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400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 5376E

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Superseding AMS 5376D

ALLOY CASTINGS, INVESTMENT, CORROSION AND HEAT RESISTANT
30Fe - 21Cr - 20Ni - 20Co - 3Mo - 2.5W - 1.0(Cb +Ta) - 0.15N
As Cast

UNS R30155

1. SCOPE:

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

1.2 Application: Primarily for small parts, such as turbine blades and vanes, requiring high strength up to 1350°F (730°C) and oxidation resistance up to 1800°F (980°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 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 2361 - Elevated 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

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

ASTM E8 - Tension Testing of Metallic Materials
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E192 - Reference Radiographs of Investment Steel Castings for Aerospace Applications
ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 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, Ø determined by wet chemical methods in accordance with ASTM E354 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Carbon	--	0.20
Manganese	1.00 -	2.00
Silicon	--	1.00
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	20.00 -	22.50
Nickel	19.00 -	21.00
Cobalt	18.50 -	21.00
Molybdenum	2.50 -	3.50
Tungsten	2.00 -	3.00
Columbian + Tantalum	0.75 -	1.25
Nitrogen	0.10 -	0.20
Iron	remainder	

3.2 Condition: As cast.

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 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). 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.

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. Specimens shall be of standard proportions in accordance with ASTM E8 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.

3.5 Properties: Castings and representative tensile specimens produced in accordance with 3.4.2 shall conform to the following requirements:

3.5.1 Separately-Cast or Integrally-Cast Specimens:

3.5.1.1 Tensile Properties:

3.5.1.1.1 At Room Temperature: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, min	80,000 psi (550 MPa)
Yield Strength at 0.2% Offset, min	45,000 psi (310 MPa)
Elongation in 4D, min	18%
Reduction of Area, min	15%

3.5.1.1.2 At 1500°F (815°C): Shall be as follows, determined in accordance with ASTM E21 on specimens heated to 1500°F + 10 (815°C + 5), held at heat for 20 - 30 min. before testing, and tested at 1500°F + 10 (815°C + 5) at a rate of 0.03 - 0.07 in./in. per min. (0.03 - 0.07 mm/mm per min.):

Tensile Strength, min	45,000 psi (310 MPa)
Elongation in 4D, min	15%

3.5.2 Castings:

3.5.2.1 Tensile Properties: When specified on the drawing or when agreed upon by purchaser and vendor, tensile specimens conforming to ASTM E8 shall be machined, from locations indicated on the drawing, from a casting or castings selected at random from each master heat. Property requirements for such specimens shall be as specified on the drawing or as agreed upon by purchaser and vendor and may be defined as specified in AMS 2360, AMS 2361, or both.

3.5.2.2 Hardness: Shall be as follows, determined in accordance with ASTM E18.

3.5.2.2.1 As Cast: Not higher than 21 HRC, or equivalent.

3.5.2.2.2 After Heat Treatment: Not higher than 28 HRC, or equivalent, after being heated to 1475°F ± 10 (800°C ± 5), held at heat for 50 hr ± 1, and cooled to room temperature.

3.6 Quality:

3.6.1 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.

3.6.1.1 Castings shall have smooth surfaces and shall be well cleaned. Metallic shot or grit shall not be used for final cleaning.

3.6.2 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.

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

3.6.4 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.

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

3.6.5.1 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 the following requirements are classified as acceptance tests and shall be performed to represent each master heat or lot as applicable:

4.2.1.1 Composition (3.1) of each master heat.

4.2.1.2 Elevated temperature tensile properties of separately-cast or Ø integrally-cast specimens (3.5.1.1.2) except as specified in 4.2.1.2.1.

4.2.1.2.1 Tensile properties of specimens cut from castings shall be determined Ø only when specified by purchaser or when representative separately-cast or integrally-cast specimens are not available. Tensile properties of separately-cast or integrally-cast specimens need not be determined when tensile properties of specimens cut from castings are determined.

4.2.1.3 Hardness (3.5.2.2.1) of castings as-cast.

4.2.1.4 Quality (3.6) of each lot of castings.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for Ø room-temperature tensile properties of separately-cast or integrally-cast specimens (3.5.1.1.1) and hardness of castings after heat treatment (3.5.2.2.2) 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 Ø 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, 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 the same master heat in a period of eight consecutive hours and presented for vendor's inspection at one time:

4.3.1 One or more chemical analysis specimens in accordance with 3.4.1 from each Ø master heat 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 master heat or Ø three or more integrally-cast specimens except when purchaser requires tensile properties of specimens cut from castings.

4.3.4 One or more castings from each master heat when properties of specimens machined from castings are required. Size, location, and number of tensile 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 tensile specimens are not specified, not less than four tensile specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each master heat.

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 procedure 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 castings, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of reapproval.

4.4.2.1 Ø 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
Gating practices
Mold preheat and metal pouring temperatures; variations of ±25°F (±15°C) from established limits are permissible
Solidification and cooling procedures
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: