



Designation: A1001 – 18

# Standard Specification for High-Strength Steel Castings in Heavy Sections<sup>1</sup>

This standard is issued under the fixed designation A1001; 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.

## 1. Scope\*

1.1 This specification covers cast alloy steels in the normalized and tempered or quenched and tempered condition, in section sizes through 37 in. (940 mm), suitable for high-strain gradient conditions such as those encountered in hooks, shackles, support frames, and other lifting devices. The classes of steel in this specification are weldable only with qualified procedures.

1.2 Section range and class selection will depend on design and service conditions. Users should note that this specification contemplates mechanical property gradients.

1.3 The values stated in inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in parentheses. 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 this specification and SI units for material ordered to this specification.

1.4 If, by agreement, castings are to be supplied in a partially completed condition, that is, all of the provisions of the product specification have not been filled, then the material marking (see Section 15) and certification (see Section 14) are to reflect the extent to which the product specification requirements have been met.

1.5 *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 Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

<sup>1</sup> 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. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A609/A609M Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof

A703/A703M Specification for Steel Castings, General Requirements, for Pressure-Containing Parts

E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film

E165/E165M Practice for Liquid Penetrant Testing for General Industry

E709 Guide for Magnetic Particle Testing

E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Inert Gas Fusion Techniques

E1447 Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by Inert Gas Fusion Thermal Conductivity/Infrared Detection Method

E1806 Practice for Sampling Steel and Iron for Determination of Chemical Composition

### 2.2 Manufacturers Standardization of the Value and Fittings Industry Standard.<sup>3</sup>

MSS SP-55 Quality Standard for Steel Castings—Visual Method

## 3. General Conditions for Delivery

3.1 Materials furnished to this specification shall conform to the applicable requirements of Specification A703/A703M, including the supplementary requirements that are indicated on the purchase order.

<sup>2</sup> 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.

<sup>3</sup> Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602.

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

3.2 Terminology and test methods shall be in accordance with Test Methods and Definitions A370.

3.3 In the case of conflict between requirements of this specification and referenced specifications, the former shall prevail.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements to be considered include, but are not limited to, the following:

- 4.1.1 A description of the casting by pattern number or a fully dimensional and toleranced drawing,
- 4.1.2 ASTM designation and year of issue,
- 4.1.3 Section range and class of steel (see Table 1),
- 4.1.4 Definition of inspection methods, extent of examination, frequency, casting quality zones, and acceptance criteria (see Section 11),
- 4.1.5 Product marking locations (see Section 15),
- 4.1.6 Certification report options (see Section 14),
- 4.1.7 Options in the specification (see 1.4 and 11.6), and
- 4.1.8 The supplementary requirements desired.

5. Test Block Requirements

5.1 The supplier shall produce a minimum of one test block for each heat.

5.2 Test block configuration shall be in accordance with Fig. 1. A standard draft angle is permitted over the length "L" of the test block, provided the minimum cylinder diameter is greater than "T" given in Table 2.

5.3 Test block size shall be in accordance with Table 2 for specified section range. The section range selection made by the purchaser (see 4.1.3) should consider casting section size

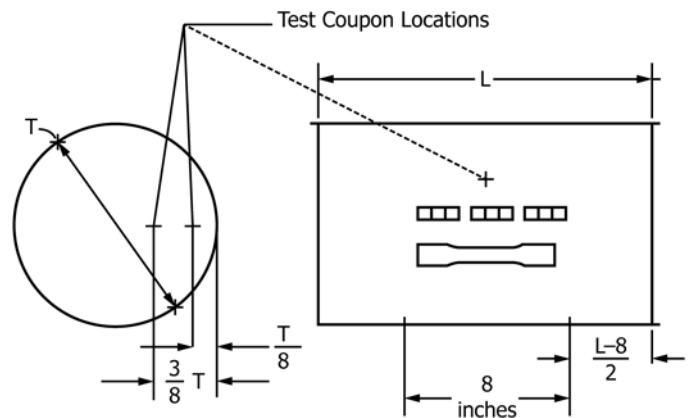


FIG. 1 Test Block Configuration

TABLE 2 Section Range Definition and Test Block Dimensions

| Section Range | Section Size, in (mm) |          | Test Block Dimensions, in (mm) <sup>A</sup> |          |
|---------------|-----------------------|----------|---|----------|
|               | Over                  | Not Over | T   | L        |
| 1             | 3 (76)                | 5 (127)  | 4 (102)                                     | 8 (203)  |
| 2             | 5 (127)               | 7 (178)  | 6 (152)                                     | 8 (203)  |
| 3             | 7 (178)               | 11 (279) | 9 (229)                                     | 9 (229)  |
| 4             | 11 (279)              | 15 (381) | 13 (330)                                    | 13 (330) |
| 5             | 15 (381)              | 21 (533) | 18 (457)                                    | 18 (457) |
| 6             | 21 (533)              | 29 (737) | 25 (635)                                    | 25 (635) |
| 7             | 29 (737)              | 37 (940) | 33 (813)                                    | 33 (813) |

<sup>A</sup> See Fig. 1.

and geometry, service conditions, mechanical property correlations developed by the supplier, or other important factors.

