



# AEROSPACE MATERIAL

Society of Automotive Engineers, Inc.

400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

## AMS 5751B

Superseding AMS 5751A

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

54Ni - 17.5Cr - 16.5Co - 4.0Mo - 2.9Ti - 2.9Al - 0.006B

Solution, Stabilization, and Precipitation Treated

Consumable Electrode or Vacuum Induction Melted

### 1. SCOPE:

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

1.2 Application: Primarily for parts, such as turbine components, requiring high strength up to 1600° F (871° C) and oxidation resistance up to 1800° F (982° 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 Society of Automotive Engineers, Inc. 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

#### 2.1.1 Aerospace Material Specifications:

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

AMS 2269 - Chemical Check Analysis Limits, Wrought Nickel and Nickel-Base Alloys

AMS 2350 - Standards and Test Methods

AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

AMS 2375 - Approval and Control of Critical Forgings

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, Pennsylvania 19103.

ASTM E10 - Brinell Hardness of Metallic Materials

ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials

ASTM E112 - Estimating the Average Grain Size of Metals

ASTM E139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt-Base Alloys

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

#### 2.3.1 Federal Standards:

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

SAE Technical Board rules provide that: "All technical reports, including standards, specifications, and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

### 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 approved analytical methods:

		min	max
∅	Carbon	--	0.15
	Manganese	--	0.75
	Silicon	--	0.75
	Sulfur	--	0.015
	Chromium	15.00 -	20.00
	Cobalt	13.00 -	20.00
	Molybdenum	3.00 -	5.00
	Titanium	2.50 -	3.25
	Aluminum	2.50 -	3.25
	Boron	0.003 -	0.010
	Iron	--	4.00
	Copper	--	0.15
	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: Hot finished, solution, stabilization, and precipitation heat treated.

3.2.1.1 Round bars shall be ground or turned, except that bars under 0.50 in. (12.7 mm) in diameter shall be cold drawn when so ordered.

∅ 3.2.2 Forgings and Flash Welded Rings: Solution, stabilization, and precipitation heat treated.

3.2.2.1 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.

3.2.3 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 treated by heating to 1975° F + 25 (1079.4° C + 14), holding at heat for 4 hr + 15 min. and cooling at a rate equivalent to air cool or faster, stabilization heat treated by heating to 1550° F + 25 (843.3° C + 14), holding at heat for 24 hr + 1, and cooling in air, and precipitation heat treated by heating to 1400° F + 25 (760° C + 14), holding at heat for 16 hr + 1, and cooling in air.

3.4 Properties:

3.4.1 Bars, Forgings, and Flash Welded Rings: Shall conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.4 and shall be capable of meeting the requirements of 3.4.1.3.

3.4.1.1 Tensile Properties at 1200° F (648.9° C): Shall be as follows, determined on specimens heated to 1200° F + 10 (648.9° C + 5.6), held at 1200° F + 10 (648.9° C + 5.6) for 30 min, before testing, and tested in accordance with ASTM E21 at 1200° F + 10 (648.9° C + 5.6) at a rate of 0.003 - 0.007 in. per in. per min. (0.003 - 0.007 mm/mm/min.) up to the yield strength:

Tensile Strength, min	170,000 psi (1172 MPa)
Yield Strength at 0.2% Offset, min	110,000 psi (758 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	6%
Reduction of Area, min	10%

3.4.1.2 Hardness: Should be not lower than 285 HB or equivalent, determined in accordance with  
Ø 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 Test at 1650° F (898.9° C): A tensile test specimen, maintained at 1650° F  $\pm$  3  
Ø (898.9° C  $\pm$  1.7) while a load sufficient to produce an initial axial stress of 25,000 psi (172 MPa) is applied continuously, shall not rupture in less than 24 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than 5% 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  
Ø axial stress of 25,000 psi (172 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.  
Ø In such case, the load required to produce an initial axial stress of 25,000 psi (172 MPa) shall be used to rupture or for 24 hr, whichever occurs first. After the 24 hr and at intervals of 8 - 16 hr, preferably 8 - 10 hr, thereafter, the stress shall be increased in increments of 2000 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 2 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.

3.4.2 Stock for Forging or Flash Welded Rings: When a sample of stock is forged to a test coupon and  
Ø heat treated as in 3.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.4 and shall be capable of meeting the requirements of 3.4.1.3. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.4 and are capable of meeting the requirements of 3.4.1.3, the tests shall be accepted as equivalent to tests of a forged coupon.

### 3.5 Quality:

3.5.1 Material shall be produced by multiple melting, using consumable electrode practice in the remelt cycle, or shall be induction melted under vacuum, unless otherwise permitted.

3.5.2 The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, bars will be acceptable in mill lengths of 6 - 25 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 (37.2 kg/m), short lengths down to 2 ft (610 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 and shall be  
Ø 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 perform such confirmatory testing as he deems necessary to assure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Tests of the product to determine conformance to composition (3.1) requirements; of bars, forgings, and flash welded rings to determine conformance to tensile property (3.4.1.1), hardness (3.4.1.2), and grain size (3.4.1.4) requirements; and of bars and forging stock to determine conformance to tolerance (3.7) requirements are classified as acceptance or routine control tests.
- 4.2.2 Qualification Tests: Tests of bars, forgings, and flash welded rings to determine conformance to stress-rupture (3.4.1.3) requirements and of stock for forging or flash welded rings to determine capability of developing specified properties (3.4.2) are classified as qualification or periodic control tests.
- 4.3 Sampling: Shall be as follows:
- 4.3.1 Bars, Flash Welded Rings, and Stock for Flash Welded Rings: In accordance with AMS 2371.
- 4.3.1.1 Tensile and stress-rupture test specimens from flash welded rings shall be taken from parent metal not including the weld-heat-affected zone.
- 4.3.2 Forgings and Forging Stock: As agreed upon by purchaser and vendor.
- 4.4. Approval: When specified, approval and control of critical forgings shall be in accordance with AMS 2375.
- 4.5 Reports:
- 4.5.1 The vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition of each heat in the shipment and the results of tests on each size from each heat to determine conformance to the tensile property, hardness, and grain size requirements. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat. If forgings are supplied, the part number and the size and melt source of stock used to make the forgings shall also be included.
- 4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.
- 4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.
5. PREPARATION FOR DELIVERY:
- 5.1 Identification: The product shall be identified as follows:
- 5.1.1 Bars: