Designation: A395/A395M – 99(Reapproved 2009)

Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures[1]

This standard is issued under the fixed designation A395/A395M; 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 ductile iron castings for pressure-retaining parts for use at elevated temperatures. Castings of all grades are suitable for use up to 450°F. For temperatures above 450°F and up to 650°F, only Grade 60–40–18 castings are suitable (Note 1).

1.2 Valves, flanges, pipe fittings, pumps, and other piping components are generally manufactured in advance and supplied from stock by the manufacturer, jobber, or dealer.

1.3 For supplemental casting requirements, Specification A834 may be utilized.

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.

NOTE 1—For service other than as specified in this section, reference should be made to Specification A536 for Ductile Iron Castings.[2]

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A247 Test Method for Evaluating the Microstructure of Graphite in Iron Castings

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A536 Specification for Ductile Iron Castings

A732/A732M Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures

A834 Specification for Common Requirements for Iron Castings for General Industrial Use

E8 Test Methods for Tension Testing of Metallic Materials

E10 Test Method for Brinell Hardness of Metallic Materials

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

E446 Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness

E689 Reference Radiographs for Ductile Iron Castings

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

F1476 Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

F1548 Specification for Performance of Fittings for Use with Gasketed Mechanical Couplings Used in Piping Applications

2.2 *Manufacturer's Standardization Society of the Valve and Fittings Industry Standard:*[3]

SP 25 Standard Marking Systems for Valves, Flanges, Pipe Fittings, and Unions

3. Classification

3.1 Castings ordered to this specification are classified by grades based on mechanical property requirements, as listed in Table 1. See note following Table 1.

4. Ordering Information

4.1 Orders for material under this specification shall include the following applicable information:

4.1.1 Drawing, catalog number, or part identifications,

4.1.1.1 For grade 65-45-15, drawing indicating critical area(s) of casting (see 7.2.2 and 7.3.2).

4.1.2 Quantity (weight or number of pieces),

4.1.3 ASTM designation and year of issue,

4.1.4 Grade (See Table 1), if a Grade is not specified, the manufacturer shall supply grade 60-40-18.

[1] This specification is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.02 on Malleable and Ductile Iron Castings.

Current edition approved May 1, 2009. Published August 2009. Originally approved in 1955. Last previous edition approved in 2004 as A395/A395M – 99 (2004). DOI: 10.1520/A0395_A0395M-99R09.

[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 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602.

TABLE 1 Mechanical Property Requirements

Property	Grade 60-40-18	Grade 65-45-15
Tensile Strength Minimum, psi [MPa]	60 000 [415]	65 000 [450]
Yield Strength Minimum, psi [MPa]	40 000 [275]	45 000 [310]
Elongation in 2 in. Minimum, %	18	15
Hardness HB, 3000 kgf Load	143-187	156-201

4.1.5 Heat-treating requirements (see 5.2.1),
4.1.6 Pressure test requirements (see 7.4.3),
4.1.7 Test samples from castings (see 11.1.1 and 12.1.1),
4.1.8 Test coupons size (see 11.2),
4.1.9 Metallographic option (see 12.1.1),
4.1.10 Place of inspection (see 16.1),
4.1.11 Certification requirements (see 17.1),
4.1.12 Identification marking (see 18.2), and
4.1.13 Supplemental Requirements (see 1.4, 7.4.2, S1 and S2).

5. Materials and Manufacture

5.1 The melting method and the nodularizing practice shall be optional with the foundry.

5.2 Except as provided in 5.2.1, all castings Grade 60-40-18 shall be given a ferritizing heat treatment that produces essentially a ferritic structure that contains no massive carbides.

5.2.1 When specified in the purchase order, Grade 60-40-18 castings may be provided in an as-cast condition provided they comply with the requirements of 7.1 and 7.2.1.

5.2.2 Castings supplied in accordance with 5.2.1 may be stress relieved by agreement between the manufacturer and purchaser.

5.3 Castings Grade 65-45-15 may be provided in as-cast condition or heat treated, provided they comply with the requirements of 7.1, 7.2.2, and 7.3.2.

6. Chemical Requirements

6.1 The casting shall conform to the following requirements for chemical composition (Note 2):

Total carbon, min, %	3.00
Silicon, max, %	2.50
Phosphorus, max, %	0.08

6.1.1 The chemical analysis for total carbon shall be made on chilled cast pencil type specimens or from thin wafers approximately 1/32 in. [0.8 mm] thick cut from test coupons. Drillings are not reliable because of the probable loss of graphite.

