

**SAE** The Engineering Society  
For Advancing Mobility  
Land Sea Air and Space®  
**INTERNATIONAL**

400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE MATERIAL SPECIFICATION

**SAE**

**AMS 5606C**

Issued 15 NOV 1971

Revised 1 JAN 1992

Superseding AMS 5606B

Submitted for recognition as an American National Standard

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

## 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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

### 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, Wrought Nickel Alloys and Cobalt Alloys

AMS 2371 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steels and Alloys, Wrought Products and Forging Stock

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

AMS 5606C

SAE

AMS 5606C

## 2.1 SAE Publications (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, 1916 Race Street, Philadelphia, PA 19103-1187.

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 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

## 2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Composition:

(R)

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.

AMS 5606C

SAE

AMS 5606C

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 + Tantalum | 2.50      | 3.30  |
| 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 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.

AMS 5606C

SAE

AMS 5606C

## 3.4 Heat Treatment:

The product shall be solution heat treated to meet the requirements of 3.5. 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 - 1800 °F (927 - 982 °C), holding at the selected temperature within  $\pm 25$  °F ( $\pm 14$  °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.

## 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.

TABLE 2A - Tensile Properties, Inch/Pound Units

| Nominal Thickness<br>Inches | Tensile<br>Strength<br>ksi, max | Yield Strength<br>at 0.2% Offset<br>ksi, max | Elongation in<br>2 Inches or 4D<br>%, min |
|-----------------------------|---------------------------------|----------------------------------------------|-------------------------------------------|
| Up to 0.187, incl           | 130                             | 80.0                                         | 30                                        |
| Over 0.187                  | 140                             | 90.0                                         | 30                                        |

TABLE 2B - Tensile Properties, SI Units

| Nominal Thickness<br>Millimeters | Tensile<br>Strength<br>MPa, max | Yield Strength<br>at 0.2% Offset<br>MPa, max | Elongation in<br>50.8 mm or 4D<br>%, min |
|----------------------------------|---------------------------------|----------------------------------------------|------------------------------------------|
| Up to 4.75, incl                 | 896                             | 552                                          | 30                                       |
| Over 4.75                        | 965                             | 621                                          | 30                                       |

3.5.1.2 Hardness: Should be not higher than specified in Table 3, or equivalent, determined in accordance with ASTM E 18 but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.1.1 are met:

AMS 5606C

SAE

AMS 5606C

TABLE 3 - Maximum Hardness

| Nominal Thickness<br>Inches | Nominal Thickness<br>Millimeters | Hardness |
|-----------------------------|----------------------------------|----------|
| Up to 0.187, incl           | Up to 4.75, incl                 | 102 HRB  |
| Over 0.187                  | Over 4.75                        | 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<br>Inches | Nominal Thickness<br>Millimeters | Bend<br>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              |

- 3.5.1.3.1 Bending requirements for product over 0.187 inch (4.75 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.
- 3.5.1.4 Grain Size: Shall be as shown in Table 5, determined by comparison of a polished and etched specimen with the chart in ASTM E 112:

TABLE 5 - Grain Size

| Nominal Thickness<br>Inches | Nominal Thickness<br>Millimeters | Grain Size               |
|-----------------------------|----------------------------------|--------------------------|
| Up to 0.187, incl           | Up to 4.75, incl                 | Predominantly 5 or finer |
| Over 0.187                  | Over 4.75                        | Predominantly 4 or finer |

- 3.5.2 After Stabilization and Precipitation Heat Treatment: The product, 0.010 - 1.000 inch (0.25 - 25.40 mm) in nominal thickness, shall have the following properties after being stabilization heat treated by heating to  $1550^{\circ}\text{F} \pm 15$  ( $843^{\circ}\text{C} \pm 8$ ), holding at heat for 3 hours  $\pm 0.25$ , and cooling in air to room temperature and precipitation heat treated by heating to  $1325^{\circ}\text{F} \pm 15$  ( $718^{\circ}\text{C} \pm 8$ ), holding at heat for 8 hours  $\pm 0.25$ , cooling at a rate of  $100^{\circ}\text{F}$  ( $56^{\circ}\text{C}$ ) 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  $\pm 0.25$ , and cooling in air. Instead of the  $100^{\circ}\text{F}$  ( $56^{\circ}\text{C}$ ) degrees per hour cooling rate to  $1150^{\circ}\text{F} \pm 15$  ( $621^{\circ}\text{C} \pm 8$ ), 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. 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: Should be not lower than 30 HRC, or equivalent, determined in accordance with ASTM E 18 but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.2.1 are met.

- 3.5.2.3 Stress-Rupture Properties at  $1200^{\circ}\text{F}$  ( $649^{\circ}\text{C}$ ): A tensile specimen, maintained at  $1200^{\circ}\text{F} \pm 3$  ( $649^{\circ}\text{C} \pm 2$ ) 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.

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

| Nominal Thickness<br>Inches | Initial Axial<br>Stress<br>ksi | Elongation in<br>2 Inches or 4D<br>%, min |
|-----------------------------|--------------------------------|-------------------------------------------|
| Up to 0.015, incl           | 95.0                           | -                                         |
| Over 0.015 to 0.025, incl   | 95.0                           | 3                                         |
| Over 0.025                  | 100                            | 3                                         |

AMS 5606C

SAE

AMS 5606C

TABLE 7B - Stress-Rupture Properties, SI Units

| Nominal Thickness<br>Millimeters | Initial Axial<br>Stress<br>MPa | Elongation in<br>50.8 mm or 4D<br>%, 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 - 16 hours, preferably 8 - 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.

## 4. QUALITY ASSURANCE PROVISIONS:

### 4.1 Responsibility for Inspection:

(R)

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

### 4.2 Classification of Tests:

Tests for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.