



Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 5701A

Superseding AMS 5701

Issued 11-15-71

Revised 4-1-81

UNS N09706

ALLOY BARS, FORGINGS, AND RINGS, CORROSION AND HEAT RESISTANT

41.5Ni - 16Cr - 37Fe - 2.9Cb - 1.8Ti

Consumable Electrode or Vacuum Induction Melted

1800°F (980°C) Solution Heat Treated

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 or flash welded rings.
- 1.2 Application: Primarily for parts requiring good machinability and high strength at room and cryogenic temperatures for short-time use up to 1000°F (540°C), particularly parts which are welded and then precipitation heat treated to develop required properties.

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 Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2261 - Tolerances, Nickel, Nickel Base, and Cobalt Base Alloy Bars and Forging Stock

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 2375 - Control of Forgings Requiring First Article Approval

AMS 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Heat and Corrosion 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 American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials

ASTM E10 - Brinell Hardness of Metallic Materials

ASTM E112 - Estimating the Average Grain Size of Metals

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.

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2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 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 spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	--	0.06
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.020
Sulfur	--	0.015
Chromium	14.50	17.50
Nickel	39.00	44.00
Columbium + Tantalum	2.50	3.30
Titanium	1.50	2.00
Aluminum	--	0.40
Boron	--	0.006
Copper	--	0.30
Iron	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 turned or ground.

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

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

- 3.3 Heat Treatment: Bars, forgings, and flash welded rings shall be solution heat treated to conform to the requirements of 3.4.1.1.1, 3.4.1.1.2, and 3.4.1.2.

- 3.3.1 Bars: No specific heat treating instructions are specified but it is recommended that the bars be solution heat treated by heating within the range 1750° - 1850°F (955° - 1010°C), holding at the selected temperature within ±25°F (±15°C) for a time commensurate with cross-sectional thickness, and cooling at a rate equivalent to air cool or faster.

- 3.3.2 Forgings and Flash Welded Rings: Shall be heated within the range 1750° - 1850°F (955° - 1010°C), held at the selected temperature within ±25°F (±15°C) for not less than 30 min., and cooled at a rate equivalent to air cool or faster. If forgings are not to be machined all over, heat treatment shall be performed in a suitable protective atmosphere or, when permitted by purchaser, a suitable protective coating may be applied to the forgings in lieu of using a protective atmosphere.

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

3.4.1 Bars, Forgings, and Flash Welded Rings:

3.4.1.1 As Solution Treated:

3.4.1.1.1 Hardness: Shall be not higher than 277 HB or equivalent, determined in accordance with ASTM E10.

3.4.1.1.2 Grain Size: Shall be as follows, determined by comparison of a polished and etched specimen with the chart in ASTM E112 or, in case of disagreement, by the intercept (Heyn) method:

3.4.1.1.2.1 Shall be predominantly 5 or finer in bars and flash welded rings 9 sq in. (58 cm²) and under in cross-sectional area.

3.4.1.1.2.2 Shall be predominantly 4 or finer in bars and flash welded rings over 9 sq in. (58 cm²) in cross-sectional area and all forgings.

3.4.1.2 After Precipitation Heat Treatment: The product shall have the following properties after being precipitation heat treated by heating to 1350°F ± 15 (735°C ± 8), holding at heat for 8 hr ± 0.25, cooling at a rate not faster than 100 F (55 C) deg per hr to 1150°F ± 15 (620°C ± 8), holding at 1150°F ± 15 (620°C ± 8) for 8 hr ± 0.25, and cooling in air. Instead of the 100 F (55 C) deg per hr cooling rate to 1150°F ± 15 (620°C ± 8), the furnace cooling may be at any rate provided the time at 1150°F ± 15 (620°C ± 8) is adjusted to give a total precipitation heat treatment time of 18 hours.

3.4.1.2.1 Tensile Properties: Shall be as specified in Table I, determined in accordance with ASTM E8:

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D, %, min	Reduction of Area %, min
Up to 2.50, excl	170,000	140,000	12	15
2.50 to 4.00, incl	170,000	135,000	12	15

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min	Reduction of Area %, min
Up to 63.50, excl	1172	965	12	15
63.5 to 101.60, incl	1172	931	12	15

3.4.1.2.1.1 Tensile property requirements of products over 4.00 in. (101.60 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.

3.4.1.2.2 Hardness: Should be not lower than 303 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 of 3.4.1.2.1 are met.

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3.2 and 3.4.1.2, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2. If specimens taken from the stock after heat treatment as in 3.3.2 and 3.4.1.2 conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4.3 Stock for Flash Welded Rings: Specimens taken from the stock after heat treatment as in 3.3.2 and 3.4.1.2 shall conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2.

3.5 Quality:

3.5.1 Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum, unless otherwise permitted by purchaser. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used.

3.5.2 The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

3.5.2.1 Forgings shall have substantially uniform macrostructure and grain flow. Standards for acceptance shall be as agreed upon by purchaser and vendor.

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 ft (1.8 - 7.3 m) but not more than 25% of any shipment shall be supplied in lengths of 6 - 9 ft (1.8 - 2.7 m) except that for bars weighing over 25 lb per ft (37 kg/m), short lengths down to 2 ft (600 mm) may be supplied.

3.7 Tolerances: Unless otherwise specified, tolerances for bars and forging stock shall conform to all applicable requirements of AMS 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 4.5. Purchaser reserves the right to sample and to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified as 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 Hardness (3.4.1.1.1) and grain size (3.4.1.1.2) of each lot of bars, forgings, and flash welded rings as solution heat treated.

4.2.1.3 Tensile properties (3.4.1.2.1) and hardness (3.4.1.2.2) of each lot of bars, forgings, and flash welded rings after precipitation heat treatment.

4.2.1.4 Tolerances (3.7) of bars and forging stock.

4.2.2 Periodic Test: Tests of forging stock (3.4.2) and stock for flash welded rings (3.4.3) to demonstrate ability to develop required properties are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.