ADOPTION NOTICE

SAE-AMS5914, "NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SHEET, STRIP, AND FOIL 52.5NI - 19CR - 3.0MO - 5.0CB - 0.90TI - 0.50AL - 18FE CONSUMABLE ELECTRODE OR VACUUM INDUCTION MELTED PRECISION COLD ROLLED, SOLUTION HEAT TREATED", was adopted on 22-MAY-95 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: ASC/ENOI, Building 560, 2530 Loop Road West, Wright-Patterson AFB, OH 45433-7101. 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 5914

Issued MAY 1995

Submitted for recognition as an American National Standard

NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SHEET, STRIP, AND FOIL
52.Ni - 19Cr - 3.0Mo - 5.0Cb - 0.90Ti - 0.50AI - 18Fe
Consumable Electrode or Vacuum Induction Melted
Precision Cold Rolled, Solution Heat Treated

1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant nickel alloy in the form of sheet, strip, and foil up to 0.015 inch in nominal thickness.

1 .1 .1 MAM 5914 is the metric version of this AMS.

1.2 Application:

These products have been used typically for the fabrication of bellows, diaphragms, and other components requiring a combination of high strength, resistance to heat and corrosion, leak tightness, and maximum fatigue life, 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
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

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 3 Preparation of Metallographic Specimens
ASTM E 8 Tension Testing of Metallic Materials
ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 21 Elevated Temperature Tension Tests for Metallic Materials
ASTM E 112 Determining the Average Grain Size
ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 345 Tension Testing of Metallic Foil
ASTM E 354 Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
ASTM E 384 Microhardness of Materials
ASTM E 407 Microetching Metals and Alloys

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

2.4 ANSI Publications:

Available from American National Standards Institute, Inc., 11 West 42nd Street, , New York, NY 10036-8002.

ANSI B46.1 Surface Texture

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
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.015
Sulfur	--	0.002
Chromium	17.00	21.00
Nickel	50.00	55.00
Molybdenum	2.80	3.30
Columbium	4.75	5.25
Titanium	0.65	1.15
Aluminum	0.20	0.80
Cobalt	--	1.00
Tantalum	--	0.05
Boron	--	0.006
Copper	--	0.30
Lead	--	0.0005 (5 ppm)
Bismuth	--	0.00003 (0.3 ppm)
Selenium	--	0.0003 (3 ppm)
Nitrogen	--	0.01
Iron	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

3.2 Melting Practice:

Alloy shall be multiple melted using consumable electrode practice in the remelt cycle. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used for remelting.

3.3 Condition:

The product shall be supplied in the following condition.

3.3.1 Sheet, Strip, and Foil: Solution heat treated, having a surface appearance comparable to a commercial corrosion-resistant steel No. 28 finish (See 8.1), or bright annealed.

3.4 Surface Roughness:

The surface texture shall meet the requirements shown in Table 2, as defined by ANSI B46.1.

TABLE 2 - Maximum Surface Roughness

Nominal Thickness Inch	Surface Roughness, RA Microinches
Up to 0.006, excl	8
0.006 to 0.010, incl	12
Over 0.010 to 0.015, incl	20

3.5 Solution Heat Treatment:

No specific heat treating instructions are specified but it is recommended that the product be solution heat treated by heating in a suitable protective atmosphere to a temperature within the range of 1725 to 1825 °F, holding at the selected temperature within ±25 °F for a time commensurate with product thickness, and cooling at a rate equivalent to an air cool or faster.

3.5.1 The protective atmosphere shall be hydrogen or argon gas with a dew point of -60 °F or lower or a vacuum of 10^{-4} Torr or better.

3.5.1.1 The use of dissociated ammonia as a protective atmosphere is not permitted.

3.6 Properties:

The product shall conform to the following requirements:

3.6.1 As Solution Heat Treated:

3.6.1.1 Tensile Properties: Shall be as shown in Table 3, determined in accordance with ASTM E 345 for foil and ASTM E 8 for sheet and strip.

TABLE 3 - Tensile Properties

Nominal Thickness Inch	Tensile Strength ksi, max	Yield Strength at 0.2% Offset ksi, max	Elongation in 2 Inches %, min
Under 0.006	150	85.0	Report
0.006 to 0.015, incl	150	85.0	25

3.6.1.2 Hardness: Shall be not higher than 266 HV or 25 HRC, or equivalent (See 8.2), determined in accordance with ASTM E 18 or ASTM E 384. Product shall not be rejected on the basis of hardness if the tensile properties of 3.6.1.1, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

3.6.1.3 Average Grain Size: Shall be as shown in Table 4 or finer, determined in accordance with ASTM E 112 at 100X magnification on a sample sectioned parallel to the direction of roiling and metallographically mounted and prepared in accordance with ASTM E 3.

TABLE 4 - Maximum Average Grain Size

Nominal Thickness Inch	ASTM Grain Size Number
Up to 0.001, incl	11.0
Over 0.001 to 0.002, incl	10.5
Over 0.002 to 0.003, incl	10.0
Over 0.003 to 0.004, incl	9.5
Over 0.004 to 0.006, excl	9.0
0.006 to 0.015, incl	8.0

3.6.1.4 Metallographic Examination: Shall be performed on a sample sectioned parallel to the direction of rolling and metallographically mounted and prepared in accordance with ASTM E 3. The unetched and etched specimen cross section shall disclose no measurable alloy-depleted surface layer (See 8.32) or laminations when evaluated at a minimum magnification of 100X.

