

# AEROSPACE MATERIAL SPECIFICATION

**SAE**

**AMS 5670C**

Issued 1 MAY 1969

Revised 1 APR 1993

Superseding AMS 5670B

Submitted for recognition as an American National Standard

NICKEL ALLOY, CORROSION AND HEAT RESISTANT, BARS, FORGINGS, AND RINGS  
72Ni - 15.5Cr - 0.95 (Cb + Ta) - 2.5Ti - 0.70Al - 7.0Fe  
1800 °F (980 °C) Solution Heat Treated, Precipitation Hardenable

UNS N07750

## 1. SCOPE:

### 1.1 Form:

This specification covers a corrosion and heat resistant nickel alloy in the form of bars, forgings, flash welded rings, and stock for forging, flash welded rings, or heading.

### 1.2 Application:

These products have been used typically for parts requiring high strength in the range 800 to 1100 °F (427 to 593 °C), particularly those parts which are formed or welded and then precipitation 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.

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## 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AMS 2261 Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars, Rods, and Wire
- MAM 2261 Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Bars, Rods, and Wire
- 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
- AMS 2374 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steel and Alloy Forgings
- AMS 2750 Pyrometry
- AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
- AMS 2808 Identification, Forgings
- AMS 7490 Rings, Flash Welded, Corrosion and Heat Resistant Austenitic Steels and Austenitic-Type Alloys or Precipitation-Hardenable Alloys

## 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 10 Brinell Hardness 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.

Table 1 - Composition

| Element              | min   | max   |
|----------------------|-------|-------|
| Carbon               | --    | 0.08  |
| Manganese            | --    | 1.00  |
| Silicon              | --    | 0.50  |
| Phosphorus           | --    | 0.015 |
| Sulfur               | --    | 0.010 |
| Chromium             | 14.00 | 17.00 |
| Nickel + Cobalt      | 70.00 | --    |
| Columbium + Tantalum | 0.70  | 1.20  |
| Titanium             | 2.25  | 2.75  |
| Aluminum             | 0.40  | 1.00  |
| Iron                 | 5.00  | 9.00  |
| Cobalt               | --    | 1.00  |
| Copper               | --    | 0.50  |

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

## 3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 Bars, Forgings, and Flash Welded Rings: Solution heat treated.

3.2.1.1 Bars shall be hot finished; round bars shall be ground or turned except that bars under 0.50 inch (12.7 mm) in nominal diameter, when so ordered, shall be cold drawn.

3.2.1.2 Forgings shall be descaled.

3.2.1.3 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, rings shall be manufactured in accordance with AMS 7490. During manufacture of flash welded rings, the stock shall not be heated to a temperature higher than 1825 °F (996 °C).

3.2.2 Stock for Forging, Flash Welded Rings, or Heading: As ordered by the forging, flash welded ring, or heading manufacturer.

3.3 Solution Heat Treatment:

(R)

Bars, forgings, and flash welded rings shall be solution heat treated by heating to  $1800\text{ }^{\circ}\text{F} \pm 25$  ( $982\text{ }^{\circ}\text{C} \pm 14$ ), holding at heat for a time commensurate with cross-sectional thickness, and cooling at a rate equivalent to an air cool or faster. Pyrometry shall be in accordance with AMS 2750.

3.4 Properties:

The product shall conform to the following requirements:

3.4.1 Bars, Forgings, and Flash Welded Rings:

3.4.1.1 As Solution Heat Treated:

3.4.1.1.1 Hardness: Shall be not higher than 320 HB, or equivalent, determined in accordance with ASTM E 10 (See 8.2).

3.4.1.2 After Precipitation Heat Treatment: Specimens from product shall have the following properties after being precipitation heat treated by heating to  $1350\text{ }^{\circ}\text{F} \pm 15$  ( $732\text{ }^{\circ}\text{C} \pm 8$ ), holding at heat for 8 hours  $\pm 0.25$ , cooling at a rate of  $100\text{ }^{\circ}\text{F} \pm 15$  ( $56\text{ }^{\circ}\text{C} \pm 8$ ) degrees per hour to  $1150\text{ }^{\circ}\text{F} \pm 15$  ( $621\text{ }^{\circ}\text{C} \pm 8$ ), holding at that temperature for 8 hours  $\pm 0.25$ , and cooling in air. Instead of the  $100\text{ }^{\circ}\text{F}$  ( $56\text{ }^{\circ}\text{C}$ ) degrees per hour cooling rate to  $1150\text{ }^{\circ}\text{F} \pm 15$  ( $621\text{ }^{\circ}\text{C} \pm 8$ ), product may be furnace cooled at any rate provided the time at  $1150\text{ }^{\circ}\text{F} \pm 15$  ( $621\text{ }^{\circ}\text{C} \pm 8$ ) is adjusted to give a total precipitation heat treatment time of 18 hours.

