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SAE-AMS5545, "NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SHEET, STRIP, AND PLATE 54NI - 19CR - 11CO - 9.8MO - 3.2TI - 1.5A1 - 0.006B VACUUM INDUCTION AND CONSUMABLE ELECTRODE MELTED, SOLUTION HEAT TREATED PRECIPITATION HEAT TREATABLE", was adopted on 01-AUG-86 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Defense Supply Center Philadelphia, ATTN: DSCP-ILEA, 700 Robbins Avenue, Philadelphia, PA 19111-5096. Copies of this document may be purchased from the Society of Automotive Engineers 400 Commonwealth Drive Warrendale, Pennsylvania, United States, 15096-0001. http://www.sae.org/

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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5545D

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Superseding AMS 5545C

Submitted for recognition as an American National Standard

NICKEL 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 NO7041

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:

These products have been used typically for parts requiring high strength up to 1600 °F (871 °C) and oxidation resistance up to 1800 °F (962 °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, 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 2750 Pyrometry
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, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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 the 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
ASTM E 384 Microhardness of Materials

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	--	0.12
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 Melting Practice:

Alloy shall be multiple melted using vacuum induction followed by consumable electrode practice in the remelt cycle.

3.3 Condition:

The product shall be supplied in the following condition:

3.3.1 Sheet and Strip: Hot 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 commercial corrosion-resistant steel finishes as applicable (See 8.2).

3.3.1.1 Sheet: No. 2D finish.

3.3.1.2 Strip: No. 1 strip finish.

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

3.4 Solution Heat Treatment:

The product shall be solution heat treated by heating in a suitable atmosphere to 1975 °F ± 25 (1079 °C ± 14), 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.

3.5 Properties:

The product shall conform to the following requirements

3.5.1 As Solution Heat Treated:

3.5.1.1 (R) Tensile Properties: Shall be as specified in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2A - Tensile Properties, Inch/Pound Units

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 0.1874, incl	180	115	30
Over 0.1874	195	140	30

TABLE 2B - Tensile Properties, SI Units

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 4.760, incl	1241	793	30
Over 4.760	1344	965	30

3.5.1.2 (R) Hardness: Shall be not higher than shown in Table 3, or equivalent (See 8.3), determined in accordance with ASTM E 18; for thin gages where superficial hardness testing is impractical, microhardness testing in accordance with ASTM E 384 may be used. Product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.1.1, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

TABLE 3 - Hardness Requirements

Nominal Thickness Inch	Nominal Thickness Millimeters	Hardness
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 0.1874, incl	Over 1.78 to 4.760, incl	30 HRC

3.5.1.3 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.

(R) TABLE 4 - Bending Parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
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 0.1874, incl	Over 3.18 to 4.760, incl	3

3.5.1.4 Average Grain Size: Shall be ASTM No. 3 or finer, determined in accordance with (R) ASTM E 112 (See 8.4).

3.5.1.5 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.

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

3.5.2.1 Tensile Properties:

3.5.2.1.1 At Room Temperature: Shall be as specified in Table 5, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 5A - Minimum Room Temperature Tensile Properties, Inch/Pound Units

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

TABLE 5B - Minimum Room Temperature Tensile Properties, SI Units

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

3.5.2.1.2 At 1400 ºF (760 ºC): Shall be as specified in Table 6, determined in accordance with (R) ASTM E 21 on specimens heated to 1400 ºF ± 10 (760 ºC ± 6), held at heat for not less than 20 minutes before testing, and tested at 1400 ºF ± 10 (760 ºC ± 6).

TABLE 6A - Minimum 1400 ºF Tensile Properties, Inch/Pound Units

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

TABLE 6B - Minimum 760 ºC Tensile Properties, SI Units

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

3.5.2.2 (R) Hardness: Shall be not lower than 35 HRC, or equivalent (See 8.3), determined in accordance with ASTM E 18; for thin gages where superficial hardness testing is impractical, microhardness testing in accordance with ASTM E 384 may be used. Product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.2.1.1, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

3.6 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.

3.7 Tolerances:

Shall conform to all applicable requirements of AMS 2262 or MAM 2262.

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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

