Designation: A 744/A 744M – 06

Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service[1]

This standard is issued under the fixed designation A 744/A 744M; 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 covers iron-chromium-nickel alloy, stainless steel castings intended for particularly severe corrosive applications.

1.2 This specification requires postweld heat-treatment of all weld repairs affecting surfaces intended to be wetted by the corrosive medium. For applications for which postweld heat-treatment is not considered mandatory for retention of acceptable corrosion resistance, refer to Specification A 743/A 743M.

NOTE 1—For general corrosion-resistant alloy castings, reference should be made to Specification A 743/A 743M. For general heat-resistant alloy castings, reference should be made to Specification A 297/A 297M. For nickel-base alloy castings, refer to Specification A 494/A 494M.

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 744 and SI units for material ordered to Specification A 744M.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A 297/A 297M Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat-Resistant, for General Application

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

A 494/A 494M Specification for Castings, Nickel and Nickel Alloy

A 732/A 732M Specification for Castings, Investment, Carbon and Low-Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures

A 743/A 743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application

A 781/A 781M Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use

A 957 Specification for Investment Castings, Steel and Alloy, Common Requirements, for General Industrial Use

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications

2.2 *American Welding Society Standards:*[3]

AWS A5.11 Specification for Nickel and Nickel Alloy Covered Welding Electrodes

AWS A5.14 Specification for Nickel and Nickel Alloy Bare Welding Rods and Electrodes

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *wetted surface*, *n*—one that contacts a corrosive environment.

4. General Conditions for Delivery

4.1 Except for investment castings, castings furnished to this specification shall conform to the requirements of Specification A 781/A 781M, including any supplementary requirements that are indicated on the purchase order. Failure to comply with the general requirements of Specification A 781/A 781M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 781/A 781M, this specification shall prevail.

4.2 Steel investment castings furnished to this specification shall conform to the requirements of Specification A 957, including any supplementary requirements that are indicated in

[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 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.

[3] Available from The American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126.

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

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the purchase order. Failure to comply with the general requirements of Specification A 957 constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 957, Specification A 957 shall prevail.

5. Ordering Information

5.1 Orders for material to this specification should include the following, as required, to describe the material adequately:

5.1.1 Description of the casting by pattern number or drawing (dimensional tolerances shall be included on the casting drawing),

5.1.2 Grade,

5.1.3 Heat treatment,

5.1.4 Identify wetted surface(s),

5.1.5 Options in the specification,

5.1.6 Whether casting are to be produced using the investment casting process, and

5.1.7 Supplementary requirements desired, including the standards of acceptance.

6. Process

6.1 Alloys shall be melted by the electric furnace process with or without separate refining, such as argon-oxygen-decarburization (AOD).

7. Heat Treatment

7.1 Castings shall be heat treated in accordance with the requirements in Table 1.

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.

8. Chemical Requirements

8.1 The materials shall conform with the chemical requirements prescribed in Table 2.

9. Workmanship, Finish, and Appearance

9.1 Machined welding ends shall be suitably protected against damage during shipping.

10. Repair by Welding

10.1 The composition of the deposited weld metal shall be similar to that of the casting except in grade CK3MCuN. In the case of Grade CK3MCuN, the composition of the deposited metal shall be similar to that of AWS A5.14 ER NiCrMo-3 (UNS NO6625) or AWS A5.11 E NiCrMo-3 (UNS W 86112) when postweld heat treatment is not required, and the composition of the deposited metal shall be either similar to that of the base metal or similar to that of AWS A5.14 ER NiCrMo-3 or AWS A5.11 E NiCrMo-3 when postweld heat treatment is required.

10.1.1 The composition of the deposited weld metal shall be similar to that of the casting except in grade CN3MN. In the case of grade CN3MN, the composition of the deposited weld metal shall be similar to that of AWS A5.14 ER NiCrMo-3 or ER NiCrMo-4 or ER NiCrMo-10, or the composition of the deposited weld metal shall be similar to that of AWS A5.11 E NiCrMo-3 or E NiCrMo-4 or E NiCrMo-10 when postweld heat treatment is or is not required.