3.4.1.2.1 Longitudinal Tensile Properties: Shall be as specified in Table 2 and 3.4.1.2.1.2, determined in accordance with ASTM E 8 or ASTM E 8M.

3.4.1.2.1.1 Bars Under 4.00 Inches (101.6 mm) in Nominal Diameter or Distance Between Parallel Sides, Forgings Under 4.00 Inches (101.6 mm) in Nominal Thickness, and Flash Welded Rings Under 4.00 Inches (101.6 mm) in Nominal Radial Thickness:

TABLE 2A - Minimum Tensile Properties, Inch/Pound Units

| Nominal Size<br>Inches | Tensile<br>Strength<br>ksi | Yield Strength<br>at 0.2% Offset<br>ksi | Elongation<br>in 4D<br>% | Reduction<br>of Area<br>% |
|------------------------|----------------------------|---|--------------------------|---------------------------|
| Up to 2.50, excl       | 170                        | 115                                     | 18                       | 18                        |
| 2.50 to 4.00, excl     | 170                        | 115                                     | 15                       | 15                        |

TABLE 2B - Minimum Tensile Properties, SI Units

| Nominal Size<br>Millimeters | Tensile<br>Strength<br>MPa | Yield Strength<br>at 0.2% Offset<br>MPa | Elongation<br>in 4D<br>% | Reduction<br>of Area<br>% |
|-----------------------------|----------------------------|---|--------------------------|---------------------------|
| Up to 63.5, excl            | 1172                       | 793                                     | 18                       | 18                        |
| 63.5 to 101.6, excl         | 1172                       | 793                                     | 15                       | 15                        |

3.4.1.2.1.2 Bars 4.00 Inches (101.6 mm) and Over in Nominal Diameter or Distance Between Parallel Sides, Forgings 4.00 Inches (101.6 mm) and Over in Nominal Thickness, and Flash Welded Rings 4.00 Inches (101.6 mm) and Over in Nominal Radial Thickness: Shall be as agreed upon by purchaser and vendor.

3.4.1.2.2 Hardness: Should be 302 - 401 HB, or equivalent, determined in accordance with ASTM E 10, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.1.2.1 are met (See 8.2).

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3 and 3.4.1.2, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2. If specimens taken from stock after heat treatment as in 3.3 and 3.4.1.2 conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4.3 Stock for Flash Welded Rings or Heading: A sample of stock heat treated as in 3.3 and 3.4.1.2 shall conform to the requirements of 3.4.1.2.1 and 3.4.1.2.2.

### 3.5 Quality:

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

3.5.1 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of re-entrant grain flow.

### 3.6 Tolerances:

(R)

Bars shall conform to all applicable requirements of AMS 2261 or MAM 2261.

#### 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:

4.2.1 Acceptance Tests: Tests for the following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Hardness (3.4.1.1.1) of each lot of bars, forgings, and flash welded rings as solution heat treated.

4.2.1.3 Tensile properties (3.4.1.2.1) and hardness (3.4.1.2.2) of each lot of bars, forgings, and flash welded rings after precipitation heat treatment.

4.2.1.4 Tolerances (3.6) of bars.

4.2.2 Periodic Tests: Tests of forging stock (3.4.2) and of stock for flash welded rings or heading (3.4.3) to demonstrate ability to develop required properties are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

##### 4.3 Sampling and Testing:

(R)

Shall be in accordance with the following:

4.3.1 Bars, Flash Welded Rings, and Stock for Forging, Flash Welded Rings, or Heading: AMS 2371.

4.3.2 Forgings: AMS 2374.

##### 4.4 Reports:

4.4.1 The vendor of bars, forgings, and flash welded rings shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and the results of tests on each lot to determine conformance to the other acceptance test requirements. This report shall include the purchase order number, heat and lot number, AMS 5670C, size, and quantity. If forgings are supplied, the part number and the size and melt source of stock used to make the forgings shall also be included.