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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5335F

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Cancelled OCT 2001

Superseding AMS 5335E

## Steel Castings, Sand
## 0.65Cr - 0.75Ni - 0.20Mo (0.25 - 0.33C) (SAE 8630 Modified)
## Normalized and Tempered

(Composition similar to UNS J13050)

CANCELLATION NOTICE

This specification has been "CANCELLED" by the Aerospace Materials Division, SAE, as of October 2001. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications.

Cancelled specifications are available from SAE.





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1. SCOPE:

1.1 Form:

This specification covers a low-alloy steel in the form of sand castings.

1.2 Application:

Primarily for parts requiring higher strength than cast carbon steels and which may be heat treated or welded.

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 2360 | Room Temperature Tensile Properties of Castings |
| AMS 2635 | Radiographic Inspection |
| AMS 2640 | Magnetic Particle Inspection |
| AMS 2645 | Fluorescent Penetrant Inspection |
| 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 A370 | Mechanical Testing of Steel Products |
| ASTM E350 | Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron |
| ASTM E446 | Reference Radiographs for Steel Castings up to 2 In. (51 mm) in Thickness |

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, determined by wet chemical methods in accordance with ASTM E350, 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 | 0.25 | 0.33 |
| Manganese | 0.60 | 0.95 |
| Silicon | 0.50 | 0.90 |
| Phosphorus | -- | 0.025 |
| Sulfur | -- | 0.025 |
| Chromium | 0.40 | 0.90 |
| Nickel | 0.40 | 1.10 |
| Molybdenum | 0.15 | 0.25 |
| Copper | -- | 0.35 |



3.2 Condition:

Normalized and tempered.

3.3 Castings:

A melt shall be the metal poured from a single furnace charge. A lot shall be all castings poured from a single melt, heat treated in the same furnace load, and presented for vendor's inspection at one time.

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 Specimens: Shall be attached to castings, if practicable, or shall be standard keel blocks conforming to ASTM A370, unless purchaser permits use of cast-to-size specimens. Specimens shall be cast with each melt of metal for castings and, when requested, shall be supplied with the castings. Keel blocks shall be cast in 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 the specimens shall be part of the melt which is used for the castings.

3.5 Heat Treatment:

Castings and representative tensile specimens shall be normalized by heating to 1700° - 1750°F (925° - 955°C), holding at heat for not less than 1 hr per inch (25 mm) of maximum cross-section but not less than 1 hr, and cooling in air to room temperature and tempered by heating to not lower than 1150°F (620°C), holding at heat for not less than 1 hr. and cooling in air.

3.6 Properties:

Castings and representative tensile specimens 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 Castings As Normalized and Tempered:

3.6.1.1 Hardness: 183 - 229 HB or equivalent.

3.6.2 After Hardening and Tempering: Castings and representative tensile specimens, normalized and tempered as in 3.5, shall meet the following requirements after being hardened by heating to 1600°F ± 25 (870°C ± 15), holding at heat for not less than 30 min., and quenching in oil and tempered by heating to 800°F ± 15 (425°C ± 8), holding at heat for 2 hr ± 0.25, and cooling in air.

3.6.2.1 Tensile Properties:

3.6.2.1.1 Separately-Cast Specimens: Shall be as follows:

| | |
|---|---|
| Tensile Strength, min | 165,000 psi (1140 MPa) |
| Yield Strength at 0.2% Offset, min | 150,000 psi (1035 MPa) |
| Elongation in 4D, min | 8% |

3.6.2.1.2 Specimens Cut from Castings: When specified on the drawing or when agreed upon by purchaser and vendor, tensile specimens as in 4.3.4 conforming to ASTM A370 shall be machined from castings selected at random from each melt. Property requirements shall be as shown on the drawing or as agreed upon by purchaser and vendor and may be defined as specified in AMS 2360.

3.6.2.2 Hardness of Castings: Shall be not lower than 331 HB or equivalent.

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 Castings shall be produced under radiographic control. This control 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 subjected to magnetic particle inspection in accordance with AMS 2640 or to fluorescent penetrant inspection in accordance with AMS 2645, or both.

3.7.4 Radiographic, magnetic particle, fluorescent penetrant, and other quality standards shall be as agreed upon by purchaser 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.

3.7.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings repaired by welding in accordance with AMS 2694.

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 4.5. 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: Tests to determine conformance to requirements for composition (3.1), hardness of castings as normalized and tempered (3.6.1.1), and quality (3.7) are classified as acceptance tests and shall be performed on each melt or lot as applicable.

4.2.2 Periodic Tests: Tests to determine conformance of separately-cast tensile specimens and of castings, when specified, to properties after hardening and tempering (3.6.2) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by 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 or 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 Two chemical analysis specimens in accordance with 3.4.1 from each melt or a casting from each lot.

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

4.3.3 Three tensile specimens in accordance with 3.4.2 from each lot, when requested.

4.3.4 One casting from each lot when properties after hardening and tempering 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 specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting or castings from each lot.

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 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
Metal pouring temperature (variation of ±50°F (±30°C) from the established limit is permissible)
Solidification and cooling procedures
Normalizing and tempering cycles
Cleaning operations
Methods of inspection

4.4.2.1.1 Any of the above process control factors for which parameters 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 and for hardness of each lot of castings as normalized and tempered and, when performed, the results of tests for the periodic tests. When properties of specimens cut from castings are specified, the report shall include the results of tests to determine conformance to such requirements. This report shall include the purchase order number, melt number, AMS 5335F, part number, and quantity.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 5335F, 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 each lot of castings 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 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:

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.