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Standard Specification for Austenitic Gray Iron Castings[1]

This standard is issued under the fixed designation A 436; 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 austenitic gray iron castings that are used primarily for their resistance to heat, corrosion, and wear. Austenitic gray iron is characterized by uniformly distributed graphite flakes, some carbides, and the presence of sufficient alloy content to produce an austenitic structure.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron[3]

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition[3]

E 94 Guide for Radiographic Examination

E 165 Test Method for Liquid Penetrant Examination

E 351 Test Methods for Chemical Analysis of Cast Iron—All Types

E 433 Reference Photographs for Liquid Penetrant Inspection

E 446 Reference Radiographs for Steel Castings Up to 2 in. [51 mm] in Thickness

3. Ordering Information

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

3.1.1 ASTM designation and date of issue,

3.1.2 Type of austenitic gray iron required (see 5.1),

3.1.3 Heat treatment required (see 4.2 through 4.5),

3.1.4 If repair of castings is permitted (see 4.6),

3.1.5 Size and number of test bars required (see 11 through 8.4 and 12.1),

3.1.6 If special tests are required (see Section 7 and 9.1),

3.1.7 If certification is required (see 14.1), and

3.1.8 If different preparation for delivery requirements are needed (see 15.1).

4. Materials and Manufacture

4.1 Melting may be done in any furnace that produces castings meeting the chemical compositions and mechanical properties outlined in this specification. These include cupolas, air furnaces, electric furnaces, crucible furnaces, and so forth.

4.2 By agreement between the manufacturer and the purchaser, the castings may be stress relieved by heating to and holding in the temperature range from 1150 to 1200°F (620 to 650°C) for not less than 1 nor more than 2 h/in. of thickness in the thickest section. Heating and cooling shall be uniform and shall be not more than 400°F (222°C)/h for castings less than 1 in. in maximum thickness, nor more than 400°F/h divided by the maximum section thickness in inches for thicker castings. During the cooling cycle, castings may be cooled in still air after the temperature has dropped to 600°F (315°C).

4.3 If the manufacturer can demonstrate that another treatment provides satisfactory stress relief, it may be used by agreement between the manufacturer and the purchaser.

4.4 Whenever dimensional changes in high-temperature service are a problem, by agreement between the manufacturer and the purchaser, the castings may be stabilized by heating at 1600°F (870°C) for 1 h/in. of section, for a minimum of 1 h. Otherwise, the austenite that is supersaturated with respect to carbon may reject carbon during service and produce dimensional changes.

4.5 By agreement between the manufacturer and the purchaser, castings with chilled edges or excessive carbides may be annealed at 1750 to 1900°F (955 to 1040°C) for ½ to 5 h, followed by uniform cooling, preferably in still air.

4.6 Castings shall not be repaired by welding, plugging, or other methods without written permission from the purchaser.

[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 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] Withdrawn

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5. Chemical Composition

5.1 Many combinations of alloys can be used to obtain an austenitic gray iron. This specification includes only the six types defined by the chemical composition limits specified in Table 1.

5.2 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.

5.3 Drillings taken from test coupons, broken test specimens, or castings shall conform to the requirements for chemical composition as given in Table 1. Sampling shall be conducted in accordance with Practice E 59 and chemical analysis in accordance with Test Methods E 351 and Test Methods E 30. Test Methods E 30 should only be used for analyzing those elements for which specific coverage is not provided for in Test Methods E 351.

5.4 Spectrometric techniques may also be used for analysis, but should a dispute arise concerning chemical composition, chemical analyses determined by Test Methods E 351 and Test Methods E 30 shall be used for referee analysis.

6. Mechanical Properties

6.1 Although these irons are not used primarily for their strength, the tensile strength and Brinell hardness are indicative of the correct metallurgical structure. The six types shall conform to the requirements given in Table 2.

