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Standard Specification for Castings, Nickel and Nickel Alloy¹

This standard is issued under the fixed designation A 494/A 494M; 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 nickel, nickel-copper, nickel-copper-silicon, nickel-molybdenum, nickel-chromium, and nickel-molybdenum-chromium alloy castings for corrosion-resistant service.

1.2 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.

2. Referenced Documents

2.1 ASTM Standards:²

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

A 488/A 488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel

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

E 8 Test Methods for Tension Testing of Metallic Materials

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

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron³

E 38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys³

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys³

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

3. Terminology

3.1 Definitions:

3.1.1 *master heat*—a single furnace charge of refined alloy, which may either be poured directly into castings or into remelt alloy for individual melts.

3.1.2 *melts*—a single furnace charge poured into castings. When master heats are used to prepare melts, a melt analysis shall be reported.

4. General Conditions for Delivery

4.1 Material furnished to this specification shall conform to the requirements of Specification A 781/A 781M, including any supplementary requirements that are indicated in 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.

5. Ordering Information

5.1 Orders for castings to this specification should include the following information:

5.1.1 Quantity, in pieces, and

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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 Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

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

5.1.2 Grade designation (Table 1) and class (Table 2).

5.2 The purchaser shall specify any of the following information required to describe adequately the desired material:

5.2.1 Heat-treat condition (see 6.1 and 6.2),

5.2.2 Repair welding (see Section 11)

5.2.3 Source inspection requirements, if any (see Specification A 781/A 781M),

5.2.4 Marking-for-identification requirements, if any (see 13.1), and

5.2.5 Supplementary requirements desired, including the standards of acceptance.

6. Heat Treatment

6.1 Castings shall be heat treated in accordance with the requirements in Table 2.

NOTE 1—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.

6.2 When Class 1 is specified, grades CY40 and M25S shall be supplied in the as-cast condition. When Class 2 is specified, grades CY40 and M25S shall be supplied in the solution-treated condition. When Class 3 is specified, grade M25S shall be supplied in the age-hardened condition.

7. Chemical Composition

7.1 These alloys shall conform to the chemical composition requirements prescribed in Table 1.

7.2 The grades that pertain to this specification are placed into the five general categories given below. The producer shall report for information all elements in Table 1 for which a limit is given for any alloy in the same alloy family. The alloy families are:

(1) Nickel – CZ100

(2) Nickel-copper – M35-1, M35-2, M30C, M30H, M25S

(3) Nickel-molybdenum – N12MV, N7M, N3M

(4) Nickel-chromium – CY40, CW6M, CW2M, CW6MC, CX2MW, CU5MCuC, CX2M

(5) Other – CY5SnBiM

7.3 An analysis of each master heat shall be made by the manufacturer to determine the percentages of the elements specified in Table 1. The analysis shall be made from a representative sample taken during the pouring of the master heat. Chemical composition shall be reported to the purchaser or his representative.

7.4 Test Methods E 76 or Test Methods E 354 shall be used for referee purposes. Test Methods E 30 or Methods E 38 shall be used if Test Methods E 76 or Test Methods E 354 do not include a method for some element present in the material.

8. Tensile Properties

8.1 One tension test shall be made from each master heat except for grades M25S and CY5SnBiM when the master heat is used to pour the castings. One tension test shall be made from each melt except for grades M25S and CY5SnBiM. Test results shall conform to the tensile requirements specified in Table 3. Test bars shall be poured in special blocks from the same heat as the castings represented.

8.2 The bar from which the test specimen is taken shall be heat treated in production furnaces to the same procedure as the castings it represents. If the castings are not heat treated, the bar used for the test specimen must not be heat treated.

8.3 Test specimens may be cut from castings, at the producer's option, instead of from test bars.

8.4 When castings are produced by methods other than investment process, tension test coupons shall be machined to the form and dimension shown in Fig. 8 of, and tested in accordance with, Test Methods E 8.

8.4.1 When castings are produced by the investment process, test specimens in accordance with Specification A 732/A 732M shall be used for measurement of tensile properties.

8.5 If any specimen shows defective machining or develops flaws, it may be discarded and another substituted from the same heats.

