

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 5404

Issued 1-1-83

Revised

ALLOY CASTINGS, INVESTMENT, CORROSION AND HEAT RESISTANT
59Ni - 12.6Cr - 9.0Co - 1.9Mo - 4.2W - 4.0Ti - 4.2Ta - 3.4Al - 0.015B - 0.10Zr - 0.90Hf
Vacuum Melted, Vacuum Cast
Solution and Precipitation Heat Treated

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 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 (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
AMS 2635 - Radiographic Inspection
AMS 2645 - Fluorescent Penetrant Inspection
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-Base Alloys

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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	0.07	- 0.20
Manganese	-	0.10
Silicon	-	0.10
Phosphorus	-	0.015
Sulfur	-	0.015
Chromium	12.20	- 13.00
Cobalt	8.50	- 9.50
Molybdenum	1.70	- 2.10
Tungsten	3.85	- 4.50
Titanium	3.85	- 4.15
Tantalum	3.85	- 4.50
Aluminum	3.20	- 3.60
Aluminum + Titanium	7.30	- 7.70
Boron	0.010	- 0.020
Zirconium	0.05	- 0.14
Hafnium	0.75	- 1.05
Columbium	-	0.10
Iron	-	0.50
Nickel	remainder	

3.2 Condition: Solution and precipitation heat treated.

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.

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 is metal blended as in 3.3.2.2 and melted and cast into ingot or pig 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 and that the total weight of metal blended does not exceed 10,000 lb (4500 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 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 Heat Treatment: Castings and representative tensile specimens shall be heat treated as follows:
- 3.5.1 Solution Heat Treatment: Heat to 2050°F $\pm$ 25 (1120°C $\pm$ 15) in an inert atmosphere or vacuum, hold at heat for 2 hr $\pm$ 0.25, and cool in air or in an inert atmosphere at a rate equivalent to air cool or faster.
- 3.5.2 Precipitation Heat Treatment: Heat to 1550°F $\pm$ 25 (845°C $\pm$ 15), hold at heat for 4 hr $\pm$ 0.5, and air cool, reheat to 1400°F $\pm$ 25 (760°C $\pm$ 15), hold at heat for 16 hr $\pm$ 0.5, and air cool to room temperature.
- 3.6 Properties: Castings and representative tensile specimens produced in accordance with 3.4.2 shall conform to the following requirements: