



Designation: A351/A351M – 18<sup>ε1</sup>

# Standard Specification for Castings, Austenitic, for Pressure-Containing Parts<sup>1</sup>

This standard is issued under the fixed designation A351/A351M; 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 ( $\epsilon$ ) 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.*

<sup>ε1</sup> NOTE—Footnote B of Table 3 was editorially corrected in August 2019.

## 1. Scope\*

1.1 This specification<sup>2</sup> 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 A216/A216M, low-alloy steel castings by Specification A217/A217M, and duplex stainless steel castings by Specification A995/A995M.

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].

1.3 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 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 non-conformance with the standard.

<sup>1</sup> 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.

Current edition approved May 1, 2018. Published May 2018. Originally approved in 1952. Last previous edition approved in 2016 as A351/A351M – 16. DOI: 10.1520/A0351\_A0351M-18E01.

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-351/SA-351M in Section II of that code.

1.4.1 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. Within the text, the SI units are shown in brackets or parentheses.

1.5 *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:<sup>3</sup>

A216/A216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

A217/A217M Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service

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

A995/A995M Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts

### 2.2 Manufacturers Standardization Society of the Valve and Fittings Industry Standard:<sup>4</sup>

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

<sup>3</sup> 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.

<sup>4</sup> Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, http://www.msshq.com.

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

### 3. General Conditions for Delivery

3.1 *Other Than Investment Castings*—Material 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 *Investment Castings*—Material 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.

3.3 The post-weld heat treatment requirements of Supplementary Requirement S50 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.

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**.

**TABLE 1 Heat-Treatment Requirements**

Grade	Temperature, min	
	°F	°C
HK30, HK40, HT30, CT15C, HG10MnN CF3, CF3A, CF8, CF8A, CF3M, CF3MA, <b>CF8M</b> , CF3MN, CG3M, CF10, CF10M, CG8M	as-cast 1900	as-cast 1040
CF10SMnN, CF8C, CF10MC	1950	1065
CN7M, CG6MMnN	2050	1120
CH8, CH10, CH20, CK20	2100	1150
CK3MCuN, CN3MN <sup>B</sup>	2200	1200
CE20N <sup>A</sup>	2225	1220

<sup>A</sup> 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.

<sup>B</sup> Castings of these grades shall be held at the specified temperature for a minimum of 4 h.

### 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 **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 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.<sup>2</sup> [65 cm<sup>2</sup>], 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.

10.3 For Grade HG10MnN, the filler metal to be used shall be established by mutual agreement between the manufacturer and the purchaser.

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 1—CE8MN and CD3MWCuN have been deleted from this specification and added to Specification **A995/A995M** as Grades 2A and 6A, respectively. CD4MCu has also been removed. Specification **A995/A995M** Grade 1B, CD4MCuN, is an acceptable substitute.