3.6.1.4.1 The microstructure, viewed at a minimum magnification of 100X on the etched surface as prepared using ASTM E 407, Etchant Number 101 (Chrome Regia), or other etchant, shall display a structure of equiaxed grains without indications of excessive alloy segregation in the form of banding. Excessive banding shall refer to individual or multiple bands with total thickness exceeding 10% of the nominal product thickness and/or total length exceeding 10 times the nominal product thickness, and in which columbium concentration exceeds 8% by weight. Figure 1 illustrates the maximum amount of banding acceptable.

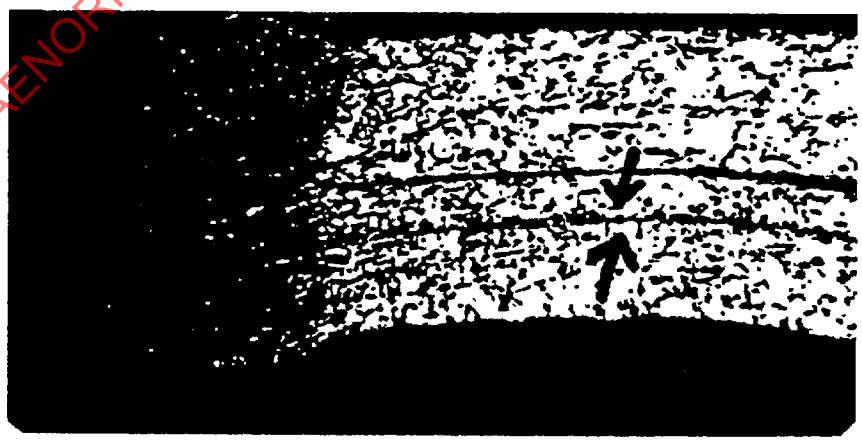

FIGURE 1 - Maximum Banding Acceptable at 100X Magnification

3.6.1.4.2 The polished surface, viewed at a minimum magnification of 100X, shall not display inclusions or stringers (See 8.3.1) exceeding the limits shown in Table 5.

TABLE 5 - Maximum Inclusion or Stringer Size

Material Thickness (T) Inch	Thickness	Length
Up to 0.001, incl	0.2T	5T
Over 0.001 to 0.002, incl	0.1T	4T
Over 0.002 to 0.003, incl	0.08T	3T
Over 0.003 to 0.004, incl	0.06T	2.5T
Over 0.004 to 0.006, excl	0.05T	2.5T
0.006 to 0.010, excl	0.05T	2.5T
0.010 to 0.015, incl	0.05T	2T

3.6.2 After Precipitation Heat Treatment: The product shall have the following properties after being precipitation heat treated by heating to 1325 °F ± 15, holding at heat for 8 hours ± 0.5, cooling at a rate of 100 F degrees per hour to 1150 °F ± 15, holding at 1150 °F ± 15 for 8 hours ± 0.5, and cooling at a rate equivalent to an air cool or faster. Instead of the 100 F degrees per hour cooling rate to 1150 °F ± 15, product may be furnace cooled at any rate provided the time at 1150 °F ± 15 is adjusted to give a total precipitation heat treatment time of 18 hours. The product shall also meet the requirements of 3.6.2.1, 3.6.2.2, and 3.6.2.3 after being re-solution heat treated by heating to 1750 °F ± 25, holding at heat for a time commensurate with product cross-section, and cooling at a rate equivalent to an air cool or faster and precipitation heat treated as above.

3.6.2.1 Tensile Properties:

3.6.2.1.1 At Room Temperature: Shall be as shown in Table 6, determined in accordance with ASTM E 345 for foil and ASTM E 8 for sheet and strip.

TABLE 6 - Minimum Room Temperature Tensile Properties

Nominal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches %
Under 0.006	180	150	report
0.006 to 0.015, incl	180	150	12

3.6.2.1.2 At 1200 °F: Shall be as shown in Table 7, determined in accordance with ASTM E 21 on specimens heated to 1200 °F ± 5, held at heat for 20 to 30 minutes before testing, and tested at 1200 °F ± 5.

TABLE 7 - Minimum 1200 °F Tensile Properties

Property	Value
Tensile Strength	140 ksi
Yield Strength at 0.2% Offset	115 ksi
Elongation in 2 Inches	5%

3.6.2.1.2.1 For product 0.010 inch and under in nominal thickness, properties may be established using a sample up to 0.025 inch in nominal thickness from the same master coil and heat. The report shall indicate the thickness at which the elevated temperature tensile test was performed.

3.6.2.2 Hardness: Shall be not lower than 344 HV or 36 HRC, or equivalent (See 8.2), determined in accordance with ASTM E 18 or ASTM E 384. Product shall not be rejected on the basis of hardness if the tensile properties of 3.6.2.1, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

3.6.2.3 Stress-Rupture Properties at 1200 °F: A tensile specimen, maintained at 1200 °F ± 3 while a load sufficient to produce an initial axial stress of 95.0 ksi or higher 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 not less than 4%. Tests shall be conducted in accordance with ASTM E 139.

3.6.2.3.1 For product 0.010 inch and under in nominal thickness stress-rupture properties may be established using a sample up to 0.025 inch in nominal thickness from the same master coil and heat. The report shall indicate the thickness at which the stress-rupture test was performed.

3.6.2.3.2 The test of 3.6.2.3 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 95.0 ksi or higher shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 to 16 hours, preferably 8 to 10 hours, thereafter, the stress shall be increased in increments of 5.0 ksi. Time to rupture and elongation requirements shall be as specified in 3.6.2.3.

3.7 Quality:

The product, as received by purchaser, shall be uniform in quality and condition and free from continuous roll marks, embedded foreign material, mechanical digs, and multiple pits and dents. The surface shall be free from continuous or multiple scratches exceeding a depth of 0.0001 inch or 2.5% of the nominal thickness, whichever is lower.