Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 5608

Issued 5-15-71
Revised

ALLOY SHEET, STRIP, AND PLATE, CORROSION AND HEAT RESISTANT
Cobalt Base - 22Cr - 22Ni - 14.5W - 0.07La

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1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant cobalt-base 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 (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., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steel and Alloys
AMS 2262 - Tolerances, Nickel, Nickel-Base, and Cobalt-Base Alloy Sheet, Strip, and Plate
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

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

ASTM A370 - Mechanical Testing of Steel Products
ASTM E8 - Tension Testing of Metallic Materials
ASTM E21 - Short-Time Elevated-Temperature Tension Tests of Materials
ASTM E112 - Estimating the Average Grain Size of Metals
ASTM E139 - Conducting Creep and Time-for-Rupture Tension Tests of 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 Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

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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 spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods.

	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	0.03	0.12
Boron	--	0.015
Iron	--	3.00
Cobalt	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248; check analysis limits for lanthanum shall be 0.00 under min or 0.01 over maximum.

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

3.2.1 Sheet and Strip: Hot or cold rolled, solution heat treated, and descaled unless solution heat treatment is performed in an atmosphere yielding a bright finish, having a surface appearance as close as possible to a commercial corrosion resistant steel No. 1 finish; standards for acceptance and rejection shall be as agreed upon by purchaser and vendor.

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 2150 F ± 25 (1176.7 C ± 14), holding at heat for a time commensurate with the thickness but not more than 30 min., 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 (1120.6 C ± 14).

3.4 Properties:

3.4.1 Tensile Properties:

3.4.1.1 At Room Temperature: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, min	125,000 psi (869 MN/m^2)
Yield Strength at 0.2% Offset, min	55,000 psi (379 MN/m^2)
Elongation in 2 in. (50.8 mm) or 4D, min	
Nominal Thickness	
Up to 0.020 in. (0.508 mm), incl	40%
Over 0.020 in. (0.508 mm)	45%

3.4.1.2 At 1200 F (648.9 C): Shall be as follows determined in accordance with ASTM E21; specimens shall be heated to 1200 F ± 5 (648.9 C ± 2.8), held at heat for 10 min. before testing, and tested at 1200 F ± 5 (648.9 C ± 2.8) at a strain rate of 0.003 - 0.007 in. per in. per min. (.003 - 0.007 mm/mm/min.) through the yield strength and a cross head speed of 0.5 in. per min. (12.7 mm/min.) above the yield strength.

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Tensile Strength, min	90,000 psi (621 MN/m^2)
Yield Strength at 0.2% Offset, min	36,000 psi (248 MN/m^2)
Elongation in 2 in. (50.8 mm) or 4D, min	
Nominal Thickness	
Up to 0.020 in. (0.508 mm), incl	40%
Over 0.020 in. (0.508 mm)	50%

3.4.1.3 Tensile test specimens for the tests of 3.4.1.1 and 3.4.1.2 shall be taken with the axis perpendicular to the direction of rolling from material 9 in. (229 mm) and over in width and with axis parallel to direction of rolling from material less than 9 in. (229 mm) wide.

3.4.2 Bending: Material in the as-received condition shall withstand, without cracking, bending in accordance with ASTM A370 at room temperature through an angle of 180 deg (3.14 rad) around a diameter equal to the bend factor times the nominal thickness of the material with axis of bend parallel to the direction of rolling:

Nominal Thickness		
Inch	(Millimeters)	Bend Factor
Up to 0.050, incl	(Up to 1.27, incl)	1.5
Over 0.050 to 0.187, incl	(Over 1.27 to 4.76, incl)	2

3.4.2.1 Material, after aging at 1600 F ± 25 (871.1 C ± 14) for 50 hr in air, shall withstand bending as in 3.4.2 around a diameter equal to three times the nominal thickness.

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

3.4.4 Stress-Rupture Test at 1700 F (926.7 C): A tensile test specimen maintained at 1700 F ± 3 (926.7 C ± 1.7) 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. Test shall be conducted in accordance with ASTM E139.

TABLE I

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

TABLE I (SI)

Nominal Thickness Millimeters	Stress MN/m^2	Elongation, % in 50.8 mm or 4D, min
Up to 0.508, incl	62.1	8
Over 0.508	75.9	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 stress specified in 3.4.4 but load shall not be changed while test is in process. 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 3.4.4 shall be used to rupture or for 48 hr, whichever occurs first. After the 48 hr and at intervals of 8 - 16 hr, preferably 8 - 10 hr, thereafter, the stress shall be increased in increments of 2,000 psi (13.8 MN/m^2). Time to rupture and elongation requirements shall be as specified in 3.4.4.

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3.5 Quality: Material shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor 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 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that material 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 routine control tests.

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 three copies of a report of the results of tests for chemical composition of each heat in the shipment and for room temperature and 1200 F (648.9 C) tensile, bending, grain size, and stress-rupture properties of each size from each heat. This report shall include the purchase order number, heat number, material specification number, size, and quantity from each heat.

4.4.2 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, 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.

4.5 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the testing of 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 material represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each sheet, strip, and plate shall be marked on one face, in the respective location indicated below, with AMS 5608, heat number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be clearly legible, shall be applied using a suitable marking fluid, and shall be capable of being removed in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance and shall be sufficiently stable to withstand normal handling.

5.1.1 Flat Strip 6 In. (152 mm) and Under in Width: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm).

5.1.2 Flat Sheet, Flat Strip Over 6 In. (152 mm) in Width, and Plate: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm), the rows being spaced not more than 6 in. (152 mm) apart and alternately staggered.

5.1.3 Coiled Sheet and Strip: Shall be marked near the outside end of the coil. The inside end shall also be marked or shall have a tag or label attached and marked with the information of 5.1.

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