



AEROSPACE MATERIAL SPECIFICATION

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

AMS 5393D

Superseding AMS 5393C

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ALLOY IRON CASTINGS, SAND, MODERATE CORROSION AND HEAT RESISTANT
2.0Cr - 20Ni (2.4 - 2.8C)

1. SCOPE:

- 1.1 Form: This specification covers a moderate corrosion and heat resistant alloy iron in the form of sand castings.
- 1.2 Application: Primarily for low-stressed parts, such as valve housings, 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. (51 mm) 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

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3. TECHNICAL REQUIREMENTS:

- 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:

Ø	min	max
Carbon (3.1.1)	2.40 -	2.80
Manganese	0.80 -	1.60
Silicon (3.1.1)	1.50 -	2.80
Phosphorus	--	0.30
Sulfur	--	0.12
Chromium	1.70 -	2.40
Nickel	18.00 -	22.00
Copper	--	0.50
Lead (3.1.2)	--	0.003

- 3.1.1 If castings have section thicknesses less than 3/4 in. (19 mm), carbon and silicon may each be as high as 3.0.

- 3.1.2 Determination not required for routine acceptance.

- 3.2 Condition: Stress relieved.

- Ø 3.3 Casting: A melt shall be the metal poured from a single ladle of 10 000 lb (4 540 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.
 Ø 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 use 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 sizes 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 Strength: Shall be not lower than 30 000 psi (207 MPa).

3.6.1.2 Hardness: Shall be 74 - 87 HRB or equivalent.

3.6.2 Castings:

3.6.2.1 Microstructure: Shall consist of an austenite matrix with uniformly distributed graphite flakes.

3.6.2.2 Tensile Strength: Shall be not lower than 30 000 psi (207 MPa).

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 74 - 87 HRB or equivalent but castings shall not be rejected on the basis of hardness if the tensile strength requirements are met.

3.6.2.4 Effect of Sub-Zero Cooling: Castings shall withstand, without the austenite transforming to martensite, being cooled to $-75^{\circ}\text{F} \pm 5$ ($-60^{\circ}\text{C} \pm 3$), holding at $-75^{\circ}\text{F} \pm 5$ ($-60^{\circ}\text{C} \pm 3$) for sufficient
Ø 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 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 shall consist of radiographic examination of castings in accordance with AMS 2635 until proper foundry
Ø 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 subjected to fluorescent penetrant inspection in accordance with
Ø 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 permission from purchaser.
Ø

3.7.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings 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
Ø 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 and as preproduction tests except that, for acceptance tests, 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. 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 tensile test 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.

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:

Type of furnace and its capacity

Size of furnace charge

Furnace atmosphere

Fluxing or deoxidation procedure

Gating and risering practices

Pouring temperature (variation of +50° F (+30° C) from the established limit is permissible)

Solidification and cooling procedures

Stress relieving heat treatment cycles

Cleaning operations

Methods of routine inspection

- 4.4.2.1.1 Any of the above control factors of processing considered proprietary by the vendor may be assigned a code designation. Each variation in such factors 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 at least one casting, or of specimens as in 3.4.1, from each melt represented and the results of tests on castings or separately-cast coupons to determine conformance to the other technical requirements of this specification. This report shall include the purchase order number, melt number, material specification number and its revision letter, 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, material specification number and its revision letter, 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 a statement that the castings conform, or shall include 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 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 practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of these 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 authorized modifications will be subject to rejection.

8. NOTES:

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