



AEROSPACE MATERIAL SPECIFICATION

AMS5399™**REV. D**

Issued 1996-03
Revised 2006-09
Reaffirmed 2023-11

Superseding AMS5399C

Nickel Alloy, Corrosion and Heat-Resistant, Investment Castings
52Ni - 19Cr - 11Co - 9.8Mo - 3.2Ti - 1.6Al - 0.006B
Vacuum-Melted, Vacuum-Cast, Solution Heat Treated
(Composition similar to UNS N07041)

RATIONALE

AMS5399D has been revised to require performance of non-destructive inspection and special processes in accordance with applicable ASTM or AMS in lieu of the previously required MIL specs, update reporting requirements and add new provisions for serialization, and is a Five Year Review and update of this specification.

AMS5399D has been reaffirmed to comply with the SAE Five-Year Review policy.

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 castings have been used typically for parts requiring high strength up to 1600 °F (871 °C) 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 724-776-4970 (outside USA), www.sae.org.

AMS 2269	Chemical Check Analysis Limits, Nickel, Nickel Alloys, and Cobalt Alloys
AMS 2361	Elevated Temperature Tensile Properties of Castings
AMS 2362	Stress Rupture Properties of Castings
AMS 2694	Repair Welding of Aerospace Castings
AMS 2750	Pyrometry
AMS 2804	Identification, Castings
AMS 2175	Castings, Classification and Inspection of

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SAE WEB ADDRESS:

Full document details: [SAE AMS5399D](http://www.sae.org/standards/content/AMS5399D)

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS5399D/>

Documents

Document Sharing Hub

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 E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
ASTM E 1417	Liquid Penetrant Inspection
ASTM E 1742	Radiographic Inspection

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 E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser (See 8.2.1 and 8.2.2).

TABLE 1 - COMPOSITION

Element	min	max
Carbon	0.06	0.12
Manganese	--	0.50
Silicon	--	0.50
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	18.00	20.00
Cobalt	10.00	12.00
Molybdenum	9.00	10.50
Titanium	3.00	3.30
Aluminum	1.40	1.80
Boron	0.003	0.010
Iron	--	5.00
Nickel	remainder	

3.1.1 Vendor may test for any element not 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 AMS 2269.

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 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.

3.2.1.1 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 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.

3.2.3 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, test, 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 solution heat treated 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, elevated temperature tensile, and stress-rupture specimens.

3.4.2.1 If replenishments are made at remelt as in 3.2.3, the 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 qualification tests of 3.4.2 are not required if tests are conducted using integrally-cast specimens (4.3.3.2) or specimens machined-from-casting (4.3.3.3).

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 publications referenced in 3.6.

3.4.4.1 Separately-cast and integrally-cast specimens may be either cast to size, 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 as agreed upon by purchaser and vendor. (See 8.2.9 and 8.5.)

3.5 Heat Treatment

Castings and representative tensile and stress-rupture specimens shall be heat treated in accordance with AMS 2750 except as specified in 3.5.1 and 3.5.2.

3.5.1 Castings and Specimens

3.5.1.1 Solution Heat Treatment

Heat in a suitable protective atmosphere to 1950 °F ± 25 (1066 °C ± 14), hold at heat for not less than three hours, and rapid quench.

3.5.2 Response to Heat Treatment

After solution heat treatment to 3.5.1, specimens shall be heat treated in accordance with the following for subsequent testing to demonstrate response to heat treatment:

3.5.2.1 Re-Solution Heat Treatment

Heat in a suitable protective atmosphere to $1950^{\circ}\text{F} \pm 25$ ($1066^{\circ}\text{C} \pm 14$), hold at heat for not less than 30 minutes, and rapid cool.

3.5.2.2 Precipitation Heat Treatment

Heat to $1400^{\circ}\text{F} \pm 25$ ($760^{\circ}\text{C} \pm 14$), hold at heat for not less than 16 hours, and cool in air.

3.5.3 Tensile and stress-rupture specimens used for master heat qualification may be heat treated separately from castings.

3.6 Properties

Conformance shall be based upon testing separately-cast specimens unless purchaser specifies integrally-cast specimens or specimens machined-from-casting. Properties for integrally-cast specimens and machined-from-casting specimens shall be specified by purchaser (See 8.5).

3.6.1 Room Temperature Tensile Properties

Not applicable.

3.6.2 Elevated Temperature Tensile Properties at 1200°F (649°C)

Shall be as specified in Table 2 on specimens heated to $1200^{\circ}\text{F} \pm 10$ ($649^{\circ}\text{C} \pm 6$) and tested at $1200^{\circ}\text{F} \pm 10$ ($649^{\circ}\text{C} \pm 6$) in accordance with ASTM E 21. Properties other than those listed may be defined as specified in AMS 2361.

3.6.2.1 Separately-Cast Specimens

Shall be as shown in Table 2.

TABLE 2 - MINIMUM ELEVATED TEMPERATURE TENSILE PROPERTIES

Property	Value
Tensile strength	110 ksi (758 MPa)
Yield Strength at 0.2% Offset	90 ksi (621 MPa)
Elongation in 4D	3%
Reduction of Area	5%

3.6.3 Stress-Rupture Properties at 1650°F (899°C)

Shall be as follows; determined in accordance with ASTM E 139. Properties other than those listed may be defined as specified in AMS 2362.

3.6.3.1 Specimens, maintained at $1650^{\circ}\text{F} \pm 3$ ($899^{\circ}\text{C} \pm 2$) while a load sufficient to produce an initial axial stress of 25.0 ksi (172 MPa) is applied continuously, shall not rupture in less than 25 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than 5% in 4D.

3.6.3.2 The test of 3.6.3.1 may be conducted using a load higher than required to produce an initial axial stress of 25.0 ksi (172 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.6.3.1.