. . .	0.18–0.24	0.08–0.20	. . .
Copper	. . .	. . .	3.0–4.0	0.75 max	. . .	. . .	. . .	. . .	. . .	0.50–1.00	. . .	. . .

[A] Grade CF8C shall have a columbium content of not less than 8 times the carbon content but not over 1.00 %.
[B] Grade CF10MC shall have a columbium content of not less than 10 times the carbon content but not over 1.20 %.

TABLE 3 Tensile Requirements

	CF3 J92700	CF3A J92700	CF8 J92600	CF8A J92600	CF3M J92800	CF-3MA J92800	CF8M J92900	CF-3MN J92804	CF8C J92710	CF10 J92950	CF10M J92901	CH8 J93400	CH10 J93401	CH20 J93402	CK20 J94202	HK30 J94203	HK40 J94204
Tensile strength, min, ksi [MPa]	70 [485]	77 [530]	70 [485]	77 [530]	70 [485]	80 [550]	70 [485]	75 [515]	70 [485]	70 [485]	70 [485]	65 [450]	70 [485]	70 [485]	65 [450]	65 [450]	62 [425]
Yield strength,[A] min, ksi [MPa]	30 [205]	35 [240]	30 [205]	35 [240]	30 [205]	37 [255]	30 [205]	37 [255]	30 [205]	30 [205]	30 [205]	28 [195]	30 [205]	30 [205]	28 [195]	35 [240]	35 [240]
Elongation in 2 in. or 50 mm,[B] min, %	35.0	35.0	35.0	35.0	30.0	30.0	30.0	35.0	30.0	35.0	30.0	30.0	30.0	30.0	30.0	10.0	10.0

	HT30 N08030	CF-10MC	CN7M N08007	CN-3MN J94651	CE-8MN	CG 6MMN J93790	CG8M J93000	CF10S-MnN J92972	CT15C N08151	CK-3MCuN J93254	CE20N J92802	CG3M J92999
Tensile strength, min, ksi [MPa]	65 [450]	70 [485]	62 [425]	80 [550]	95 [655]	85 [585]	75 [515]	85 [585]	63 [435]	80 [550]	80 [550]	75 [515]
Yield strength,[A] min, ksi [MPa]	28 [195]	30 [205]	25 [170]	38 [260]	65 [450]	42.5 [295]	35 [240]	42.5 [295]	25 [170]	38 [260]	40 [275]	35 [240]
Elongation in 2 in. or 50 mm,[B] min, %	15.0	20.0	35.0	35	25.0	30.0	25.0	30.0	20.0	35	30.0	25

[A] Determine by the 0.2 % offset method.

[B] When ICI test bars are used in tensile testing as provided for in Specification A 985/A 985M, the gage length to reduced section diameter ratio shall be 4 to 1.

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.

S2. Destruction Tests

S5. Radiographic Inspection

S6. Liquid Penetrant Inspection

S10. Examination of Weld Preparation

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

S11. Post Weld Heat Treatment

S11.1 All austenitic castings, except Grades HK, HT, and CT15C, which have been subjected to weld repairs, shall be given a post-weld solution heat treatment.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 351/A 351M – 05) that may impact the use of this standard. (Approved March 1, 2006)

(*1*) Revised Scope wording to meet the guidelines of A01 Form and Style Manual and A01 Template for developing product specifications.
(*2*) Revised Reference Documents – added A 985/A 985M for investment castings.
(*3*) Revised General Conditions for Delivery to add the requirements for investment castings.
(*4*) Deleted Fe from Table 2. Fe comprises the balance for all alloys in this specification.
(*5*) Revised Table 3 reference to ICI test bars from A 703/A 703M to A 985/A 985M for investment castings.
(*6*) Deleted Reduction of Area from Table 3. There are no alloys with RA requirements.

Committee A01 has identified the location of selected changes to this standard since the last issue (A 351/A 351M – 03) that may impact the use of this standard (Approved May 1, 2005).

(1) Removed CD4MCu and CD3MWCuN and reference to duplex stainless steel grades from the title and text. See Specification A 995/A 995M.