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400 Commonwealth Dr., Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5882B

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Superseding AMS 5882A

ALLOY FORGINGS, CORROSION AND HEAT RESISTANT 55Ni - 15Cr - 17Co - 5.0Mo - 3.5Ti - 4.0Al - 0.025B Solution, Stabilization, and Precipitation Heat Treated Powder-Metallurgy Product

UNS N13017

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant nickel alloy powder-metallurgy product in the form of forgings.

1.2 Application: Primarily for highly-stressed parts, such as rotating parts of gas turbine engines, requiring high strength and corrosion and oxidation resistance up to 1400°F (760°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications 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 2269 - Chemical Check Analysis Limits, Wrought Nickel Alloys and Cobalt Alloys
AMS 2350 - Standards and Test Methods
AMS 2374 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Forgings and Forging Stock
AMS 2376 - Qualification, Approval, and Control of Premium-Quality Forgings, Alloy Steels and Heat-Treatable Corrosion and Heat Resistant Steels and Alloys
AMS 2808 - Identification, Forgings
AMS 5852 - Alloy Billets and Preforms, Corrosion and Heat Resistant, 55Ni - 15Cr - 17Co - 5.0Mo - 3.5Ti - 4.0Al - 0.025B, Powder-Metallurgy Product, Hot Isostatically Pressed

2.1.2 Aerospace Recommended Practices:

ARP1313 - Determination of Trace Elements in High Temperature Alloys

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E8M - Tension Testing of Metallic Materials (Metric)
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E112 - Determing Average Grain Size
ASTM E139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E292 - Conducting Time-for-Rupture Notch Tension Tests of Materials
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-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Material: Forgings shall be forged, from AMS 5852 billets or preforms, by a suitable process or processes to the required shape.

3.2 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E354, by spectrochemical methods, or by other analytical methods acceptable to purchaser except that lead and bismuth shall be determined in accordance with ARP1313 and oxygen and nitrogen shall be determined by Leco Gas Analyzer or equivalent:

	min		max
Carbon	0.02	-	0.06
Manganese	--		0.15
Silicon	--		0.20
Phosphorus	--		0.015
Sulfur	--		0.015
Chromium	14.00	-	16.00
Cobalt	16.00	-	18.00
Molybdenum	4.50	-	5.50
Titanium	3.35	-	3.65
Aluminum	3.85	-	4.15
Boron	0.020	-	0.030
Tungsten	--		0.05
Iron	--		0.50
Copper	--		0.10
Zirconium	--		0.06
Lead	--		0.0002 (2 ppm)
Bismuth	--		0.00003 (0.3 ppm)
Oxygen	--		0.010 (100 ppm)
Nitrogen	--		0.0050 (50 ppm)
Nickel	remainder		

3.2.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269; no variation over maximum will be permitted for lead, bismuth, oxygen, and nitrogen.

3.3 Condition: Solution, stabilization, and precipitation heat treated.

3.4 Heat Treatment: Shall be as follows:

3.4.1 Solution Heat Treatment: Heat to a temperature within the range 1975° - 2075°F (1079° - 1135°C), hold at the selected temperature within ±15°F (±8°C) for 4 hours ± 0.25, and cool at a rate equivalent to air cool or faster.

3.4.2 Stabilization Heat Treatment: Heat to 1600°F ± 15 (871°C ± 8), hold at heat for 8 hours ± 0.5, and cool to room temperature at a rate equivalent to an air cool; reheat to 1800°F ± 15 (982°C ± 8), hold at heat for 4 hours ± 0.25, and cool at a rate equivalent to an air cool.

3.4.3 Precipitation Heat Treatment: Heat to 1200°F ± 15 (649°F ± 8), hold at heat for 24 hours ± 0.5, and air cool to room temperature; reheat to 1400°F ± 15 (760°C ± 8), hold at heat for 8 hours ± 0.25, and air cool to room temperature.

3.5 Properties: Forgings shall conform to the following requirements:

3.5.1 Microstructure: Shall show recrystallized grains and freedom from lack of cohesion along prior particle boundaries and shall be essentially free of voids and hollows, conforming to standards specified by purchaser; conformance shall be determined by microscopic examination at 100X and/or 400X magnification of specimens polished and etched in Kalling's reagent.

