

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5711B

Issued 12-1-73  
Revised 1-1-90

Superseding AMS 5711A

ALLOY BARS, FORGINGS, AND RINGS, CORROSION AND HEAT RESISTANT  
65Ni - 15.8Cr - 15.2Mo - 0.30Al - 0.05La  
Solution Heat Treated

UNS N06635

## 1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant nickel alloy in the form of bars, forgings, flash welded rings, and stock for forging, flash welded rings, or heading.

1.2 Application: Primarily for parts, such as turbine rotors and seals, flanges, and fasteners, requiring relatively high strength up to 1800°F (982°C) and oxidation resistance up to 2000°F (1093°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 publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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### 2.1.1 Aerospace Material Specifications:

- AMS 2261 - Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars
- MAM 2261 - Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Bars
- AMS 2269 - Chemical Check Analysis Limits, Wrought Nickel Alloys and Cobalt Alloys
- AMS 2350 - Standards and Test Methods
- AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock
- AMS 2374 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Forgings and Forging Stock
- AMS 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
- AMS 2808 - Identification, Forgings
- AMS 7490 - Rings, Flash Welded, Corrosion and Heat Resistant Austenitic Steels and Austenitic-Type Alloys

### 2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

- ASTM E 8 - Tension Testing of Metallic Materials
- ASTM E 8M - Tension Testing of Metallic Materials (Metric)
- ASTM E 10 - Brinell Hardness of Metallic Materials
- ASTM E 112 - Determining Average Grain Size
- 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

### 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 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E354, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	--	0.02
Manganese	0.30 -	1.00
Silicon	0.20 -	0.75
Phosphorus	--	0.020
Sulfur	--	0.015
Chromium	14.50 -	17.00
Molybdenum	14.00 -	16.50
Aluminum	0.10 -	0.50
Lanthanum	0.01 -	0.10
Cobalt	--	2.00
Tungsten	--	1.00
Boron	--	0.015
Iron	--	3.00
Copper	--	0.35
Nickel	remainder	

- 3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

- 3.2 Condition: The product shall be supplied in the following condition:

- 3.2.1 Bars, Forgings, and Flash Welded Rings: Solution heat treated and descaled.

- 3.2.1.1 Bars shall be hot finished; round bars shall be ground or turned.

- 3.2.1.2 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, rings shall be manufactured in accordance with AMS 7490.

- 3.2.2 Stock for Forging, Flash Welded Rings, or Heading: As ordered by the forging, flash welded ring, or heading manufacturer.

- 3.3 Solution Heat Treatment: Bars, forgings, and flash welded rings shall be solution heat treated by heating to  $1950^{\circ}\text{F} \pm 25$  ( $1066^{\circ}\text{C} \pm 14$ ), holding at heat for a time commensurate with section thickness, and cooling at a rate equivalent to an air cool or faster.

- 3.4 Properties: The product shall conform to the following requirements:

### 3.4.1 Bars, Forgings, and Flash Welded Rings:

3.4.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E 8 or ASTM E 8M:

Tensile Strength, minimum	105,000 psi (724 MPa)
Yield Strength at 0.2% Offset, minimum	40,000 psi (276 MPa)
Elongation in 4D, minimum	48%
Reduction of Area, minimum	47%

3.4.1.2 Hardness: Should be not higher than 241 HB, or equivalent, determined in accordance with ASTM E10, but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4.1.3 Stress-Rupture Properties at 1500°F (816°C): A tensile specimen, maintained at 1500°F  $\pm$  3 (816°C  $\pm$  2) while a load sufficient to produce an initial axial stress of 15,000 psi (103 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 10% in 4D. Test shall be conducted in accordance with ASTM E139.

3.4.1.3.1 The test of 3.4.1.3 may be conducted using a load higher than required to produce an initial axial stress of 15,000 psi (103 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

3.4.1.3.2 When permitted by purchaser, the test of 3.4.1.3 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 15,000 psi (103 MPa) shall be used to rupture or for 23 hours, whichever occurs first. After 23 hours and at intervals of 8 - 16 hours, preferably 8 - 10 hours, thereafter, the stress shall be increased in increments of 2,000 psi (13.8 MPa). Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

3.4.1.4 Grain Size: Shall be predominantly 4 or finer with occasional grains as large as 2 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E 112 or, in case of disagreement, by the intercept (Heyn) method.

3.4.2 Stock for Forging, Flash Welded Rings, and Heading: As agreed upon by purchaser and vendor.

### 3.5 Quality:

3.5.1 Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle.

3.5.2 The product, 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 product.

3.5.3 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of re-entrant grain flow.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars will be acceptable in mill lengths of 6 - 24 feet (1.8 - 7.3 m) but not more than 25% of any shipment shall be supplied in lengths of 6 - 9 feet (1.8 - 2.7 m) except that for bars weighing over 25 pounds per foot (37 kg/m), short lengths down to 2 feet (610 mm) may be supplied.

3.7 Tolerances: Bars shall conform to all applicable requirements of AMS 2261 or MAM 2261.

#### 4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product 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 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

#### 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for the following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Tensile properties (3.4.1.1), hardness (3.4.1.2), stress-rupture properties (3.4.1.3), and grain size (3.4.1.4) of each lot of bars, forgings, and flash welded rings.

4.2.1.3 Tolerances (3.7) of bars.

4.2.2 Periodic Tests: Tests for the following requirements are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser:

4.2.2.1 Ability of stock for forging, flash welded rings, and heading (3.4.2) to develop required properties.

4.2.2.2 Grain flow (3.5.3) of forgings.

4.3 Sampling and Testing: Shall be in accordance with the following; the number of specimens to be sampled shall be the minimum number of specimens tested. A heat shall be the consumable electrode remelted ingots produced from alloy originally melted as a single furnace charge: