Designation: A 823 – 99 (Reapproved 2003)

Standard Specification for Statically Cast Permanent Mold Gray Iron Castings[1]

This standard is issued under the fixed designation A 823; 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.

1. Scope

1.1 This specification covers gray iron castings that are statically cast in permanent molds.

1.2 No precise quantitative relationship can be stated between the properties of the iron in various locations of the same casting or between the properties of a casting and those of a test specimen cast from the same iron (see Appendix X1).

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 247 Test Method for Evaluating the Microstructure of Graphite in Iron Castings

A 644 Terminology Relating to Iron Castings

E 8 Test Methods for Tension Testing of Metallic Materials

E 10 Test Method for Brinell Hardness of Metallic Materials

2.2 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment[3]

2.3 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[3]

3. Terminology

3.1 Definitions for many terms common to iron castings are found in Terminology A 644. A classification of graphite structure is found in Test Method A 247.

4. Classification

4.1 Castings ordered and produced under this specification are classified into a number of grades based on the properties of separately cast test bars. The test bar shall be selected on the basis of the controlling section size of the casting (see 9.1 and 9.2 and Table 1).

TABLE 1 Permanent Mold Gray Iron Specifications

Grade	Tensile Strength, min, ksi (MPa)[A]	BHN
	Uncored—Annealed	
A-SA	30 000 (207)	163–207
A-SB	25 000 (172)	163–207
A-SC	20 000 (138)	163–207
A-SS	18 000 (124)	143–207
	Cored—Annealed	
A-CA	30 000 (207)	143–207
A-CB	25 000 (172)	143–207
A-CC	20 000 (138)	143–207
	Uncored—Normalized	
N-SA	30 000 (207)	170–229
N-SB	25 000 (172)	170–229
N-SC	20 000 (138)	170–229
N-SS	18 000 (124)	149–229
	Cored—Normalized	
N-CA	30 000 (207)	170–229
N-CB	25 000 (172)	149–229
N-CC	20 000 (138)	149–229

[A] Refer to Fig. X1.1 for the relationship between tensile strength and section size.

4.2 Castings may be produced in the as cast state provided the requirements of this standard in Table 1 are met. However, annealing or normalizing heat treatments are usual and customary and are a basis for classification.

4.3 The grades are designated A for annealed or N for normalized. This is followed by an S or a C to designate a solid or a cored casting, followed by an A, B, C, or S to designate the test bar to be poured with the castings. Examples of proper designations are as follows:

Permanent Mold Castings, ASTM Specification A 823, Grade N-SB

Permanent Mold Castings, ASTM Specification A 823, Grade A-CC

5. Ordering Information

5.1 Orders for material to this specification shall include the following information:

5.1.1 ASTM designation number and year of issue.

5.1.2 Grade of iron required (see Section 4 and Table 1).

5.1.3 The size of the separately cast test bar (letter classification A, B, C, or S) which best represents the thickness of the controlling section of the casting (see 4.1 and Table 2).

5.1.4 Location for Brinell Hardness determination (see 10.1.1).

[1] This specification is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.01 on Gray Iron 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 Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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TABLE 2 Diameters and Lengths of Cast Test Bars

Test Bar	As-Cast Diameter, in. (mm)[A]			Length, in. (mm)	
	Nominal (Mid-Length)	Minimum (Bottom)	Maximum (Top)	Minimum (Specified)	Maximum (Recommended)
A	0.88 (22.4)	0.85 (21.6)	0.96 (24.4)	5.0 (125)	6.0 (150)
B	1.20 (30.5)	1.14 (29.0)	1.32 (33.5)	6.0 (150)	9.0 (230)
C	2.00 (50.8)	1.90 (48.3)	2.10 (53.3)	7.0 (175)	10.0 (255)
S[B]	. . .	. . .	. . .	. . .	. . .

[A] The diameter is the controlling section for the appropriate permanent mold specification (see Section 9).

[B] All dimensions of test bar S shall be agreed upon by the manufacturer and the purchaser.

5.1.5 Lot size (see Section 16).

5.1.6 Special requirements (see Section 17).

5.1.7 Special preparation for delivery (see Section 22).

5.1.8 Saving tested specimens or unbroken test bars (see 19.1.1).

6. Chemical Composition

6.1 The chemical composition shall be such as to produce the mechanical properties required by this specification. As a reference, typical compositions covering all grades are shown in Table X1.1 in Appendix X1.