3.5.2 Grain Size: Predominantly 4 or finer with occasional grains as large as 1 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.5.3 Tensile Properties: Shall be as follows for forgings 4.0 inches (101.6 mm) and under in nominal thickness, determined in either the longitudinal or transverse direction except that testing in the transverse direction applies only to forgings from which a tensile specimen not less than 2.50 inches (63.5 mm) in length can be obtained; testing in the longitudinal direction is not required on forgings tested in the transverse direction. Tensile property requirements for forgings over 4.0 inches (101.6 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.5.3.1 At Room Temperature: Shall be as follows, determined in accordance with ASTM E8 or ASTM E8M:

Tensile Strength, minimum	195,000 psi (1344 MPa)
Yield Strength at 0.2% Offset, minimum	140,000 psi (965 MPa)
Elongation in 4D, minimum	16%
Reduction of Area, minimum	18%

3.5.3.2 At 1400°F (760°C): Shall be as follows, determined in accordance with ASTM E21 on specimens heated to 1400°F ± 10 (760°C ± 6), held at heat for 20 to 30 minutes before testing, and tested at 1400°F ± 10 (760°C ± 6):

Tensile Strength, minimum	150,000 psi (1034 MPa)
Yield Strength at 0.2% Offset, minimum	125,000 psi (861 MPa)
Elongation in 4D, minimum	20%
Reduction of Area, minimum	30%

3.5.4 Hardness: Should be 311 - 401 HB, or equivalent, determined in accordance with ASTM E10, but forgings shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.3.1 are met.

3.5.5 Stress-Rupture Properties at 1400°F (760°C): Shall be as follows; testing of notched specimens and of combination smooth-and-notched specimens shall be performed in accordance with ASTM E292 and of smooth specimens in accordance with ASTM E139:

3.5.5.1 Ø A standard cylindrical combination smooth-and-notched specimen conforming to ASTM E292, maintained at 1400°F ± 3 (760°C ± 2) while a load sufficient to produce an initial axial stress of 85,000 psi (586 MPa) is applied continuously, shall not rupture in less than 15 hours. The test shall be continued to rupture without change of load. Rupture shall occur in the smooth section and elongation of this section after rupture, measured at room temperature, shall be not less than 12% in 4D.

3.5.5.2 Ø As an alternate procedure, separate smooth and notched specimens, machined from adjacent sections of the same piece with gage sections conforming to the respective dimensions shown in ASTM E292, may be tested individually under the conditions of 3.5.5.1. The smooth specimen shall not rupture in less than 15 hours and elongation after rupture, measured at room temperature, shall be not less than 12% in 4D. The notched specimen shall not rupture in less time than the companion smooth specimen but need not be tested to rupture.

3.5.5.3 The tests of 3.5.5.1 and 3.5.5.2 may be conducted using a load higher than required to produce an initial axial stress of 85,000 psi (586 MPa) but load shall not be changed while test is in progress. Time to rupture, rupture location, and elongation requirements shall be as specified in 3.5.5.1.

3.5.5.4 When permitted by purchaser, the tests of 3.5.5.1 and 3.5.5.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 85,000 psi (586 MPa) shall be used to rupture or for 15 hours, whichever occurs first. After the 15 hours and at intervals of 8 - 16 hours, preferably 8 - 10 hours, thereafter, the stress shall be increased in increments of 5,000 psi (34.5 MPa). Time to rupture, rupture location, and elongation requirements shall be as specified in 3.5.5.1.

3.5.6 Creep Properties at 1300°F (704°C): A smooth tensile specimen shall be maintained at 1300°F ± 3 (704°C ± 2) while a load sufficient to produce an initial axial stress of 74,000 psi (510 MPa) is applied continuously for 110 hours or until 0.1% plastic strain is produced, whichever is longer. The plastic strain after 110 hours and the time to 0.1% plastic strain shall be reported. Gage dimensions of specimens and techniques used to measure creep shall be as agreed upon by purchaser and vendor. Tests shall be conducted in accordance with ASTM E139.

3.6 Quality: Forgings, 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 forgings.