5.4 Tension and Charpy impact tests shall be performed on specimens taken from both the 1/8T and 3/8T locations and shall be oriented within the 8-in. (203-mm) midsection as shown in Fig. 1.

<https://standards.iteh.ai/catalog/standards/sist/f9fc60cd-0639-4a03-b790-ad8e6d0de0f2/astm-a1001-18>

TABLE 1 Required Mechanical Properties

| Section Range | Class | Chemistry Grade <sup>A</sup> | Tensile Strength, min ksi (MPa) |                   | Yield Strength, min ksi (MPa) at 0.2 % Offset |                   | Elongation, 2 in (50 mm) or 4d, min, % |                   | Reduction of Area, min % |                   | Charpy V-Notch, Min Average, ft-lb (J) |                   |
|---------------|-------|------------------------------|---------------------------------|-------------------|---|-------------------|--|-------------------|--------------------------|-------------------|--|-------------------|
|               |       |                              | T/8 <sup>B</sup>                | 3T/8 <sup>B</sup> | T/8 <sup>B</sup>                              | 3T/8 <sup>B</sup> | T/8 <sup>B</sup>                       | 3T/8 <sup>B</sup> | T/8 <sup>B</sup>         | 3T/8 <sup>B</sup> | T/8 <sup>B</sup>                       | 3T/8 <sup>B</sup> |
| 1             | A     | I, II                        | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 1             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 15                                     | 11                | 30                       | 22                | 25 (34)                                | 15 (20)           |
| 1             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 17                                     | 13                | 34                       | 26                | 25 (34)                                | 15 (20)           |
| 2             | A     | I                            | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 2             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 16                                     | 12                | 32                       | 24                | 25 (34)                                | 15 (20)           |
| 2             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 18                                     | 14                | 36                       | 28                | 25 (34)                                | 15 (20)           |
| 3             | A     | I, III                       | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 3             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 17                                     | 13                | 34                       | 26                | 25 (34)                                | 15 (20)           |
| 3             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 19                                     | 16                | 38                       | 32                | 25 (34)                                | 15 (20)           |
| 4             | A     | I, II                        | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 4             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 19                                     | 16                | 38                       | 32                | 25 (34)                                | 15 (20)           |
| 4             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 21                                     | 18                | 42                       | 36                | 25 (34)                                | 15 (20)           |
| 5             | A     | I, II                        | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 5             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 19                                     | 16                | 38                       | 32                | 25 (34)                                | 15 (20)           |
| 5             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 21                                     | 18                | 42                       | 36                | 25 (34)                                | 15 (20)           |
| 6             | A     | I                            | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 6             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 19                                     | 16                | 38                       | 32                | 25 (34)                                | 15 (20)           |
| 6             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 21                                     | 18                | 42                       | 36                | 25 (34)                                | 15 (20)           |
| 7             | A     | I                            | 110 (760)                       | 100 (690)         | 90 (620)                                      | 80 (550)          | 18                                     | 15                | 36                       | 30                | 25 (34)                                | 15 (20)           |
| 7             | B     | I                            | 105 (725)                       | 95 (655)          | 85 (585)                                      | 76 (525)          | 19                                     | 16                | 38                       | 32                | 25 (34)                                | 15 (20)           |
| 7             | C     | I                            | 90 (620)                        | 80 (550)          | 70 (485)                                      | 63 (435)          | 21                                     | 18                | 42                       | 36                | 25 (34)                                | 15 (20)           |

<sup>A</sup> See 7.1. Chemistry other than these listed can be used if properties are met.

<sup>B</sup> See Fig. 1.

5.5 Oxygen and nitrogen gas content tests shall be performed on specimens taken from the 3/8T location and shall be within the 8-in. (203-mm) midsection as shown in Fig. 1.

**6. Materials and Manufacture**

6.1 The steel shall be made by electric furnace process with methods to conform to the maximum gas levels given in Table 3. These methods may include a special refining process such as argon-oxygen-decarburization (AOD).

6.2 Heat treatment procedure shall be reported to the purchaser by the supplier for the specified section range, class, and grade.

6.2.1 Multiple austenitizing is permitted.

6.2.2 Multiple tempering is permitted. The minimum final tempering temperature shall not be less than 1100 °F (593 °C). Post-weld heat treatment shall not be less than 1050 °F (566 °C).

6.3 Test block(s) may be heat treated separately from the castings they represent.

6.3.1 Test block(s) shall be heat treated in the same production heat treat equipment, in the same facility, and to the same procedure as the castings to be produced. Test block(s) are excluded from post-weld heat treatment (see 12.2.9).

6.3.2 The test block(s) tempering temperature shall be within ±25 °F (14 °C) of the casting tempering temperature.

6.4 Heat treatment charts showing time and temperature shall be prepared and held available for inspection by the purchaser.

**7. Chemical Composition**

7.1 Supplier shall select the casting chemistry grade from Table 1 for the section range and class specified by the purchaser.