6.2 By agreement between the manufacturer and purchaser, chemical composition requirements may be specified.

7. Heat Treatment

7.1 Although castings may be provided in the as cast condition, when necessary, heat treatment shall be such as to produce the mechanical properties required in this standard.

8. Tensile Requirements

8.1 Test bars representing castings conforming to this specification shall meet the requirements for tensile strength described in Table 1.

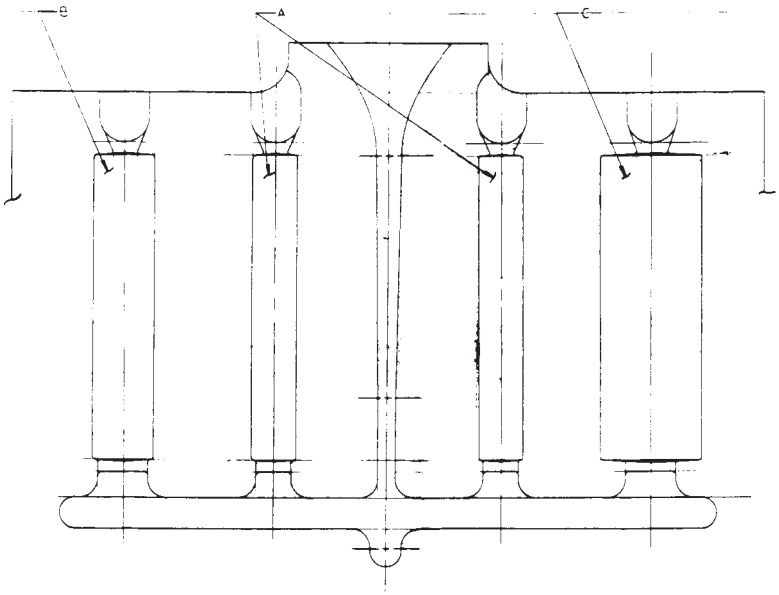
9. Cast Test Bars

9.1 Test bars shall be separate castings poured from the same iron as the castings they represent and shall have dimensions as shown in Table 2. Allowance may be made for reasonable pattern draft within the tolerances shown in Table 2. Test bars A, B, and C are all standard test bars in the form of simple cylinders. Test bar S is special and is intended for use where the controlling section of the casting is over 2 in.

9.2 The test bar selected shall be based on the controlling section size of the casting. This shall be determined by the dimensions of the largest cylinder that will fit into the controlling section of the casting with the additional requirement that the height of the cylinder must be at least equal to its diameter.

9.3 The test bars shall be cast in a permanent mold. The mold shall be of similar material, design, and construction as that used to make the production castings. The test bar permanent mold shall be preheated with three consecutive pours, after which, starting with the fourth pour, the bars can be used for the tension test. A suitable design for a mold is shown in Fig. 1.

9.4 By specific agreement between the manufacturer and the purchaser, test bars removed from the castings may be substituted for separately cast test bars. The location from which the bars are taken shall be as agreed between the parties and indicated on the casting drawing or data base equivalent.



Required Features:

1. Material—Permanent molds.
2. Position—Bars vertical.
3. *L*—See Table 2.
4. *D*—See Table 2.

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

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9.5 Where test specimens are to represent heat treated castings, they shall accompany the castings in the same heat treat lot(s), or by agreement, be subjected to the same thermal cycle that the castings undergo.

10. Hardness Requirements

10.1 Brinell hardness readings taken on the castings shall conform to the requirements in Table 1.

10.1.1 The area or areas on the castings where the hardness is to be determined shall be established by agreement between manufacturer and purchaser and shall be shown on the casting drawing.

10.1.2 Brinell hardness shall be determined in accordance with Test Method E 10. Sufficient surface material shall be removed (generally 0.010 to 0.030 in.) to ensure that the measured hardness is representative of the basic iron structure.

10.1.3 Brinell hardness measurements shall be undertaken at room temperature, defined as 50–95 °F (10–35 °C).

11. Dimensional Requirements

11.1 The castings shall conform to the dimensions or drawings furnished by the purchaser, or, if there are no drawings, to the dimensions predicted by the pattern equipment supplied by the purchaser.

12. Workmanship and Finish

12.1 The surface of the casting shall be inspected visually, particularly in critical areas, for such surface defects as cracks, hot tears, adhering sand and scale, cold shuts, and gas holes.

12.2 No repairing by plugging or welding of any kind shall be permitted unless written permission is granted by the purchaser.