10.2 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 after preparation for repair exceeds 20 % of the actual 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 other weld repairs shall be considered minor. Major and minor weld repairs shall be subject to the same quality standards as are used to inspect the castings. When methods involving high temperatures are used in the removal of discontinuities, castings shall be preheated to 50°F [10°C] min.

10.3 Castings shall be postweld heat treated in accordance with Table 1 after all major weld repairs and after those minor weld repairs involving either of the following conditions: (*1*) welding on a wetted surface, or (*2*) welding that heats a wetted surface to or above 800°F [425°C].

TABLE 1 Heat Treatment Requirements

Grade	Heat Treatment
CF8 (J92600), CG8M (J93000), CF8M (J92900), CF8C (J92710), CF3 (J92500), CF3M (J92800), CG3M (J92999)[A]	Heat to 1900°F [1040°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CN7M (N08007)	Heat to 2050°F [1120°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CN7MS (J94650)	Heat to 2100°F [1150°C] min, 2150°F [1180°C] max, hold for sufficient time (2 h min) to heat casting to temperature, and quench in water.
CN3MN J94651	Heat to 2100°F [1150°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or cool rapidly by other means.
CK3MCuN (J93254)	Heat to 2100°F [1150°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.

[A] For optimum tensile strength, ductility, and corrosion resistance, the solution annealing temperatures for Grades CF8M, CG8M, and CF3M should be in excess of 1900°F [1040°C].

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TABLE 2 Chemical Requirements

Grade	Type	Composition, %														
		Carbon, max	Manganese, max	Silicon, max	Phosphorus, max	Sulfur, max	Chromium	Nickel	Molybdenum	Columbium	Copper	Selenium	Tungsten, max	Vanadium, max	Iron, max	Nitrogen
CF8 (J92600)	19 Chromium, 9 Nickel	0.08	1.50	2.0	0.04	0.04	18.0–21.0	8.0–11.0	. . .	. . .	. . .					
CF8M (J92900)	19 Chromium, 10 Nickel with Molybdenum	0.08	1.50	2.0	0.04	0.04	18.0–21.0	9.0–12.0	2.0–3.0	. . .	. . .					
CF8C (J92710)	19 Chromium, 10 Nickel, with Columbium	0.08	1.50	2.0	0.04	0.04	18.0–21.0	9.0–12.0	. . .	[A]	. . .					
CF3 (J92500)	19 Chromium, 9 Nickel	0.03[B]	1.50	2.0	0.04	0.04	17.0–21.0	8.0–12.0	. . .	. . .						
CF3M (J92800)	19 Chromium, 10 Nickel with Molybdenum	0.03[B]	1.50	1.50	0.04	0.04	17.0–21.0	9.0–13.0	2.0–3.0	. . .	. .					
CG3M (J92999)	19 Chromium, 11 Nickel, with Molybdenum	0.03	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .
CG8M (J93000)	19 Chromium, 11 Nickel, with Molybdenum	0.08	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	. . .	. . .					
CN7M (N08007)	20 Chromium, 29 Nickel, with Copper and Molybdenum	0.07	1.50	1.50	0.04	0.04	19.0–22.0	27.5–30.5	2.0–3.0	. . .	3.0–4.0					
CN7MS (J94650)	19 Chromium, 24 Nickel, with Copper and Molybdenum	0.07	1.0	2.50–3.50	0.04	0.03	18.0–20.0	22.0–25.0	2.5–3.0	. . .	1.5–2.0					
CN3MN (J94651)	21 Chromium, 24 Nickel with Molybdenum and Nitrogen	0.03	2.00	1.00	0.040	0.010	20.0–22.0	23.5–25.5	6.00–7.00	. . .	0.75 max	. . .	. . .	. . .	. . .	0.18–0.26
CK3MCuN (J93254)	20 Chromium, 18 Nickel with Molybdenum and Copper	0.025	1.20	1.00	0.045	0.010	19.5–20.5	17.5–19.5	6.0–7.0	. . .	0.50–1.00	. . .	. . .	. . .	. . .	0.180–0.240

[A] Grade CF8C shall have a columbium content of not less than eight times the carbon content and not more than 1.0 %. If a columbium-plus-tantalum alloy in the approximate Cb:Ta ratio of 3:1 is used for stabilizing this grade, the total columbium-plus-tantalum content shall not be less than nine times the carbon content and shall not exceed 1.1 %.