6.1.2 For each reduction of 0.01 % below the maximum specified phosphorus content, an increase of 0.08 % silicon above the specified maximum will be permitted up to a maximum of 2.75 %.

NOTE 2—Silicon contents above 2.75 %, or phosphorus contents above 0.08 % have a tendency to lower the impact resistance of the material. If the carbon content is below 3.00 %, excess cementite may form during cooling and if this is not removed during heat treatment, the impact resistance of the material may be lowered.

7. Requirements

7.1 *Tensile Properties:*

7.1.1 The ductile iron as represented by the test specimens shall conform to the mechanical property requirements in Table 1.

7.2 *Hardness:*

7.2.1 For Grade 60–40–18, the hardness of the castings and test specimens shall be within the limits in Table 1.

7.2.2 For Grade 65–45–15, the hardness of test specimen and the critical area(s) of the casting, as identified on the casting drawing, shall be within the limits in Table 1. If the grade 65–45–15 casting drawing does not have critical area(s) of the casting identified, all areas of the casting shall be within the hardness limits in Table 1.

7.3 *Microstructure:*

7.3.1 For Grade 60-40-18, the microstructure of the separately cast test coupon or the casting shall be essentially ferritic and contain no massive carbides, and have a minimum of 90 % Type I and Type II Graphite as in Fig. 1 or Plate I of Test Method A247.

7.3.2 For Grade 65-45-15, the microstructure of the critical areas of the casting, as identified on the casting drawing, shall be 45 % pearlitic, maximum, contain no massive carbides, and have a minimum 90 % Type I and Type II Graphite as in Fig. 1 or Plate I of Test Method A247.

7.4 *Pressure Test Requirements :*

7.4.1 Each pressure retaining Grade 60-40-18 casting shall be tested after machining to the test pressure specified by the applicable standard of ANSI, ASME Boiler and Pressure Vessel Code, or other pertinent code, and shall show no leaks.

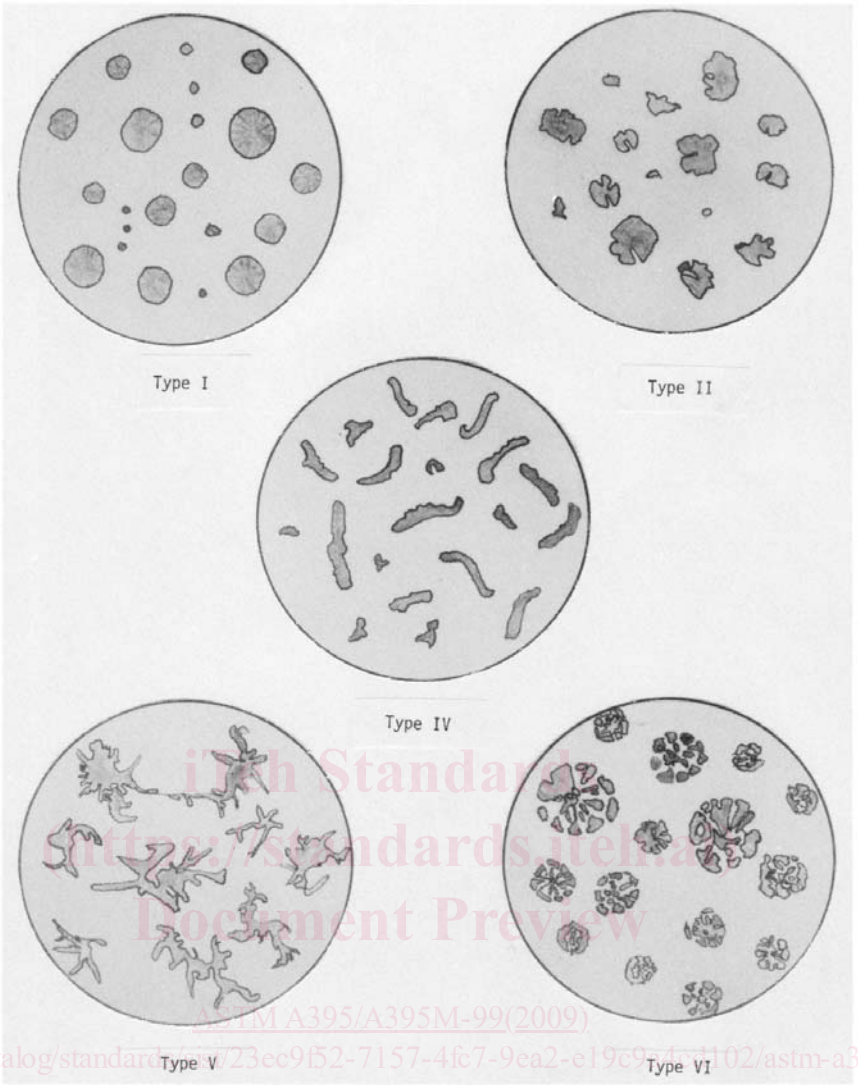
7.4.2 Castings Grade 65-45-15 manufactured under this specification shall be capable of passing hydrostatic test(s) compatible with the rating of the finished cast component. Such tests shall be conducted by the casting manufacturer only when Supplementary Requirement S2 is specified.