13. Number of Tests and Retests

13.1 The manufacturer shall cast and prepare at least three test bars for each lot of castings intended to conform to this specification. The manufacturer shall conduct the specified tests unless the manufacturer and purchaser agree that the tests shall be made by another qualified laboratory. Only one bar need be tested if the results conform to the property requirements of this specification. If any test specimen shows defective or improper machining, or obvious lack of continuity of metal, it may be discarded and replaced by another specimen from another test bar from the same lot.

13.2 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.

13.3 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. A valid test is one wherein the specimen has been properly prepared and appears to be sound and on which the approved test procedure has been followed.

13.4 If sufficient separately cast test pieces are not available, the manufacturer shall have the option of removing a test specimen from a location of representative casting, as agreed upon between the manufacturer and purchaser.

13.5 If the first test results indicate that a heat treatment or an additional heat treatment is needed to meet the test requirements, the entire lot of castings and the representative test specimens shall be heat treated or reheat treated together. Testing shall proceed in accordance with 13.1,13.2,13.3, and 13.4 .

14. Tension Test Specimens

14.1 For test bar A, the tension test specimen A, as shown in Fig. 2, shall be machined concentric with the axis of the test bar.

14.2 For test bar B, the tension test specimen B, as shown in Fig. 2, shall be machined concentric with the axis of the test bar.

14.3 For test bar C, tension test specimen C, as shown in Fig. 2, shall be machined concentric with the axis of the test bar. Unless the size of the tensile test specimen to be machined from test bar C is specified in writing by the purchaser, the decision whether to use tension test specimen B or C shall be made by the manufacturer of the castings.

14.4 For test bar S, the nature and dimensions of the tension test specimen shall be determined by agreement between the manufacturer and the purchaser. Test bar S is to be used whenever the controlling section exceeds 2 in.

15. Tension Test

15.1 Tension testing shall be determined in accordance with Test Methods E 8.

15.2 The tension test specimens shall fit the holders of the testing machine in such a way that the load shall be axial.

15.3 The elapsed time from the beginning of loading in the tension test to the instant of fracture shall be not less than 15 s for test specimen A and not less than 20 s for test specimens B or C.

16. Description of a Lot

16.1 The manufacturer may define a lot as any of the following:

16.1.1 A lot size may be established by agreement between the manufacturer and the purchaser.

16.1.2 Absent such an agreement as described in 16.1.1, a lot shall be a group of castings weighing less than 2000 lb (910 kg) each when the total weight of the group does not exceed 8000 lb (3600 kg) and when poured continuously within 4 h from the same melt and from consecutive charges of essentially the same percentages and types of materials.

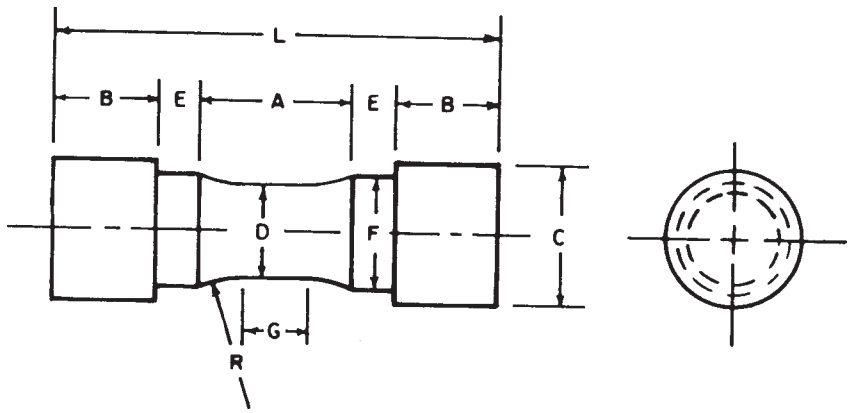
17. Special Requirements

17.1 When agreed upon in writing by the manufacturer and the purchaser, it may be necessary for the castings to meet special requirements as to hardness, chemical composition, microstructure, pressure tightness, radiographic soundness, dimensions, surface finish, etc.

18. Identification Marking

18.1 When the size of the casting permits, each casting shall bear the identifying mark of the manufacturer and the part or

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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 (19)	1.25 (32)
D—Diameter	0.500 ± 0.010 (12.7 ± 0.25)	0.750 ± 0.015 (19.1 x± 0.4)	1.25 ± 0.025 (32 ± 0.6)
R—Radius of fillet, min	1 (25)	1 (25)	2 (50)
A—Length of reduced section, min	1 ¼ (32)	1 $^{21}/_{32}$ (42)	2 $^{17}/_{32}$ (64)
L—Overall length, min	3 ¾ (95)	4 $^{5}/_{32}$ (106)	6 ⅜ (160)
C—Diameter of end section, approx	⅞ (22.2)	1¼ (31.8)	1 ⅞ (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]	[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

pattern number at a location shown on the covering drawing or, if not shown on the drawing, at a location at the discretion of the producer.

