Designation: A 278/A 278M – 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 A 278/A 278M; 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[2] 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]

A 644 Terminology Relating to Iron Castings

E 8 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 A 644.

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.

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

[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.

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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.

for castings up to 25-mm in section. For heavier sections the 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.

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

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 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.

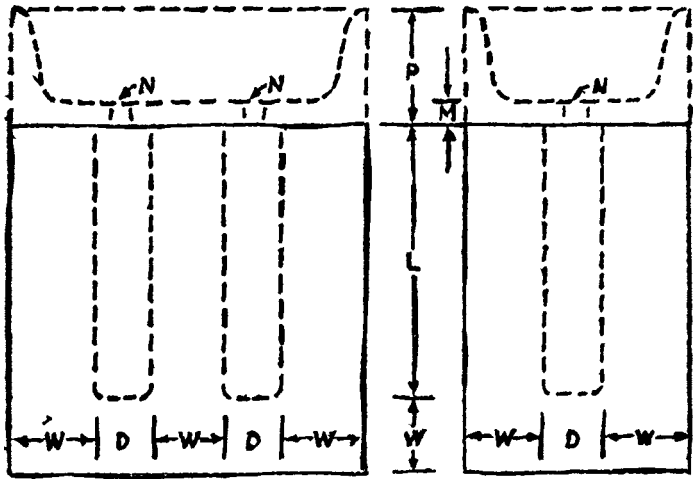
11. Workmanship, Finish, and Appearance

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.

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

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Number of test bars in a single mold-2 suggested.
L—see Table 1.
D—see Table 1.
W—not less than diameter, *D*.
P—2 in. (50-mm) suggested
N—5/16 in. (8-mm) in diameter, suggested
M—1.5 *N*, suggested

FIG. 1 Suitable Design and Dimensions for Mold for Separately Cast Cylindrical Test Bars for Gray Iron

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.

12. Sampling

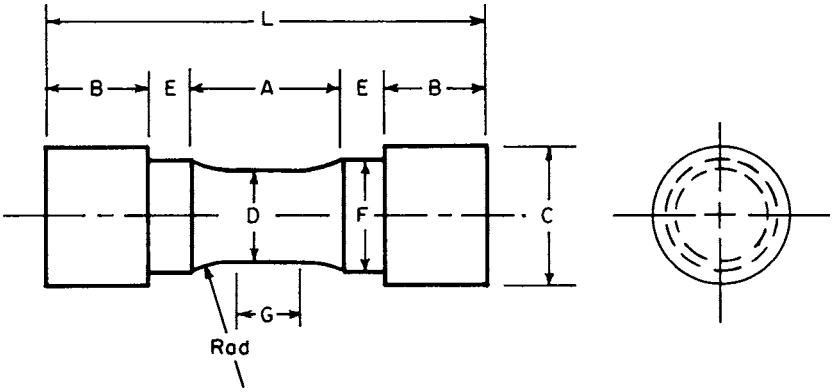
12.1 A lot shall consist of one of the following:

12.1.1 All the metal poured from a single heating in a batch type melting furnace,

12.1.2 All the metal from two or more batch type melting furnaces poured into a single ladle or single casting, or

12.1.3 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 4 h, whichever is the shorter period.

12.1.3.1 The purchaser may agree to extend the 4-h time period to 8 h if the manufacturer can demonstrate sufficient process control to warrant such an extension.



Dimensions, in. (mm)	Tension Test Specimen A	Tension Test Specimen B	Tension Test Specimen C
G— Length of parallel, min	0.50 (13)	0.75 (20)	1.25 (32)
D— Diameter	0.500 ± 0.010 (13 ± 0.25)	0.750 ± 0.015 (20 ± 0.4)	1.25 ± 0.025 (32 ± 0.5)
R— Radius of fillet, min	1 (25)	1 (25)	2 (50)
A— Length of reduced section, min	1¼ (32)	1½ (38)	2¼ (57)
L— Overall length, min	3¾ (95)	4 (100)	6⅜ (160)
C— Diameter of end section, approximate	⅞ (22)	1¼ (32)	1⅞ (47)
E— Length of shoulder, min	¼ (6)	¼ (6)	5/16 (8)
F— Diameter of shoulder	5/8 ± 1/64 (16 ± 0.5)	15/16 ± 1/64 (25 ± 0.5)	1 7/16 ± 1/64 (36 ± 0.5)
B— Length of end section [A]			

[A] Optional to fit holders on testing machine. If threaded, root diameter shall not be less than dimension *F*.

FIG. 2 Tension-Test Specimens

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13. Tension Test Specimens

13.1 Tension test specimens A and B in Fig. 2 shall be machined from test bars A and B in Table 1, respectively.

13.2 The purchaser shall specify whether test specimen B or C is to be machined from test bar C. If no choice is made, the manufacturer shall make the selection.

13.3 The size of the test specimen to be machined from test bar S shall be as agreed upon between the manufacturer and purchaser.

14. Number of Tests and Retests

14.1 One tension test shall be performed on each lot in accordance with Test Method E 8 and conform to the tensile requirements specified.

14.2 If the results of a valid test fail to conform to the requirements of this specification, two retests shall be made. If either retest fails to meet the specification requirements, the castings represented by these test specimens shall be rejected.

14.3 If, after testing, a test specimen shows evidence of a defect, the results of the test may be invalidated and another made on a specimen from the same lot.

15. Repair

15.1 Any repairs performed on castings produced to this specification shall be agreed upon between the manufacturer and purchaser.

16. Certification

16.1 When requested by the purchaser, the manufacturer shall furnish his certification stating that the material was manufactured, sampled, tested, and inspected in accordance with this specification including the year date. The certification shall also include the results of all tests performed.

16.2 A signature is not required on the certification. However, the document shall clearly identify the organization submitting the certification and the authorized agent of the manufacturer who certified the test results. Notwithstanding the absence of a signature, the organization submitting the certification is responsible for its content.

17. Inspection

17.1 All tests and inspections required by this specification shall be performed by the manufacturer or other reliable sources whose services have been contracted for by the manufacturer. Complete records of all tests and inspections shall be maintained by the manufacturer and shall be available for review by the purchaser.

18. Rejection and Rehearing

18.1 Castings which fail to conform to the requirements specified when inspected or tested by the purchaser or his agent may be rejected. Rejection shall be reported to the manufacturer or supplier promptly and in writing. In case of dissatisfaction with the test results, the manufacturer or supplier may make claim for a rehearing.

19. Product Marking

19.1 Castings shall have the name of the manufacturer, or his recognized trademark, and the class of iron to which it conforms, cast or indelibly stamped on a surface indicated by the purchaser or in such a position as not to injure the usefulness of the casting.

20. Keywords

20.1 elevated temperature service; gray iron castings; pressure containing parts

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