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

AEROSPACE MATERIAL SPECIFICATION

AMS 5765B
Superseding AMS 5765A

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UNS R30816

ALLOY BARS AND FORGINGS, CORROSION AND HEAT RESISTANT
43Co - 20Cr - 20Ni - 4.0Mo - 4.0W - 4.0Cb

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant cobalt alloy in the form of bars, forgings, and forging stock.

1.2 Application: Primarily for parts and assemblies, such as turbine rotors, shafts, and blades, requiring high strength up to 1500°F (816°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, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
AMS 2261 - Tolerances, Nickel, Nickel Base, and Cobalt Base Alloy Bars and Forging Stock
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 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Heat and Corrosion Resistant Steels and Alloys
AMS 2808 - Identification, Forgings

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E18 - Rockwell Hardness and Rockwell Superficial 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, 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 354, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Carbon	0.32	0.42
Manganese	1.00	2.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	19.00	21.00
Nickel	19.00	21.00
Molybdenum	3.50	4.50
Tungsten	3.50	4.50
Columbium + Tantalum	3.50	4.50
Iron	--	5.00
Cobalt	40.00	--

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Bars: Hot rolled, solution and precipitation heat treated.

3.2.2 Forgings: Solution and precipitation heat treated and, unless otherwise specified, anodically pickled.

3.2.3 Forging Stock: As ordered by forging manufacturer.

3.3 Heat Treatment: Bars and forgings shall be solution heat treated by heating to 2150°F ± 25 (1176.7°C ± 14), holding at heat for not less than 1 hr, and quenching in water and precipitation heat treated by heating to 1400°F ± 10 (732.2°C ± 5.6) holding at heat for 12 - 16 hr, and cooling in air.

3.4 Properties:

3.4.1 Bars and Forgings:

3.4.1.1 Grain Size: Shall be 1 or finer, determined by comparison of a polished and etched specimen with the chart in ASTM E112, unless otherwise specified.

3.4.1.2 Tensile Properties:

3.4.1.2.1 At 1350°F (732.2°C): Shall be as follows, determined on specimens cut from bars, heated to 1350°F ± 10 (732.2°C ± 5.6), held at 1350°F ± 10 (732.2°C ± 5.6) for 30 min. before testing, and tested in accordance with ASTM E21 at 1350°F ± 10 (732.2°C ± 5.6) at a rate of 0.045 - 0.062 in. (1.14 - 1.57 mm) per minute:

Tensile Strength, min	80,000 psi (552 MPa)
Elongation in 4D, min	10%

3.4.1.2.2 At 1500°F (815.6°C): Shall be as follows; determined on specimens cut from forgings, heated to 1500°F ± 10 (815.6°C ± 5.6), held at 1500°F ± 10 (815.6°C ± 5.6) for 30 min. before testing, and tested in accordance with ASTM E21 at 1500°F ± 10 (815.6°C ± 5.6) at a rate of 0.045 - 0.062 in. (1.14 - 1.57 mm) per minute:

Tensile Strength, min	65,000 psi (448 MPa)

3.4.1.3 Hardness: Shall be 24 - 35 HRC or equivalent, determined in accordance with ASTM E18.

3.4.1.4 Stress-Rupture Properties at 1350°F (732.2°C): A tensile test specimen, maintained at 1350°F ± 3 (732.2°C ± 1.7) while a load sufficient to produce an initial axial stress of 38,000 psi (262 MPa) is applied continuously, shall not rupture in less than 100 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than 8% in 4D. Tests shall be conducted in accordance with ASTM E139.

3.4.1.4.1 The test of 3.4.1.4 may be conducted using a load higher than required to produce an initial axial stress of 38,000 psi (262 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.4.1.4.

3.4.1.4 When permitted by purchaser, the test of 3.4.1 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 38,000 psi (262 MPa) shall be used to rupture or for 100 hr., whichever occurs first. After the 100 hr., the stress may be increased to not over 50,000 psi (345 MPa). The elongation requirement shall be as specified in 3.4.1.

3.4.2 Forging Stock: Specimens taken from forging stock, after heat treatment as in 3.3, shall conform to the requirements of 3.4.1.2, 3.4.1.3, and 3.4.1.4.

3.5 Quality: The product, as received by the 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, 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 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 and forgings to determine conformance to grain size (3.4.1.1), hardness (3.4.1.3), tensile property (3.4.1.2.1 or 3.4.1.2.2, as applicable), and stress-rupture property (3.4.1.4) requirements.

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

4.2.2 Periodic Tests: Tests of forging stock to demonstrate ability to meet specified requirements (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 as follows:

Ø 4.3.1 Bars: In accordance with AMS 2371.

4.3.2 Forgings and Forging Stock: As agreed upon by purchaser and vendor except that for forgings, a Ø tensile test specimen shall be taken from each of two forgings from each heat.

Ø 4.4 Approval: When specified, approval and control of 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 showing the results Ø of tests for chemical composition of each heat and for grain size, hardness, tensile, and stress-rupture properties of each size from each heat. 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 require- Ø ments, 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:

Ø 5.1.1 Bars: In accordance with AMS 2806.

5.1.2 Forgings: In accordance with AMS 2808.

Ø 5.1.3 Forging Stock: As agreed upon by purchaser and vendor.

5.2 Packaging:

5.2.1 The product shall be prepared for shipment in accordance with commercial practice to ensure carrier Ø acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.2 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-163, Level A Ø or Level C, as specified in the request for procurement. Commercial packaging as in 5.2.1 will be acceptable if it meets the requirements of Level C.