AEROSPACE MATERIAL SPECIFICATION

AMS5397	REV. E

Issued 1965-02
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Revised 2015-05

Superseding AMS5397D

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

(Composition similar to UNS N13100)

RATIONALE

AMS5397E results from a limited scope ballot to correct an error in referenced paragraphs (3.4.2.2).

1. SCOPE

1.1 Form

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

1.2 Application

These products have been used typically for small parts, such as turbine blades, requiring high strength and oxidation resistance up to 1800 °F (982 °C), but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2269 Chemical Check Analysis Limits, Nickel, Nickel Alloys, and Cobalt Alloys

AMS2360 Room Temperature Tensile Properties of Castings

AMS2362 Stress-Rupture Properties of Castings

AMS2694 In-Process Welding of Aerospace Castings

AMS2804 Identification, Castings

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5397E

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E8/E8M	Tension Testing 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
ASTM E1417/E1417M	Liquid Penetrant Testing
ASTM E1742/E1742M	Radiographic Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E354, by spectrographic methods, or by other analytical methods acceptable to purchaser (See 8.2.1 and 8.2.2):

Table 1 - Composition

Element	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
Other Elements (3.1.1)	--	--
Nickel	remainder	

3.1.1 Vendor may test for any element not otherwise listed in Table 1 and include this analysis in the report of 4.5. Limits of acceptability may be specified by purchaser (See 8.2.3).

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2269.

3.2 Melting Practice

Castings and specimens shall be poured at casting vendor's facility either from a melt (See 8.2.4) of a master heat, or directly from a master heat (See 3.4.2 and 8.2.5).

3.2.1 The metal for castings and specimens shall be melted and poured under vacuum without loss of vacuum between melting and pouring. When authorized by purchaser (See 8.2.6), protective atmosphere may be used in lieu of vacuum for pouring of castings.

3.2.2 Revert (gates, sprues, risers, and rejected castings) may be used only in the preparation of master heats; revert shall not be remelted directly without refining for pouring of castings. Melting of revert creates a new master heat.

3.2.3 Portions of two or more qualified master heats (See 3.4.2) may be melted together and poured into castings using a procedure authorized by purchaser.

3.2.4 If melts (See 8.2.4) are modified by replenishment (See 8.2.7), vendor shall have a written procedure acceptable to purchaser which defines the controls, tests and traceability criteria for both castings and separately-cast specimens. Control factors of 4.4.2.2 shall apply.

3.3 Condition

Castings shall be delivered in the as-cast condition.

3.4 Test Specimens

Specimens shall be either separately-cast, integrally-cast (See 8.2.8), or machined from a casting, and shall conform to 3.2.

3.4.1 If specimens are separately-cast, vendor shall have a written procedure acceptable to purchaser. Control factors of 4.4.2.2 shall apply.

3.4.2 Each master heat shall be qualified by evaluation of chemical, tensile, and stress-rupture specimens.

3.4.2.1 If replenishments are made at remelt as in 3.2.4, frequency of sampling and testing used by the vendor for qualification to 3.4.2 shall be acceptable to purchaser.

3.4.2.2 Tensile and stress-rupture tests for master heat qualification are not required if these tests are conducted using integrally-cast specimens (4.3.2.2) or specimens machined-from-casting (4.3.2.3) on each lot.

3.4.3 Chemical Analysis Specimens

Shall be of any convenient size and shape.

3.4.4 Tensile and Stress-Rupture Specimens

Shall be of standard proportions in accordance with ASTM E8/E8M (See 8.3), and ASTM E139, respectively.

3.4.4.1 Separately-cast and integrally-cast specimens may be either cast to size, and/or cast oversize and subsequently machined to 0.250-inch (6.35-mm) diameter.

3.4.4.2 When integrally-cast specimens and/or specimens machined-from-casting are specified, specimen size and location shall be agreed upon by purchaser and vendor (See 8.2.9 and 8.4).

3.5 Heat Treatment

Not applicable.

3.6 Properties

Conformance shall be based upon testing of separately-cast specimens unless purchaser specifies integrally-cast specimens or specimens machined-from-casting. Properties for integrally-cast specimens and specimens machined-from-casting shall be as specified by purchaser (See 8.4).

3.6.1 Room Temperature Tensile Properties

Shall be as specified in 3.6.1.1, determined in accordance with ASTM E8/E8M. Properties other than those listed in Table 2 may be defined as specified in AMS2360.

3.6.1.1 Separately-Cast Specimens

Shall be as shown in Table 2.

Table 2 - Minimum tensile properties

Property	Value
Tensile Strength	115 ksi (795 MPa)
Yield Strength at 0.2% Offset	95 ksi (655 MPa)
Elongation in 4D	5%

3.6.2 Stress-Rupture Properties at 1800 °F (982 °C)

Shall be as follows, determined in accordance with ASTM E139. Properties other than those listed may be defined as specified in AMS2362.

3.6.2.1 Specimens, maintained at 1800 °F ± 3 (982 °C ± 2) while a load sufficient to produce an initial axial stress of 29.0 ksi (200 MPa) or higher 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.

3.6.2.2 The test of 3.6.2.1 may be conducted using a load higher than required to produce an initial axial stress of 29.0 ksi (200 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.6.2.1.

3.6.2.2.1 The test of 3.6.2.1 may be conducted using incremental loading. In such cases, the load required to produce an initial axial stress of 29.0 ksi (200 MPa) or higher shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 hours, minimum, thereafter, the stress shall be increased in increments of 2.5 ksi (17 MPa). Time to rupture and elongation requirements shall be as specified in 3.6.2.1.

3.6.3 Hardness

Not applicable.

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. 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. This control shall consist of radiographic examination of castings in accordance with ASTM E1742/E1742M 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 ASTM E1417/E1417M.

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 peened, plugged, impregnated or welded unless authorized by purchaser.

3.7.5.1 When permitted in writing by purchaser, castings may be in-process welded in accordance with AMS2694.

3.7.6 Grain Size

3.7.6.1 Grain Size Distribution

Shall be substantially uniform, equiaxed, non-columnar grains without pronounced segregation of fine and coarse grained areas.

3.7.6.2 Actual Grain Size

Grain size and method of measurement shall be as agreed upon by purchaser and vendor.

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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Tests for composition (3.1), tensile properties (3.6.1) and stress-rupture properties (3.6.2) of separately-cast specimens, quality (3.7) and grain size (3.7.6) of castings, and when specified (See 8.4), tensile and stress-rupture properties of specimens integrally-cast or machined-from-castings are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests

Radiographic soundness (3.7.2) is a periodic test and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests

All technical requirements are preproduction tests and shall be performed on specimens or sample castings as applicable (4.3) when a change in control factors occurs (4.4.2.2), and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

The minimum testing performed by vendor shall be in accordance with the following:

4.3.1 One chemical analysis specimen or a casting from each master heat shall be tested for conformance with Table 1; if 3.4.2.1 applies, test frequency shall be acceptable to purchaser.

4.3.2 Tensile property and stress-rupture tests shall be conducted to determine conformance with 3.6.1 and 3.6.2. Sampling and test frequency is dependent upon the type and origin of the specimen specified by purchaser (See 3.4.4 and 3.6) or selected by vendor (See 4.3.2.4). When 3.4.2.1 applies, specimen source and test frequency shall be acceptable to purchaser.

4.3.2.1 For separately-cast specimens in the as-cast condition, two specimens from each master heat shall be tested; one for conformance to Table 2 and one for conformance to 3.6.2.

4.3.2.2 For integrally-cast specimens in the as-cast condition, two specimens shall be randomly selected from each lot and tested for conformance with properties specified by purchaser (See 3.6 and 8.4).

4.3.2.3 For specimens machined-from-casting, one casting shall be randomly selected from each lot and tested in the as-cast condition at each location shown on the engineering drawing for conformance with properties specified by purchaser (See 3.6 and 8.4).

4.3.2.3.1 When size and location of specimens are not shown, two specimens shall be tested, one from the thickest section and one from the thinnest section. Once established under 4.4.2.2, test locations may be changed only as agreed upon by purchaser and vendor.

4.3.2.4 When acceptable to purchaser, specimens machined-from-casting may be used in lieu of both separately-cast and integrally-cast specimens, and integrally-cast specimens may be used in lieu of separately-cast specimens. In each case, the resultant properties shall conform to the requirements of 3.6 or to alternative requirements specified by purchaser (See 8.4).

4.3.2.4.1 When specimens are selected for test as in 4.3.2.4 from an origin other than that specified by purchaser, vendor shall include in the report of 4.5 a description of the source of the specimen that was tested.

4.3.2.5 When casting size, section thickness, gating method, or other factors do not permit conformance with 4.3.2.2 or 4.3.2.3, sampling and testing shall be agreed upon by purchaser and vendor.

4.3.3 Castings shall be inspected in accordance with 3.7 to the methods, frequency, and acceptance standards specified by purchaser.

4.4 Approval

4.4.1 Sample casting(s) from new or reworked master patterns produced under the casting procedure of 4.4.2 shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser.

4.4.2 For each casting part number, vendor shall establish parameters for process control factors that will consistently produce castings and test specimens meeting the requirements of the casting drawing and this specification. These parameters shall constitute the approved casting procedure and shall be used for production of subsequent castings and test specimens. If necessary to make any change to these parameters, vendor shall submit a statement of the proposed change for purchaser reapproval. When requested, vendor shall also submit test specimens, sample castings, or both to purchaser for reapproval.

4.4.2.1 Production castings produced prior to receipt of purchaser's approval shall be at vendor's risk.

4.4.2.2 Control factors for producing castings and separately-cast specimens include, but are not limited to, the following factors. Supplier's procedures shall identify tolerances, ranges, and/or control limits, as applicable. Control factors for separately-cast specimens must generally represent, but need not be identical to, those factors used for castings (See 3.2.3 and 3.4.1).

Composition of ceramic cores, if used
Arrangement and number of patterns in the mold (including integrally-cast specimens, if applicable)
Size, shape, and location of gates and risers
Mold refractory formulation
Grain refinement methods, if applicable
Mold back-up material (weight, thickness, or number of dips)
Type of furnace, vacuum, and charge for melting
Mold preheat and metal pouring temperatures
Fluxing or deoxidation procedure
Replenishment procedure, if applicable
Time molten metal is in furnace
Solidification and cooling procedures
Cleaning operations (mechanical and chemical)
Straightening
Final inspection methods
Location of specimens machined-from-casting, if applicable.

4.4.2.2.1 Any of the 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.

4.4.2.2.1.1 Unless otherwise agreed upon by purchaser and vendor, purchaser shall be entitled to review proprietary control factor details and coding at vendor's facility.

4.5 Reports

The vendor of castings shall furnish with each shipment a certification document declaring that castings have been processed, tested, and inspected as specified and that the results of the inspections and tests conform to requirements.

4.5.1 Unless otherwise specified, vendor shall furnish test report(s) showing the results of tests and inspections conducted in accordance with 4.2 and 4.3.

4.5.1.1 Chemical analysis determinations, property test data, and the results of any retests conducted shall be expressed numerically to reflect actual quantitative test values.

4.5.1.2 Inspection and preproduction results shall be reported at the frequency specified by, and in a format acceptable to purchaser.

4.5.1.3 Objective evidence of purchaser's review and acceptance of nonconforming material shall be provided with the certification document at each shipment (See Section 7).

4.5.2 The statement of conformity and test report(s) shall include or be traceable to the purchase order number, master heat identification, lot number, AMS5397E, part number, quantity, and when required (See 5.1.2) the list of individual serial numbers or serial number range.

4.5.2.1 If 4.3.2.4.1 applies, the mechanical property test report shall denote the source of the specimens that were tested.

4.5.3 Test reports for acceptance testing of 4.2 shall be as follows:

4.5.3.1 For each master heat:

Composition (See 4.3.1)
Room temperature tensile properties (See 4.3.2.1)
Stress-rupture properties (See 4.3.2.1).

4.5.3.2 For each lot:

Inspection results (See 4.3.3)
Integrally-cast or machined-from-casting room temperature and stress-rupture properties, when specified (See 3.6, 4.3.2.2 and 4.3.2.3).

4.5.4 The vendor shall retain records of processing and inspection in accordance with purchaser requirements.

4.6 Resampling and Retesting

If results of a valid test fail to meet specified requirements, two additional specimens in accordance with 4.3 from the same master heat, modified melt (See 3.2.4), or lot, as applicable, shall be tested for each nonconforming characteristic. Results of each additional test, and the average of the results of all tests (original and retests) shall meet specified requirements; otherwise, the master heat or lot shall be rejected. Results of all tests shall be reported.

4.6.1 A test may be declared invalid if failure is due to specimen mispreparation, test equipment malfunction, improper test procedure, or the presence of random process defects such as inclusions or gas holes in a tensile specimen.