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SAE-AMS5545, "NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SHEET, STRIP, AND PLATE 54NI - 19CR - 11CO - 9.8MO - 3.2TI - 1.5A1 - 0.006B VACUUM INDUCTION AND CONSUMABLE ELECTRODE MELTED, SOLUTION HEAT TREATED PRECIPITATION HEAT TREATABLE", was adopted on 01-AUG-86 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Defense Supply Center Philadelphia, ATTN: DSCP-ILEA, 700 Robbins Avenue, Philadelphia, PA 19111-5096. Copies of this document may be purchased from the Society of Automotive Engineers 400 Commonwealth Drive Warrendale, Pennsylvania, United States, 15096-0001. <http://www.sae.org/>

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# AEROSPACE MATERIAL SPECIFICATION

**SAE** AMS 5545D

Issued JAN 1961  
Revised APR 1996

Submitted for recognition as an American National Standard

Superseding AMS 5545C

NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SHEET, **STRIP**, AND PLATE

54Ni - 19Cr - 11Co - 9.8Mo - 3.2Ti - 1.5Al - 0.006B

Vacuum Induction and Consumable Electrode Melted, Solution Heat Treated

Precipitation Heat Treatable

UNS NO7041

## 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 high strength up to 1600 °F (871 °C) and oxidation resistance up to 1800 °F (962 °C), 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, 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 2750 Pyrometry

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

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## 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 21  | Elevated Temperature Tension Tests of Metallic Materials                                                       |
| ASTM E 112 | Determining the 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 | Microhardness of Materials                                                                                     |

## 2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services 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:

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        | --        | 0.12  |
| Manganese     | --        | 0.10  |
| Silicon       | --        | 0.50  |
| Sulfur        | --        | 0.015 |
| Chromium      | 18.00     | 20.00 |
| Cobalt        | 10.00     | 12.00 |
| Molybdenum    | 9.00      | 10.50 |
| Titanium      | 3.00      | 3.30  |
| Aluminum      | 1.40      | 1.60  |
| Boron (3.1.1) | 0.0030    | 0.010 |
| Iron          | --        | 5.00  |
| Copper        | --        | 0.50  |
| Nickel        | remainder |       |

3.1.1 Boron may be less than 0.0030% by weight, determined on sheet and strip under 0.050 inch (1.27 mm) in nominal thickness provided the specified content is met on stock prior to rolling into sheet or strip.

3.1.2 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

3.2 Melting Practice:

Alloy shall be multiple melted using vacuum induction followed by consumable electrode practice in the remelt cycle.

3.3 Condition:

The product shall be supplied in the following condition:

3.3.1 Sheet and Strip: Hot or 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 the following commercial corrosion-resistant steel finishes 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 Solution Heat Treatment:

The product shall be solution heat treated by heating in a suitable atmosphere to  $1975^{\circ}\text{F} \pm 25$  ( $1079^{\circ}\text{C} \pm 14$ ), holding at heat for not less than 60 minutes per inch (25 mm) of nominal thickness, and cooling at a rate equivalent to a rapid air cool or faster. Pyrometry shall be in accordance with AMS 2750.

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 (R) 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 0.015, incl           | 170                             | 100                                          | 20                                        |
| Over 0.015 to 0.115, incl   | 170                             | 100                                          | 30                                        |
| Over 0.115 to 0.1874, incl  | 180                             | 115                                          | 30                                        |
| Over 0.1874                 | 195                             | 140                                          | 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 0.38, incl                 | 1172                            | 689                                          | 20                                       |
| Over 0.38 to 2.92, incl          | 1172                            | 689                                          | 30                                       |
| Over 2.92 to 4.760, incl         | 1241                            | 793                                          | 30                                       |
| Over 4.760                       | 1344                            | 965                                          | 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 property requirements of 3.5.1.1, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

