



Designation: A744/A744M – 21

Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service¹

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 (ϵ) 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.

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 post-weld heat treatment of all weld repairs affecting surfaces intended to be wetted by the corrosive medium. For applications for which post-weld 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 nonconformance 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.

1.4 *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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

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

A494/A494M Specification for Castings, Nickel and Nickel Alloy

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/A957M Specification for Investment Castings, Steel and Alloy, Common Requirements, for General Industrial Use

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.

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

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.

4.2 Steel investment castings furnished to this specification shall conform to the requirements of Specification **A957/A957M**, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification **A957/A957M** constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification **A957/A957M**, Specification **A957/A957M** 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 Composition Requirements

8.1 The materials shall conform with the chemical composition 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 post-weld 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 post-weld 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 post-weld 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 cm²]. 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.

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), 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 h, quench in water or cool rapidly by other means.

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



TABLE 2 Chemical Composition Requirements

Grade (UNS) Type	Element, weight % ^{A,B}										
	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Niobium ^C	Copper	Nitrogen
CF8 (J92600) 19Cr-9Ni	0.08	1.50	0.04	0.04	2.0	18.0-21.0	8.0-11.0	...	...	...	...
CF8M (J92900) 19Cr-10Ni-Mo	0.08	1.50	0.04	0.04	2.0	18.0-21.0	9.0-12.0	2.0-3.0	...	...	...
CF8C (J92710) 19Cr-10Ni-Nb	0.08	1.50	0.04	0.04	2.0	18.0-21.0	9.0-12.0	...	<i>D</i>	...	...
CF3 (J92500) 19Cr-9Ni	0.03	1.50	0.04	0.04	2.0	17.0-21.0	8.0-12.0	...	...	...	...
CF3M (J92800) 19Cr-10Ni-Mo	0.03	1.50	0.04	0.04	1.50	17.0-21.0	9.0-13.0	2.0-3.0	...	...	...
CG3M (J92999) 19Cr-11Ni-Mo	0.03	1.50	0.04	0.04	1.50	18.0-21.0	9.0-13.0	3.0-4.0	...	...	...
CG8M (J93000) 19Cr-11Ni-Mo	0.08	1.50	0.04	0.04	1.50	18.0-21.0	9.0-13.0	3.0-4.0	...	...	...
CN7M (N08007) 20Cr-29Ni-Mo-Cu	0.07	1.50	0.04	0.04	1.50	19.0-22.0	27.5-30.5	2.0-3.0	...	3.0-4.0	...
CN7MS (J94650) 19Cr-24Ni-Mo-Cu	0.07	1.0	0.04	0.03	2.50-3.50	18.0-20.0	22.0-25.0	2.5-3.0	...	1.5-2.0	...
CN3MN (J94651) 21Cr-24Ni-Mo-N	0.03	2.00	0.040	0.010	1.00	20.0-22.0	23.5-25.5	6.00-7.00	...	0.75	0.18-0.26
CK3MCuN (J93254) 20Cr-18Ni-Mo-Cu	0.025	1.20	0.045	0.010	1.00	19.5-20.5	17.5-19.5	6.0-7.0	...	0.50-1.00	0.180-0.240
CN3MCu (J80020) 20Cr-29Ni-Mo-Cu	0.03	1.50	0.030	0.015	1.0	19.0-22.0	27.5-30.5	2.0-3.0	...	3.0-3.5	...

^A All values are maximums unless a range is provided.

^B Where ellipses (...) appear in this table, there is no requirement, and the element need not be analyzed for or reported.

^C Columbium (Cb) and niobium (Nb) are interchangeable names for the same element 41.

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

10.3 Except for grades CK3MCuN and CN3MN, castings shall be post-weld 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.

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

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 (A744/A744M) 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 Specifications **A781/A781M** and **A957/A957M**. Those which are ordinarily considered for use with this specification are given below. Others enumerated in Specifications **A781/A781M** and **A957/A957M** 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

S50. Intergranular Corrosion Test

S50.1 An intergranular corrosion test shall be performed in accordance with the appropriate practice for the grade involved as listed in Practices **A262**, 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.

S51. Tension Test

S51.1 Tensile properties shall be determined from material representing each heat. Testing shall be performed in accordance with Specification **A781/A781M** or **A957/A957M** for investment castings. The results shall conform to the requirements specified in **Table S51.1**.

S52. Surface Carbon Analysis

S52.1 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.