7. *Magnetic Property Requirements* Magnetic Property Requirements

7.1 A convenient shop test for differentiating the various types of austenitic gray iron is based on the fact that a ground face of either the test bars or the castings of Types 1, 2, and 4 will not attract a small steel horseshoe-type magnet, that is normally attracted to steel. Types 1*b*, 2*b*, 3, and 5 may be attracted to a magnet. This nonmagnetic test is a convenient qualitative test only for Types 1, 2, and 4 and shall not be used as a basis for acceptance. In the event that nonmagnetic castings are specified, the magnetic permeability test shall be used. The specific test conditions and magnetic permeability limits shall be agreed upon between the manufacturer and the purchaser.

NOTE 1—Alnico magnets should not be used.

8. Test Bars

8.1 The separately cast test bars from which tension test specimens are to be machined shall be cast to the size and shape shown in Fig. 1. The size of bar cast to represent the casting shall be at the option of the purchaser. In case no option is expressed, the manufacturer shall make the choice. The test bars shall be cast in open molds made of suitable core sand with a minimum of 1½ in. (38 mm) of sand on all sides and bottom of the ½-in. (13-mm) and 1-in. (25-mm) sizes, and 3 in. (76 mm) of sand for the 3-in. test bar.

8.2 By agreement between the manufacturer and the purchaser, the 1-in. (25-mm) keel block shown in Fig. 2 may be used. It shall be an open mold made of suitable core sand with a minimum of 1½ in. (38 mm) of sand on all sides and bottom.

8.3 It is recommended that test bars be poured immediately after the castings and from the same ladle of metal. If castings are to be heat treated, test bars shall be included in the same furnace load.

8.4 By agreement between the manufacturer and the purchaser, tension test specimens may be cut directly from centrifugal or other permanent mold castings. The location and orientation of such tension test specimens cut from castings shall be specified as agreed upon by the manufacturer and the purchaser.

9. Workmanship, Finish, and Appearance

9.1 The castings shall conform substantially to the dimensions on the drawings furnished by the purchaser, or if no drawing has been provided, to the dimensions predicated by the pattern supplied by the purchaser. The castings shall be free of injurious defects. Surfaces of the castings shall be free of burnt-on sand and shall be reasonably smooth. In other respects, the castings shall conform to whatever points may be specifically agreed upon between the manufacturer and the purchaser.

10. Tension Test Specimens

10.1 The round tension test specimen with 2-in. or 50-mm gage length shown in Fig. 3 shall be used, except when the ½-in. (13-mm) "Y" block is used or when specimens are cut from castings under ¾-in. (19.0-mm) thickness. In these cases, either of the test specimens shown in Fig. 4 shall be satisfactory.

TABLE 1 Chemical Requirements

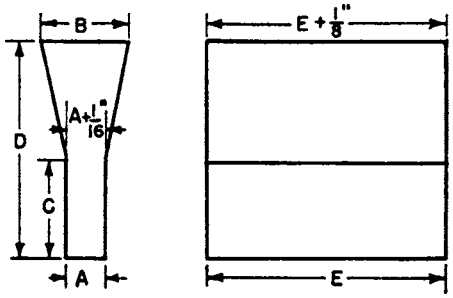
Element	Composition, %							
	Type 1	Type 1b	Type 2	Type 2b	Type 3	Type 4	Type 5	Type 6
Carbon, total, max	3.00	3.00	3.00	3.00	2.60	2.60	2.40	3.00
Silicon	1.00–2.80	1.00–2.80	1.00–2.80	1.00–2.80	1.00–2.00	5.00–6.00	1.00–2.00	1.50–2.50
Manganese	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5
Nickel	13.50–17.50	13.50–17.50	18.00–22.00	18.00–22.00	28.00–32.00	29.00–32.00	34.00–36.00	18.00–22.00
Copper	5.50–7.50	5.50–7.50	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	3.50–5.50
Chromium	1.5–2.5	2.50–3.50	1.5–2.5	3.00–6.00[A]	2.50–3.50	4.50–5.50	0.10 max	1.00–2.00
Sulfur, max	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Molybdenum, max	...	...	...	...	...	...	...	1.00

[A] Where some machining is required, the 3.00–4.00 % chromium range is recommended.

