

ALLOY SHEET, STRIP, AND PLATE, CORROSION AND HEAT RESISTANT
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: Primarily for formed and drawn parts requiring high strength up to 1800°F (982°C) and oxidation resistance up to 2000°F (1093°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 shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

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 2350 - Standards and Test Methods

AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock

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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 E21 - Elevated Temperature Tension Tests of Metallic Materials
- ASTM E112 - Determining Average Grain Size
- ASTM E139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
- ASTM E290 - Semi-Guided Bend Test for Ductility 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 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 spectrochemical methods, or by other analytical methods acceptable to purchaser:

	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 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 a commercial corrosion-resistant steel No. 1 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 2125° - 2250°F (1163° - 1232°C), holding at the selected temperature within +25°F (+14°C) for a time commensurate with section thickness but not more than 30 minutes, 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 follows, determined in accordance with ASTM E8:

Tensile Strength, minimum	125,000 psi (862 MPa)
Yield Strength at 0.2% Offset, minimum	55,000 psi (379 MPa)
Elongation in 2 Inches (50.8 mm) or 4D, Minimum	
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 follows, determined in accordance with ASTM E21 on specimens heated to 1200°F ± 5 (649°C ± 3), held at heat for 20 - 30 minutes before testing, and tested at 1200°F ± 5 (649°C ± 3):

Tensile Strength, minimum	90,000 psi (621 MPa)
Yield Strength at 0.2% Offset, minimum	36,000 psi (248 MPa)
Elongation in 2 Inches (50.8 mm) or 4D, Minimum	
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 0.187 inch (4.75 mm) and under in nominal thickness shall withstand, without cracking, bending in accordance with ASTM E290 through an angle of 180 degrees around a diameter equal to the bend factor times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

Nominal Thickness		Bend Factor
Inch	Millimetres	
Up to 0.050, incl	Up to 1.27, incl	1.5
Over 0.050 to 0.187, incl	Over 1.27 to 4.75, incl	2

3.4.2.1 Bending requirements for product over 0.187 inch (4.75 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.3 Grain Size: Four or finer, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

- 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 I 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 I. Tests shall be conducted in accordance with ASTM E139.

TABLE I

Nominal Thickness Inches	Stress psi	Elongation in 2 Inches or 4D %, minimum
Up to 0.020, incl	9,000	8
Over 0.020	11,000	15

TABLE I (SI)

Nominal Thickness Millimetres	Stress MPa	Elongation in 50.8 mm or 4D %, minimum
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 a load higher than required to produce the applicable initial axial stress specified in Table I but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.4.4.
- 3.4.4.2 When permitted by purchaser, 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 I shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 - 16 hours, preferably 8 - 10 hours, thereafter, the stress shall be increased in increments of 2000 psi (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 cm²) 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° - 2100°F (1093° - 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.
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 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.
- 4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each heat or lot as applicable.
- 4.3 Sampling: Shall be in accordance with AMS 2371.
- 4.4 Reports:
- 4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition and oxidation resistance of each heat and for room temperature and 1200°F (650°C) tensile, bending, grain size, and stress-rupture properties of each lot. This report shall include the purchase order number, heat number, AMS 5608B, size, and quantity.