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

AEROSPACE MATERIAL SPECIFICATION

AMS5772A
Superseding AMS 5772

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UNS R30188

ALLOY BARS, FORGINGS, AND RINGS, CORROSION AND HEAT RESISTANT
40Co - 22Cr - 22Ni - 14.5W - 0.07 La

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant cobalt 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 high strength up to 1800°F (980°C) and oxidation resistance up to 2000°F (1095°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, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2261 - Tolerances, Nickel, Nickel Base, and Cobalt Base Alloy Bars and Forging Stock
AMS 2350 - Standards and Test Methods
AMS 2269 - Chemical Check Analysis Limits, Wrought Nickel Alloys and Cobalt Alloys
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 E139 - 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 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 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	0.05	0.15
Ø Manganese	--	1.25
Silicon	0.20	0.50
Phosphorus	--	0.020
Sulfur	--	0.015
Chromium	20.00	24.00
Nickel	20.00	24.00
Tungsten	13.00	16.00
Lanthanum	0.02	0.12
Boron	--	0.015
Iron	--	3.00
Cobalt	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:

Ø 3.2.1 Bars: Hot finished and solution heat treated; round bars shall be ground or turned.

3.2.2 Forgings and Flash Welded Rings: Solution heat treated. Surface finish shall be as agreed upon by purchaser and the forging or flash welded ring manufacturer.

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 heat treated by heating to 2150°F ± 25 (1175°C ± 15), holding at heat for not less than 15 min., and cooling at a rate which will produce product meeting the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.3.

3.3.1 Any thermal treatment following solution heat treatment as in 3.3 shall not involve use of temperatures higher than 2050°F ± 25 (1120°C ± 15).

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: Specimens taken in the longitudinal direction from bars, in the circumferential direction from parent metal of flash welded rings, and from forgings in locations agreed upon by purchaser and vendor shall have the following properties, determined in accordance with ASTM E8:

Tensile Strength, min	125,000 psi (862 MPa)
Yield Strength at 0.2% Offset, min	55,000 psi (379 MPa)
Elongation in 4D, min	45%

3.4.1.2 Hardness: Shall be as follows, determined in accordance with ASTM E10:

3.4.1.2.1 Bars: Not higher than 302 HB or equivalent, determined approximately midway between center and surface.

3.4.1.2.2 Forgings and Flash Welded Rings: Not higher than 293 HB or equivalent.

3.4.1.3 Stress-Rupture Properties at 1700°F (927°C): A tensile test specimen, maintained at 1700°F ± 3 (927°C ± 2) while a load sufficient to produce an initial axial stress of 13,000 psi (90 MPa) is applied continuously to specimens from bars and flash welded rings and of 12,000 psi (83 MPa) is similarly applied to specimens from forgings, 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 15% 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 the applicable initial axial stress specified in 3.4.1.3 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 the applicable initial axial stress specified in 3.4.1.3 shall be used to rupture or for 23 hr, whichever occurs first. After the 23 hr and at intervals of 8 - 16 hr, preferably 8 - 10 hr, thereafter, the stress shall be increased in increments of 2000 psi (14 MPa). Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

3.4.1.4 Oxidation Resistance: Shall be as follows, determined in accordance with 4.5.1:

3.4.1.4.1 Ø Metal converted to oxide scale plus any continuous intergranular oxidation shall not exceed an average of 0.0015 in. (0.038 mm) per side or 0.003 in. (0.08 mm) per specimen.

3.4.1.4.2 Ø Specimens displaying localized areas greater than 0.062 in. (1.57 mm) in diameter with excessive oxidation attack, unless such attack can be attributed to contact with ceramic supports, shall be considered invalid and the test repeated. If the condition is duplicated, the product is not acceptable.

3.4.2 Ø Stock for Forging or Flash Welded Rings: When a sample of stock is forged to a test coupon and solution heat treated as in 3.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.1, 3.4.1.2.2, 3.4.1.3, and 3.4.1.4. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.1.1, 3.4.1.2.2, 3.4.1.3, and 3.4.1.4, the tests shall be accepted as equivalent to tests of a forged coupon.

3.5 Ø Quality: 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.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars will be acceptable in mill lengths of 6 - 20 ft (1.8 - 6.1 m) but not more than 10% of any order shall be supplied in lengths shorter than 10 ft (3 m).

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 4.6. 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 requirements for composition (3.1), tensile properties (3.4.1.1), hardness (3.4.1.2), stress-rupture properties (3.4.1.3), and oxidation resistance (3.4.1.4) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests of stock for forgings or flash welded rings to demonstrate ability 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 the purchaser.

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed on the first-article shipment of a forging to a purchaser, when a change in material or processing 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, the contracting officer, or the 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 Test Methods:

4.5.1 Oxidation Resistance:

4.5.1.1 Specimen Preparation: Specimens shall have surface area not less than 1.5 sq in. (9.7 cm^2) available for exposure in excess of material required for fixturing. Both sides of the specimen shall have a 120-grit surface finish. Specimens' dimensions shall be measured within ±0.0003 in. (±0.008 mm). Specimens shall be degreased.

4.5.1.2 Testing: Specimens shall be subjected to 4 cycles, each cycle consisting of heating to 2000° - 2100°F (1095° - 1150°C), holding at the selected temperature within ±25°F (±15°C) for 25 hr ± 1, and cooling in air to 300°F (150°C) or lower between each cycle for a total of 100 hr ± 4 at heat. Specimens may be partially inserted into inert ceramic bricks or suspended from inert ceramic rods or suitable metallic rods, but shall not be placed in crucibles. The specimens may be tested in a muffle or comparable furnace providing air flow is such that the required surface areas are equally exposed to the flowing air and temperature.