



Designation: A744/A744M – 06

# 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*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 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 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

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 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) <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)	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.

<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, %														
		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	...	<sup>A</sup>	...					
CF3 (J92500)	19 Chromium, 9 Nickel	0.03 <sup>B</sup>	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 <sup>B</sup>	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

<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>B</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.