SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5772D

Issued 1971-05
Revised 2004-01
Reaffirmed 2009-06

Superseding AMS 5772C

Cobalt Alloy, Corrosion and Heat-Resistant, Bars, Forgings, and Rings
40Co - 22Cr - 22Ni - 14.5W - 0.07La
Solution Heat Treated

(Composition similar to UNS R30188)

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:

These products have been used typically for parts requiring high strength up to 1800 °F (982 °C) and oxidation resistance up to 2000 °F (1093 °C), but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2261	Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars, Rods, and Wire
AMS 2269	Chemical Check Analysis Limits, Nickel, Nickel Alloys, and Cobalt Alloys
AMS 2371	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS 2374	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steel and Alloy Forgings

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5772D

2.1 (Continued):

AMS 2750	Pyrometry
AMS 2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys
AMS 2808	Identification, Forgings
AMS 7490	Rings, Flash Welded, Corrosion and Heat-Resistant Austenitic Steels and Austenitic-Type Alloys, or Precipitation-Hardenable Alloys

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 10	Brinell Hardness of Metallic Materials
ASTM E 139	Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	0.05	0.15
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 applicable requirements of AMS 2269.

3.2 Condition:

The product shall be supplied in the following condition:

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, rings 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 Solution Heat Treatment:

Bars, forgings, and flash welded rings shall be solution heat treated by heating to 2150 °F ± 25 (1177 °C ± 14), holding at heat for a time commensurate with cross-sectional thickness, 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. Pyrometry shall be in accordance with AMS 2750.

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 (1121 °C ± 14).

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 properties shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	125 ksi (862MPa)
Yield Strength at 0.2% Offset	55 ksi (379 MPa)
Elongation in 4D	45%

3.4.1.2 Hardness: Shall be as follows, determined in accordance with ASTM E 10:

3.4.1.2.1 Bars: Not higher than 302 HB, or equivalent (See 8.2), determined approximately midway between center and surface.

3.4.1.2.2 Forgings and Flash Welded Rings: Not higher than 293 HB, or equivalent (See 8.2).

3.4.1.3 Stress-Rupture Properties at 1700 °F (927 °C): A tensile specimen, maintained at 1700 °F ± 3 (927 °C ± 2) while a load sufficient to produce an initial axial stress of 13.0 ksi (90 MPa) or higher is applied continuously to specimens from bars and flash welded rings and of 12.0 ksi (83 MPa) or higher 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 E 139.

3.4.1.3.1 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 or higher stress shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 to 16 hours thereafter, the stress shall be increased in increments of 2.0 ksi (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 4.4.1:

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

3.4.1.4.2 Specimens displaying localized areas greater than 0.062 inch (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 Forging Stock: 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.

3.4.3 Stock for Flash Welded Rings: Specimens taken from the stock after solution heat treatment as in 3.3 shall conform to the requirements of 3.4.1.1, 3.4.1.2.2, 3.4.1.3, and 3.4.1.4.

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 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 reentrant grain flow.

3.6 Tolerances:

Bars 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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: 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 acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests of forging stock (3.4.2) and of stock for flash welded rings (3.4.3) to demonstrate ability to develop required properties and grain flow of die forgings (3.5.1) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 Bars, Flash Welded Rings, and Stock for Forging or Flash Welded Rings: In accordance with AMS 2371.

4.3.2 Forgings: In accordance with AMS 2374.

4.4 Test Methods:

4.4.1 Oxidation Resistance:

4.4.1.1 Specimen Preparation: Specimens shall have surface area not less than 1.5 square inches (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 inch (± 0.008 mm). Specimens shall be degreased.

4.4.1.2 Testing: Specimens shall be subjected to four cycles, each cycle consisting of heating to 2000 to 2100 °F (1093 to 1149 °C), holding at the selected temperature within ±25 °F (±14 °C) for 25 hours ± 1, and cooling in air to 300 °F (149 °C) or lower between each cycle for a total of 100 hours ± 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.

4.4.1.3 Examination: Test specimens shall be cross sectioned and examined metallographically in the as-polished condition at not lower than 500X magnification. Not less than eight randomly selected surface areas, 0.008 inch (0.20 mm) in length, shall be measured and the values averaged to determine compliance with 3.4.1.4.

4.5 Reports:

The vendor of the product shall furnish with each shipment a report showing the following results of tests and relevant information:

4.5.1 For each heat: Composition.

4.5.2 For each lot of bars, forgings, and flash welded rings:

Tensile Properties
Hardness
Stress-rupture properties
Oxidation resistance.

4.5.3 A statement that the product conforms to the other technical requirements.

4.5.4 Purchase order number
Heat and lot numbers
AMS 5772D
Size
Quantity.

4.5.5 If forgings are supplied, the size and melt source of stock used to make the forgings.

4.6 Resampling and Retesting:

Shall be as follows:

4.6.1 Bars, Flash Welded Rings, and Stock for Forging or Flash Welded Rings: In accordance with AMS 2371.

4.6.2 Forgings: In accordance with AMS 2374.

5. PREPARATION FOR DELIVERY:

5.1 Sizes:

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