AEROSPACE MATERIAL SPECIFICATION

AMS5605™	REV. H

Issued 1971-11
Reaffirmed 2011-08
Revised 2024-09

Superseding AMS5605G

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 (Alloy 706)
(Composition similar to UNS N09706)

RATIONALE

AMS5605H is the result of a Five-Year Review and update of the specification. The revision updates composition testing and reporting (see 3.1 and 3.1.1), updates finish requirements (see 3.3.1), clarifies bend test requirements (see 3.5.1.3), adds pyrometry control (see 3.5.2), adds strain rate control during tensile testing (see 3.5.2.1.1), establishes minimum sizes for tests (see 3.5.1, 3.5.2.1, 3.5.2.2, and 8.2), and updates the exceptions requirements (see 3.5.3 and 8.5).

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 +1 724-776-4970 (outside USA), www.sae.org.

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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5605H/

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

AMS2283 Composition Testing Methods for Nickel- and Cobalt-Based Alloys

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

AMS2750 Pyrometry

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

AS7766 Terms Used in Aerospace Metals Specifications

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, www.astm.org.

ASTM E8/E8M Tension Testing of Metallic Materials

ASTM E18 Rockwell Hardness of Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E290 Bend Testing of Material for Ductility

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Composition shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2283 or by other analytical methods acceptable to the 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 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.2 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 that 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

Sheet and strip shall be hot or cold rolled, solution heat treated, and, unless solution heat treatment is performed in an atmosphere yielding a bright finish, descaled producing a uniform finish.

3.3.2 Plate

Plate shall be 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 5 minutes, and cooling at a rate equivalent to an air cool or faster. Pyrometry shall be in accordance with AMS2750.

3.4.1 Continuous Heat Treatment

When continuous heat treating is used, process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat-treating lines shall be established by the producer and validated by testing of product to the requirements of 3.5.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 As Solution Heat Treated

As solution heat-treated properties for product 0.005 inch (0.12 mm) and over shall be as follows:

3.5.1.1 Tensile Properties

Tensile properties shall be as shown in Table 2, determined in accordance with ASTM E8/E8M.

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 0.1875, excl	130	80	30
0.1875 and over	140	90	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 mm or 4D %, Min
Up to 4.762, excl	896	552	30
4.762 and over	965	621	30

3.5.1.2 Hardness

Solution heat-treated hardness shall be not higher than shown in Table 3, or equivalent (see 8.2), determined in accordance with ASTM E18. 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 Inches	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 transverse tested in accordance with ASTM E290. Testing shall be performed at room temperature. Bend requirements shall be in accordance with Table 4. When visually examined, the specimen shall exhibit no cracking. In case of dispute, the results of tests using the guided bend test of ASTM E290 shall govern.

Table 4 - Bending parameters

Nominal Thickness Inches	Nominal Thickness Millimeters	Angle Degrees	Bend Radius[1, 2]
Up to 0.050, incl	Up to 1.27, incl	180 min	0.5t
Over 0.050 to 0.1875, excl	Over 1.27 to 4.762, excl	180 min	1t

[1] Bend radius is defined as a bend factor multiplied by the nominal thickness (t).
[2] Prior versions of this specification may have specified a bend factor and a bend diameter in lieu of bend radius.

3.5.1.4 Average Grain Size

The average grain size shall be as shown in Table 5, determined in accordance with ASTM E112.

Table 5 - Average grain size

Nominal Thickness Inches	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

3.5.1.5 Susceptibility to Intergranular Attack

Specimens from the product shall pass the intergranular corrosion test performed in accordance with ASTM A262, Practice E.

3.5.2 Response to Precipitation Heat Treatment

The product shall have the following properties after being precipitation heat treated by heating to 1350 °F ± 15 °F (732 °C ± 8 °C), holding at heat for 8 hours ± 0.25 hour, cooling at a rate of 100 °F (56 °C) per hour to 1150 °F ± 15 °F (621 °C ± 8 °C), holding at 1150 °F ± 15 °F (621 °C ± 8 °C) for 8 hours ± 0.25 hour, and cooling in air. Instead of the 100 °F (56 °C) per hour cooling rate to 1150 °F ± 15 °F (621 °C ± 8 °C), the furnace cooling may be at any rate provided the time at 1150 °F ± 15 °F (621 °C ± 8 °C) is adjusted to give a total precipitation heat-treatment time of not less than 18 hours. Pyrometry shall be in accordance with AMS2750.

3.5.2.1 Tensile Properties - Response to Heat Treatment

Tensile properties in response to heat treatment for product 0.005 inch (0.12 mm) and over shall be as shown in Table 6, determined in accordance with ASTM E8/E8M.

Table 6A - Minimum tensile properties - response to heat treatment, inch/pound units

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

Table 6B - Minimum tensile properties - response to heat treatment, SI units

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50 mm or 4D %
Up to 4.762, excl	1207	1000	12
4.762 and over	1172	965	12

3.5.2.1.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (±0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced parallel section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min). The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.