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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5608E

Issued MAY 1971
Revised OCT 2001
Reaffirmed APR 2006

Superseding AMS 5608D

Cobalt Alloy, Corrosion and Heat Resistant, Sheet, Strip, and Plate
40Co - 22Cr - 22Ni - 14.5W - 0.07La
Solution Heat Treated

(Composition similar to 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 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 canceled 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.

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, 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 2807	Identification, Carbon and Low-Alloy Steels, Corrosion and Heat Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing
AS4194	Sheet and Strip Surface Finish Nomenclature

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 480/A 480M	Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
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 Average Grain Size
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 290	Bend Testing Material for Ductility
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 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 in accordance with ASTM A 480/A 480M and AS4194 comparable to 3.2.1.1 or 3.2.1.2 as applicable.

3.2.1.1 Sheet: No. 2D or better finish.

3.2.1.2 Strip: No. 1 or better strip finish.

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

3.3 Heat Treatment:

The product shall be solution heat treated by heating to a temperature within the range 2125to 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 at a rate equivalent to air cooling or faster.

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 2A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
Up to 0.020, incl	125	55	40
Over 0.020	125	55	45

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Thickness Millimeter	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
Up to 0.51, incl	862	379	40
Over 0.51	862	379	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 not less than 20minutes before testing, and tested at 1200 °F ± 5 (649 °C ± 3).

TABLE 3A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
Up to 0.020, incl	90	36.0	40
Over 0.020	90	36.0	50

TABLE 3B - Minimum Tensile Properties, SI Units

Nominal Thickness Millimeter	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
Up to 0.51, incl	621	248	40
Over 0.51	621	248	50

3.4.2 Bending: Product 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 Parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	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 4.760, incl	2

3.4.3 Average Grain Size: Shall be 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 Millimeter	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 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 5 or higher stress shall be used to rupture or for 23hours, whichever occurs first. After the 23 hours and at intervals of 8 to16hours, preferably 8 to 10 hours, 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 representing each heat shall be prepared in accordance with 3.4.5.1, tested in accordance with 3.4.5.2, and meet the requirements of 3.4.5.3.

3.4.5.1 Specimens shall have not less than 1.5 square inch (9.7 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 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 four 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 25hours ± 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 0.062inch (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.