Material Grade	Element, % (max, except where range is given)											
	Carbon	Manganese	Silicon	Sulfur	Phosphorus	Chromium	Nickel	Molybdenum	Columbium (Niobium) <sup>D</sup>	Vanadium	Nitrogen	Copper
CE20N J92802	0.20	1.50	1.50	0.040	0.040	23.0–26.0	8.0–11.0	0.50	...	...	0.08–0.20	...
CF3, CF3A J92700	0.03	1.50	2.00	0.040	0.040	17.0–21.0	8.0–12.0	0.50	...	...	...	...
CF8, CF8A J92600	0.08	1.50	2.00	0.040	0.040	18.0–21.0	8.0–11.0	0.50	...	...	...	...
CF3M, CF3MA J92800	0.03	1.50	1.50	0.040	0.040	17.0–21.0	9.0–13.0	2.0–3.0	...	...	...	...
CF8M J92900	0.08	1.50	1.50	0.040	0.040	18.0–21.0	9.0–12.0	2.0–3.0	...	...	...	...
CF3MN J92804	0.03	1.50	1.50	0.040	0.040	17.0–21.0	9.0–13.0	2.0–3.0	...	...	0.10–0.20	...
CF8C J92710	0.08	1.50	2.00	0.040	0.040	18.0–21.0	9.0–12.0	0.50	A	...	...	...
CF10 J92950	0.04–0.10	1.50	2.00	0.040	0.040	18.0–21.0	8.0–11.0	0.50	...	...	...	...
CF10M J92901	0.04–0.10	1.50	1.50	0.040	0.040	18.0–21.0	9.0–12.0	2.0–3.0	...	...	...	...
CF10MC	0.10	1.50	1.50	0.040	0.040	15.0–18.0	13.0–16.0	1.75–2.25	B	...	...	...
CF10SMnN J92972	0.10	7.00–9.00	3.50–4.50	0.030	0.060	16.0–18.0	8.0–9.0	...	...	...	0.08–0.18	...
CG3M J92999	0.03	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	...	...	...	...
CG6MMnN J93790	0.06	4.0–6.0	1.00	0.030	0.040	20.5–23.5	11.5–13.5	1.50–3.00	0.10–0.30	0.10–0.30	0.20–0.40	...
CG8M J93000	0.08	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	...	...	...	...
CH8 J93400	0.08	1.50	1.50	0.040	0.040	22.0–26.0	12.0–15.0	0.50	...	...	...	...
CH10 J93401	0.04–0.10	1.50	2.00	0.040	0.040	22.0–26.0	12.0–15.0	0.50	...	...	...	...
CH20 J93402	0.04–0.20	1.50	2.00	0.040	0.040	22.0–26.0	12.0–15.0	0.50	...	...	...	...



TABLE 2 Continued

Material Grade	Element, % (max, except where range is given)											
	Carbon	Manganese	Silicon	Sulfur	Phosphorus	Chromium	Nickel	Molybdenum	Columbium (Niobium) <sup>D</sup>	Vanadium	Nitrogen	Copper
CK20 J94202	0.04–0.20	1.50	1.75	0.040	0.040	23.0–27.0	19.0–22.0	0.50	...	...	...	...
CK3MnCuN J93254	0.025	1.20	1.00	0.010	0.045	19.5–20.5	17.5–19.5	6.0–7.0	...	...	0.18–0.24	0.50–1.00
CN3Mn J94651	0.03	2.00	1.00	0.010	0.040	20.0–22.0	23.5–25.5	6.0–7.0	...	...	0.18–0.26	0.75
CN7M N08007	0.07	1.50	1.50	0.040	0.040	19.0–22.0	27.5–30.5	2.0–3.0	...	...	...	3.0–4.0
CT15C N08151	0.05–0.15	0.15–1.50	0.50–1.50	0.03	0.03	19.0–21.0	31.0–34.0	...	0.50–1.50	...	...	...
HG10MnN J92604	0.07–0.11	3.0–5.0	0.70	0.030	0.040	18.5–20.5	11.5–13.5	0.25–0.45	<sup>C</sup>	...	0.20–0.30	0.50
HK30 J94203	0.25–0.35	1.50	1.75	0.040	0.040	23.0–27.0	19.0–22.0	0.50	...	...	...	...
HK40 J94204	0.35–0.45	1.50	1.75	0.040	0.040	23.0–27.0	19.0–22.0	0.50	...	...	...	...
HT30 N08030	0.25–0.35	2.00	2.50	0.040	0.040	13.0–17.0	33.0–37.0	0.50	...	...	...	...

<sup>A</sup> Grade CF8C shall have a columbium (niobium) content of not less than 8 times the carbon content but not over 1.00 %.

<sup>B</sup> Grade CF10MC shall have a columbium (niobium) content of not less than 10 times the carbon content but not over 1.20 %.

<sup>C</sup> Grade HG10MnN shall have a columbium (niobium) content of not less than 8 times the carbon, but not over 1.00 %.