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TABLE 2 Mechanical Requirements

	Type 1	Type 1b	Type 2	Type 2b	Type 3	Type 4	Type 5	Type 6
Tensile strength, min, ksi (MPa)	25 (172)	30 (207)	25 (172)	30 (207)	25 (172)	25 (172)	20 (138)	25 (172)
Brinell hardness (3000 kg)	131 183	149 212	118 174	171 248	118 159	149 212	99 124	124 174



Dimensions	"Y" Block Size					
	For Castings of Thickness Less than ½ in. (13 mm)		For Castings of Thickness ½ in. (13 mm) to 1½ in. (38 mm)		For Castings of Thickness of 1½ in. (38 mm) and Over	
	in.	mm	in.	mm	in.	mm
A	½	13	1	25	3	75
B	1⅝	40	2⅛	54	5	125
C	2	50	3	75	4	100
D	4	100	6	150	8	200
E	7	175	7	175	7	175
	approx	approx	approx	approx	approx	approx

NOTE—1/16 in. = 1.6 mm; ⅛ in. = 3.2 mm.

FIG. 1 "Y" Blocks for Test Coupons

11. Number of Test

11.1 The number of test bars cast shall be agreed upon by the manufacturer and the purchaser.

11.2 One tension test shall be made from sections cut from the test bars as shown in Fig. 5. If any tension test specimen shows obvious defects, another may be cut from the same test bar or from another test bar representing the same metal.

12. Other Tests

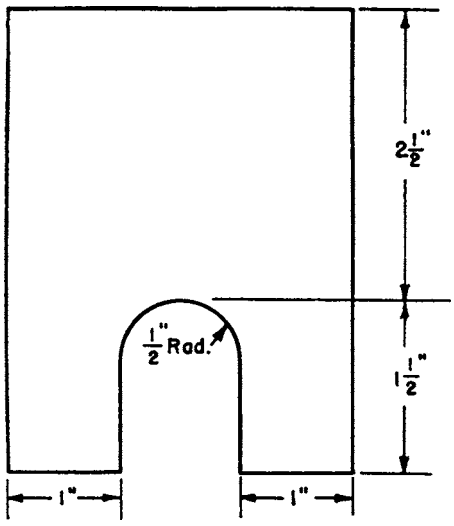
12.1 Hydrostatic tests for pressure castings, fracture tests, microstructure standards, radiography standards, and liquid penetrant inspection may be set up by mutual agreement between the manufacturer and the purchaser.

12.2 Radiography, when required, shall be in accordance with Guide E 94 and Reference Radiographs E 446.

12.3 Liquid penetrant inspection, when required, shall be in accordance with Test Method E 165 and Reference Photographs E 433.

13. Responsibility for Inspection

13.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the manufacturer



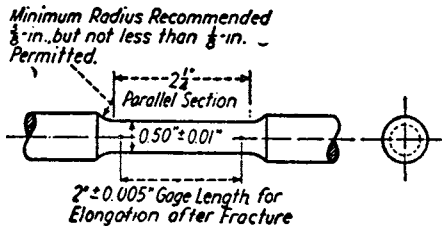
Metric Equivalents

in.	½	1	1½	2
mm	13	25	38	51

NOTE—The length of the keel block shall be 6 in. (152 mm).

