SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS5315	REV. D

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Superseding AMS5315C

Ductile (Nodular) Iron Castings, Sand 60,000 psi (415 MPa) Tensile Strength Ferritize Annealed

UNS F33101

RATIONALE

AMS5315D has been reaffirmed to comply with the SAE five-year review policy.

NONCURRENT NOTICE

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of August, 1992. It is recommended, therefore, that this specification not be specified for new designs.

"NONCURRENT" refers to those materials which have previously been widely used and which may be required on some existing deigns in the future. The Aerospace Materials Division, however, does not recommend these as standard materials for future use in new designs. Each of these "NONCURRENT" specifications is available from SAE upon request.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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http://www.sae.org/technical/standards/AMS5315D

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, medium strength, good 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 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 2694	Repair Welding of Aerospace Castings
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 Publication and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 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, determined by wet chemical methods in accordance with ASTM E351 or by spectrographic or 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:

Ferritize annealed.

3.3 Casting:

A melt shall be the metal poured from a single magnesium-treated ladle of 5000 lb (2300 kg) or less. A lot shall be all castings of the same part number poured from a single melt and heat treated together as a batch.

3.4 Test Specimens:

3.4.1 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.

3.4.2 Tensile Coupons: Shall be standard keel blocks as shown in Fig. 1, unless purchaser permits use of "Y" blocks as shown in Fig. 2 or modified keel blocks cast in molds as shown in Fig. 4. 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.

3.4.3 Graphite Examination Specimens: Shall be cast from molds as shown in Fig. 5 and shall represent the last metal poured from the melt.

3.5 Heat Treatment:

Castings and representative tensile coupons shall be ferritize annealed by heating to the proper temperature and for the proper time to meet the requirements of 3.6. At least one set of tensile coupons shall be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals of not longer than 3 hours.

3.6 Properties:

Castings and representative tensile coupons shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370.

3.6.1 Tensile Properties: Shall be as follows; 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, 0.350 in. (8.75 mm) diameter at the reduced parallel section from 1/2 in. (12.50 mm) "Y" block or 0.500 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	60,000 psi (415 MPa)
Yield Strength at 0.2% Offset, min	45,000 psi (310 MPa)
Elongation in 4D, min	15%

3.6.1.2 Specimens Cut from Castings or from Integrally-Cast Coupons: Shall be as follows:

Tensile Strength, min	60,000 psi (415 MPa)
Yield Strength at 0.2% Offset, min	45,000 psi (310 MPa)
Elongation in 4D, min	10%

3.6.2 Hardness: Castings should have hardness not higher than 190 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: The microstructure of castings and tensile coupons, after heat treatment, shall consist of spherical graphite in a matrix of ferrite with a few areas of pearlite permissible; it shall be essentially free from carbide. The microstructure of the graphite shall be not less than 90% Types I and II graphite as illustrated in ASTM A247, Plate I.

3.6.3.1 When permitted by purchaser, graphite examination may be performed in lieu of tensile testing.

3.7 Quality:

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

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

3.7.2 Inspections 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.

3.7.3.1 When permitted in writing by purchaser, defects in castings may be repaired by welding in accordance with AMS 2694 using filler metal specified by 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 required tests. Results of such tests shall be reported to the purchaser as required by 4.3. 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 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) of each melt.

4.2.1.2 Tensile properties of separately-cast specimens (3.6.1.1) representing each lot or, when specified by purchaser, tensile properties of specimens cut from castings or from integrally-cast coupons (3.6.1.2) from each lot except when purchaser permits graphite examination (3.6.3) in lieu of tensile testing.

4.2.1.2.1 Tensile properties of specimens cut from castings or from integrally-cast coupons shall be determined 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 or from integrally-cast coupons are determined.

4.2.1.3 Graphite microstructure (3.6.3) of each lot in lieu of tensile properties, when permitted by purchaser.

4.2.1.3.1 Tensile properties of separately-cast specimens from each lot need not be determined when graphite examination of each lot is permitted by purchaser.

4.2.2 Periodic Tests: Tests to determine conformance requirements for hardness (3.6.2) and microstructure (3.6.3) 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:

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

4.2.3.1 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 For Acceptance Tests:

4.3.1.1 One chemical analysis specimen in accordance with 3.4.1 from each melt or a casting from each lot.

4.3.1.2 Three tensile specimens in accordance with 3.4.2 from each lot except when properties of specimen machined from castings or from integrally-cast coupons are required or when graphite examination is permitted in lieu of tensile testing as in 4.3.1.3.

4.3.1.3 When permitted by purchaser in lieu of tensile testing, two graphite examination specimens in accordance with 3.4.3 from each lot.

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

4.3.1.5 One or more castings from each lot or two or more integrally-cast coupons from each lot when properties machined from castings or from integrally-cast coupons are required. Size, location, and number of specimens machined from castings or from integrally-cast coupons 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 representing the thickest section and one representing the thinnest section, shall be cut from a casting or castings from each lot.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor.

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 process control factors 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 process control factors, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, test specimens, sample 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
Metal 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 process control factors 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 a report showing the results of tests for chemical composition of at least one casting or of specimens as in 3.4.1 from each melt represented, the results of tests for tensile properties of separately-cast specimens representing each lot or, when specified by purchaser or as permitted by 4.5.1.1, of specimens cut from castings or from integrally-cast coupons from each lot, and stating that the castings conform to the other technical requirements of this specification. This report shall include the purchase order number, AMS 5315D, melt number, lot number, part number, and quantity.

4.5.1.1 When permitted by purchaser, results of tests for microstructure of graphite may be reported in lieu of results of tensile testing of specimens cut from castings or from integrally-cast coupons. In such case, vendor shall report results of tensile tests of separately-cast tensile coupons.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 5315D, 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 lot 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 on the results of testing three additional specimen 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:

Shall be in accordance with AMS 2804.

5.2 Packaging:

5.2.1 Castings shall be prepared for shipment in accordance with commercial 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 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 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Dimensions and properties in inch/pound units are primary; dimensions and properties in SI units are shown as the approximate equivalents of the primary units and are presented only for information.

8.3 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.
Acceptance standards and methods for inspection for quality (See 3.7.2)
Applicable level of packaging (See 5.2.2)

8.4 Similar Specifications:

MIL-I-24137 is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

8.5 Castings meeting the requirements of this specification have been classified under Federal Standardization Area Symbol “MECA”.