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

AEROSPACE MATERIAL SPECIFICATION

AMS 5671C
Superseding AMS 5671B
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ALLOY BARS, FORGINGS, AND RINGS, CORROSION AND HEAT RESISTANT

UNS N07750

72Ni - 15.5Cr - 0.95(Cb + Ta) - 2.5Ti - 0.70Al - 7.0Fe
Consumable Electrode or Vacuum Induction Melted
1800°F (982°C) Solution Heat Treated

1. SCOPE:

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

1.2 Application: Primarily for parts, such as flanges, cases, and turbine rotors, requiring high strength at temperatures in the range 800 - 1100°F (425° - 595°C), particularly those which are formed or welded and then 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 Alloys, Wrought Products Except Forgings
AMS 2374 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Forgings and Forging Stock
AMS 2375 - Approval and Control of Critical Forgings
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 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, PA 19120.

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 approved analytical methods:

	min	max
Carbon	--	0.08
Manganese	--	0.35
Silicon	--	0.35
Phosphorus (3.1.1)	--	0.015
Sulfur	--	0.010
Chromium	14.00	17.00
Nickel + Cobalt	70.00	--
Columbium + Tantalum	0.70	1.20
Titanium	2.25	2.75
Aluminum	0.40	1.00
Iron	5.00	9.00
Cobalt (3.1.1)	--	1.00
Copper	--	0.50

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, Forgings, and Flash Welded Rings: Solution heat treated.

3.2.1.1 Bars shall be hot finished; round bars shall be ground or turned except that bars under 0.50 in. (12.7 mm) in nominal diameter, when so ordered, shall be cold drawn.

3.2.1.2 Forgings: Shall be descaled.

3.2.1.3 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, unless otherwise specified. During manufacture of flash welded rings, the stock shall not be heated to a temperature higher than 1825° F (995° C), unless otherwise agreed upon by purchaser and vendor.

3.2.2 Stock for Forgings and 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 1800° F ± 25 (982° C ± 15), holding at heat for not less than 1 hr, and cooling at a rate equivalent to 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 As Solution Heat Treated:

3.4.1.1.1 Hardness: Shall be as follows; determined in accordance with ASTM E10:

3.4.1.1.2.1 Bars: Not higher than 320 HB or equivalent, determined approximately midway between outer surface and center.

3.4.1.1.2.2 Forgings and Flash Welded Rings: Not higher than 320 HB or equivalent.

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 (732° C ± 8), holding at heat for 8 hr ± 0.25, cooling at a rate of 100 F ± 15 (56 C ± 8) deg per hr to 1150° F ± 15 (621° C ± 8), holding at 1150° F ± 15 (621° C ± 8) for 8 hr ± 0.25, and air cooling. Instead of the 100 F (56 C) deg per hr cooling rate to 1150° F ± 15 (621° C ± 8), product may be furnace cooled at any rate provided the time at 1150° F ± 15 (621° 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, Table II, and 3.4.1.2.1.3 determined in accordance with ASTM E8.

3.4.1.2.1.1 Bars Under 2.50 In. (63.5 mm) in Nominal Diameter or Thickness, Forgings under 2.50 In. (63.5 mm) in Nominal Thickness, and Flash Welded Rings Under 2.50 In. (63.5 mm) in Nominal Radial Thickness:

TABLE I

Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min	Reduction of Area %, min
Longitudinal	170,000	115,000	18	18
Transverse	165,000	110,000	15	15

TABLE I (SI)

Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min	Reduction of Area %, min
Longitudinal	1172	743	18	18
Transverse	1138	758	15	15

3.4.1.2.1.2 Bars 2.50 to 4.00 In. (63.5 to 101.6 mm), Excl, in Nominal Diameter or Thickness, Forgings 2.50 to 4.00 In. (63.5 to 101.6 mm), Excl, in Nominal Thickness, and Flash Welded Rings 2.50 to 4.00 In. (63.5 to 101.6 mm), Excl, in Nominal Radial Thickness:

TABLE II

Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min	Reduction of Area %, min
Longitudinal	170,000	115,000	15	15
Transverse	160,000	105,000	12	12

TABLE II (SI)

Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min	Reduction of Area %, min
Longitudinal	1172	743	15	15
Transverse	1103	724	12	12

3.4.1.2.1.3 Tensile property requirements for bars 4.00 in. (101.6 mm) and over in nominal diameter or thickness, forgings 4.00 in. (101.6 mm) and over in nominal thickness, and flash welded rings 4.00 in. (101.6 mm) and over nominal in radial thickness shall be as agreed upon by purchaser and vendor.

3.4.1.2.1.4 Longitudinal tensile property requirements of 3.4.1.2.1.1 and 3.4.1.2.1.2 apply to specimens taken with the axis approximately parallel to the grain flow, and to specimens taken in the radial direction and in the tangential direction at the rim of disc forgings. All other specimens shall be considered to be in the transverse direction.

3.4.1.2.1.5 Transverse tensile property requirements of 3.4.1.2.1.1 and 3.4.1.2.1.2 apply only to product from which tensile test specimens not less than 2-1/2 in. (63.5 mm) long can be obtained.

3.4.1.2.1.6 Tensile tests in the longitudinal direction are not required from product tested in the transverse direction.

3.4.1.2.1.7 Specific locations of specimens shall be as agreed upon by purchaser and vendor.

3.4.1.2.2 Hardness: Should be 302 - 401 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 Stock for Forging or Flash Welded Rings: When a sample of stock is forged to a test coupon and heat treated as in 3.3 and 3.4.1.2, specimens taken from heat treated coupon shall conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2. If specimens taken from stock after heat treatment as in 3.3 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.

3.5 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. 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
ø from foreign materials and from internal and external imperfections detrimental to usage of the product.

ø 3.5.2.1 Forgings shall have substantially uniform macrostructure and 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 (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 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 ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: The following are classified as acceptance tests:

4.2.1.1 Tests of the product to determine conformance to composition (3.1) requirements.

4.2.1.2 Tests of bars, forgings, and flash welded rings as solution heat treated to determine conformance to hardness (3.4.1.1.1) requirements.

4.2.1.3 Tests of bars, forgings, and flash welded rings after precipitation heat treatment to determine conformance to tensile property (3.4.1.2.1) and hardness (3.4.1.2.2) requirements.

4.2.1.4 Tests of bars and forging stock to determine conformance to tolerance (3.7) requirements.

4.2.2 Periodic Tests: Tests of stock for forging or flash welded rings, to demonstrate ability to develop required properties (3.4.2) are classified as periodic tests.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests.

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, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be in accordance with the following; a heat shall be the consumable electrode remelted ingots produced from alloy originally melted as a single furnace charge:

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

4.3.1.1 Specimens for tensile tests of flash welded rings shall be taken from parent metal not including the weld-heat-affected zone.

4.3.2 Forgings and Forging Stock: AMS 2374 and the following:

4.3.2.1 Specimens for tensile tests of disc forgings shall be cut from any plane perpendicular to the axis of the forging with axis of specimen in the selected plane perpendicular to a radius. When size and shape permit, additional specimens shall be cut with the axis of specimen approximately parallel to the axis of the forging. Size, location, and number of specimens shall be as agreed upon by purchaser and vendor.

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