TABLE 3 - Hardness Requirements

| Nominal Thickness<br>Inch  | Nominal Thickness<br>Millimeters | Hardness |
|----------------------------|----------------------------------|----------|
| Up to 0.040, incl          | Up to 1.02, incl                 | 75 HR15N |
| Over 0.040 to 0.070, incl  | Over 1.02 to 1.78, incl          | 64 HRA   |
| Over 0.070 to 0.1874, incl | Over 1.78 to 4.760, incl         | 30 HRC   |

3.5.1.3 Bending: Product 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 shown in Table 4 times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

(R) TABLE 4 - Bending Parameters

| Nominal Thickness<br>Inch  | Nominal Thickness<br>Millimeters | Bend<br>Factor |
|----------------------------|----------------------------------|----------------|
| Up to 0.062, incl          | Up to 1.57, incl                 | 2              |
| Over 0.062 to 0.125, incl  | Over 1.57 to 3.18, incl          | 2.5            |
| Over 0.125 to 0.1874, incl | Over 3.18 to 4.760, incl         | 3              |

3.5.1.4 Average Grain Size: Shall be ASTM No. 3 or finer, determined in accordance with  
(R) ASTM E 112 (See 8.4).

3.5.1.5 Microstructure: Metallographic examination shall disclose no significant alloy-depleted layer or other undesirable surface condition. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5.2 After Precipitation Heat Treatment: The product shall have the following properties after being precipitation heat treated by heating to 1400 °F ± 15 (760 °C ± 8), holding at heat for not less than 16 hours, and cooling in air:

3.5.2.1 Tensile Properties:

3.5.2.1.1 At Room Temperature: Shall be as specified in Table 5, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 5A - Minimum Room Temperature Tensile Properties, Inch/Pound Units

| Nominal Thickness<br>Inches | Tensile<br>Strength<br>ksi | Yield Strength<br>at 0.2% Offset<br>ksi | Elongation in<br>2 Inches or 4D<br>% |
|-----------------------------|----------------------------|-----------------------------------------|--------------------------------------|
| Up to 0.020, incl           | 160                        | 120                                     | 6                                    |
| Over 0.020                  | 170                        | 130                                     | 10                                   |

TABLE 5B - Minimum Room Temperature Tensile Properties, SI Units

| Nominal Thickness<br>Millimeters | Tensile<br>Strength<br>MPa | Yield Strength<br>at 0.2% Offset<br>MPa | Elongation in<br>50.8 mm or 4D<br>% |
|----------------------------------|----------------------------|-----------------------------------------|-------------------------------------|
| Up to 0.51, incl                 | 1103                       | 827                                     | 6                                   |
| Over 0.51                        | 1172                       | 896                                     | 10                                  |

3.5.2.1.2 At 1400 °F (760 °C): Shall be as specified in Table 6, determined in accordance with  
(R) ASTM E 21 on specimens heated to 1400 °F ± 10 (760 °C ± 6), held at heat for not less than 20 minutes before testing, and tested at 1400 °F ± 10 (760 °C ± 6).

TABLE 6A - Minimum 1400 °F Tensile Properties, Inch/Pound Units

| Nominal Thickness<br>Inches | Tensile<br>Strength<br>ksi | Yield Strength<br>at 0.2% Offset<br>ksi | Elongation in<br>2 Inches or 4D<br>% |
|-----------------------------|----------------------------|-----------------------------------------|--------------------------------------|
| Up to 0.020, incl           | 130                        | 110                                     | 3                                    |
| Over 0.020                  | 140                        | 110                                     | 3                                    |

TABLE 6B - Minimum 760 °C Tensile Properties, SI Units

| Nominal Thickness<br>Millimeters | Tensile<br>Strength<br>MPa | Yield Strength<br>at 0.2% Offset<br>MPa | Elongation in<br>50.8 mm or 4D<br>% |
|----------------------------------|----------------------------|-----------------------------------------|-------------------------------------|
| Up to 0.51, incl                 | 896                        | 758                                     | 3                                   |
| Over 0.51                        | 965                        | 758                                     | 3                                   |

3.5.2.2 Hardness: Shall be not lower than 35 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 property requirements of 3.5.2.1.1, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

### 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:

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