Designation: A 890/A 890M – 99 (Reapproved 2007)

Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application[1]

This standard is issued under the fixed designation A 890/A 890M; 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.

1. Scope

1.1 This specification covers a group of cast duplex stainless steels (austenitic/ferritic).

1.2 The duplex stainless steel alloys offer a combination of enhanced mechanical properties and corrosion resistance when properly balanced in composition and properly heat treated. Ferrite levels are not specified, but these alloys will develop a range of approximately 30 to 60 % ferrite with the balance austenite.

1.3 The values stated in either inch-pound units or metric (SI) units are to be regarded separately as standard. Within the text the metric (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.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

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

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

E 562 Test Method for Determining Volume Fraction by Systematic Manual Point Count

E 1245 Practice for Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis

3. Ordering Information

3.1 Orders for material to this specification shall include the following, as required, to describe the material adequately:

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

3.1.2 Specification designation and grade including year of issue,

3.1.3 Options in the specification (See 9.1), and

3.1.4 Supplementary requirements desired, including the standards of acceptance.

4. Process

4.1 The steel shall be made by the electric furnace process with or without separate refining such as argon-oxygen-decarburization (AOD).

5. Heat Treatment

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

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. Chemical Composition

6.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 2.

7. General Requirements

7.1 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

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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.

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TABLE 1 Heat Treatment Requirements

Grade	Heat Treatment
1A, 1B, 1C	Heat to 1900°F [1040°C] minimum, hold for sufficient time to heat casting uniformly to temperature, quench in water or rapid cool by other means.
2A	Heat to 2050°F [1120°C] minimum, hold for sufficient time to heat casting uniformly to temperature, quench in water or rapid cool by other means.
3A	Heat to 1950°F [1070°C] minimum, hold for sufficient time to heat casting uniformly to temperature, quench in water or rapid cool by other means.
4A	Heat to 2050°F [1120°C] minimum for sufficient time to heat casting uniformly to temperature and water quench, or the casting may be furnace cooled to 1850°F [1010°C] minimum, hold for 15 min minimum and then water quench. A rapid cool by other means may be employed in lieu of water quench.
5A	Heat to 2050°F [1120°C] minimum, hold for sufficient time to heat casting to temperature, furnace cool to 1910°F [1045°C] minimum, quench in water or rapid cool by other means.
6A	Heat to 2010°F [1100°C] minimum, hold for sufficient time to heat casting uniformly to temperature, quench in water or cool rapidly by other means.

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.

8. Repair by Welding

8.1 The composition of the deposited weld metal may be similar to that of the casting or may be suitably alloyed to achieve the desired corrosion resistance and mechanical properties.

8.2 Weld repairs shall be subject to the same quality standards as are used to inspect the castings.

8.3 When post weld/heat treatment is believed necessary for adequate corrosion resistance or impact resistance, Supplementary Requirement S33 Post Weld/Heat Treatment shall be included in the purchase order.

9. Product Marking

9.1 Castings shall be marked for material identification with the specification designation and grade. 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 between the manufacturer and the purchaser. Marking shall be in such position as not to injure the usefulness of the casting.

10. Keywords

10.1 austenite; duplex stainless steel; ferrite; stainless steel; steel castings

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TABLE 2 Chemical Requirements

Grade	1A	1B	1C[A]	2A
Type	25Cr-5Ni-Mo-Cu	25Cr-5Ni-M0-Cu-N	25Cr-6Ni-Mo-Cu-N	24Cr-10Ni-Mo-N
UNS	J93370	J93372	J93373	J93345
ACI	CD4MCu	CD4MCuN	CD3MCuN	CE8MN
Composition:				
Carbon, max	0.04	0.04	0.030	0.08
Manganese, max	1.00	1.0	1.20	1.00
Silicon, max	1.00	1.0	1.10	1.50
Phosphorus, max	0.040	0.04	0.030	0.04
Sulfur, max	0.040	0.04	0.030	0.04
Chromium	24.5–26.5	24.5–26.5	24.0-26.7	22.5–25.5
Nickel	4.75–6.00	4.7–6.0	5.6-6.7	8.0–11.0
Molybdenum	1.75–2.25	1.7–2.3	2.9-3.8	3.0–4.5
Copper	2.75–3.25	2.7–3.3	1.40-1.90	. . .
Tungsten	. . .	. . .	. . .	. . .
Nitrogen		0.10–0.25	0.22-0.33	0.10–0.30

