



Designation: A278/A278M – 01 (Reapproved 2006)

Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C)¹

This standard is issued under the fixed designation A278/A278M; 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 (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification² covers gray iron for castings suitable for pressure-containing parts for use at temperatures up to 650°F (350°C).

1.2 Classes of Iron:

1.2.1 Castings of all classes are suitable for use up to 450°F (230°C). For temperatures above 450°F and up to 650°F, only Class 40, 45, 50, 55, and 60 castings are suitable.

1.2.2 Castings of all classes are suitable for use up to 230°C. For temperatures above 230°C and up to 350°C, only Class 275, 300, 325, 350, 380, and 415 castings are suitable.

2. Referenced Documents

2.1 ASTM Standards:³

- A644 Terminology Relating to Iron Castings
- E8 Test Methods for Tension Testing of Metallic Materials

3. Terminology

3.1 Definitions of many terms common to gray iron castings may be found in Terminology A644.

4. Classification

4.1 Classification by tensile strength.

4.1.1 Castings ordered to this specification are classified based upon the minimum tensile strength of the iron in ksi, in English units. Class 25 has a minimum specified tensile strength of 25 ksi.

4.1.2 Castings ordered to this specification are classified based upon the minimum tensile strength of the iron in MPa, in Metric units. Class 150 has a minimum specified tensile strength of 150 MPa.

¹ This specification is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.01 on Grey and White Iron Castings.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-278 in Section II of that Code.

³ 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.

5. Ordering Information

5.1 Orders for material in this specification should include the following information:

- 5.1.1 ASTM designation and year date,
- 5.1.2 Class of iron required and service temperature,
- 5.1.3 Quantity,
- 5.1.4 *Heat Treatment*:

5.1.4.1 Whether or not heat treatment is required for Class 40, 45, 50, 55, and 60 castings to be used at temperatures at 450°F or less (see 6.2),

5.1.4.2 Whether or not heat treatment is required for Class 275, 300, 325, 350, 380, and 415 castings to be used at temperatures at 230°C or less (see 6.2),

5.1.5 The size of separately cast test bar to be poured (see Section 9 and Table 1),

5.1.6 The size of test specimen to be machined from test bars C or S, and

5.1.7 Special requirements.

6. Materials and Manufacture

6.1 Castings intended for use above 450°F (230°C) shall be stress-relieved by placing them in a suitable furnace at a temperature not exceeding 400°F (200°C) and heating them uniformly to the temperatures and for the times specified in Table 2. The heating and cooling rates shall be uniform and shall not be more than 400°F/h (250°C/h) for castings of 1-in. (25-mm) maximum section. For heavier sections the maximum heating and cooling rates in degrees Fahrenheit per hour shall be 400 divided by the maximum section thickness.

6.2 Heat Treatment and Cooling Rate:

6.2.1 Castings of Class Nos. 45, 50, 55, and 60, which are to be used at temperatures below 450°F, may be heat treated in accordance with 6.1 or they shall be cooled in the mold to 500°F at an average rate of not more than 100°F/h for castings up to 1 in. in section. For heavier sections the maximum cooling rate in degrees Fahrenheit per hour shall be 100 divided by the maximum section thickness.

6.2.2 Castings of Class Nos. 275, 300, 325, 350, 380, and 415, which are to be used at temperatures below 230°C, may be heat treated in accordance with 6.1 or they shall be cooled in the mold to 250°C at an average rate of not more than 50°C/h for castings up to 25-mm in section. For heavier sections the

TABLE 1 Diameters and Lengths of Cast Test Bars

Test Bar	As-Cast Diameter, in. (mm)		Length, in. (mm)		
	Minimum (Bottom)	Maximum (Top)	Minimum (Specified)	Maximum (Recommended)	
A	0.88 (23)	0.85 (22)	0.96 (25)	5.0 (125)	6.0 (1.50)
B	1.20 (33)	1.14 (32)	1.32 (36)	7.0 (150)	9.0 (230)
C	2.00 (54)	1.90 (53)	2.10 (58)	6.0 (175)	10.0 (255)
S ^A					

^A All dimensions of Test Bar S shall be agreed upon by the manufacturer and the purchaser.