FIG. 2 Keel Block for Test Coupons

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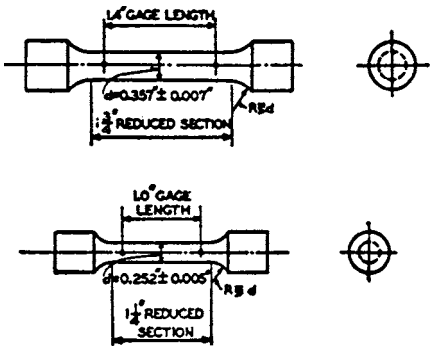


Metric Equivalents

in.	mm	in.	mm
0.005	0.13	0.50	12.7
0.01	2.5	2	50.8
1/8	3.2	2 1/4	57.2
3/8	9.5		

NOTE—The gage length and fillets shall be as shown but the ends may be of any shape to fit the holders of the testing machine in such a way that the load shall be axial. The reduced section shall have a gradual taper from the ends toward the center, with the ends 0.003 to 0.005 in. (0.08 to 0.13 mm) larger in diameter than the center.

FIG. 3 Standard Round Tension Test Specimen with 2-in. or 50-mm Gage Length

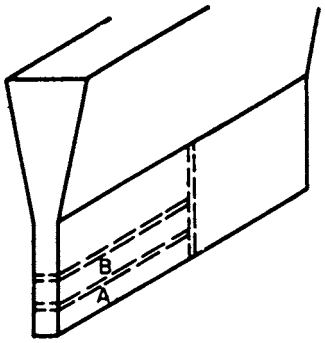


Metric Equivalents

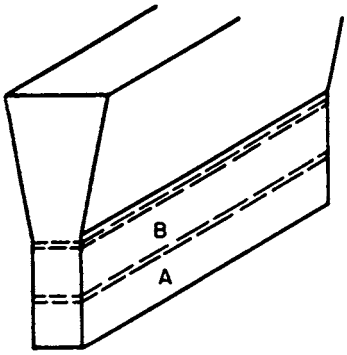
in.	mm	in.	mm
0.005	0.13	1.0	25.4
0.007	0.18	1 1/4	31.8
0.252	6.40	1.4	35.6
0.357	9.07	1 3/4	44.4

NOTE 1—If desired, the length of the reduced section may be increased to accommodate an extensometer.

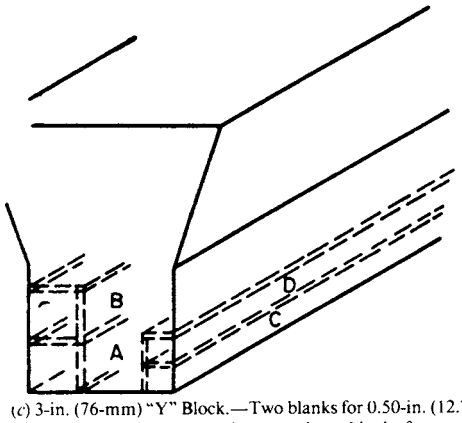
FIG. 4 Examples of Small-Size Specimens Proportional to Standard ½-in. (12.7-mm) Round Specimen



(*a*) ½-in. (13-mm) "Y" Block.—Two blanks for 0.252-in. (6.40-mm) diameter tension test specimens.



(*b*) 1-in. (25-mm) "Y" Block.—Two blanks for 0.50-in. (12.7-mm) diameter tension test specimens or transverse tests.



(*c*) 3-in. (76-mm) "Y" Block.—Two blanks for 0.50-in. (12.7-mm) diameter tension test specimens and two blanks for transverse test.

FIG. 5 Sectioning Procedure for "Y" Blocks

may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the purchaser. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

14. Waiving of Inspection by Agreement

14.1 When agreed upon in writing by the purchaser and the supplier, a certification shall be made the basis of acceptance of the material. This shall consist of a copy of the manufacturer's test report or a statement by the supplier, accompanied by a copy of the test results, that the material has been sampled, tested, and inspected in accordance with the provisions of the specification specified. Each certification so furnished shall be signed by an authorized agent of the supplier or manufacturer.

15. Preparation for Delivery

15.1 Unless otherwise specified in the contract or purchase order, cleaning, preservation, and packaging of castings shall be in accordance with the manufacturer's commercial practice. Packing and marking shall also be adequate to ensure acceptance and safe delivery by the carrier for the mode of transportation employed.

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16. Keywords

16.1 austenitic; gray iron castings; high-nickel

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