SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 5605E

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Superseding AMS 5605D

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

AMS 5605E 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.

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.

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
AMS 2807	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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

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	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 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
ASTM E 384	Microindentation 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 AMS 2269.

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 in accordance with ASTM A 480/A 480M and AS4194 comparable to 3.3.1.1 or 3.3.1.2 as applicable .

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 or ASTM 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 °F ± 15 (732 °C ± 8), holding at heat for 8 hours ± 0.25, cooling at a rate of 100 F (56 C) degrees per hour to 1150 °F ± 15 (621 °C ± 8), holding at 1150 °F ± 15 (621 °C ± 8) for 8 hours ± 0.25, and cooling in air. Instead of the 100 F (56 C) degrees per hour cooling rate to 1150 °F ± 15 (621 °C ± 8), the furnace cooling may be at any rate provided the time at 1150 °F ± 15 (621 °C ± 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 or ASTM 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