8.6 To determine conformance with the tension test requirements, an observed value or calculated value shall be rounded in accordance with Practice E 29 to the nearest 500 psi [3.5 MPa] for yield and tensile strength and to the nearest 1 % for elongation and reduction of area.

9. Workmanship, Finish, and Appearance

9.1 Critical surfaces of all castings intended for corrosion-resistant service shall be cleaned. Cleaning may be accomplished by blasting with clean sand or metallic corrosion-resistant shot or by other approved methods.

10. Quality

10.1 The castings shall not be peened, plugged, or impregnated to stop leaks.

10.2 Internal chills and chaplets may be used in the manufacture of castings. However, the chills, chaplets and affected cast material must be completely removed.



TABLE 1 Chemical Requirements

Note—Values are maximum unless otherwise indicated.

Alloy Family	Ni	Ni-Cu					Ni-Mo					Ni-Cr										Other
		M25S	M30C ^A	M30H	M35-1 ^A	M35-2	N3M	N7M	N12MV	CU5MCuC	CW2M	CW6M	CW6MC	CW12MW	CX2M	CX2MW	CY40					
Grade	CZ100	N24025	N24130	N24135	N24030	N24020	J30003	J30007	N30012	N08826	N26455	N30107	N26625	N30002N	260692259	26069222	N06040	N26055				
UNS Numbers	N02100	N24025	N24130	N24135	N24030	N24020	J30003	J30007	N30012	N08826	N26455	N30107	N26625	N30002N	260692259	26069222	N06040	N26055				
Composition, %																						
C, max	1.00	0.25	0.30	0.35	0.30	0.35	0.03	0.07	0.12	0.050 max	0.02	0.07	0.06	0.12	0.02	0.02	0.40	0.05				
Mn, max	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.00	1.0	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.5				
Si, max	2.00	3.5-4.5	1.0-2.0	1.25	2.7-3.7	2.00	0.50	1.00	1.00	1.0	0.80	1.00	1.00	1.00	0.50	0.80	3.00	0.5				
P, max	0.03	0.03	0.03	0.03	0.03	0.03	0.040	0.040	0.040	0.030	0.03	0.040	0.015	0.040	0.020	0.025	0.03	0.03				
S, max	0.03	0.03	0.03	0.03	0.03	0.03	0.030	0.030	0.030	0.030	0.03	0.030	0.015	0.030	0.020	0.025	0.03	0.03				
Cu	1.25 max	27.0-33.0	26.0-33.0	26.0-33.0	27.0-33.0	26.0-33.0	...	...	...	1.50-3.50	...	...	...	...	...	...	...	...
Mo	...	...	...	...	...	...	30.0-33.0	30.0-33.0	26.0-30.0	2.5-3.5	15.0-17.5	17.0-20.0	8.0-10.0	16.0-18.0	15.0-16.5	12.5-14.5	...	2.0-3.5	
Fe	3.00 max	3.50 max	3.50 max	3.50 max	3.50 max	3.50 max	3.00 max	3.00 max	4.0-6.0	balance	2.0 max	3.0 max	5.0 max	4.5-7.5	1.50 max	2.0-6.0	11.0 max	2.0 max				
Ni	95.00 min	balance	balance	balance	balance	balance	balance	balance	balance	38.0-44.0	balance	balance	balance	balance	balance	balance	balance	balance				
Cr	...	...	...	...	...	...	1.0	1.0	1.00	19.5-23.5	15.0-17.5	17.0-20.0	20.0-23.0	15.5-17.5	22.0-24.0	20.0-22.5	14.0-17.0	11.0-14.0	
Cb (Nb)	...	...	1.0-3.0	0.5 max	...	0.5 max	...	...	...	0.60-1.20	...	...	3.15-4.50	...	...	...	...	...
W	...	...	...	...	...	...	...	...	...	...	1.0 max	...	...	3.75-5.25	2.5-3.5	...	...	...	
V	...	...	...	...	...	...	...	...	0.20-0.60	...	...	...	...	0.20-0.40	0.35 max	...	...	...	
Bi	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3.0-5.0
Sn	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3.0-5.0

^A Order M35-1 or M30C when weldability is required.

^B Element to be analyzed and reported for information only.