

ALLOY, CORROSION AND HEAT RESISTANT, SHEET, STRIP, AND PLATE
54Ni - 19Cr - 11Co - 9.8Mo - 3.2Ti - 1.5Al - 0.006B
Vacuum Induction and Consumable Electrode Melted, Solution Heat Treated
Precipitation Heat Treatable UNS N07041

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant nickel alloy in the form of sheet, strip, and plate.

1.2 Application: Primarily for parts requiring high strength up to 1600°F (871°C) and oxidation resistance up to 1800°F (982°C)

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.

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

AMS 2750 - Pyrometry

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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 18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
- ASTM E 21 - Elevated Temperature Tension Tests of Metallic Materials
- ASTM E 112 - Determining Average Grain Size
- 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 Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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 E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	--	0.12
Manganese	--	0.10
Silicon	--	0.50
Sulfur	--	0.015
Chromium	18.00	- 20.00
Cobalt	10.00	- 12.00
Molybdenum	9.00	- 10.50
Titanium	3.00	- 3.30
Aluminum	1.40	- 1.60
Boron (3.1.1)	0.0030	- 0.010
Iron	--	5.00
Copper	--	0.50
Nickel	remainder	

3.1.1 Boron may be less than 0.0030% by weight, determined on sheet and strip under 0.050 inch (1.27 mm) in nominal thickness provided the specified content is met on stock prior to rolling into sheet or strip.

3.1.2 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 or cold rolled, solution heat treated, and, unless
 0 solution heat treatment is performed in an atmosphere yielding a bright finish, descaled having a surface appearance conforming to 3.2.1.1 or 3.2.1.2 as applicable (See 8.2).

3.2.1.1 Sheet: No. 2D finish.

3.2.1.2 Strip: No. 1 strip finish.
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3.2.2 Plate: Hot rolled, solution heat treated, and descaled.

3.3 Solution Heat Treatment: The product shall be solution heat treated by
 0 heating to $1975^{\circ}\text{F} \pm 25$ ($1079^{\circ}\text{C} \pm 14$) in a suitable atmosphere, holding at heat for not less than 60 minutes per inch (25 mm) of nominal thickness, and cooling at a rate equivalent to a rapid air cool or faster. Pyrometry shall be in accordance with AMS 2750.

3.4 Properties: The product shall conform to the following requirements:

3.4.1 As Solution Heat Treated:

3.4.1.1 Tensile Properties: Shall be as specified in Table I, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE I

Nominal Thickness Inches	Tensile Strength ksi, max	Yield Strength at 0.2% Offset ksi, max	Elongation in 2 Inches or 4D %, min
Up to 0.015, incl	170	100	20
Over 0.015 to 0.115, incl	170	100	30
Over 0.115 to 0.187, incl	180	115	30
Over 0.187	195	140	30

TABLE I (SI)

Nominal Thickness Millimeters	Tensile Strength MPa, max	Yield Strength at 0.2% Offset MPa, max	Elongation in 50.8 mm or 4D %, min
Up to 0.38, incl	1172	689	20
Over 0.38 to 2.92, incl	1172	689	30
Over 2.92 to 4.75, incl	1241	793	30
Over 4.75	1344	965	30

- 3.4.1.2 Hardness: Should be not higher than shown below, or equivalent, determined in accordance with ASTM E 18, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.1.1 are met.

Nominal Thickness		Hardness
Inch	Millimeters	
Up to 0.040, incl	Up to 1.02, incl	75 HR15N
Over 0.040 to 0.070, incl	Over 1.02 to 1.78, incl	64 HRA
Over 0.070 to 0.187, incl	Over 1.78 to 4.75, incl	30 HRC

- 3.4.1.2.1 Hardness of product over 0.187 inch (4.75 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

- 3.4.1.3 Bending: Product 0.187 inch (4.75 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 times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

Nominal Thickness		Bend Factor
Inch	Millimeters	
Up to 0.062, incl	Up to 1.57, incl	2
Over 0.062 to 0.125, incl	Over 1.57 to 3.18, incl	2.5
Over 0.125 to 0.187, incl	Over 3.18 to 4.75, incl	3

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

- 3.4.1.4 Grain Size: Shall be predominantly 3 or finer with occasional grains as large as 1 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E 112.

- 3.4.1.5 Microstructure: Metallographic examination shall disclose no significant alloy depleted layer or other undesirable surface condition. Standards for acceptance shall be as agreed upon by purchaser and vendor.

- 3.4.2 After Precipitation Heat Treatment: The product shall have the following properties after being precipitation heat treated by heating to 1400°F ± 15 (760°C ± 8), holding at heat for not less than 16 hours, and cooling in air:

- 3.4.2.1 Tensile Properties:

3.4.2.1.1 At Room Temperature: Shall be as specified in Table II, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE II

Nominal Thickness Inches	Tensile Strength ksi, min	Yield Strength at 0.2% Offset ksi, min	Elongation in 2 Inches or 4D %, min
Up to 0.020, incl	160	120	6
Over 0.020	170	130	10

TABLE II (SI)

Nominal Thickness Millimeters	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
Up to 0.51, incl	1103	827	6
Over 0.51	1172	896	10

3.4.2.1.2 At 1400°F (760°C): Shall be as specified in Table III, determined in accordance with ASTM E 21 on specimens heated to 1400°F ± 10 (760°C ± 6), held at heat for 20 - 30 minutes before testing, and tested at 1400°F ± 10 (760°C ± 6).

TABLE III

Nominal Thickness Inches	Tensile Strength ksi, min	Yield Strength at 0.2% Offset ksi, min	Elongation in 2 Inches or 4D %, min
Up to 0.020, incl	130	110	3
Over 0.020	140	110	3

TABLE III (SI)

Nominal Thickness Millimeters	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
Up to 0.51, incl	896	758	3
Over 0.51	965	758	3

3.4.2.2 Hardness: Should be not lower than 35 HRC, or equivalent, determined in accordance with ASTM E 18, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.2.1.1 are met.