Designation: A1091/A1091M – 16ε1

Standard Specification for Steel Castings, Creep-Strength Enhanced Ferritic Alloy, for Pressure-Containing Parts, Suitable for High Temperature Service[1]

This standard is issued under the fixed designation A1091/A1091M; 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.

ε[1] NOTE—Table 3 was editorially corrected in April 2017.

1. Scope

1.1 This specification covers creep-strength enhanced alloy steel castings for valves, flanges, fittings, and other pressure-containing parts intended primarily for high-temperature service (see Note 1). However, they are not restricted to such applications, and the castings may be used for other applications for which the attributes of the material, as defined by this specification, are suitable.

1.2 One grade of martensitic alloy steel, Grade C91, is covered (see Note 2). It is provided in two classes, differentiated by the type of heat treatment after weld repairs. This and similar steels are characterized by a predominantly tempered martensitic or tempered Bainitic microstructure that is stabilized by the precipitation of temper-resistant particles at various precipitate nucleation sites in the microstructure. Such steels are designed to have creep-rupture strengths significantly superior to those of alloys of nominally similar compositions, but in which the precipitates or nucleation sites are absent. Since this crucial difference cannot be revealed by room-temperature mechanical property tests, these alloys require tighter controls on manufacturing and processing.

NOTE 1—The grades covered by this specification represent materials that are generally suitable for assembly with other castings or wrought steel parts by fusion welding. It is not intended to imply that these grades possess equal degrees of weldability; therefore, it is the responsibility of the purchaser to establish a suitable welding technique. Since these grades possess varying degrees of suitability for high-temperature service, it is also the responsibility of the purchaser to determine which grade shall be furnished, due consideration being given to the requirements of the applicable construction codes.

NOTE 2—The committee formulating this specification has included one grade of material that is considered to represent a type of ferritic alloy steel suitable for valves, flanges, fittings, and other pressure-containing parts. Additional alloy steels will be considered for inclusion in this specification by the committee as the need becomes apparent.

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 non-conformance with the standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A335/A335M Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service

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

A802/A802M Practice for Steel Castings, Surface Acceptance Standards, Visual Examination

A985/A985M Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts

A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe

2.2 *ANSI Standards*[3]

ANSI B46.1 Surface Texture

2.3 *ASME Boiler and Pressure Vessel Code*[4]

ASME Boiler and Pressure Vessel Code Section I

ASME Boiler and Pressure Vessel Code Section III

[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 American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

ASME Boiler and Pressure Vessel Code Section IV
ASME Boiler and Pressure Vessel Code Section VIII
ASME Boiler and Pressure Vessel Code Section IX
ASME Boiler and Pressure Vessel Code Section XII

2.4 *Other ASME Codes*[4]

B16.34 Valves Flanged, Threaded and Welding End
B31.1 Power Piping
B31.3 Process Piping

2.5 *AWS Specifications*[5]

A5.5/A5.5M Low Alloy Steel Electrodes for Shielded Metal Arc Welding
A5.23/A5.23M Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
A5.28/A5.28M Low Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding
A5.29/A5.29M Low Allow Steel Electrodes for Flux Cored Arc Welding

3. General Conditions for Delivery

3.1 Except for investment castings and centrifugally cast pipe, castings furnished to this specification shall conform to the requirements of Specification A703/A703M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A703/A703M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A703/A703M, this specification shall prevail.

3.2 Investment castings furnished to this specification shall conform to the requirements of Specification A985/A985M including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A985/A985M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A985/A985M, Specification A985/A985M shall prevail.

3.3 Centrifugally cast pipe furnished under this specification shall conform to the requirements of Specification A999/A999M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A999/A999M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A999/A999M, this specification shall prevail.

4. Ordering Information

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

4.1.1 Except for centrifugally cast pipe,

4.1.1.1 A description of the casting by pattern number or drawing (dimensional tolerances shall be included on the casting drawing),

4.1.1.2 Grade and Class of steel,

4.1.1.3 Options in the specification (see 5.1.5, 5.2, 7.1.4, 8.4, 10.3.5, and 10.3.7, 10.3.8.2, and 10.3.8.3),

4.1.1.4 Whether the castings are to be produced using the investment casting process, and

4.1.1.5 The supplementary requirements desired including the standards of acceptance.

4.1.2 Centrifugally cast pipe,

4.1.2.1 Quantity (feet, centimeters, or number of lengths),

4.1.2.2 Name of material (centrifugally cast pipe),

4.1.2.3 Grade of steel,

4.1.2.4 Size (outside or inside diameter and minimum wall thickness),

4.1.2.5 Length (specific or random) (Section on Permissible Variations in Length of Specification A999/A999M),

4.1.2.6 End finish (Section on Ends of Specification A999/A999M),

4.1.2.7 Options in the specification (see 5.1.5, 5.2, 7.1.4, 8.4, 10.3.5, and 10.3.7, 10.3.8.2, and 10.3.8.3),

4.1.2.8 Whether the castings are to be used in ASME Boiler & Pressure Vessel Code Sections I, III, IV, VIII, and XII construction; or in ASME Codes B16.34, B31.1, B31.3, or other ASME construction codes,and,

4.1.2.9 The supplementary requirements desired.

5. Materials and Manufacture

5.1 *Heat-Treatment*—Castings shall be furnished in the austenitized and tempered condition.

5.1.1 Before heat treatment, castings shall be allowed to cool to a temperature below the transformation range.

5.1.2 Castings shall be heat treated by heating to a temperature range of 1900 to 1975°F [1040 to 1080°C] and either air cooled or accelerated cooled from the austenitizing temperature by air blasting or liquid quenching, to a temperature of 200°F [95°C] or below, followed by tempering at 1350 to 1470°F [730 to 800°C].

5.1.3 Compliance with the temperature ranges specified in 5.1.2, for castings heat treated singly, shall be verified by a thermocouple or thermocouples placed directly on the castings.

5.1.4 Compliance with the temperature ranges specified in 5.1.2, for castings heat treated in batches, shall be verified by thermocouples placed on selected castings in each batch.

5.1.5 Unless specified by the purchaser, the number and locations of thermocouples to be placed on each casting, or on castings in each heat-treatment batch, shall be at the discretion of the producer.

5.1.6 A record of the final austenitizing and tempering heat treatment, and, if specified in the order (see 10.3.7), of any and all subsequent sub-critical heat treatments, shall be made and shall be shown on the material test report. The record shall include both the number and locations of thermocouples applied to each casting, or to each heat-treatment batch of castings.

5.2 *Machining*—Centrifugally cast pipe shall be machined on the inner and outer surfaces to a roughness value no greater than 250μ in. [6.35 μm] arithmetical average deviation (AA) from the mean line unless otherwise specified as in ANSI B46.1.

[5] Available from American Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, http://www.aws.org.