TABLE 2 Stress Relieving Requirements

Class	Metal Temperature, °F (°C)	Holding Time, h ^A
40, 45, 50, 55, 60 (275, 300, 325, 350, 380, 415)	1050 to 1200 (565 to 650)	2 (2 min) ^B 12 (12 max) ^B

^A In no case shall the holding time be less than 1 h/in. of maximum metal section, or in excess of 12 h max, dependent upon which governs.

^B In no case shall the holding time be less than 1 h for every 25-mm metal section, or in excess of 12 h max, depending upon which governs.

maximum cooling rate in degrees Celsius per hour shall be 1250 divided by the maximum section thickness.

7. Chemical Composition

7.1 Carbon Equivalent:

7.1.1 Class 40, 45, 50, 55, and 60 castings intended for service above 450°F (230°C) shall have a maximum carbon equivalent of 3.8 % as calculated from the equation $CE = \%C + 0.3 (\%Si + \%P)$. The maximum phosphorus and sulfur contents shall be 0.25 % and 0.12 %, respectively.

7.1.2 Class 275, 300, 325, 350, 380, and 415 castings intended for service above 230°C shall have a maximum carbon equivalent of 3.8 % as calculated from the equation $CE = \%C + 0.3 (\%Si + \%P)$. The maximum phosphorus and sulfur contents shall be 0.25 % and 0.12 %, respectively.

7.2 The chemical analysis for total carbon shall be made on either chilled cast pencil-type specimens or thin wafers approximately 1/32 in. thick cut from test coupons. Drillings shall not be used because of attendant loss of graphite.

8. Tensile Requirements

8.1 Iron used in supplying castings to this specification shall conform to the tensile requirements prescribed in **Table 3** and **Table 4**.

9. Test Bars

9.1 Separately cast test bars having the dimensions shown in **Table 1** shall be poured from the same lot as the castings

TABLE 3 Tensile Requirements

Class	Tensile Strength, min, ksi
No. 20	20
No. 25	25
No. 30	30
No. 35	35
No. 40	40
No. 45	45
No. 50	50
No. 55	55
No. 60	60

TABLE 4 Tensile Requirements (SI)

Class	Tensile Strength, min, MPa
No. 150	150
No. 175	175
No. 200	200
No. 225	225
No. 250	250
No. 275	275
No. 300	300
No. 325	325
No. 350	350
No. 380	380
No. 415	415

represented. The size of the test bar to be poured shall be selected by the purchaser using **Table 5**. In the event no choice is made, the selection will be made by the manufacturer.

9.2 Separately cast test bars shall be heat treated in the same furnace together with the castings represented.

9.3 At the option of the manufacturer, test coupons may be removed from the casting at a location agreed upon between the manufacturer and purchaser.

9.4 Castings weighing in excess of 2000 lb may be represented either by separately cast test bars (9.1) or by integrally cast test bars having a cooling rate closely approximating that of the controlling section of the casting.

9.5 For castings weighing in excess of 10 000 lb or having a controlling section greater than 2 in., test bars may be removed from the casting or integral projections having a cross section no less than the controlling section. The minimum tensile strength requirement for tension tests performed on either of these test bars shall be 80 % of the specified class.

10. Molding and Pouring Test Bars

10.1 The test bars shall be cast in dried siliceous sand molds maintained at approximately room temperature. A suitable design for a mold is shown in **Fig. 1**.

11. Workmanship, Finish, and Appearance

11.1 All castings shall be made in a workmanlike manner and shall conform to the dimensions on drawings furnished by the purchaser. If the pattern is supplied by the purchaser without drawings, the dimensions of the casting shall be as predicted by the pattern.

11.2 The surface of the casting shall be free of adhering sand, scale, cracks, and hot tears as determined by visual examination. Other surface discontinuities shall meet the visual acceptance standards specified in the order.

TABLE 5 Separately Cast Test Bars for Use When a Specific Correlation Has Not Been Established Between the Test Bar and the Casting

Thickness of the Wall of the Controlling Section of the Casting, in. (mm)	Test Bar
Under 0.25 (6)	S
0.25 to 0.50 (6 to 12)	A
0.51 to 1.00 (13 to 25)	B
1.01 to 2 (26 to 50)	C
Over 2 (50)	S