



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AMS 5394A

Superseding AMS 5394

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ALLOY IRON CASTINGS, DUCTILE, SAND, CORROSION AND HEAT RESISTANT
2.0Cr - 20Ni (2.4 - 3.0C)

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant alloy ductile iron in the form of sand castings.

1.2 Application: Primarily for parts, such as valve and compressor housings, subject to moderate stresses and requiring moderate corrosion and heat resistance up to 1200°F (650°C).

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 Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2635 - Radiographic Inspection
AMS 2645 - Fluorescent Penetrant Inspection
AMS 2804 - Identification, Castings

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

ASTM A370 - Mechanical Testing of Steel Products
ASTM E351 - Chemical Analysis of Cast Iron - All Types
ASTM E446 - Reference Radiographs for Steel Castings up to 2 in. in Thickness

2.3 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:

SAE Technical Board rules provide that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

3.1 Composition: Shall conform to the following percentages by weight, 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 approved analytical methods:

	min	max
Carbon	2.40	3.00
Manganese	0.80	1.60
Silicon	2.00	3.20
Phosphorus	--	0.25
Sulfur	--	0.15
Chromium	1.70	2.40
Nickel	18.00	22.00
Copper	--	0.50
Lead	--	0.003

3.2 Condition: Stress relieved.

3.3 Casting: A melt shall be the metal poured from a single magnesium-treated ladle of 10,000 lb (4540 kg) or less.

3.4 Test Specimens:

3.4.1 Chemical Analysis Specimens: Shall be of any convenient size, shape, and form for vendor's tests. When chemical analysis specimens are required by purchaser, specimens shall be cast to a size, shape, and form agreed upon by purchaser and vendor.

3.4.2 Tensile Test Coupons: Shall be standard keel blocks conforming to ASTM A370 unless purchaser permits use of "Y" blocks as shown in Fig. 1. Coupons shall be cast with each melt of metal for castings, shall be cast in open molds made of suitable core sand, shall be poured directly after pouring the castings, and shall be kept in the mold until black. Metal for coupons shall be part of the melt which is used for the castings. Molding practice and the coupon size, when used of "Y" blocks is permitted, shall, insofar as practicable, be such that cooling rates of castings and coupons are substantially the same. Tensile test specimens in accordance with ASTM A370 shall be machined from the coupons after heat treatment as in 3.5.

3.5 Heat Treatment: Castings and representative tensile test coupons shall be heated to a temperature not lower than 1400°F (760°C) which will produce substantially the same hardness in castings and tensile test coupons, held at heat for not less than 60 min. per inch (25 mm) of nominal cross-section, and cooled in air. When section size of castings and test coupons are such that the same stress-relieving temperature is used for both, at least one set of tensile test coupons shall be placed in a batch-type furnace with each load of castings or in a continuous-type furnace at intervals of not longer than 3 hours.

3.6 Properties: Castings and representative tensile test coupons produced in accordance with 3.4.2 shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.6.1 Separately-Cast Coupons:

3.6.1.1 Tensile Properties: Shall be as follows:

Tensile Strength, min	55,000 psi (379 MPa)
Yield Strength at 0.2% Offset, min	32,000 psi (221 MPa)
Elongation in 4D, min	7%

3.6.1.2 Hardness: Shall be 75 - 88 HRB or equivalent.

3.6.2 Castings:

3.6.2.1 Microstructure: Shall consist of spheroidal graphite with small amounts of carbide in matrix of austenite, essentially free from flake graphite.

3.6.2.2 Tensile Properties: Shall be as follows, determined on specimens cut from castings:

Tensile Strength, min	55,000 psi (379 MPa)
Yield Strength at 0.2% Offset, min	32,000 psi (221 MPa)
Elongation in 4D, min	5%

3.6.2.2.1 Specimens cut from castings are not required for acceptance of castings; however, properties
 Ø obtained from such specimens may be the basis for acceptance of castings.

3.6.2.3 Hardness: Should be 75 - 88 HRB or equivalent but castings shall not be rejected on the basis of
 Ø hardness if the tensile property requirements of 3.6.2.2 are met.

3.6.2.4 Effect of Sub-Zero Cooling: Castings shall withstand, without the austenite transforming to
 Ø martensite, being cooled to $-76^{\circ}\text{F} \pm 5$ ($-60^{\circ}\text{C} \pm 3$), holding at $-76^{\circ}\text{F} \pm 5$ ($-60^{\circ}\text{C} \pm 3$) for sufficient time to equalize, and warming to room temperature. Castings so treated shall be sufficiently nonmagnetic to prevent a small steel magnet from adhering to the casting.

3.7 Quality:

3.7.1 Castings, as received by the purchaser, shall be uniform in quality and condition, sound, and free
 Ø 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. Metallic shot or grit shall not be used for final cleaning, unless otherwise permitted by purchaser.

3.7.2 Castings shall be produced under radiographic control, unless otherwise specified. This control
 Ø shall consist of radiographic examination of castings in accordance with AMS 2635 until proper foundry technique, which will produce castings free from harmful internal imperfections, is established for each part number and of production castings as necessary to ensure maintenance of satisfactory quality.

3.7.3 When specified, castings shall be subject to fluorescent penetrant inspection in accordance with AMS 2645.

3.7.4 Radiographic, fluorescent penetrant, and other quality standards shall be as agreed upon by purchaser
 Ø and vendor. ASTM E446 may be used to define radiographic acceptance standards.

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

3.7.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings
 Ø repaired by welding provided the weld repair area has properties comparable to those of the parent metal. Repair welds shall be subjected to the same inspection procedures and acceptance standards required of the castings. Weld repair areas shall be suitably marked to facilitate inspection. Repair welding shall be performed prior to any heat treatment and nondestructive testing specified herein.

4. QUALITY ASSURANCE PROVISIONS:

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

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests except that when tensile properties are determined on specimens cut from castings, separately-cast test coupons need not be tested.

4.2.1 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 Two chemical analysis specimens in accordance with 3.4.1 and/or a casting from each melt.

4.3.2 Three tensile test coupons in accordance with 3.4.2 from each melt, when requested.

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

4.3.4 One or more castings from each melt when properties of specimens machined from castings are required. Specific size, locations, 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 tensile test specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting 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.

4.4.2 Vendor shall establish for production of sample castings of each part number 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 control factors of processing, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, sample test coupons, 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:

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Type of furnace and its capacity

Size of furnace charge

Furnace atmosphere

Fluxing or deoxidation procedure

Gating and risering practices

Pouring temperature (variation of $\pm 50^{\circ}\text{F}$ ($\pm 30^{\circ}\text{C}$) from the established limit is permissible)

Solidification and cooling procedures

Cleaning operations

Methods of routine inspection