

AEROSPACE
MATERIAL
SPECIFICATION

AMS 5364A
Superseding AMS 5364

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STEEL CASTINGS, INVESTMENT, CORROSION AND HEAT RESISTANT
19.5Cr - 10.5Ni - 0.65(Cb+Ta)
Solution Heat Treated

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant steel in the form of investment castings.

1.2 Application: Primarily for small structural parts of intricate design, such as exhaust couplings and fittings, where welding during fabrication may be required, for use up to 1500°F (815°C) but useful at the higher temperatures only when stresses are low.

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
- Ø AMS 2360 - Room Temperature Tensile Properties of Castings
- AMS 2635 - Radiographic 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 A262 - Detecting Susceptibility to Intergranular Attack in Stainless Steels

ASTM A370 - Mechanical Testing of Steel Products

ASTM E192 - Reference Radiographs of Investment Steel Castings for Aerospace Applications

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

- 2.3 U.S. Government Publication: Available from Commanding Officer, Naval Publication 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 Specifications:

Ø MIL-H-6875 - Heat Treatment of Steels

- 2.3.3 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 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
Manganese	--	2.00
Silicon	--	1.50
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	18.00 -	21.00
Nickel	9.00 -	12.00
Columbium + Tantalum	8xC -	1.00
Molybdenum	--	0.75
Copper	--	0.75

- 3.2 Condition: Solution heat treated.

- 3.3 Casting: Castings shall be poured either from remelted metal from a master heat or directly from a master heat. In either case, metal for casting shall be qualified as in 3.4.

- 3.3.1 A master heat is refined metal of a single furnace charge or is metal blended as in 3.3.2. Gates, sprues, risers, and rejected castings shall be used only in preparation of master heats; they shall not be remelted directly, without refining, for pouring of castings.
- 3.3.2 Unless prohibited by purchaser, metal from two or more master heats may be blended provided that the composition of each master heat to be blended is within the limits of 3.1 and that the total weight of metal blended does not exceed 15,000 lb (6800 kg). Ingot and pig may be blended together, shot may be blended, but shot shall not be blended with ingot or pig. When two or more master heats are blended, the resultant blend shall be considered a master heat.
- 3.4 Master Heat Qualification: Each master heat shall be qualified by evaluation of chemical analysis and tensile specimens conforming to 3.4.1 and 3.4.2, respectively. A master heat may be considered conditionally qualified if vendor's test results show conformance to all applicable requirements of this specification. However, except when purchaser waives confirmatory testing, final qualification shall be based on purchaser's test results. Conditional qualification of a master heat shall not be construed as a guarantee of acceptance of castings poured therefrom.
- 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 cast from remelted metal from each master heat except when castings are poured directly from a master heat, in which case the specimens shall also be poured directly from the master heat.
- Ø Specimens shall be of standard proportions in accordance with ASTM A370 with 0.250 in. (6.25 mm) diameter at the reduced parallel gage section. They shall be cast to size or shall be cast oversize and subsequently machined to 0.250 in. (6.25 mm) diameter. Center gating may be used. Specimens may be excised from castings when specified.
- 3.5 Heat Treatment: Castings and representative tensile specimens shall be solution heat treated by heating to $1950^{\circ}\text{F} \pm 50$ ($1065^{\circ}\text{C} \pm 30$), holding at
- Ø heat for not less than 1 hr per inch (25 mm) of maximum section thickness but in no case less than 30 min., and rapid cooling. Heat treating equipment and controls as specified in MIL-H-6875 shall be used.
- 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 Separately-Cast Specimens:

3.6.1.1 Tensile Properties: Shall be as follows:

Tensile Strength, min	70,000 psi (485 MPa)
Yield Strength at 0.2% Offset, min	30,000 psi (205 MPa)
Elongation in 4D, min	30%

3.6.2 Castings:

3.6.2.1 Hardness: Shall be not higher than 88 HRB or equivalent.

3.6.2.2 Tensile Properties: When specified on the drawing or when agreed upon by purchaser and vendor, tensile specimens as in 4.3.4 conforming to
Ø ASTM A370 shall be machined from locations indicated on the drawing from a casting or castings selected at random from each lot. Property requirements for such specimens shall be as shown on the drawing or as agreed upon by purchaser and vendor and may be defined as specified in AMS 2360.

3.6.2.3 Intergranular Corrosion: Specimens cut from castings, after sensitizing treatment, shall show no evidence of intercrystalline surface attack when examined microscopically after being exposed to the copper/copper sulfate/sulfuric acid test performed in accordance with ASTM A262, Practice E.

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 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 and vendor. ASTM E192 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
Ø 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
Ø 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), tensile properties of separately-cast specimens
Ø (3.6.1.1), hardness (3.6.2.1), tensile properties of specimens cut from castings (3.6.2.2) when specified, and quality (3.7) are classified as acceptance tests and shall be performed on each master heat or lot as applicable.
- 4.2.2 Periodic Tests: Tests to determine conformance to requirements for
Ø intergranular corrosion (3.6.2.3) 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; a lot shall be all
Ø castings of the same part number, poured from a single master heat in a period of 8 consecutive hours, solution heat treated as a batch, and presented for vendor's inspection at one time:
- 4.3.1 Two chemical analysis specimens in accordance with 3.4.1 from each master heat or a casting from each lot.

- 4.3.2 Three tensile specimens in accordance with 3.4.2 from each lot except when integral, attached coupons are to be used. In this case, one integral coupon shall be obtained from each of three castings or clusters of castings selected at random from the lot. Coupons shall be located on the casting at the option of the vendor unless otherwise specified on the casting drawing or agreed upon by purchaser and vendor. The coupons shall be of a size and shape to enable specimens conforming to ASTM A370 with 0.250 in. (6.25 mm) diameter at the reduced gage section to be machined from each coupon.
- 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 lot when tensile properties of specimens cut from castings are specified and when requested for intergranular corrosion testing. 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 master 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 separately for tensile specimens used for master heat qualification and for production of sample castings of each part number parameters for the process control factors which will produce tensile specimens meeting master heat qualification requirements and acceptable castings; these shall constitute the approved casting procedures and shall be used for producing subsequent master heat qualification specimens and 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, tensile specimens, sample casting, 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 tensile specimens and castings include, but are not limited to, the following:

Type of furnace and its capacity
Type and size of furnace charge
Time molten metal is in furnace
Furnace atmosphere
Fluxing or deoxidation procedure
Number of ladles used in pour
Mold refractory formulation
Mold back-up material
Riser-gating practices
Mold preheat and pouring temperatures (variations of $\pm 25^{\circ}\text{F}$ ($\pm 15^{\circ}\text{C}$) from established limits are permissible)
Solidification and cooling procedures
Solution heat treatment cycles
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 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 cast in a mold with parts, from each master heat represented and the results of tests on each lot to determine conformance to the other acceptance test requirements, and stating that the castings conform to the other technical requirements of this specification. 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, master heat number or code symbol, AMS 5364A, part number, and quantity from each master heat.
- 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, AMS 5364A, 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 master heat 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.