<sup>D</sup> Columbium (Cb) and niobium (Nb) are alternate names for Element 41.

**TABLE 3 Tensile Requirements**

Material Grade	Tensile strength, min, ksi [MPa]	Yield strength, <sup>A</sup> min, ksi [MPa]	Elongation in 2 in. or 50 mm, <sup>B</sup> min, %
CE20N J92802	80 [550]	40 [275]	30
CF3 J92700	70 [485]	30 [205]	35
CF3A J92700	77 [530]	35 [240]	35
CF8 J92600	70 [485]	30 [205]	35
CF8A J92600	77 [530]	35 [240]	35
CF3M J92800	70 [485]	30 [205]	30
CF3MA J92800	80 [550]	37 [255]	30
<b>CF8M J92900</b>	<b>70 [485]</b>	<b>30 [205]</b>	<b>30</b>
CF3MN J92804	75 [515]	37 [255]	35
CF8C J92710	70 [485]	30 [205]	30
CF10 J92950	70 [485]	30 [205]	35
CF10M J92901	70 [485]	30 [205]	30
CF10MC	70 [485]	30 [205]	20
CF10SMnN J92972	85 [585]	42.5 [295]	30
CG3M J92999	75 [515]	35 [240]	25
CG6MMnN J93790	85 [585]	42.5 [295]	30
CG8M J93000	75 [515]	35 [240]	25
CH8 J93400	65 [450]	28 [195]	30
CH10 J93401	70 [485]	30 [205]	30
CH20 J93402	70 [485]	30 [205]	30
CK20 J94202	65 [450]	28 [195]	30
CK3MCuN J93254	80 [550]	38 [260]	35
CN3MN J94651	80 [550]	38 [260]	35
CN7M N08007	62 [425]	25 [170]	35
CT15C N08151	63 [435]	25 [170]	20

**TABLE 3** *Continued*

Material Grade	Tensile strength, min, ksi [MPa]	Yield strength, <sup>A</sup> min, ksi [MPa]	Elongation in 2 in. or 50 mm, <sup>B</sup> min, %
HG10MnN J92604	76 [525]	33 [225]	20
HK30 J94203	65 [450]	35 [240]	10
HK40 J94204	62 [425]	35 [240]	10
HT30 N08030	65 [450]	28 [195]	15

<sup>A</sup> Determine by the 0.2 % offset method.

<sup>B</sup> When ICI test bars are used in tensile testing as provided for in Specification **A985/A985M**, the gauge 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 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.

### S2. Destruction Tests

### S5. Radiographic Inspection

### S6. Liquid Penetrant Inspection

### S10. Examination of Weld Preparation

### S33. Stabilization Heat Treatment of CF8C

S33.1 CF8C shall be stabilized at 1600 to 1650 °F [870 to 900 °C] for a minimum time of 1 h/in. [25 mm] of thickness and water quenched or rapidly cooled by other means. The grade designation symbol shall be followed by the symbol “S33.”

### S34. Stabilization Heat Treatment of CF10MC

S34.1 CF10MC shall be stabilized at 1600 to 1650 °F [870 to 900 °C] for a minimum time of 1 h/in. [25 mm] of thickness and water quenched or rapidly cooled by other means. The grade designation symbol shall be followed by the symbol “S34.”

### S50. Post-Weld Heat Treatment

S50.1 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.

S50.2 The post-weld treatment for grades CK3MCuN and CN3MN shall be as specified in **Table 3**, except that the minimum soak time for castings that have already been heat treated according to **Table 3** may be 1 h.



**SUMMARY OF CHANGES**

Committee A01 has identified the location of selected changes to this standard since the last issue (A351/A351M – 16) that may impact the use of this standard. (Approved May 1, 2018.)

*(1) Supplementary Requirement S11 changed to S50.*

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or [service@astm.org](mailto:service@astm.org) (e-mail); or through the ASTM website ([www.astm.org](http://www.astm.org)). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>*