7.1.1 Chemical composition shall conform to Table 4 for Grades II and III.

7.1.2 Grade I designates the use of an alternate chemistry selected by the supplier. Alternate chemistries shall conform to the allowable element ranges and limits given in Table 5.

7.2 A product analysis shall be made for specification conformance. The product analysis shall be performed on a specimen taken from the test block(s) in Section 5 and shall be from the 3/8T location and shall be within the 8-in. (203-mm) midsection as shown in Fig. 1. The supplier shall perform the product analysis in addition to any other process control analysis.

**TABLE 3 Maximum Gas Content Levels**

| Section Range | Nitrogen, ppm | Oxygen, ppm | Oxygen Analysis Tolerance, ppm | Oxygen Analysis Limit, ppm <sup>A</sup> |
|---------------|---------------|-------------|--------------------------------|---|
| 1             | 110           | 100         | 30                             | 130                                     |
| 2             | 110           | 100         | 30                             | 130                                     |
| 3             | 100           | 90          | 27                             | 117                                     |
| 4             | 100           | 90          | 27                             | 117                                     |
| 5             | 90            | 80          | 24                             | 104                                     |
| 6             | 80            | 70          | 21                             | 91                                      |
| 7             | 70            | 60          | 18                             | 78                                      |

<sup>A</sup> Specification compliance level is average value of three determinations; see 10.3.

**TABLE 4 Chemical Grade Composition (Maximum Percent Unless Range is Given)**

| Element:                           | Grade       |                     |                     |
|------------------------------------|-------------|---------------------|---------------------|
|                                    | I           | II                  | III                 |
| Carbon                             | See Table 5 | ... to 0.20 to 0.28 | ... to 0.20 to 0.28 |
| Manganese                          | ...         | 1.00 to 1.40        | 1.00 to 1.40        |
| Phosphorus                         | ...         | 0.02                | 0.03                |
| Sulfur                             | ...         | 0.015               | 0.025               |
| Silicon                            | ...         | 0.30 to 0.60        | 0.30 to 0.60        |
| Nickel                             | ...         | 1.00 to 1.30        | 1.00 to 1.30        |
| Chromium                           | ...         | 0.80 to 1.20        | 0.80 to 1.20        |
| Molybdenum                         | ...         | 0.60 to 0.85        | 0.60 to 0.85        |
| Aluminum                           | ...         | 0.03                | 0.07                |
| Residual Elements:                 | See Table 5 |                     |                     |
| Zirconium                          | ...         | A                   | A                   |
| Copper                             | ...         | A                   | A                   |
| Titanium                           | ...         | A                   | A                   |
| Tungsten                           | ...         | A                   | A                   |
| Vanadium                           | ...         | A                   | A                   |
| Columbium                          | ...         | A                   | A                   |
| Boron                              | ...         | A                   | A                   |
| Total Content of Residual Elements | ...         | 0.60                | 0.60                |

<sup>A</sup> Reported for information only.

**TABLE 5 Element Tolerance Ranges and Maximum Limits for Alternate Chemistries**

| Element                | Average of Declared Range, (%) | Maximum Range (%) | Maximum Limit (%) |
|------------------------|--------------------------------|-------------------|-------------------|
| Carbon                 | All                            | 0.08              | 0.35              |
| Manganese              | <1.00                          | 0.30              | ...               |
|                        | ≥1.00                          | 0.40              | ...               |
| Phosphorus             | All                            | ...               | 0.02              |
| Sulfur                 | All                            | ...               | 0.015             |
| Nickel                 | <1.50                          | 0.30              | ...               |
|                        | ≥1.50                          | 0.50              | ...               |
| Chromium               | <1.50                          | 0.40              | ...               |
|                        | ≥1.50                          | 0.50              | ...               |
| Molybdenum             | All                            | 0.25              | ...               |
| Aluminum               | All                            | 0.04              | 0.06              |
| Vanadium               | All                            | 0.10              | ...               |
| Copper <sup>A</sup>    | ...                            | ...               | ...               |
| Titanium <sup>A</sup>  | ...                            | ...               | ...               |
| Columbium <sup>A</sup> | ...                            | ...               | ...               |
| Zirconium <sup>A</sup> | ...                            | ...               | ...               |
| Nitrogen <sup>A</sup>  | ...                            | ...               | ...               |

<sup>A</sup> Reported for information only.

7.3 Retests for conformance are permitted in accordance with Section 13.

**8. Tension Test**

8.1 Tension tests shall be performed on test specimens taken from test block(s) as determined in Section 5.

8.1.1 One tension test specimen is required at each of the 1/8T and 3/8T locations and shall be oriented within the 8-in. (203-mm) midsection as shown in Fig. 1.

8.1.2 Tension test specimens shall be machined to the form and dimension shown in Fig. 4 of Test Methods and Definitions A370 and tested in accordance with those test methods.

8.2 Mechanical properties shall conform to the requirements given in Table 1.

8.3 Retests for conformance are permitted in accordance with Section 13.