[B] For purposes of determining conformance with this specification, the observed or calculated value for carbon content shall be rounded to the nearest 0.01 % in accordance with the rounding method of Practice E 29.

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NOTE 3—The maximum wetted surface temperature of 800°F [425°C] permitted on minor weld repairs without subsequent heat treatment for the austenitic grades is necessary to avoid sensitization to intergranular corrosion. Minor repairs of this type can be made by using a low heat input (example, 50 000 J/in.) welding process or by cooling wetted surfaces with water during welding, or both. Wetted surface temperature measurement can be accomplished with temperature-indicating crayon or contact pyrometer.

11. Rejection and Rehearing

11.1 Samples that represent rejected material shall be preserved for two weeks from the date of transmission of the rejection report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

12. Product Marking

12.1 Castings shall be marked for material identification with the ASTM specification number (A 744/A 744M) and grade symbol, that is, CF8, CN7M, etc. In addition, the manufacturer's name or identification mark and the pattern number shall be cast or stamped using low-stress stamps on all castings. Small-size castings may be such that marking must be limited consistent with the available area. The marking of heat numbers on individual castings shall be agreed upon by the manufacturer and the purchaser. Marking shall be in such position as not to injure the usefulness of the casting.

13. Keywords

13.1 austenitic stainless steel; corrosion; stainless steel; steel castings

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall not apply unless specified in the purchase order. A list of standard supplementary requirements for use at the option of the purchaser is included in Specification A 781/A 781M. Those which are ordinarily considered for use with this specification are given below. Others enumerated in Specification A 781/A 781M may be used with this specification upon agreement between the manufacturer and the purchaser.

S2. Radiographic Examination

S3. Liquid Penetrant Examination

S5. Examination of Weld Preparation

S6. Certification

S7. Prior Approval of Major Weld Repairs

S21. Intergranular Corrosion Test

S21.1 An intergranular corrosion test shall be performed in accordance with the appropriate practice for the grade involved, as listed in Practices A 262, or as agreed upon with the purchaser. Intergranular corrosion tests on stabilized or 0.03 % carbon maximum grades (CF3, CF3M, CF8C, CG3M, CK3MCuN, and CN3MN) shall be made on sensitized specimens. On all other grades of chromium-nickel steels, intergranular corrosion tests shall be made on specimens representative of the as-shipped condition.

S22. Tension Test

S22.1 Tensile properties shall be determined from material representing each heat. The bar from which the test specimen is taken shall be heat-treated in production furnaces to the same procedure as the casting it represents. The results shall conform to the requirements specified in Table S22.1.

S22.2 Test bars shall be poured in separately cast keel blocks similar to Fig. 1 or Fig. 2 of Specification A 781/A 781M.

S22.3 Tension test specimens may be cut from heat-treated castings, or from as-cast castings if no heat treatment is specified for the castings, instead of from test bars, when agreed upon by the manufacturer and the purchaser.

S22.4 Test specimens shall be machined to the form and dimensions of the standard round 2-in. [50-mm] gage length specimen shown in Fig. 6 of Test Methods and Definitions A 370, unless the purchase order is for investment castings, in which case, the specimens shall be prepared in accordance with S3.2 of Specification A 732/A 732M. Testing shall be in accordance with Test Methods and Definitions A 370.