19. Responsibility for Inspection

19.1 Unless otherwise specified in the contract or purchase order, the manufacturer shall be responsible for carrying out all the tests and inspections required by this specification, using his own or other reliable facilities, and he shall maintain complete records of all such tests and inspections. Such records shall be available for review by the purchaser.

19.1.1 When agreed upon between manufacturer and purchaser, tested specimens or unbroken test bars from the same lot shall be saved for a period for 3 months after the date of the test report.

19.2 The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to the prescribed requirements.

20. Rejection and Resubmission

20.1 Any castings or lot of castings failing to comply with the requirements of this specification may, where possible, be reprocessed, retested, and reinspected. If the tests and inspections on the reprocessed casting(s) show compliance with this specification, the castings shall be acceptable; if they do not, they shall be rejected.

20.2 If the purchaser should find that a casting or lot of castings fails to comply with this specification subsequent to receipt at his facility, he shall so notify the manufacturer promptly and in no case later than 6 weeks after receipt of the shipment, stating clearly the basis for rejection.

21. Certification

21.1 When specified by the purchaser's order or contract, a manufacturer's certification or compliance statement that the casting or lot of castings was made, sampled, tested, and inspected in accordance with this specification, including a report of test results signed by an authorized agent of the manufacturer, shall be furnished at the time of shipment, and such certification or compliance statement shall be the basis for acceptance of the casting or lot of castings.

22. Preparation for Delivery

22.1 Unless otherwise stated in the contract or order, the cleaning, preservation, and packing of castings for shipment shall be in accordance with the manufacturer's commercial practice. Packaging and marking shall also be adequate to identify the contents and to ensure acceptance and safe delivery by the carrier for the mode of transportation employed.

22.2 *U.S. Government Procurement*—When specified in the contract or purchase order, marking for shipment shall be in accordance with the requirements of Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military activities.

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23. Keywords

23.1 chemical composition; gray iron; hardness; heat treatment; iron castings; statically cast permanent mold; tensile strength

APPENDIXES

(Nonmandatory Information)

X1. MECHANICAL PROPERTIES OF CASTINGS

X1.1 The mechanical properties of iron castings are influenced by the cooling rate during and after solidification, by chemical composition (particularly carbon equivalent)(see Table X1.1), by the design of the casting, by the design and nature of the mold, by the location and effectiveness of gates and risers, and by certain other factors.

X1.2 The cooling rate in the mold and, hence, the properties developed in any particular section are influenced by the presence of cores, chills and chaplets, changes in section thickness, and the existence of bosses, projections, and intersections, such as junctions of ribs and bosses. Because of the complexity of the interactions of these factors, no precise quantitative relationship can be stated between the properties of the iron in various locations of the same casting or between the properties of a casting and those of a test specimen cast from the same iron. When such a relationship is important and must be known for a specific application, it may be determined by appropriate experimentation.