7.4.3 Castings Grade 60-40-18, ordered under this specification not covered by ANSI standards and ASME Pressure Vessel Code, and castings for special service applications, shall be tested to such pressures as may be agreed upon by the manufacturer and the purchaser.

7.4.4 For castings Grade 60-40-18, it is realized that the foundry may be unable to perform the hydrostatic test prior to shipment, or that the purchaser may wish to defer testing until additional work or machining has been performed on the casting. Castings ordered in the rough state for final machining by the purchaser may be tested hydrostatically prior to shipment by the manufacturer at pressures to be agreed upon with the purchaser. However, the foundry is responsible for the satisfactory performance of the castings under the final hydrostatic test.

8. Workmanship and Finish

8.1 The surface of the casting shall be examined visually and shall be free from adhering sand, scale, cracks, and hot tears. Any other surface discontinuities shall meet visual acceptance standards specified in the order.



NOTE 1—Graphite types are identical with Plate 1 of Test Method A247 and are so identified.

FIG. 1 Suggested Classification of Graphite Form in Ductile Cast Iron

9. Repair

9.1 Castings for valves, flanges, pipe fittings, pumps, and other piping components ordered under applicable ANSI standards shall not be repaired by plugging, welding, brazing, or impregnation.

9.2 Castings Grade 60-40-18 not covered in 9.1 which leak on hydrostatic tests may be repaired by plugging, provided the following requirements are met:

9.2.1 No welding or brazing is permitted.

9.2.2 The diameter of the plug shall not exceed the diameter of a standard 2 in. [ISO R2] pipe plug.

9.2.3 The plugs, where practical, shall conform in all dimensions to the standard ISO ⅜ plugs. In addition, they shall have full thread engagement corresponding to the thickness in the repaired section. Where a tapered plug is impractical because of the excess wall thickness in terms of plug diameter and coincident thread engagement, other types of plugs may be used provided both full engagement and effective sealing against pressure are obtained. Where possible, the ends of the plug should be ground smooth after installation to conform to the inside and outside contours of the wall of the pressure vessel or pressure part.

9.2.4 The material from which the plug is manufactured shall conform in all respects to the materials specifications that apply to the pressure vessel or pressure part.

9.2.5 The area adjacent to the drilled hole shall be examined by radiography, and shall meet the Level 3 acceptance requirements of Reference Radiographs E689 and supporting Reference Radiographs E446, E186, or E280 as applicable and defined in accordance with Reference Radiographs E689.

9.2.6 The thickness of any repaired section in relation to the size of the plug used shall not be less than that given in Table 2.

9.2.7 The minimum radius of repaired sections of cylinders or cones in relation to the size of plug used shall not be less than that given in Table 3.

TABLE 2 Minimum Thickness of Repaired Sections

Iron Pipe Size Plug, in.	Minimum Thickness Repaired Section, in. [mm]
⅛	11/32 [8]
¼	7/16 [10]
⅜	½ [13]
½	21/32 [17]
¾	¾ [19]
1	13/16 [21]
1¼	⅞ [23]
1½	15/16 [24]
2	1 [26]

TABLE 3 Minimum Radius of Repaired Sections

Iron Pipe Size Plug, in.	Minimum Radius of Cylinder or Cone, in. [mm]
⅛	9/16 [15]
¼	11/16 [18]
⅜	1 1/16 [28]
½	1¼ [32]
¾	2 [52]
1	2½ [64]
1¼	4 [104]
1½	5¼ [136]
2	8⅛ [208]

9.2.8 A repaired area may consist of a maximum of three plugs with a spacing such that the ligaments between adjacent plugs shall not be less than listed in Table 4. Other defective areas may also be repaired by plugging provided the minimum ligament between plugs in adjacent areas is not less than twice the distance from the nearest plug, the values for which are listed in Table 4.

