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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5397C

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Noncurrent	NOV 1995
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Superseding AMS 5397B

Alloy Castings, Investment, Corrosion and Heat Resistant
50Ni - 9.5Cr - 15Co - 3.0Mo - 4.8Ti - 5.5Al - 0.015B - 0.95V - 0.06Zr
Vacuum Melted, Vacuum Cast
As Cast

UNS N13100

NONCURRENT NOTICE

This specification has been declared “NONCURRENT” by the Aerospace Materials Division, SAE, as of November 1995. It is recommended, therefore, that this specification not be specified for new designs.

“NONCURRENT” refers to those materials which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division, however, does not recommend these as standard materials for future use in new designs. Each of these “NONCURRENT” specifications is available from SAE.

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1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant nickel alloy in the form of investment castings.

1.2 Application:

Primarily for small parts, such as turbine blades, requiring high strength 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 Specification:

AMS 2268	Chemical Check Analysis Limits, Cast Nickel and Nickel Alloys
AMS 2280	Trace Element Control, Nickel Alloy Castings
AMS 2350	Standards and Test Methods
AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2362	Stress-Rupture 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 E139	Conducting Creep, Creep-Rupture, and Stress-Rupture 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 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 E354, 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	0.15	0.20
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	8.00	11.00
Cobalt	13.00	17.00
Molybdenum	2.00	4.00
Titanium	4.50	5.00
Aluminum	5.00	6.00
Titanium + Aluminum	10.00	11.00
Boron	0.01	0.02
Vanadium	0.70	1.20
Zirconium	0.03	0.09
Iron	--	1.00
Nickel	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2268.

3.2 Condition:

As cast.

3.3 Casting:

3.3.1 The metal for castings shall be melted and poured under vacuum without loss of vacuum between melting and pouring. When permitted by purchaser, protective atmosphere may be used in lieu of vacuum for pouring of castings. Trace element control shall be in accordance with AMS 2280.

3.3.2 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.

3.3.2.1 A master heat is refined metal of a single furnace charge or metal blended as in 3.3.2.2 melted and cast into ingot under vacuum. 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.

3.3.2.2 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. 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. 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 Specimens:

3.5.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, min	115,000 psi (795 MPa)
Yield Strength at 0.2% Offset, min	95,000 psi (655 MPa)
Elongation in 4D, min	5%

3.5.1.2 Stress-Rupture Properties at 1800°F (980°C): Specimens, maintained at 1800°F ± 3 (980°C ± 2) while a load sufficient to produce an initial axial stress of 29,000 psi (200 MPa) is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than 4% in 4D. Test shall be performed in accordance with ASTM E139.

3.5.1.2.1 The test of 3.5.1.2 may be conducted using a load higher than required to produce an initial axial stress of 29,000 psi (200 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.5.1.2.

3.5.1.2.2 When permitted by purchaser, the test of 3.5.1.2 may be conducted using incremental loading. In such cases, the load required to produce an initial axial stress of 29,000 psi (200 MPa) shall be used to rupture or for 23 hr, whichever occurs first. After the 23 hr and at intervals of 8 - 16 hr, preferably 8 - 10 hr, thereafter, the stress shall be increased in increments of 2500 psi (17 MPa). Time to rupture and elongation requirements shall be as specified in 3.5.1.2.

3.5.2 Castings:

3.5.2.1 Grain Size: Shall be substantially uniform, equiaxed, non-columnar grains without pronounced segregation of fine and coarse grained areas. Actual grain size and method of measurement shall be as agreed upon by purchaser and vendor.

3.5.2.2 Tensile and Stress-Rupture Properties: When specified on the drawing or when agreed upon by purchaser and vendor, tensile specimens conforming to ASTM E8 shall be machined from 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 2362, or both.

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, unless otherwise permitted by purchaser.

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: Except as specified in 4.2.1.1, tests to determine conformance to requirements for composition (3.1), tensile properties (3.5.1.1) and stress-rupture properties (3.5.1.2) of separately-cast specimens, grain size (3.5.2.1) and quality (3.6) of castings, and when specified, tensile and stress-rupture properties of specimens cut from castings (3.5.2.2) are classified as acceptance tests and shall be performed on each master heat or lot as applicable.

4.2.1.1 Tensile and stress-rupture properties of specimens cut from castings shall be determined only when specified by purchaser or when separately-cast specimens are not available. Tensile and stress-rupture properties of separately-cast specimens need not be determined when such properties are determined on specimens cut from castings.

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 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.

4.2.2.1 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; a lot shall be all castings of the same part number poured from the same master heat in a period of not longer than eight consecutive hours, and presented for vendor's inspection at one time.

4.3.1 Two chemical analysis specimens in accordance with 3.4.1 or a casting from each master heat.

4.3.2 Six tensile specimens in accordance with 3.4.2 from each master heat, three specimens each for tensile testing and stress-rupture testing.

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 master heat 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 four tensile specimens, two from the thickest section and two 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 test 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, 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 test specimens and castings include, but are not limited to, the following:

Type of furnace and its capacity
Type and size of furnace charge
Vacuum level
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.