

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

64Ni - 5.0Cr - 24.5Mo - 5.5Fe
Solution Heat Treated

UNS N10004

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, such as turbine shrouds and seals, requiring oxidation resistance up to 1600°F (870°C), good strength up to 1200°F (650°C), and low coefficient of expansion.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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 2261 - Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars and Forging Stock
- MAM 2261 - Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt 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

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2.1.1 Aerospace Material Specifications (Cont'd):

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 E10 - Brinell Hardness of Metallic Materials

ASTM E21 - Elevated Temperature Tension Tests of Metallic 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 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E354 or by spectrochemical or other analytical methods approved by purchaser:

	min	max
Carbon	--	0.12
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.050
Sulfur	-	0.050
Chromium	4.00 -	6.00
Molybdenum	23.00 -	26.00
Iron	4.00 -	7.00
Vanadium	--	0.60
Cobalt (3.1.1)	--	2.50
Nickel + Cobalt	remainder	

3.1.1 Determination not required for routine acceptance.

3.1.2 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: Hot rolled, solution heat treated, and descaled. Rounds 0.75 in. (19.0 mm) and over in nominal diameter shall be ground.
- 3.2.2 Forgings: Solution heat treated and descaled.
- 3.2.3 Flash Welded Rings: Solution heat treated.
- 3.2.3.1 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.
- 3.2.4 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 by heating to $2150^{\circ}\text{F} + 25$ ($1175^{\circ}\text{C} + 15$), holding at heat for a time commensurate with section thickness but not less than 20 min., and cooling at a rate equivalent to a rapid 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 at 1500°F (815°C): Shall be as follows, determined in accordance with ASTM E21 on specimens heated to $1500^{\circ}\text{F} \pm 5$ ($815^{\circ}\text{C} \pm 3$), held at heat for 20 - 30 min. before testing, and tested at $1500^{\circ}\text{F} \pm 5$ ($815^{\circ}\text{C} \pm 3$):
- | | |
|-----------------------|----------------------|
| Tensile Strength, min | 55,000 psi (380 MPa) |
| Elongation in 4D, min | 10% |
- 3.4.1.2 Hardness: Should be 170 - 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.
- 3.4.2 Stock for Forging or Flash Welded Rings: As agreed upon by purchaser and vendor.
- 3.5 Quality: 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.
- 3.5.1 Forgings shall have substantially uniform macrostructure. Standards for acceptance shall be as agreed upon by purchaser and vendor.
- 3.5.2 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 ft (2 - 7.5 m) but not more than 25% of any shipment shall be supplied in lengths of 6 - 9 ft (2 - 3 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: Bars and forging stock 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 4.5. 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 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 Elevated temperature tensile properties (3.4.1.1) and hardness (3.4.1.2) of each lot of bars, forgings, and flash welded rings.

4.2.1.3 Tolerances (3.7) of bars and forging stock.

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

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all applicable technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement of forgings, substantiating test data and, when requested, preproduction forgings shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Bars, Flash Welded Rings, and Stock for Flash Welded Rings: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2374.

4.4 Approval: When specified, approval and control of forgings shall be in accordance with AMS 2375.

4.5 Reports: