



Designation: **A781/A781M—12a A781/A781M – 12b**

Standard Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use¹

This standard is issued under the fixed designation A781/A781M; 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 requirements that are mandatory requirements of the following steel casting specifications issued by ASTM. If the product specification specifies different requirements, the product specification shall prevail.

| ASTM Designation | Title of Specification |
|------------------|---|
| A27/A27M | Steel Castings, Carbon, for General Application |
| A128/A128M | Steel Castings, Austenitic Manganese |
| A148/A148M | Steel Castings, High Strength, for Structural Purposes |
| A297/A297M | Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant for General Application |
| A447/A447M | Steel Castings, Chromium-Nickel-Iron Alloy (25-12 Class), for High-Temperature Service |
| A494/A494M | Castings, Nickel and Nickel Alloy |
| A560/A560M | Castings, Chromium-Nickel Alloy |
| A743/A743M | Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application |
| A744/A744M | Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe |
| A747/A747M | Steel Castings, Stainless, Precipitation Hardening |
| A890/A890M | Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application |
| A915/A915M | Steel Castings, Carbon and Alloy, Chemical Requirements Similar to Standard Wrought Grades |
| A958 | Steel Castings, Carbon and Alloy, with Tensile Requirements, Chemical Requirements Similar to Standard Wrought Grades |
| A1002 | Castings, Nickel-Aluminum Ordered Alloy |

1.2 This specification also covers a group of supplementary requirements that may be applied to the above specifications as indicated therein. These are provided for use when additional testing or inspection is desired and apply only when specified individually by the purchaser in the order.

1.3 The requirements of the individual material specification, and this general specification shall prevail in the sequence named.

1.4 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

A27/A27M Specification for Steel Castings, Carbon, for General Application

A128/A128M Specification for Steel Castings, Austenitic Manganese

A148/A148M Specification for Steel Castings, High Strength, for Structural Purposes

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

A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

A447/A447M Specification for Steel Castings, Chromium-Nickel-Iron Alloy (25-12 Class), for High-Temperature Service

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

A488/A488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel
A494/A494M Specification for Castings, Nickel and Nickel Alloy
A560/A560M Specification for Castings, Chromium-Nickel Alloy
A609/A609M Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof
A743/A743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
A744/A744M Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
A747/A747M Specification for Steel Castings, Stainless, Precipitation Hardening
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
A800/A800M Practice for Steel Casting, Austenitic Alloy, Estimating Ferrite Content Thereof
A802/A802M Practice for Steel Castings, Surface Acceptance Standards, Visual Examination
A890/A890M Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/
Ferritic) for General Application
A915/A915M Specification for Steel Castings, Carbon, and Alloy, Chemical Requirements Similar to Standard Wrought Grades
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
A958 Specification for Steel Castings, Carbon and Alloy, with Tensile Requirements, Chemical Requirements Similar to
Standard Wrought Grades
A967 Specification for Chemical Passivation Treatments for Stainless Steel Parts
A991/A991M Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products
A1002 Specification for Castings, Nickel-Aluminum Ordered Alloy
A1058 Test Methods for Mechanical Testing of Steel Products—Metric
E94 Guide for Radiographic Examination
E125 Reference Photographs for Magnetic Particle Indications on Ferrous Castings
E165 Practice for Liquid Penetrant Examination for General Industry
E186 Reference Radiographs for Heavy-Walled (2 to 4½-in. (50.8 to 114-mm)) Steel Castings
E280 Reference Radiographs for Heavy-Walled (4½ to 12-in. (114 to 305-mm)) Steel Castings
E340 Test Method for Macroetching Metals and Alloys
E353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron
Alloys
E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and
Cobalt Alloys
E446 Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness
E709 Guide for Magnetic Particle Testing

3. Terminology

- 3.1 *Definitions:*
3.1.1 The definitions in Test Methods and Definitions **A370**, Test Methods, Practices, and Terminology **A751**, Terminology **A941**, and Test Methods for Mechanical Testing of Steel Products – Metric **A1058** are applicable to this specification and those listed in 1.1.
3.1.2 *test coupon, n*—the part from which the test specimen will be extracted.
3.1.3 *test specimen, n*—the part that will be acted upon in a test.

4. Materials and Manufacture

- 4.1 *Melting Process*—The steel shall be made by open-hearth or electric furnace process with or without separate refining, such as argon-oxygen-decarburization (AOD), unless otherwise specified in the individual specification.
4.2 *Heat Treatment:*
4.2.1 Castings shall be heat treated in the working zone of a furnace that has been surveyed in accordance with Test Method **A991/A991M**.
4.2.2 When castings are heat treated at temperatures above 2000°F [1100°C], then the working zone shall have been established by a survey performed at not more than 25°F [15°C] below nor more than 200°F [110°C] above the minimum heat treatment temperature specified for the grade. If a minimum heat treatment temperature is not specified for the grade, then the survey temperature shall be not more than 50°F [30°C] below nor more than 175°F [100°C] above the furnace set point used.

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.

4.2.3 The maximum variation in measured temperature as determined by the difference between the highest temperature and the lowest temperature shall be as agreed between the purchaser and producer except that during production heat treatment, no portion of the furnace shall be below the minimum specified temperature nor above the maximum specified temperature for the grade being processed.

5. Chemical Composition

5.1 *Chemical Analysis*—Chemical analysis of materials covered by this specification shall be in accordance with Test Methods, Practices, and Terminology **A751**.

5.2 *Heat Analysis*—An analysis of each heat shall be made by the manufacturer to determine the percentages of the elements specified in the individual specification for the grade being poured. The analysis shall be made from a test sample preferably taken during the pouring of the heat. When drillings are used, they shall be taken not less than ¼ in. [6.4 mm] beneath the surface. The chemical composition thus determined shall conform to the requirements in the individual specification for the grade being poured.

5.3 *Product Analysis*—A product analysis may be made by the purchaser from material representing each heat, lot, or casting. The analysis shall be made on representative material. Samples for carbon analysis of carbon and alloy steel shall be taken no closer than ¼ in. [6 mm] to a cast surface, except that castings too thin for this shall be analyzed on representative material. The chemical composition thus determined shall meet the requirements specified in the applicable specification for the grade involved, or shall be subject to rejection by the purchaser, except that the chemical composition determined for carbon and low alloy steel and stainless steel castings may vary from the specified limits by the amounts shown in **Table 1** and **Table 2**, respectively. The product analysis tolerances of **Table 1** and **Table 2** are not applicable as acceptance criteria for heat analysis by the casting manufacturer. When comparing product and heat analysis for other than carbon and low alloy steels and stainless steels, the reproducibility Data R_2 , in Test Methods **E353** or **E354**, as applicable, shall be taken into consideration.

5.4 *Unspecified Elements*—When chemical analysis for elements not specified for the grade ordered is desired, Supplementary Requirement S13 may be specified.

TABLE 1 Product Analysis Tolerances—Carbon and Low Alloy Steels

| Element | Range, % ^A | Tolerances ^{B, C} Over Maximum or Under Minimum Limit, % |
|---------|-----------------------|---|
| C | up to 0.65 | $0.03 \times \% C_L + 0.02$ |
| | above 0.65 | 0.04 |
| Mn | up to 1 | $0.08 \times \% Mn_L + 0.01$ |
| | above 1 | 0.09 |
| Si | up to 0.60 | $0.22 \times \% Si_L - 0.01$ |
| | above 0.60 | 0.15 |
| P | all | $0.13 \times \% P_L + 0.005$ |
| S | all | $0.36 \times \% S_L + 0.001$ |
| Ni | up to 2 | $0.10 \times \% Ni_L + 0.03$ |
| | above 2 | 0.25 |
| Cr | up to 2 | $0.07 \times \% Cr_L + 0.04$ |
| | above 2 | 0.18 |
| Mo | up to 0.6 | $0.04 \times \% Mo_L + 0.03$ |
| | above 0.6 | 0.06 |
| V | up to 0.25 | $0.23 \times \% V_L + 0.004$ |
| | above 0.25 | 0.06 |
| W | up to 0.10 | $0.08 \times \% W_L + 0.02$ |
| | above 0.10 | 0.02 |
| Cu | up to 0.15 | $0.18 \times \% Cu_L + 0.02$ |
| | above 0.15 | 0.05 |
| Al | up to 0.10 | $0.08 \times \% Al_L + 0.02$ |
| | above 0.10 | 0.03 |

^A The range denotes the composition limits up to which tolerances are computed by the equation, and above which the tolerances are given by a constant.

^B The subscript_L for the elements in each equation indicates that the limits of the element specified by the applicable specification are to be inserted into the equation to calculate the tolerance for the upper limit and the lower limit (if applicable), respectively. Examples of computing tolerances are presented in footnote C.

^C To illustrate the computation of the tolerance, consider the manganese maximum of 0.70 for a 0.30 carbon grade 65-35 in Specification **A27/A27M**. The maximum permissible deviation is $(0.08 \times 0.70 + 0.01) = 0.066$. Therefore, the highest acceptable product analysis is 0.766. Similarly, for a 0.20 carbon grade 70-40 in Specification **A27/A27M**, the maximum manganese content is 1.40; thus, the highest acceptable product analysis is $(1.40 + 0.09) = 1.49$.

TABLE 2 Product Analysis Tolerances—Stainless Steels

| Elements | Limit or Maximum of Specified Range, % | Tolerance Over the Maximum Limit or Under the Minimum Limit | | Elements | Limit or Maximum of Specified Range, % | Tolerance Over the Maximum Limit or Under the Minimum Limit | |
|---------------------------|--|---|-------------------------|--------------------------|--|---|-------|
| | | Limit | Limit | | | Limit | Limit |
| Carbon | to 0.010, incl | 0.002 | | Titanium | to 1.00, incl | 0.05 | |
| | over 0.010 to 0.030, incl | 0.005 | | | over 1.00 to 3.00, incl | 0.07 | |
| | over 0.030 to 0.20, incl | 0.01 | | Cobalt | — | — | — |
| | over 0.20 to 0.60, incl | 0.02 | | | over 0.05 to 0.50, incl | 0.01 ^A | |
| | over 0.60 to 1.20, incl | 0.03 | | | over 0.50 to 2.00, incl | 0.02 | |
| Manganese | to 1.00, incl | 0.03 | | over 2.00 to 5.00, incl | 0.05 | | |
| | over 1.00 to 3.00, incl | 0.04 | | Columbium plus tantalum | — | — | — |
| | over 3.00 to 6.00, incl | 0.05 | | | to 1.50, incl | 0.05 | |
| | over 6.00 to 10.00, incl | 0.06 | | — | — | — | |
| | over 10.00 to 15.00, incl | 0.10 | | Tantalum | — | — | — |
| over 15.00 to 20.00, incl | 0.15 | | to 0.10, incl | | 0.02 | | |
| Phosphorus | to 0.040, incl | 0.005 | | Copper | to 0.50, incl | 0.03 | |
| | over 0.040 to 0.20, incl | 0.010 | | | over 0.50 to 1.00, incl | 0.05 | |
| — | — | — | over 1.00 to 3.00, incl | | 0.10 | | |
| Sulfur | to 0.040, incl | 0.005 | | | over 3.00 to 5.00, incl | 0.15 | |
| | over 0.040 to 0.20, incl | 0.010 | | over 5.00 to 10.00, incl | 0.20 | | |
| | over 0.20 to 0.50, incl | 0.020 | | Aluminum | — | — | — |
| Silicon | to 1.00, incl | 0.05 | | | to 0.15, incl | —0.005, +0.01 | |
| | over 1.00 to 3.00, incl | 0.10 | | | over 0.15 to 0.50, incl | 0.05 | |
| | over 3.00 to 6.00, incl | 0.15 | | over 0.50 to 2.00, incl | 0.10 | | |
| Chromium | over 4.00 to 10.00, incl | 0.10 | | Nitrogen | to 0.02, incl | 0.005 | |
| | over 10.00 to 15.00, incl | 0.15 | | | over 0.02 to 0.19, incl | 0.01 | |
| | over 15.00 to 20.00, incl | 0.20 | | | over 0.19 to 0.25, incl | 0.02 | |
| | over 20.00 to 30.00, incl | 0.25 | | | over 0.25 to 0.35, incl | 0.03 | |
| Nickel | to 1.00, incl | 0.03 | | over 0.35 to 0.45, incl | 0.04 | | |
| | over 1.00 to 5.00, incl | 0.07 | | over 0.45 to 0.55, incl | 0.05 | | |
| | over 5.00 to 10.00, incl | 0.10 | | Tungsten | to 1.00, incl | 0.03 | |
| | over 10.00 to 20.00, incl | 0.15 | | | over 1.00 to 2.00, incl | 0.05 | |
| | over 20.00 to 30.00, incl | 0.20 | | | Vanadium | to 0.50, incl | 0.03 |
| Molybdenum | — | — | | over 0.50 to 1.50, incl | | 0.05 | |
| | over 0.20 to 0.60, incl | 0.03 | | Selenium | — | — | — |
| | over 0.60 to 2.00, incl | 0.05 | | | all | 0.03 | |
| over 2.00 to 8.00, incl | 0.10 | | | | | | |

