SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS5914 | REV. A

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Superseding 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

(Composition similar to UNS N07719)

RATIONALE

This document has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Form:

This specification covers a precision cold rolled corrosion and heat resistant nickel alloy in the form of sheet and strip over 0.005 up to 0.015, inclusive, inch in nominal thickness and foil up to 0.005 inch, inclusive, 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 issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
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SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5914A

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

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
AS4194	Sheet and Strip Surface Finish Nomenclature

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM A 480/A 480M	Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
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 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 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York,NY10036-8002.

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 applicable 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 Cold Rolled Sheet, Strip, and Foil: Solution heat treated, having a surface appearance in accordance with ASTM A 480/A 480M and AS4194 comparable to a 2B finish, 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 the protective atmosphere of 3.5.1 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 E345 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	Report
0.006 to 0.015, incl	150	85	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 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

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 rolling 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 8.3.1) 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 another 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 8.3.2) 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 ASTME345 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 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

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.

3.8 Tolerances:

3.8.1 Thickness: Thickness tolerance including crown shall be ±5% of the nominal thickness for product 0.0015 inch and over and ±8% including crown for product under 0.0015 inch in nominal thickness, measured not less than 3/8 inch from the edge on widths 2 inches and over and not less than 1/8 inch from the edge on widths under 2 inches.

3.8.2 Width: Product shall not vary in width more than shown in Table 8.

TABLE 8 - Width Tolerance

Width Range Inches	Tolerance, Inch Plus and Minus
Up to 1, incl	0.003
Over 1 to 3, incl	0.004
Over 3 to 10, incl	0.005
Over 10 to 20, incl	0.010
Over 20	0.020

3.8.3 Flatness, length, and straightness shall conform to all applicable requirements of AMS 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 testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: The following requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Surface roughness (3.4), average grain size (3.6.1.3), and tolerances (3.8) of each lot.

4.2.1.3 Tensile properties (3.6.1.1), hardness (3.6.1.2), and microstructure (3.6.1.4) of each lot as solution heat treated.

4.2.1.4 Room temperature tensile properties (3.6.2.1.1) and hardness (3.6.2.2) of each lot after precipitation heat treatment.