

**AEROSPACE  
MATERIAL  
SPECIFICATION**

**AMS 5359B**

Superseding AMS 5359A

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STEEL CASTINGS, SAND, CORROSION AND HEAT RESISTANT      UNS J92001  
15Cr - 4.0Ni - 2.3Mo - 0.08N  
Solution Heat Treated

1. SCOPE:

- 1.1 Form: This specification covers a corrosion and heat resistant steel in the form of sand castings.
- 1.2 Application: Primarily for parts requiring corrosion resistance, high strength, and oxidation resistance up to 850°F (450°C), and especially where parts require welding during fabrication.

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 2635 - Radiographic Inspection  
AMS 2640 - Magnetic Particle Inspection  
AMS 2645 - Fluorescent Penetrant Inspection  
AMS 2694 - Repair Welding of Aerospace Castings  
AMS 2804 - Identification, Castings

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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 E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

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 Federal 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,  $\emptyset$  determined by wet chemical methods in accordance with ASTM E353, 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            | 0.08 -  | 0.15  |
| Manganese         | 0.40 -  | 1.10  |
| Silicon           | -- -    | 0.75  |
| Phosphorus        | -- -    | 0.04  |
| Sulfur            | -- -    | 0.03  |
| Chromium          | 14.50 - | 15.50 |
| Nickel            | 3.50 -  | 4.50  |
| Molybdenum        | 2.00 -  | 2.60  |
| Nitrogen          | 0.05 -  | 0.11  |
| Carbon + Nitrogen | 0.15 -  | 0.25  |

3.2 Condition: Solution heat treated except as specified in 3.5.2.

3.3 Casting: A melt shall be the metal poured from a single furnace charge of 5000 lb (2300 kg) or less. A lot shall be all castings poured from a single melt in not more than 8 consecutive hours and heat treated together as a batch.

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 the 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: All castings and separately-cast tensile specimens shall be heat treated as follows:

3.5.1 Solution Heat Treatment: Heat to  $2000^{\circ}\text{F} + 50$  ( $1095^{\circ}\text{C} + 30$ ), hold at heat for not less than 1 hr per inch (25 mm) of maximum section thickness and cool rapidly in air for castings with all cross-sections 1 in. (25 mm) and under in nominal thickness and in water or oil for castings with any cross-section greater than 1 in. (25 mm).

3.5.2 Equalized and Overtempered: When specified by purchaser, castings, after heat treatment as in 3.5.1, shall be heated to  $1400^{\circ}\text{F} + 50$  ( $760^{\circ}\text{C} + 30$ ), held at heat for not less than 3 hr, cooled in air to room temperature or below, reheated to  $1050^{\circ}\text{F} + 25$  ( $565^{\circ}\text{C} + 15$ ), held at heat for not less than 3 hr, and cooled in air.

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

3.6.1 As Solution Heat Treated or As Solution Treated, Equalized, and Over Tempered:

3.6.1.1 Hardness: Castings shall have hardness not higher than 39 HRC or equivalent.

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3.6.2 After Austenite Conditioning, Sub-Zero Cooling, and Tempering: Tensile specimens produced in accordance with 3.4.2 and specimens cut from castings, heat treated in accordance with 3.5.1, shall conform to the requirements of 3.6.2.1 and 3.6.2.2 after being austenite conditioned by heating to 1725° - 1850°F (940° - 1010°C), holding at heat for not less than 1 hr per inch (25 mm) of cross-section, and quenching in water or cooling as rapidly as possible to room temperature, sub-zero cooled by cooling to not warmer than -100°F (-75°C), holding at that temperature for not less than 3 hr, and warming in air to room temperature, and tempered by heating to 1000°F  $\pm$  25 (540°C  $\pm$  15), holding at heat for not less than 3 hr, and cooling in air:

3.6.2.1 Tensile Properties:

|                                    |                        |
|------------------------------------|------------------------|
| Tensile Strength, min              | 165,000 psi (1140 MPa) |
| Yield Strength at 0.2% Offset, min | 140,000 psi ( 965 MPa) |
| Elongation in 4D, min              | 8%                     |

3.6.2.2 Hardness: Should not be lower than 37 HRC or equivalent but castings shall not be rejected on the basis of hardness if the tensile property requirements are met.

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 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 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 and/or fluorescent penetrant inspection in accordance with AMS 2645.

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 all technical requirements of this specification are classified as acceptance tests and shall be performed on each melt or lot as applicable.

4.2.2 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 material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 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 from each melt and/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 melt, when requested.

4.3.4 One or more castings from each lot 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 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 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
  - Pouring temperature (variation of  $\pm 50^{\circ}\text{F}$  ( $\pm 30^{\circ}\text{C}$ ) from the established limit is permissible)
  - Solidification and cooling procedures
  - Solution, austenite conditioning, sub-zero cooling, and tempering heat treatments
  - 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 at least one casting or of specimens as in 3.4.1 from each melt represented and the results of tests on each lot to determine conformance to the other technical requirements of this specification. This report shall include the purchase order number, melt number, AMS 5359B, part number, and quantity from each melt.