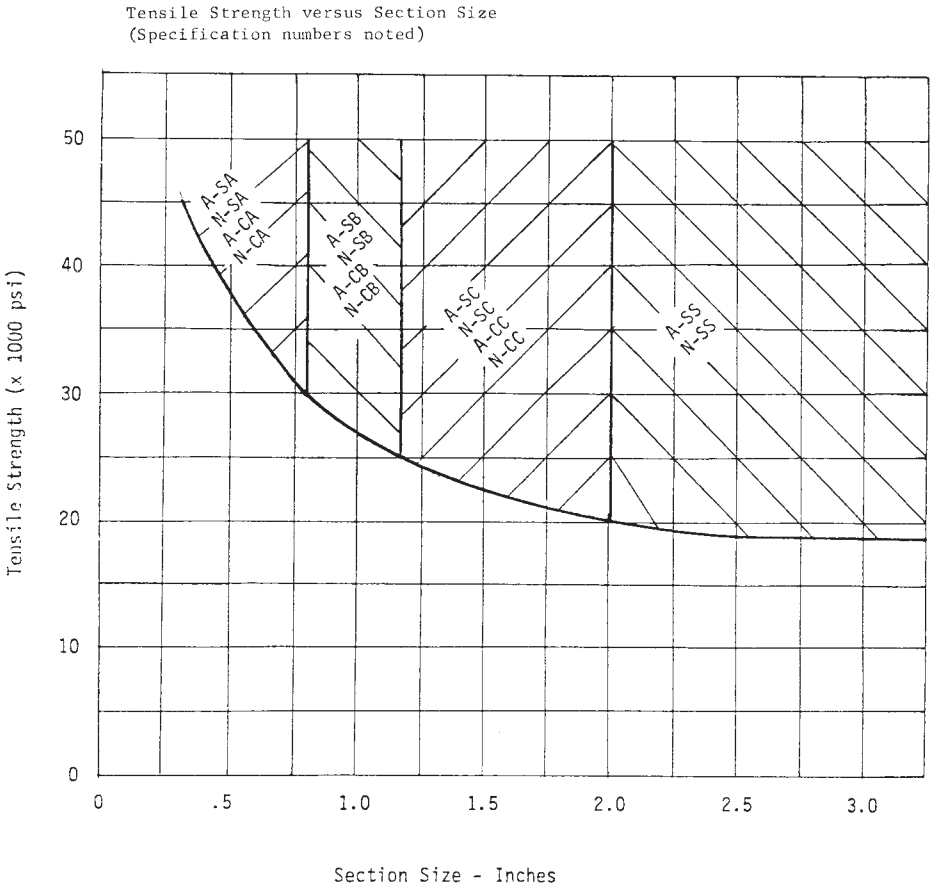
TABLE X1.1 Typical Chemical Compositions—All Grades

Carbon	3.30–3.70 %
Silicon	2.20–2.80 %
Manganese	0.40–1.00 %
Phosphorus	0.45 % max
Sulfur	0.15 % max

X1.3 When reliable information is unavailable on the relationship between properties in a casting and those in a separately cast test specimen and where experimentation would be unfeasible, the size of the test casting should be so selected as to approximate the thickness of the main or controlling section of the casting (see Fig. X1.1).

X1.4 If iron castings are welded, (see 12.2), the microstructure of the iron is usually altered, particularly in the vicinity of the weldment. Therefore, the properties of the casting may be adversely affected by welding. Where practical, appropriate post weld heat treatment may reduce this effect of the welding.

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NOTE—The relationship of permanent mold gray iron tensile strength versus section size is shown above. Castings with controlling section up to 0.875 in. will have a minimum tensile strength of 30 000 psi (207 MPa). Castings with controlling section between 0.875 and 1.2 in. will have a minimum tensile strength of 25 000 psi (172 MPa). Castings with controlling section between 1.2 and 2.0 in. will have a minimum tensile strength of 20 000 psi (138 MPa).

FIG. X1.1 Tensile Strength versus Section Size of Permanent Mold Gray Iron

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X2. MICROSTRUCTURE

X2.1 Information on microstructure is given in Table X2.1.

TABLE X2.1 Permanent Mold Gray Iron Graphite and Matrix Information

Grade	Graphite[A]	Matrix
	Uncored—Annealed	
A-SA, A-SB, A-SC	Predominantly type D, size 5-8, some type A, size 4-6	Essentially ferrite
A-SS	Type D, size 5-8 with type A, size 3-6 and some type C	
	Cored—Annealed	
A-CA, A-CB	Predominantly type D, size 5-8 and some type A, size 4-6	Essentially ferrite
A-CC	Type D, size 5-8, type A and B, size 3-6	
	Uncored—Normalized	
N-SA, N-SB	Predominantly type D, size 5-8, some type A, size 4-6	Ferrite plus 10–20 % pearlite
N-SC	Type D, size 5-8 and type A, size 3-6, some type C	Ferrite plus 10–25 % pearlite at surface, up to 50 % at center
N-SS	Type D, size 5-8, type A, size 3-6, some type C	Ferrite plus 10 % pearlite at surface, up to 60 % at center
	Cored—Normalized	
N-CA, N-CB	Predominantly type D, size 5-8, some type A, size 4-6.	Ferrite plus 10–20 % pearlite Ferrite plus 10–20 % pearlite near core
N-CC	Type D, size 5-8, type A and B, size 3-6	Ferrite plus 10 % pearlite at surface and 50 % pearlite at center

[A] Graphite type and size in accordance with Test Method A 247.

X3. HEAT TREATMENT

X3.1 Castings may be in the as-cast, annealed, or normalized conditions.

X3.2 When needed to achieve the requirements of this standard, the annealing or normalizing heat treatment cycles may be determined by the manufacturer.

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