9.3 Surface imperfections in castings Grade 60-40-18 other than valves, flanges, pipe fittings, pumps, and other piping components may be repaired by plugging provided the depth of the plug is not greater than 20 % of the thickness of the casting section and the diameter of the plug is not greater than its length. Repair of surface defects may not be done on pressure-containing portions of castings. The plug need not be threaded. The conditions of 9.2.1 and 9.2.4 shall also be satisfied.

10. Sampling

10.1 A lot shall consist of one of the following:

10.1.1 All the metal from a single heating in a batch-type melting furnace.

10.1.2 All the metal poured from two or more batch-type melting furnaces into a single ladle or a single casting.

TABLE 4 Minimum Ligament Between Plugs[A,B]

Nominal Plug Diameter, in.	Minimum Ligament Between Plugs, in. [mm]			
	⅛, ¼, ⅜	½, ¼	1, 1¼	1½, 2
⅛, ¼, ⅜	2⅝ [67]	4⅛ [105]	6⅝ [169]	9½ [242]
½, ¾	4⅛ [105]	4⅛ [105]	6⅝ [169]	9½ [242]
1, 1¼	6⅝ [169]	6⅝ [169]	6⅝ [169]	9½ [242]
1½, 2	9½ [242]	9½ [242]	9½ [242]	9½ [242]

[A] Based on efficiency of 80 %.

[B] Example: Assume three plugs are required for repair, one ⅛ in., one ⅜ in., and one 1½ in. The minimum distance permitted is as follows:
Ligament distance between ⅛ and ⅜-in. plugs is 2⅝ in. [67mm].
Ligament distance between ⅛ and 1½-in. plugs is 9½ in. [242 mm].
Ligament distance between ⅜ and 1½-in. plugs is 9½ in. [242 mm].

10.1.3 All the metal poured from a continuous melting furnace for a given period of time between changes in charge, processing conditions, or aim-for chemistry, or 8 h, whichever is the shorter period.

11. Test Coupon

11.1 The separately cast test coupons poured from the same lot as the castings they represent from which the tension test specimen is machined shall be cast to the size and shape shown in Fig. 2, Fig. 3, or Fig. 4. Cast coupons shall be identified with the castings they represent. Sectioning procedure for removing test specimens from Y-blocks is shown in Fig. 5.

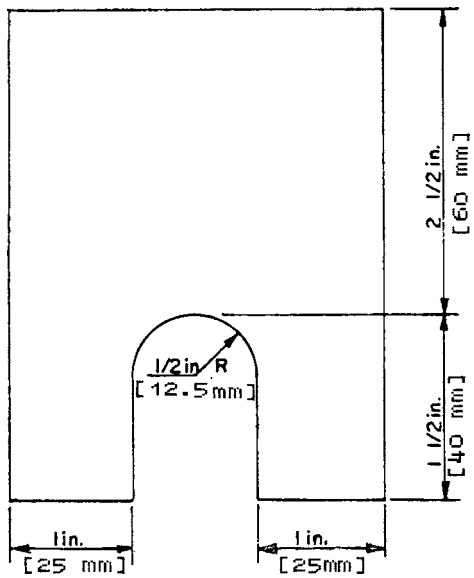
11.1.1 Test samples may be removed from castings at locations designated on a drawing or as agreed to by manufacturer and purchaser.

11.1.2 Test bars removed from castings shall conform to Fig. 6. The testing diameter shall be ½ in. [12.5 mm] if possible. Smaller diameters shall be utilized if necessary.

11.2 The test coupon size shall be as mutually agreed upon between the manufacturer and purchaser. In the absence of agreement, it shall be the option of the manufacturer.

11.3 The test coupons shall be cast in molds made of suitable core sand having a minimum wall thickness of 1½ in. [38 mm] for the ½ in. [12.5 mm], 1 in. [25 mm] sizes, and 3 in. [75 mm] for the 3 in. [75 mm] size. The coupons shall be left in the mold until they have changed to a black color (approximately 900°F [480°C] or less). The keel block as shown in Fig. 2 or the modified keel block produced from the mold shown in Fig. 4 may be substituted for the 1 in. [25 mm] block shown in Fig. 3.

11.4 When investment castings are made to this specification, the manufacturer may use test specimens cast to size incorporated in the mold with the castings or separately cast to size using the same type of mold and the same thermal conditions that are used to produce the castings. These test



NOTE 1—The length of the keel block shall be 6 in. [152 mm]

FIG. 2 Keel Block for Test Coupons