



Designation: A744/A744M – 13

# Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service<sup>1</sup>

This standard is issued under the fixed designation A744/A744M; 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 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 [A743/A743M](#).

NOTE 1—For general corrosion-resistant alloy castings, reference should be made to Specification [A743/A743M](#). For general heat-resistant alloy castings, reference should be made to Specification [A297/A297M](#). For nickel-base alloy castings, refer to Specification [A494/A494M](#).

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 non-conformance with the standard.

1.3.1 Within the text, the SI units are shown in brackets.

1.3.2 Inch-pound units are applicable for material ordered to Specification A744 and SI units for material ordered to Specification A744M.

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

[A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels](#)

[A297/A297M Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application](#)

<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 15, 2013. Published June 2013. Originally approved in 1977. Last previous edition approved in 2011 as A744/A744M – 10<sup>ε</sup>. DOI: 10.1520/A0744\_A0744M-13.

<sup>2</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.

[A370 Test Methods and Definitions for Mechanical Testing of Steel Products](#)

[A494/A494M Specification for Castings, Nickel and Nickel Alloy](#)

[A732/A732M Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures](#)

[A743/A743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application](#)

[A781/A781M Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use](#)

[A957 Specification for Investment Castings, Steel and Alloy, Common Requirements, for General Industrial Use](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

2.2 *American Welding Society Standards*:<sup>3</sup>

[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 [A781/A781M](#), including any supplementary requirements that are indicated on the purchase order. Failure to comply with the general requirements of Specification [A781/A781M](#) constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification [A781/A781M](#), this specification shall prevail.

<sup>3</sup> 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

4.2 Steel investment castings furnished to this specification shall conform to the requirements of Specification **A957**, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification **A957** constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification **A957**, Specification **A957** 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.<sup>2</sup> [65 cm<sup>2</sup>]. 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 Except for grades CK3MCuN and CN3MN, 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].

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.

**TABLE 1 Heat Treatment Requirements**

Grade	Heat Treatment
CF8 (J92600), CG8M (J93000), CF8M (J92900), CF8C (J92710), CF3 (J92500), CF3M (J92800), CG3M (J92999) <sup>A</sup>	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), CN3MCu (J80020)	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] minimum, 2150°F [1180°C] maximum, hold for sufficient time (2 h min) to heat casting to temperature, and quench in water.
CK3MCuN (J93254), CN3MN (J94651)	Heat to 2200°F [1200°C] minimum, hold for a minimum of 4 hours, quench in water or cool rapidly by other means.

<sup>A</sup> 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].



TABLE 2 Chemical Requirements

Grade	Type	Composition, %														
		Car- bon, max	Manga- nese, max	Silicon, max	Phos- phorus, max	Sul- fur, max	Chromium	Nickel	Molyb- denum	Co- lum- bium	Copper	Sele- nium	Tung- sten, max	Vana- dium, max	Iron, max	Nitro- gen
CF8	19 Chromium, 9 Nickel	0.08	1.50	2.0	0.04	0.04	18.0-21.0	8.0-11.0	...	...	...	...	...	...	...	...
CF8M	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	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	19 Chromium, 9 Nickel	0.03 <sup>#</sup>	1.50	2.0	0.04	0.04	17.0-21.0	8.0-12.0	...	...	...	...	...	...	...	...
CF3M	19 Chromium, 10 Nickel with Molybdenum	0.03 <sup>#</sup>	1.50	1.50	0.04	0.04	17.0-21.0	9.0-13.0	2.0-3.0	...	...	...	...	...	...	...
CG3M	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	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	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	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	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	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	...
CN3MCu	20 Chromium, 29 Nickel, with Copper and Molybdenum	0.03	1.50	1.0	0.030	0.015	19.0 - 22.0	27.5 - 30.5	2.0 - 3.0	3.0 - 3.5	...	...	...	...	...	...

<sup>A</sup> 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 %.

<sup>#</sup> 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 E29.