



AEROSPACE MATERIAL SPECIFICATION

AMS5605

REV. F

Issued 1971-11
Revised 2013-08

Superseding AMS5605E

Nickel Alloy, Corrosion and Heat-Resistant, Sheet, Strip, and Plate
41.5Ni - 16Cr - 37Fe - 2.9Cb (Nb) - 1.8Ti
Consumable Electrode or Vacuum Induction Melted
1800 °F (982 °C) Solution Heat Treated
(Composition similar to UNS N09706)

RATIONALE

AMS5605F revises Reports (4.4) and is a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a corrosion and heat-resistant nickel alloy in the form of sheet, strip, and plate 1.00 inch (25.4 mm) and under in nominal thickness.

1.2 Application

These products have been used typically for parts requiring good machinability and high strength at room and cryogenic temperatures and for short-time use up to 1000 °F (538 °C), particularly for those parts which are formed or welded and then heat treated to develop required properties, 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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), or www.sae.org.

AMS2262 Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Sheet, Strip, and Plate

AMS2269 Chemical Check Analysis Limits, Nickel, Nickel Alloys and Cobalt Alloys

AMS2371 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock

AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

AS4194 Sheet and Strip Surface Finish Nomenclature

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, or www.astm.org.

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

ASTM E 8/E 8M Tension Testing of Metallic Materials

ASTM E 18 Rockwell Hardness of Metallic Materials

ASTM E 112 Determining Average Grain Size

ASTM E 290 Bend Test of Materials for Ductility

ASTM E 354 Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

ASTM E 384 Knoop and Vickers Hardness of Materials

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	--	0.06
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.020
Sulfur	--	0.015
Chromium	14.50	17.50
Nickel	39.00	44.00
Columbium (Niobium)	2.50	3.30
Tantalum	--	0.05
Titanium	1.50	2.00
Aluminum	--	0.40
Boron	--	0.006
Copper	--	0.30
Iron	remainder	

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2269.

3.2 Melting Practice

Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum. 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 and Strip

Cold rolled, solution heat treated free from continuous carbide network 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 described in ASTM A 480/A 480M and AS4194 and the following:

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 Heat Treatment

No specific solution heat treatment is 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 1750 to 1850 °F (954 to 1010 °C), holding at the selected temperature within ± 25 °F (± 14 °C) for a time commensurate with section thickness but not less than five minutes, and cooling at a rate equivalent to an air cool or faster.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 As Solution Heat Treated

3.5.1.1 Tensile Properties

Shall be as shown in Table 2, determined in accordance with ASTM E 8/E 8M.

TABLE 2A - TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inch	Tensile Strength ksi, max	Yield Strength at 0.2% Offset ksi, max	Elongation in 2 Inches or 4D %, min
Up to 0.1875, excl	130	80.0	30
0.1875 and over	140	90.0	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 4.762, excl	896	552	30
4.762 and over	965	621	30

3.5.1.2 Hardness

Shall be not higher than shown in Table 3, or equivalent (See 8.2), 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 properties of 3.5.1.1 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

TABLE 3 - MAXIMUM HARDNESS

Nominal Thickness Inch	Nominal Thickness Millimeters	Hardness
Up to 0.1875, excl	Up to 4.762, excl	102 HRB
0.1875 and over	4.762 and over	25 HRC

3.5.1.3 Bending

Product under 0.1875 inch (4.762 mm) in nominal thickness shall be tested in accordance with ASTM E 290 using a sample nominally 0.75 inch (19.0 mm) in width, with its axis of bending parallel to the direction of rolling, and shall withstand, without cracking, when bending at room temperature 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. In case of dispute, the results of tests using the guided bend test of ASTM E 290 shall govern.

TABLE 4 - BENDING PARAMETERS

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
Up to 0.050, incl	Up to 1.27, incl	1
Over 0.050 to 0.1875, excl	Over 1.27 to 4.762, excl	2

3.5.1.4 Average Grain Size

Shall be as shown in Table 5, determined in accordance with ASTM E 112.

TABLE 5 - AVERAGE GRAIN SIZE

Nominal Thickness Inch	Nominal Thickness Millimeters	ASTM Grain Size No.
Up to 0.1875, excl	Up to 4.762, excl	5 or finer
0.1875 and over	4.762 and over	4 or finer

3.5.2 After Precipitation Heat Treatment

The product shall have the following properties after being precipitation heat treated by heating to $1350^{\circ}\text{F} \pm 15$ ($732^{\circ}\text{C} \pm 8$), holding at heat for 8 hours ± 0.25 , cooling at a rate of 100°F (56°C) degrees per hour to $1150^{\circ}\text{F} \pm 15$ ($621^{\circ}\text{C} \pm 8$), holding at $1150^{\circ}\text{F} \pm 15$ ($621^{\circ}\text{C} \pm 8$) for 8 hours ± 0.25 , and cooling in air. Instead of the 100°F (56°C) degrees per hour cooling rate to $1150^{\circ}\text{F} \pm 15$ ($621^{\circ}\text{C} \pm 8$), the furnace cooling may be at any rate provided the time at $1150^{\circ}\text{F} \pm 15$ ($621^{\circ}\text{C} \pm 8$) is adjusted to give a total precipitation heat treatment time of not less than 18 hours.

3.5.2.1 Tensile Properties

Shall be as shown in Table 6, determined in accordance with ASTM E 8/E 8M.

TABLE 6A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
Up to 0.1875, excl	175	145	12
0.1875 and over	170	145	12

TABLE 6B - MINIMUM 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 4.762, excl	1207	1000	12
4.762 and over	1172	965	12

3.5.2.2 Hardness

Shall be not lower than 34 HRC, or equivalent (See 8.2), 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 properties of 3.5.2.1 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.