S22.5 If the results of the mechanical tests for any heat, lot, or casting do not conform to the requirements specified, retests are permitted as outlined in Test Methods and Definitions A 370. At the manufacturer's option, castings may be reheat treated and retested. When castings are reheat treated, they may not be reaustenitized more than three times without the approval of the purchaser. Testing after reheat treatment shall consist of the full number of specimens taken from locations complying with the specification or order.

S23. Surface Carbon Analysis

S23.1 An analysis for carbon shall be made from a casting representative of each heat. The sample for the analysis shall be within 0.010 in. [0.25 mm] of the surface and be taken after removal of scale and other contaminants at a location to be agreed upon between the manufacturer and purchaser. The carbon content shall meet the carbon requirement of the pertinent grade as shown in Table 2. Other sampling depths and surface carbon requirements may be agreed upon between the purchaser and manufacturer.

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TABLE S22.1 Tensile Requirements

Grade	UNS	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. [50 mm], min, %[A]
			ksi	[MPa]	ksi	[MPa]	
CF8	(J92600	19 Chromium, 9 Nickel	70[B]	[485][B]	30[B]	[205][B]	35
CF8M	(J92900)	19 Chromium, 10 Nickel, with Molybdenum	70	[485]	30	[205]	30
CF8C	(J92710)	19 Chromium, 10 Nickel, with Columbium	70	[485]	30	[205]	30
CF3	(J92500)	19 Chromium, 9 Nickel	70	[485]	30	[205]	35
CF3M	(J92800)	19 Chromium, 10 Nickel, with Molybdenum	70	[485]	30	[205]	30
CG3M	(J92999)	19 Chromium, 11 Nickel, with Molybdenum	75	[515]	35	[240]	25
CG8M	(J93000)	19 Chromium, 11 Nickel, with Molybdenum	75	[520]	35	[240]	25
CN7M	(N08007)	20 Chromium, 29 Nickel, with Copper and Molybdenum	62	[425]	25	[170]	35
CN7MS	(J94650)	19 Chromium, 24 Nickel, with Copper and Molybdenum	70	[485]	30	[205]	35
CN3MN	(J94651)	21 Chromium, 24 Nickel, with Molybdenum and Nitrogen	80	[550]	38	[260]	35
CK3MCuN	(J93254)	20 Chromium, 18 Nickel with Molybdenum and Copper	80	[550]	38	[260]	35

[A] When ICI test bars are used in tensile testing as provided for in this specification, the gage length to reduced section diameter ratio shall be 4:1.
[B] For low ferrite or nonmagnetic castings of this grade, the following values shall apply: Tensile strength, min, 65 ksi [450 MPa]; yield point, min, 28 ksi [195 MPa].

APPENDIX

(Nonmandatory Information)

X1. RECOMMENDED FILLER METALS FOR CAST STAINLESS STEELS

X1.1 Listed in Table X1.1, for information, are the filler metals most commonly recommended for welding cast stainless steels. Only those materials having AWS designations are included. The standard prefixes designating covered electrodes, bare rod, etc., and the usability suffixes have been intentionally omitted. Special applications or supplier or customer preference may dictate the use of alternate or overmatched filler materials.

TABLE X1.1 Recommended Filler Materials for Cast Stainless Steels

Casting ACI Designation	UNS	Recommended Filler Material (AWS Designation)
CF8	(J92600)	308
CF8M	(J92900)	316, 308Mo
CF8C	(J92710)	309Cb, 347
CF3	(J92500)	308L
CF3M	(J92800)	308MoL 316L
CG3M	(J92999)	317L
CG8M	(J93000)	317
CN3MN	(J94651)	NiCrMo-3 NiCrMo-12
CN7M	(N08007)	320, 320LR
CN7MS	(J94650)	320, 320LR
CK3MCuN	(J93254)	NiCrMo-3 NiCrMo-12

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SUMMARY OF CHANGES

Committee A01 on Steel, Stainless Steel, and Related Alloys has identified the location of selected changes to this standard since the last issue (A 744/A 744M-00 (2004)) that may impact the use of this standard.

(*1*) Revised Sections 2, 4, and 5 to reference investment casting general requirements A 957.

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