



Designation: A47/A47M – 99 (Reapproved 2018)^{ε1}

Standard Specification for Ferritic Malleable Iron Castings¹

This standard is issued under the fixed designation A47/A47M; 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 U.S. Department of Defense.

^{ε1} NOTE—Footnote 4 was updated editorially and Footnote 5 was added editorially in November 2018.

1. Scope

1.1 This specification² covers ferritic malleable castings for general engineering usage at temperatures from normal ambient to approximately 400 °C [750 °F].

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

1.3 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 nonconformance with the standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*³

[A153/A153M Specification for Zinc Coating \(Hot-Dip\) on Iron and Steel Hardware](#)

[A247 Test Method for Evaluating the Microstructure of Graphite in Iron Castings](#)

[A644 Terminology Relating to Iron Castings](#)

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.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-47 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.

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E10 Test Method for Brinell Hardness of Metallic Materials](#)

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness](#)

2.2 *Military Standard:*⁴

[MIL-STD-129 Marking for Shipment and Storage](#)

2.3 *Federal Standard:*⁵

[Fed. Std. No. 123 Marking for Domestic Shipment \(Civilian Agencies\)](#)

3. Terminology

3.1 *Definitions*—Definitions for many terms common to iron are found in Terminology [A644](#).

4. Classification

4.1 Castings ordered and produced under this specification are classified under the following grades based on tests on separately cast test bars. Separately cast test bars shall be poured from the same lot of iron as the castings they represent and shall be heat treated with those castings except as provided in [7.2.3](#).

4.1.1 *Grade 32510 [Grade 22010]:*

4.1.1.1 The first three digits of the grade designation indicate the minimum yield strength (×100 psi [MPa]), and the last two digits indicate the minimum elongation (% in 2 in. [50 mm]).

5. Ordering Information

5.1 The purchase order for castings ordered under this specification shall state the specification designation, the year in which the specification was issued, and the grade of

⁴ Available from General Services Administration – Vendor Support Center, <https://vsc.gsa.gov/administration/files/MIL-STD-129R.pdf>.

⁵ Available from General Services Administration – Vendor Support Center, <https://vsc.gsa.gov/administration/files/Compliance-with-FED-STD-123H.pdf>.

malleable iron to be supplied. Any option or special additions to the basic requirements of this specification shall be clearly and fully stipulated.

6. Chemical Composition

6.1 The chemical composition of the iron shall be such as to produce the structural and mechanical properties required by this specification.

7. Mechanical Properties

7.1 Factors influencing the properties of castings and their relationship to those of test specimens and separate test castings are discussed in **Appendix X1**.

7.2 Tension Test Specimens:

7.2.1 The tension test specimens shall be cast to the form and dimensions shown in **Fig. 1** or **Fig. 2**, in the same kind of molding material used for the production castings. At least three such specimens shall be cast from a representative ladle of iron either from each batch-melted heat or, in continuous melting, from each 4-h pour period during which the purchaser's castings were poured, or as otherwise agreed upon between manufacturer and purchaser.

7.2.2 All test specimens shall be suitably identified with the designation of either the batch-melted heat or the pour period of a continuous heat.

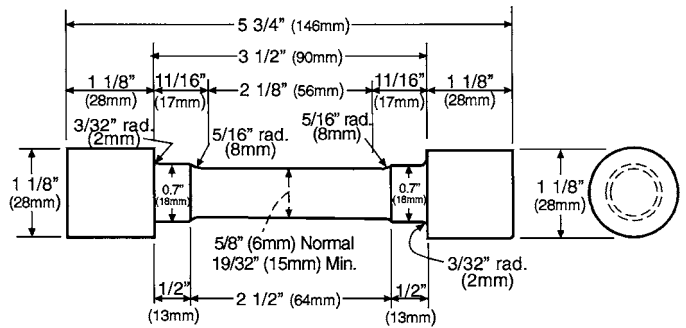
7.2.3 All test specimens shall be heat treated in the same production furnaces and in the same cycles as the castings they represent. However, in those instances wherein the critical sections of the production castings differ appreciably from that of the central portion of the test specimens, the time cycle for tempering the test specimens may be altered from that of the production lot in order to obtain similar microstructures or hardness, or both, in both specimen and castings. In such cases the hardness of the specimens shall be tested and reported along with the tensile test results.

7.2.4 The tension test is usually performed on unmachined specimens. However, for referee work, the specimen may be machined from the standard cast bar to the dimensions shown in **Fig. 3**.

7.3 Tension Test Method:

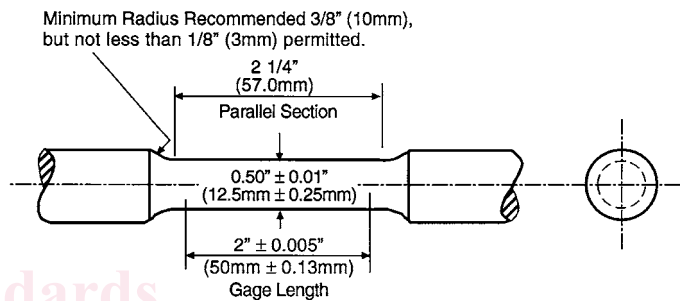
7.3.1 The gage length of the standard tension specimen shall be 2.00 ± 0.01 in. [50.0 ± 0.3 mm].

7.3.2 The diameter used to compute the cross-sectional area shall be the average between the largest and smallest diameters in that section of the 2-in. [50-mm] gage length having the smallest diameter and shall be measured to the nearest 0.001 in. [0.2 mm]. No cast bar having a mean diameter less than 0.590 in. [15.0 mm] shall be accepted for test.



NOTE 1—Modifications may be made in the dimensions indicated above for those details of the specimen outside of the gage length as required by testing procedure and equipment.

FIG. 2 Alternative Unmachined Tension Test Specimen



NOTE 1—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 Machined Tension Test Specimen

7.3.3 After reaching a stress equivalent to approximately half of the anticipated yield stress, the speed of the moving head of the testing machine shall not exceed 0.50 in./min [12.5 mm/min] through the breaking load.

7.3.4 While the values for yield point and yield strength are not identical, they are sufficiently close for most applications of ferritic malleable irons to be used interchangeably. They may be determined by any of the approved techniques described in the paragraphs on Determination of Yield Strength and Yield Point of Test Methods **E8/E8M**. If determined as yield strength, that stress producing an extension under load of 0.01 in. [0.25 mm] over the 2-in. [50-mm] gage length (for example, 0.5 % extension) or an offset of 0.2 % shall be taken as the yield stress, which shall be converted to yield strength by dividing by the original cross-sectional area of the gage length

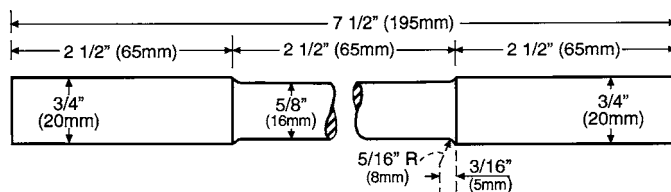


FIG. 1 Tension Test Specimen

found in accordance with 7.3.2. It shall be reported to the nearest 100 psi [MPa]. In referee work, yield strength shall be determined as the stress that produces an extension under load of 0.5 % of the gage length.

7.3.5 The tensile strength shall be the maximum load carried by the specimen during the test divided by the original cross-sectional area of the gage length, as found in accordance with 7.3.2. It shall be reported to the nearest 100 psi [MPa].

7.3.6 The elongation is the increase in gage length after fracture of a tensile specimen, measured to the nearest 0.01 in. [0.25 mm], expressed as a percentage of the original gage length. It shall be reported to the nearest 0.5 %.

7.4 Retesting:

7.4.1 If, after testing, a specimen shows evidence of a defect, another tension test may be made on a companion specimen. Also, a retest shall be permitted whenever fracture occurs outside the central 50 % of the gage length.

7.4.2 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, the castings represented by these test specimens shall be rejected. A valid test is one wherein the test specimen has been properly prepared and appears to be sound and on which the approved test procedure has been followed.

7.4.3 If sufficient companion test bars are unavailable, the manufacturer shall have the option of testing a specimen cut from a representative casting. Therefore, as stated in X1.3, the mechanical properties of such tension test specimen removed from a production casting will not necessarily correspond to those of a standard separately cast test specimen, the values in Table 1 do not apply. Instead, the mechanical properties of the test specimen from the casting must equal or exceed the average of those from similar test specimens removed from the same location from two castings of the same design where separately cast test bars meet the requirements of Table 1.

7.4.4 If the first test results indicate that a reheat treatment is needed to meet the test requirements, the entire lot of castings and the representative test specimens shall be reheat treated together. Testing shall then be repeated in accordance with 7.4.1 – 7.4.3.

7.4.5 The results of all tests, including retests, shall be posted in permanent record, which shall state any abnormalities observed during the test and in the fractured ends. Such records shall be kept for at least one year after shipment of the production castings and shall be available for examination by the purchaser or by his authorized representative.

7.4.6 If not covered in the purchase agreement, the frequency of tension testing shall be in accordance with 7.2.1 and

sufficiently often to ensure uniformity of product and compliance with minimum test requirements.

7.4.7 Tension test results, obtained in accordance with the above subsections, must conform to the values of Table 1 for acceptance under this specification except as provided in 7.4.3.

7.4.8 When agreed upon between manufacturer and purchaser, tested specimens or unbroken test bars shall be preserved by the manufacturer for a period of three months after the date of the test report.

7.5 Hardness Test—If the purchase agreement requires hardness testing, the acceptable hardness range shall be stated and a test location clearly shown on the covering drawing(s).

7.5.1 Hardness Test Method—The Brinell method of hardness testing in accordance with Test Method E10 shall be employed whenever possible.

7.5.2 For castings of such size or shape that do not permit Brinell testing with the standard 3000-kgf load, the 500 kgf may be employed, the hardness number being reported as HB 10/500/15. In very unusual cases where it is impossible to use the Brinell method, the Rockwell test may be substituted, using Test Methods E18 with an appropriate Rockwell scale. Conversions of hardness values from one method to another according to Hardness Conversion Tables E140, which does not specifically cover cast irons, are approximate only and, therefore, are generally inadvisable.

7.5.3 Sufficient material shall be removed from the cast surface to ensure that the measured surface is representative.

7.5.4 Sampling procedures and the frequency of hardness testing shall be fully detailed on the purchase agreement. Otherwise, hardness tests shall be performed at the discretion of the producer.

7.5.5 Castings failing to conform to the required hardness range may be reheat treated and retested. If after reheat treating they still fail the hardness requirements, they shall be rejected.

7.5.6 Typical hardness maximums for this grade of malleable iron are listed in Table 2.

8. Microstructure Requirements

8.1 The microstructure of the malleable iron shall consist of temper carbon nodules distributed through a ferritic matrix and shall be free of excessive pearlite, massive carbides, and primary graphite.

8.2 When agreed upon by the purchaser and producer, the maximum decarburization at any as-cast surface after heat treatment may be stipulated in writing, as measured by visual depletion of combined carbon after polishing, etching in nital, and viewing at 100x.

8.3 In reference work, the metallographic practice recommended in Test Method A247 shall be followed.

9. Soundness Requirements

9.1 All castings, on visual examination, shall be sound and free of obvious shrinkage and porosity.

TABLE 1 Tension Test Requirements

Inch-Pound Grades			
English Grade	Tensile Strength, min, psi	Yield Strength, min, psi	Elongation in 2 in, min, %
32510	50 000	32 500	10
Metric Grades			
Metric Grade	Tensile Strength, min, MPa	Yield Strength min, MPa	Elongation in 50 mm, min, %
22010	340	220	10

TABLE 2 Typical Hardness

Inch-Pound Grade [Metric Grade]	Hardness, maximum HB	Indentation Value Diameters, mm
325 10 [22010]	156	4.8