SAE The Engineering Resource For Advancing Mobility
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 5316B
Superseding AMS 5316A

Issued 5-1-54
Revised 4-1-82

DUCTILE (NODULAR) IRON CASTINGS, SAND 80,000 psi (550 MPa) Tensile Strength As Cast

UNS F34100

1. SCOPE:

1.1 Form: This specification covers a ductile (nodular) iron in the form of sand castings.

1.2 Application: Primarily for general usage where shock resistance, high strength, some ductility, and/or machinability are required.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2804 - Identification, Castings

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A247 - Evaluating the Microstructure of Graphite in Iron Castings
ASTM A370 - Mechanical Testing of Steel Products
ASTM E351 - Chemical Analysis of Cast Iron - All Types

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E351, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	3.2 -	4.0
Manganese	--	0.8
Silicon (3.1.1)	1.7 -	2.5
Phosphorus (3.1.1)	--	0.08

3.1.1 Silicon may be as high as 2.8% if phosphorus is not over 0.05%.

3.1.2 The melt shall be treated with magnesium as necessary to meet the tensile and microstructure requirements but analysis for magnesium is not required.

3.2 Condition: As cast, except that castings may be normalized or normalized and tempered to meet the specified properties.

3.3 Casting: A melt shall be the metal poured from a single magnesium-treated ladle of 5000 lb (2300 kg) or less.

3.4 Test Specimens:

3.4.1 Tensile Coupons: Shall be standard keel blocks as shown in Fig. 1, unless Ø purchaser permits use of "Y" blocks as shown in Fig. 2 or modified keel blocks cast in molds as shown in Fig. 4. When requested, the coupons shall be supplied with castings. Coupons shall be cast in open molds made of suitable core sand, shall be poured directly after pouring the castings, and shall be left in the mold until black. Metal for the coupons shall be part of the melt which is used for the castings. Molding practice, and the coupon size when use of "Y" blocks is permitted, shall be such that cooling rates of castings and coupons are substantially the same.

3.4.2 Chemical Analysis Specimens: For carbon determinations, a chilled pencil-type specimen shall be cast or a solid sample shall be cut from the tensile coupon, the graphite examination specimen, or an actual casting.

3.4.3 Graphite Examination Specimens (Optional): When castings are heat treated, graphite examination specimens may be used in lieu of tensile coupons to represent each melt and, when used, shall be cast in molds as shown in Fig. 5. The specimens shall be cast with each melt of metal for castings and shall represent the last metal poured from the melt. The specimens shall meet the requirements of 3.6.3.1.

3.5 Heat Treatment: Castings may be normalized or normalized and tempered to meet the requirements of 3.6.

3.5.1 When heat treatment is performed, tensile coupons as in 3.4.1 from each melt shall be heat treated with the castings they represent.

3.6 Properties: Castings shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.6.1 Tensile Properties: Conformance to the requirements of 3.6.1.1 shall be used as basis for acceptance of castings except when purchaser specifies that the requirements of 3.6.1.2 apply.

3.6.1.1 Separately-Cast Specimens: Shall be as follows, determined on tensile specimens, 0.357 in. (9.00 mm) diameter at the reduced parallel section from 1/2 in. (12.5 mm) "Y" block or 0.505 in. (12.50 mm) diameter at the reduced parallel section from other tensile coupons, cut from the coupons as shown in Figs. 1 and 3 or in Fig. 4:

Tensile Strength, min	80,000 psi (550 MPa)
Yield Strength at 0.2% Offset, min	60,000 psi (415 MPa)
Elongation in 4D, min	3%

3.6.1.2 Specimens Cut from Castings: Shall be as follows when tensile properties of actual castings are determined:

Tensile Strength, min	80,000 psi (550 MPa)
Yield Strength at 0.2% Offset, min	60,000 psi (415 MPa)
Elongation in 4D, min	2%

3.6.2 Hardness: Castings should have hardness of 201 - 269 HB or equivalent but shall not be rejected on the basis of hardness if the tensile property requirements of 3.6.1.2 are met.

3.6.3 Microstructure:

3.6.3.1 The microstructure of the graphite in the graphite examination specimens of 3.4.3 shall be not less than 90% Types I and II graphite as illustrated in ASTM A247, Plate I.

3.6.3.2 The microstructure of castings and tensile coupons shall consist of spheroidal graphite in a matrix of ferrite and fine pearlite; it shall be essentially free from carbide. The microstructure of the graphite alone shall meet the requirements of 3.6.3.1.

3.7 Quality:

3.7.1 Castings, as received by purchaser, shall be uniform in quality and Ø condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the castings.

3.7.1.1 Castings shall have smooth surfaces and shall be well cleaned.

3.7.2 Inspection standards and procedures shall be as agreed upon by purchaser and vendor.

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

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of castings shall supply all samples for vendor's tests and shall be responsible for performing all Ø required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Except as specified in 4.2.1.2.1 and 4.2.1.3.1, tests Ø to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each melt:

4.2.1.1 Composition (3.1).
Ø

4.2.1.2 Tensile properties of separately-cast specimens (3.6.1.1) from each melt Ø or, when specified by purchaser, tensile properties of specimens cut from castings (3.6.1.2).

4.2.1.2.1 Tensile properties of specimens cut from castings shall be determined Ø only when specified by purchaser or when separately-cast specimens are not available. Tensile properties of separately-cast specimens need not be determined when tensile properties of specimens cut from castings are determined.

4.2.1.3 Graphite microstructure (3.6.3.2) in lieu of tensile
Ø properties, when permitted by purchaser.

4.2.1.3.1 Ø Tensile properties of separately-cast specimens on each heat treat batch when graphite examination of each melt is permitted by purchaser.