Grade	3A	4A	5A[A]	6A[A]
Type	25Cr-5Ni-Mo-N	22Cr-5Ni-Mo-N	25Cr-7Ni-Mo-N	25Cr-7Ni-Mo-N
UNS	J93371	J92205	J93404	J93380
ACI	CD6MN	CD3MN	CE3MN	CD3MWCuN
Composition:				
Carbon, max	0.06	0.03	0.03	0.03
Manganese, max	1.00	1.50	1.50	1.00
Silicon, max	1.00	1.00	1.00	1.00
Phosphorus, max	0.040	0.04	0.04	0.030
Sulfur, max	0.040	0.020	0.04	0.025
Chromium	24.0–27.0	21.0–23.5	24.0–26.0	24.0–26.0
Nickel	4.0–6.0	4.5–6.5	6.0–8.0	6.5–8.5
Molybdenum	1.75–2.5	2.5–3.5	4.0–5.0	3.0–4.0
Copper	. . .	1.00, max	. . .	0.5–1.0
Tungsten	. . .	. . .	. . .	0.5–1.0
Nitrogen	0.15–0.25	0.10–0.30	0.10–0.30	0.20–0.30

[A] % Cr + 3.3 % Mo + 16 % N ≥ 40.

SUPPLEMENTARY REQUIREMENTS

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

S2. Radiographic Examination

S3. Liquid Penetrant Examination

S5. Examination of Weld Preparation

S6. Certification

S7. Prior Approval of Major Weld Repairs

S9. Charpy Impact Test

S10. Hardness Test

S12. Test Report

S13. Unspecified Elements

S31. Estimating Ferrite Content

S31.1 Ferrite contents shall be determined by point count (Practice E 562), by other quantitative metallographic methods such as image analysis (Practice E 1245), by measurement of magnetic response, or by other methods upon agreement between the manufacturer and the purchaser. Frequency of testing and location of tests shall be by agreement between the manufacturer and the purchaser.

S32. Tensile Requirements

S32.1 One tensile test shall be made from each heat and shall conform to the tensile requirements specified in Table S32.1. Test bars shall be poured in special blocks from the same heat as the castings represented. (See S32.4.)

S32.2 The bar from which the test specimen is removed shall be heat-treated in production furnaces to the same procedure as the castings it represents.

S32.3 Test specimens may be cut from heat-treated castings, at the producer's option, instead of from test bars.

S32.4 Test coupons may be cast integrally or as separate cast blocks in accordance with Figs. 1 and 2 of Specification A 781/A 781M. Tension coupons shall be machined to the form and dimensions of Fig. 4 of Test Methods and Definitions A 370, except when investment castings are ordered. When investment castings are ordered, the manufacturer may prepare

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TABLE S32.1 Tensile Requirements

Grade	1A	2A	3A	4A
Type	25Cr-5Ni-Mo-Cu	24Cr-10Ni-Mo-N	25Cr-5Ni-Mo-N	22Cr-5Ni-Mo-N
Tensile strength, ksi [MPa], min	100 [690]	95 [655]	95 [655]	90 [620]
Yield strength (0.2 % offset), ksi [MPa], min	70 [485]	65 [450]	65 [450]	60 [415]
Elongation in 2 in. [50 mm], %, min[A]	16	25	25	25

Grade	5A	6A	1B	1C
Type	25Cr-7Ni-Mo-N	25Cr-7Ni-Mo-N	25Cr-5Ni-Mo-Cu-N	25Cr-6Ni-Mo-Cu-N
Tensile strength, ksi [MPa], min	100 [690]	100 [690]	100 [690]	100 [690]
Yield strength (0.2 % offset), ksi [MPa], min	75 [515]	65 [450]	70 [485]	65 [450]
Elongation in 2 in. [50 mm], %, min[A]	18	25	16	25

[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.

test specimens in accordance with S3.2 of Specification A 732/A 732M. Testing shall be in accordance with Test Methods and Definitions A 370.

S32.5 If any specimen shows defective machining or develops flaws, it may be discarded and another substituted from the same heat.

S32.6 To determine conformance with the tension test requirements, an observed value or calculated value shall be rounded off in accordance with Practice E 29 to the nearest 500 psi [5 MPa] for yield and tensile strength and to the nearest 1 % for elongation and reduction of area.

S33. Post Weld/Heat Treatment

S33.1 Castings shall be heat-treated after major weld repairs, but heat treatment after minor weld repairs is not required except upon agreement between the manufacturer and the purchaser.

S33.2 Weld repairs shall be considered major in the case of a casting that has leaked on hydrostatic testing 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.

S33.3 Post weld heat treatment shall be in accordance with Table 1.

S34. Prior Approval of Weld Material

S34.1 The purchaser must give approval of all weld filler materials to be used prior to any weld repairs.

S35. Heat Treatment of Test Material

S35.1 Test material for each heat shall be heat-treated with the castings it represents.

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