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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5608C

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Superseding AMS 5608B

Submitted for recognition as an American National Standard

COBALT ALLOY, CORROSION AND HEAT RESISTANT, SHEET, STRIP, AND PLATE
40Co - 22Cr - 22Ni - 14.5W - 0.07La
Solution Heat Treated

UNS R30188

1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant cobalt alloy in the form of sheet, strip, and plate.

1.2 Application:

These products have been used typically for formed and drawn 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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2262	Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Sheet, Strip, and Plate
MAM 2262	Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Sheet, Strip, and Plate
AMS 2269	Chemical Check Analysis Limits, Wrought 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 2807	Identification, Carbon and Low Alloy Steels, Corrosion and Heat Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 112	Determining the Average Grain Size
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 290	Semi-Guided Bend Test for Ductility of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

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 requirements of AMS 2269.

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 (R) Sheet and Strip: Hot rolled or cold rolled, solution heat treated, and unless solution heat treatment is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the following finishes conforming to 3.2.1.1 and 3.2.1.2 as applicable (See 8.2).

3.2.1.1 (R) Sheet: No. 2D or better finish.

3.2.1.2 (R) Strip: No. 1 or better strip finish.

3.2.2 Plate: Hot rolled, solution heat treated, and descaled.

3.3 (R) Heat Treatment:

The product shall be solution heat treated by heating to a temperature within the range 2125 to 2250 °F (1163 to 1232 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with section thickness, and cooling rapidly in air.

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 Tensile Properties:

3.4.1.1 At Room Temperature: Shall be as 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 (862 MPa)
Yield Strength at 0.2% Offset	55.0 ksi (379 MPa)
Elongation in 2 Inches (50.8 mm) or 4D	
Nominal Thickness	
Up to 0.020 inch (0.51 mm), incl	40%
Over 0.020 inch (0.51 mm)	45%

3.4.1.2 At 1200 °F (649 °C): Shall be as shown in Table 3, determined in accordance with ASTM E 21 on specimens heated to 1200 °F ± 5 (649 °C ± 3), held at heat for 20 to 30 minutes before testing, and tested at 1200 °F ± 5 (649 °C ± 3):

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	90.0 ksi (621 MPa)
Yield Strength at 0.2% Offset	36.0 ksi (248 MPa)
Elongation in 2 Inches (50.8 mm) or 4D	
Nominal Thickness	
Up to 0.020 inch (0.51 mm), incl	40%
Over 0.020 inch (0.51 mm)	50%

3.4.2 Bending: Product 0.1874 inch (4.762 mm) and under in nominal thickness shall withstand, without cracking, bending in accordance with ASTM E 290 through an angle of 180 degrees around a diameter equal to the bend factor shown in Table 4 times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

TABLE 4 - Bending Requirements

Nominal Thickness Inch	Nominal Thickness mm	Bend Factor
Up to 0.050, incl	Up to 1.27, incl	1.5
Over 0.050 to 0.1874, incl	Over 1.27 to 4.762, incl	2

3.4.3 Averagae Grain Size: ASTM No. 4 or finer, determined in accordance with ASTM E 112.

3.4.4 Stress-Rupture Properties at 1700 °F (927 °C): A tensile specimen, maintained at 1700 °F ± 3 (927 °C ± 2) while the load required to produce the initial axial stress shown in Table 5 or higher stress is applied continuously, 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 as specified in Table 5. Tests shall be conducted in accordance with ASTM E 139.

TABLE 5A - Stress-Rupture Properties, Inch/Pound Units

Nominal Thickness Inches	Stress ksi	Elongation in 2 Inches or 4D %, min
Up to 0.020, incl	9.0	8
Over 0.020	11.0	15

TABLE 5B - Stress-Rupture Properties, SI Units

Nominal Thickness mm	Stress MPa	Elongation in 50.8 mm or 4D %, min
Up to 0.51, incl	62.1	8
Over 0.51	75.8	15

3.4.4.1 (R) The test of 3.4.4 may be conducted using incremental loading. In such case, the load required to produce the applicable initial axial stress specified in Table 1 shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 to 16 hours, preferably 8 to 10 hours, thereafter, the stress shall be increased in increments of 2.0 ksi (13.8 MPa). Time to rupture and elongation requirements shall be as specified in 3.4.4.

3.4.5 Oxidation Resistance: A specimen prepared in accordance with 3.4.5.1 and tested in accordance with 3.4.5.2 shall meet the requirements of 3.4.5.3.

3.4.5.1 Specimens shall have not less than 1.5 square inch (10 cm^2) test surface in excess of material required for fixturing. Test surfaces shall be hand polished using 120 grit or finer silicon carbide paper and then degreased. Specimens may be fixtured during test by insertion into inert ceramic brick or by suspension from inert ceramic rods. Specimens shall not be placed in crucibles.

3.4.5.2 Specimens shall be subjected to 4 cycles; each cycle shall consist of heating to a temperature within the range 2000 to 2100 °F (1093 to 1149 °C), holding at the selected temperature within ±25 °F (±14 °C) for 25 hours ± 1, and air cooling to 300 °F (149 °C) or lower between cycles. Heating shall be performed in a furnace which provides natural convection air flow such that test surfaces are equally exposed.

3.4.5.3 A polished cross-section, examined at not lower than 500X magnification, shall have not more than 0.0015 inch (0.038 mm) average affected metal (that metal converted to oxide scale plus any continuous intergranular oxidation) per side.

3.4.5.3.1 Specimens with localized areas of affected metal greater than 0.062 inch (1.57 mm) in diameter shall be considered invalid unless the condition can be attributed to contact with the ceramic supports, and shall be rerun. If the condition occurs on the retest, the product is not acceptable.

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.