4.2.2 Ø Periodic Tests: Tests to determine conformance to the following requirements are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by the purchaser:

4.2.2.1 Ø Hardness (3.6.2) and microstructure (3.6.3) when tensile properties are determined on each melt.

4.2.2.2 Ø Hardness (3.6.2) and microstructure (3.6.3.1) when graphite microstructure is determined on each melt.

4.2.3 Ø Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the first-article shipment of a casting to a purchaser, when a change in processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 Ø For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Ø Three tensile specimens in accordance with 3.4.1, except when properties of specimens machined from castings are required, one chemical analysis specimen in accordance with 3.4.2, and two graphite examination specimens in accordance with 3.4.3 from each melt.

4.3.2 Ø Two preproduction castings in accordance with 4.4.1 of each part number.

4.3.3 Ø One or more castings from each melt when properties of specimens machined from cstings are required. Size, location, and number of specimens machined from castings shall be as specified on the drawing or as agreed upon by purchaser and vendor. When size, location, and number of specimens are not specified, not less than two specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting or castings from each melt.

4.4 Approval:

4.4.1 Sample castings from new or reworked patterns and the casting procedure shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser.

4.4.2 Vendor shall establish for production of sample castings of each part number parameters for the control factors of processing which will produce acceptable castings; these shall constitute the approved casting procedure and shall be used for producing production castings. If necessary to make any change in parameters for the control factors of processing, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, sample test specimens, castings, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of reapproval.

4.4.2.1 Control factors for producing castings include, but are not limited to, the following:

Type of furnace
Furnace atmosphere
Fluxing or deoxidation procedure
Gating and risering practices
Inoculation procedure
Pouring temperature (variation of ±50°F (±30°C) from the established limit is permissible)
Solidification and cooling procedures
Heat treatment procedures
Cleaning operations
Methods of inspection

4.4.2.1.1 Any of the above control factors of processing for which parameters are considered proprietary by the vendor may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.5 Reports:

4.5.1 The vendor of castings shall furnish with each shipment three copies of a report showing the results of tests for chemical composition of each melt and for tensile properties of the test coupons representing each melt within a heat treat lot, except that if graphite examination specimens are used in lieu of tensile coupons to represent each melt, then the tensile properties of the coupons representing each heat treat lot shall be reported. This report shall include the purchase order number, AMS 5316B, melt number, heat treat lot number, part number, and quantity from each melt.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 5316B, contractor or other direct supplier of castings, part number, and quantity. When castings for making parts are produced or purchased by the parts vendor, that vendor shall inspect castings from each melt represented to determine conformance to the requirements of this specification and shall include in the report either a statement that the castings conform or copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the castings may be based Ø on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the castings represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Castings shall be identified in accordance with AMS 2804.

5.2 Packaging:

5.2.1 Castings shall be prepared for shipment in accordance with commercial Ø practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the castings to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.2 For direct U.S. Military procurement, packaging shall be in accordance Ø with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.2.1 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Castings not conforming to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 For direct U.S. Military procurement, purchase documents should specify not less than the following:

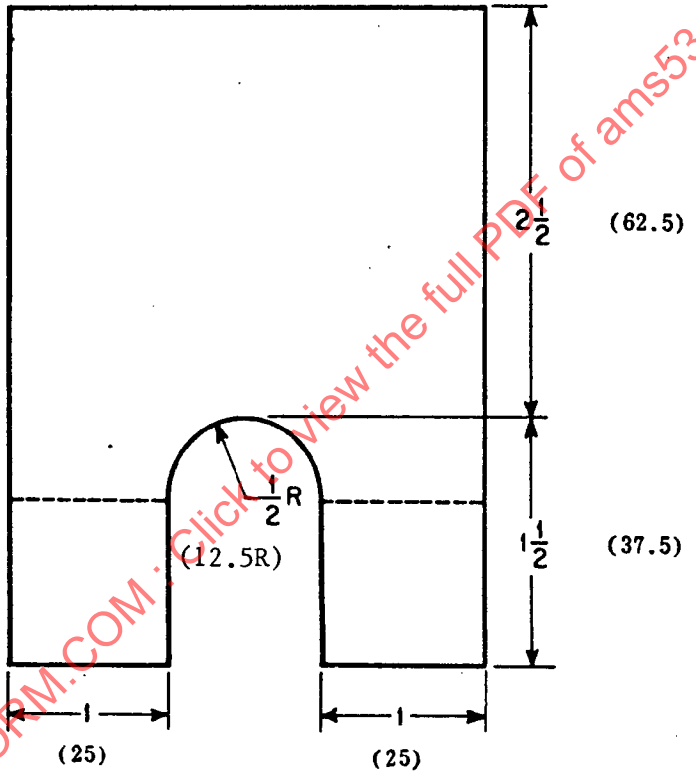
Title, number, and date of this specification
Part number or pattern number of castings desired
Quantity of castings desired
Type, location, and number of specimens for tensile testing when properties of specimens cut from castings are required
Applicable level of packaging (See 5.2.2)

8.3 Similar Specifications:

8.3.1 This specification exceeds the minimum requirements of MIL-I-24137 (SHIPS), Amendment 2, Class A, dated 24 December 1980.

8.3.2 MIL-I-24137 and ASTM A536 are listed for information only and shall not be construed as acceptable alternates unless all requirements of this AMS are met.

8.4 Castings meeting the requirements of this specification have been classified under Federal Supply Classification (FSC) MECA.



Length of Block shall be 6 in. (150 mm)

Dimensions are in inches (millimetres)

Figure 1

This specification is under the jurisdiction of AMS Committee "E".