



# AEROSPACE MATERIAL SPECIFICATION

AMS5709

REV. H

Issued 1963-07  
Revised 2008-03  
Reaffirmed 2013-12

Superseding AMS5709G

Nickel Alloy, Corrosion and Heat-Resistant, Bars and Forgings  
58Ni - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4Al - 0.05Zr - 0.006B  
Consumable Electrode or Vacuum Induction Melted  
1975 °F (1079 °C) Solution, Stabilization, and Precipitation Heat Treated  
(Composition similar to UNS N07001)

## RATIONALE

AMS5709H has been reaffirmed to comply with the SAE five-year review policy.

### 1. SCOPE

#### 1.1 Form

This specification covers a corrosion and heat-resistant nickel alloy in the form of bars, forgings, and forging stock.

#### 1.2 Application

These products have been used typically for parts, such as pins, nuts, and turbine blades, requiring high strength up to 1500 °F (816 °C) and oxidation resistance up to 1750 °F (954 °C), 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 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AMS2261	Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars, Rods, and Wire
AMS2269	Chemical Check Analysis Limits, Nickel, Nickel Alloys, and Cobalt Alloys
AMS2371	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS2374	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steel and Alloy Forgings
AMS2750	Pyrometry

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SAE WEB ADDRESS:

AMS2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys  
 AMS2808 Identification, Forgings

## 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 E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials  
 ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials  
 ASTM E 354 Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

## 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	0.02	0.10
Manganese	--	0.10
Silicon	--	0.15
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	18.00	21.00
Cobalt	12.00	15.00
Molybdenum	3.50	5.00
Titanium	2.75	3.25
Aluminum	1.20	1.60
Zirconium	0.02	0.08
Boron	0.003	0.010
Iron	--	2.00
Copper	--	0.10
Lead	--	0.0005 (5 ppm)
Bismuth	--	0.00003 (0.3 ppm)
Selenium	--	0.0003 (3 ppm)
Nickel	remainder	

#### 3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2269.

### 3.2 Melting Practice

Alloy shall be multiple melted using consumable electrode practice in the remelt cycle or shall be multiple vacuum melted. 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 Bars

Hot finished and descaled, solution, stabilization, and precipitation heat treated. Round bars shall be ground or turned.

#### 3.3.2 Forgings

Solution, stabilization, and precipitation heat treated.

#### 3.3.3 Forging Stock

As ordered by the forging manufacturer.

### 3.4 Heat Treatment

Bars and forgings shall be heat treated as follows; pyrometry shall be in accordance with AMS2750.

#### 3.4.1 Solution Heat Treatment

Heat to 1975 °F ± 25 (1079 °C ± 14), hold at heat for 4 hours ± 0.5, and cool at a rate equivalent to an air cool or faster.

#### 3.4.2 Stabilization Heat Treatment

Heat to 1550 °F ± 15 (843 °C ± 8), hold at heat for 4 hours ± 0.5, except that blade forgings shall be held at heat for 24 hours ± 1, and cool in air.

#### 3.4.3 Precipitation Heat Treatment

Heat to 1400 °F ± 15 (760 °C ± 8), hold at heat for 16 hours ± 1, and cool in air.

### 3.5 Properties

The product shall conform to the following requirements:

#### 3.5.1 Bars and Forgings

##### 3.5.1.1 Hardness

Shall be 32 to 42 HRC, or equivalent (See 8.2), determined in accordance with ASTM E 18.

##### 3.5.1.2 Grain Size Uniformity

Uniformly mixed grain sizes are permissible. Segregated areas of coarse or fine grains shall not exceed 20% of any field at 100X magnification. Standards for acceptance may be agreed upon by purchaser and vendor.

##### 3.5.1.3 Stress-Rupture Properties at 1500 °F (816 °C)

A tensile specimen, maintained at 1500 °F ± 3 (816 °C ± 2) while a load sufficient to produce an initial axial stress of 47.5 ksi (328 MPa) or higher 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 not lower than 8% in 4D. Tests shall be conducted in accordance with ASTM E 139.

3.5.1.3.1 The test of 3.5.1.3 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 47.5 ksi (328 MPa) or higher shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 hours minimum, 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 3.5.1.3.

### 3.5.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.4, specimens taken from the heat treated coupon shall conform to the requirements of 3.5.1.1, 3.5.1.2, and 3.5.1.3. If specimens taken from the stock after heat treatment as in 3.4 conform to the requirements of 3.5.1.1, 3.5.1.2, and 3.5.1.3, the tests shall be accepted as equivalent to tests of a forged coupon.

### 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.

3.6.1 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.

### 3.7 Tolerances

Bars shall conform to all applicable requirements of AMS2261.

## 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.

### 4.2 Classification of Tests

#### 4.2.1 Acceptance Tests

The following 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 (3.5.1.1), grain size uniformity (3.5.1.2), and stress-rupture properties (3.5.1.3) of each lot of bars and forgings.

4.2.1.3 Tolerances (3.7) of bars.

#### 4.2.2 Periodic Tests

The ability of forging stock (3.5.2) to develop required properties and grain flow of die forgings (3.6.1) 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

Shall be as follows:

#### 4.3.1 Bars and Forging Stock

In accordance with AMS2371, with stress rupture specimens oriented as specified for tensile specimens.