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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5606D

Issued NOV 1971
Revised SEP 2000

Superseding AMS 5606C

Alloy, Corrosion and Heat Resistant, Sheet, Strip, and Plate
41.5Ni - 16Cr - 37Fe - 2.9Cb - 1.8Ti
Consumable Electrode or Vacuum Induction Melted
1750 °F (954 °C) Solution Heat Treated

UNS N09706

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1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant nickel alloy in the form of sheet, strip, and plate.

1.2 Application:

These products have been used typically for parts requiring resistance to creep and stress-rupture up to 1300 °F (704 °C), oxidation resistance up to 1800 °F (982 °C), and good machinability, 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

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
MAM 2262	Tolerances, Metric, 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

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2.1 (Continued):

AMS 2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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 the Average Grain Size
ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
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 Microhardness 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.

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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	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, and, unless solution heat treatment is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to 3.3.1.1 or 3.3.1.2 as applicable (See 8.2).

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 1700 to 1800 °F (927 to 982 °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 specified in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

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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 0.187, excl	130	80.0	30
0.187 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 4.75, excl	896	552	30
4.75 and over	965	621	30

3.5.1.2 Hardness: Shall be not higher than shown in Table 3, or equivalent (See 8.3), 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.

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TABLE 3 - Maximum Hardness

Nominal Thickness Inches	Nominal Thickness Millimeters	Hardness
Up to 0.187, excl	Up to 4.75, excl	102 HRB
0.187 and over	4.75 and over	25 HRC

3.5.1.3 Bending: Product 0.187 inch (4.75 mm) and under in nominal thickness shall withstand, without cracking, bending in accordance with ASTM E 290 through an angle of 180 degrees around a diameter equal to the bend factor times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

TABLE 4 - Bending

Nominal Thickness Inches	Nominal Thickness Millimeters	Bend Factor
Up to 0.050, incl	Up to 1.27, incl	1
Over 0.050 to 0.187, incl	Over 1.27 to 4.75, incl	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 Inches	Nominal Thickness Millimeters	Grain Size
Up to 0.187, excl	Up to 4.75, incl	5 or finer
Over 0.187, and over	Over 4.75	4 or finer

3.5.2 After Stabilization and Precipitation Heat Treatment: The product, 0.010 to 1.000 inch (0.25 to 25.40 mm) in nominal thickness, shall have the following properties after being stabilization heat treated by heating to 1550 °F ± 15 (843 °C ± 8), holding at heat for 3 hours ± 0.25, and cooling in air to room temperature and precipitation heat treated by heating to 1325 °F ± 15 (718 °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), 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. Properties of product under 0.010 inch (0.25 mm) or over 1.000 inch (25.40 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.5.2.1 Tensile Properties: Shall be as specified in Table 6, determined in accordance with ASTM E 8 or ASTM E 8M:

TABLE 6 - Minimum Tensile Properties

Property	Value
Tensile Strength	170 ksi (1172 MPa)
Yield Strength at 0.2% Offset	135 ksi (931 MPa)
Elongation in 2 Inches (50.8 mm) or 4D	12%

3.5.2.2 Hardness: Shall be not lower than 30 HRC, or equivalent (See 8.3), 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.

3.5.2.3 Stress-Rupture Properties at 1200 °F (649 °C): A tensile specimen, maintained at 1200 °F ± 3 (649 °C ± 2) while a load sufficient to produce the initial axial stress specified in Table 7 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 as specified in Table 7. Tests shall be conducted in accordance with ASTM E 139.

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TABLE 7A - Stress-Rupture Properties, Inch/Pound Units

Nominal Thickness Inches	Initial Axial Stress ksi	Elongation in 2 Inches or 4D %, min
Up to 0.015, incl	95	--
Over 0.015 to 0.025, incl	95	3
Over 0.025	100	3

TABLE 7B - Stress-Rupture Properties, SI Units

Nominal Thickness Millimeters	Initial Axial Stress MPa	Elongation in 50.8 mm or 4D %, min
Up to 0.38, incl	655	--
Over 0.38 to 0.64, incl	655	3
Over 0.64	689	3

3.5.2.3.1 The test of 3.5.2.3 may be conducted using a load higher than required to produce the initial axial stress specified in Table 7 but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.5.2.3.

3.5.2.3.2 When permitted by purchaser, the test of 3.5.2.3 may be conducted using incremental loading. In such case, the load required to produce the initial axial stress specified in Table 7 shall be maintained 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 (34.5 MPa). Time to rupture and elongation requirements shall be as specified in 3.5.2.3.

3.6 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances:

Shall conform to all applicable requirements of AMS 2262 or MAM 2262.

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