^A Product analysis limits for cobalt under 0.05 % have not been established, and the manufacturer should be consulted for those limits.

<https://standards.iteh.ai/catalog/standards/sist/0f972f00-7ef7-4a13-ae32-9264b7909c5a/astm-a781-a781m-12b>

5.5 *Grade Substitution*—Grade substitution is not permitted. Grade substitution occurs when the material being supplied contains one or more elements that are not specified for the supplied material such that the material conforms to the requirements of a different grade.

6. Mechanical Test Requirements

6.1 The individual product specifications vary as to whether mechanical tests are required; for this reason, and to determine specific test requirements, the individual product specification should be reviewed.

6.2 Unless otherwise specified by the purchaser, when mechanical properties are required by the product specification, test coupons may be cast integrally with the castings, or as separate blocks, in accordance with Fig. 1, Fig. 2, or Fig. 3, except when Supplementary Requirement S15 is specified. The test coupon in Fig. 3 shall be employed only for austenitic alloy castings with cross sections less than 2½ in. [65 mm].³

6.3 Choice of testing track from the options listed in Test Methods A1058 when material is ordered to an M suffix (SI units) product standard, should be identified by the purchaser in the ordering information. If the choice of test track is not specified in the order, then the default ASTM track shall be used as noted in Test Methods A1058.

7. Workmanship, Finish, and Appearance

7.1 All castings shall be made in a workmanlike manner and shall conform to the dimensions on drawings furnished by the purchaser before manufacture is started. If the pattern is supplied by the purchaser, the dimensions of the casting shall be as predicated by the pattern.

³ Information on the relationship of mechanical properties determined on test coupons obtained as specified in 6.2 with those obtained from the casting may be found in *The Steel Casting Handbook*, Fifth Edition, Steel Founders' Society of America, pp. 15-35 through 15-43, 1980.

NOTE 1—*Test Coupons for Large and Heavy Steel Castings*: The test coupons in Fig. 1 are to be used for large and heavy steel castings. However, at the option of the foundry the cross-sectional area and length of the standard coupon may be increased as desired.

10. Inspection

10.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy that the material is being produced and furnished in accordance with the applicable specification. Foundry inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspections, with the exception of product analysis (5.3), shall be made at the place of manufacture unless otherwise agreed.

11. Rejection

11.1 Subsequent to acceptance at the manufacturer's works, material that is found to be unacceptable as determined by requirements specified in the order may be rejected by the purchaser. The manufacturer should be notified of such rejection. If the manufacturer is dissatisfied with the results of any tests performed by the purchaser, he may make claim for a rehearing.

12. Keywords

12.1 castings; common requirements; steel and alloy

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