Designation: ~~A220/A220M – 99 (Reapproved 2014)~~ A220/A220M – 99 (Reapproved 2018)$^{\varepsilon 1}$

Standard Specification for Pearlitic Malleable Iron[1]

This standard is issued under the fixed designation A220/A220M; 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.

ε^1 NOTE—Footnotes 5 and 6 were updated editorially in November 2018.

1. Scope

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

1.1.1 For continuous service at temperatures up to ~~1200°F [650°C]~~1200 °F [650 °C], design factors should be incorporated to compensate for possible property changes, as demonstrated by Marshall and Sommer[2] and by Pearson.[3]

1.2 Without knowledge of casting geometry and process details, no quantitative relationship can be stated between the properties of the iron in the various locations of a casting and those of a test bar cast from the same iron.

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 ~~non-conformance~~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:*[4]

A247 Test Method for Evaluating the Microstructure of Graphite in Iron Castings

A644 Terminology Relating to Iron Castings

~~E8~~E8/E8M Test Methods for Tension Testing of Metallic Materials ~~[Metric] E0008_E0008M~~

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:*[5]

MIL-STD-129 Marking for Shipment and Storage

2.3 *Federal Standard:*[6]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

[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] Marshall, L. C., and Sommer, G. F., "Stress-Rupture Properties of Malleable Iron at Elevated Temperatures," *Proceedings,* ~~American Society of Testing and Materials,~~ ASTM International, Vol 58, pp. 752–773.

[3] Pearson, D. A., "Stress-Rupture and Elongation Properties of Malleable Iron at Elevated Temperatures," *Transactions,* 70th Castings Congress and Exposition, May 9, 1966.

[4] 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] Available from ~~Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.~~General Services Administration – Vendor Support Center, https://vsc.gsa.gov/administration/files/MIL-STD-129R.pdf.

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

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions for many terms common to iron castings are found in Terminology A644.

4. Classification

4.1 Iron produced for castings ordered under this specification is classified in a number of grades as shown in Table 1 and is qualified by 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.

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 pearlitic malleable iron to be supplied.

5.2 Any options 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 mechanical properties required by this specification.

7. Mechanical Requirements

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 *Tensile Test:*

7.2.1 *Tensile Test Specimens:*

7.2.1.1 The tensile test specimens shall be cast to the form and dimensions shown in Fig. 1 or Fig. 2 using the same kind of molding material used for the production castings.

7.2.1.2 All test specimens shall be suitably identified with the designation of the pour period.

7.2.1.3 All test specimens shall be heat treated in the same production furnace and for the same cycles as the castings they represent.

7.2.2 *Tensile Test Method:*

7.2.2.1 The tensile 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.

7.2.2.2 *Gauge Length*—The gauge length of the standard tensile specimen shall be 2.00 ± 0.01 in. [50.0 ± 0.3 mm].

7.2.2.3 *Cross-Sectional Area*—The diameter used to compute the cross-sectional area shall be the average between the largest and smallest diameter in that section of the 2-in. [50-mm] gauge length having the smallest diameter and shall be measured to the nearest 0.001 in. [0.02 mm]. No cast bar having a mean diameter less than 1 9/32 in. [15 mm] shall be accepted for test.

TABLE 1 Tensile Test Requirements

Inch-Pound Grades			
English Grade	Tensile Strength, min	Yield Strength, min	Elongation, mn
	psi	psi	2 in., %
40010	60 000	40 000	10
45008	65 000	45 000	8
45006	65 000	45 000	6
50005	70 000	50 000	5
60004	80 000	60 000	4
70003	85 000	70 000	3
80002	95 000	80 000	2
90001	105 000	90 000	1
Metric Grades			
Metric Grade	Tensile Strength, min	Yield Strength, min	Elongation, min
	MPa	MPa	50 mm, %
280M10	400	280	10
310M8	450	310	8
310M6	450	310	6
340M5	480	340	5
410M4	550	410	4
480M3	590	480	3
550M2	650	550	2
620M1	720	620	1

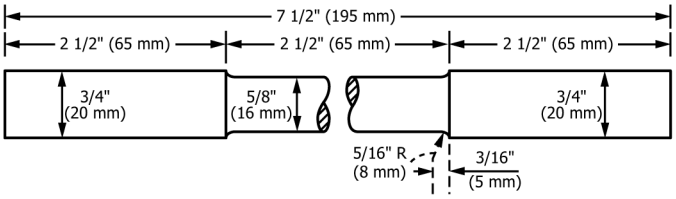
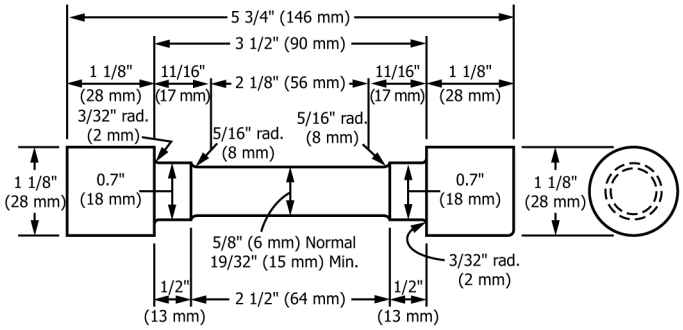
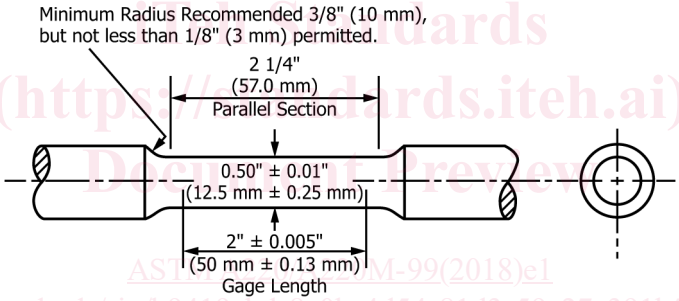


FIG. 1 Unmachined Tension Test Specimen



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

FIG. 2 Alternative Unmachined Tension Test Specimen



NOTE 1—The gauge length and filets 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

7.2.2.4 *Speed of Testing*—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./mm [12.5 mm/min] through the breaking load.

7.2.2.5 *Yield Strength*—Yield strength may be determined by any of the approved techniques described in Test Methods ~~E8~~E8/E8M. In referee work, it shall be determined at an offset of 0.2 % from the stress-strain curve. Yield strength shall be reported to the nearest 100 psi [megapascal].

7.2.2.6 *Tensile Strength*—The tensile strength shall be the maximum load carried by the specimen during the test divided by the original cross-sectional area of the gauge length, as found in accordance with 7.2.2.3. It shall be reported to the nearest 100 psi [megapascal].

7.2.2.7 *Elongation*—The increase in gauge length after fracture of a tensile specimen, measured to the nearest 0.01 in. [0.25 mm] expressed as a percentage of the original gauge length. It shall be reported to the nearest 0.5 %.

7.2.3 *Number of Tests and Retests:*

7.2.3.1 At least three tensile test specimens shall be cast from a representative ladle of iron from each 4-h pour period during which the purchaser's castings were poured.

7.2.3.2 Only one test specimen need be tested to qualify each pour period and heat treatment batch, provided the requirements of this specification are met by that test specimen.

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