AEROSPACE MATERIAL SPECIFICATION

AMS5670™	REV. H

Issued 1969-05
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Superseding AMS5670G

Nickel Alloy, Corrosion- and Heat-Resistant, Bars, Forgings, and Rings and Stock for Rings, Forgings, and Heading
72Ni - 15.5Cr - 0.95Cb (Nb) - 2.5Ti - 0.70Al - 7.0Fe (X750)
1800 °F (982 °C) Solution Heat-Treated, Precipitation-Hardenable
(Composition similar to UNS N07750)

RATIONALE

AMS5670H is the result of a Five-Year Review and update of the specification. The revision updates the Title to match the Scope, revises composition testing and reporting requirements (see 3.1 and 3.1.1), adds conditions for larger bars (see 3.2.1.1.1), prohibits bars being cut from plates (see 3.2.1.2 and 4.4.5), clarifies heat treatment time (see 3.4.1.2), adds the option for additional requirements for forging stock (see 4.4.7 and 8.6), and updates the exception requirements (see 8.5).

1. SCOPE

1.1 Form

This specification covers a corrosion- and heat-resistant nickel alloy in the form of bars, forgings, and flash-welded rings under 4.00 inches (101.6 mm) in nominal thickness or diameter, and stock of any size 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 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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5670H

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), 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

AMS2283 Composition Testing Methods for Nickel- and Cobalt-Based 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

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

AMS2808 Identification, Forgings

AMS7490 Rings, Flash Welded, Corrosion and Heat-Resistant Austenitic Steels, Austenitic-Type Iron, Nickel or Cobalt Alloys, or Precipitation-Hardenable Alloys

AS7766 Terms Used in Aerospace Metals Specifications

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 E8/E8M Tension Testing of Metallic Materials

ASTM E10 Brinell Hardness of Metallic Materials

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Composition shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2283 or by other analytical methods acceptable to the 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	70.00	--
Columbium (Niobium)	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 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2269.

3.2 Condition

3.2.1 Bars, Forgings, and Flash-Welded Rings

Bars, forgings and flash-welded rings shall be 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.

3.2.1.1.1 Bars, other than hexagons, over 2.75 inches (69.8 mm) in nominal diameter or least distance between parallel sides shall be hot finished or cold finished.

3.2.1.2 Bars shall not be cut from plate (see 4.4.5).

3.2.1.3 Forgings shall be descaled.

3.2.1.4 Flash-welded rings shall not be supplied unless specified or permitted on the purchaser's part drawing. When supplied, rings shall be manufactured in accordance with AMS7490. 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

Stock for forging, flash-welded rings or heading shall be as ordered by the forging, flash-welded ring, or heading manufacturer.

3.3 Solution Heat Treatment

Bars, forgings, and flash-welded rings shall be solution heat treated by heating to 1800 °F ± 25 °F (982 °C ± 14 °C), 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 AMS2750.

3.4 Properties

3.4.1 Bars, Forgings, and Flash-Welded Rings

3.4.1.1 As Solution Heat Treated

3.4.1.1.1 Hardness

Hardness shall be not higher than 320 HBW, or equivalent (see 8.2), determined in accordance with ASTM E10.

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 °F ± 15 °F (732 °C ± 8 °C), holding at heat for 8 hours ± 0.25 hour, cooling at a rate of 100 °F ± 15 °F (56 °C ± 8 °C) per hour to 1150 °F ± 15 °F (621 °C ± 8 °C), holding at that temperature for 8 hours ± 0.25 hour, and cooling in air. Instead of the 100 °F (56 °C) per hour cooling rate to 1150 °F ± 15 °F (621 °C ± 8 °C), product may be furnace cooled at any rate provided the time at 1150 °F ± 15 °F (621 °C ± 8 °C) is adjusted to give a total precipitation heat treatment time of 18 hours minimum.

3.4.1.2.1 Longitudinal Tensile Properties

Bars under 4.00 inches (101.6 mm) in nominal diameter or distance between parallel sides (thickness), 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 shall meet the properties shown in Table 2, determined in accordance with ASTME 8/E8M.

3.4.1.2.2 Mechanical property requirements for product outside the range covered by 1.1 shall be agreed upon between the purchaser and producer.

Table 2A - Minimum tensile properties, inch/pound units

Nominal Diameter, Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D or 2 inches %	Reduction of Area %
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 Diameter, Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D or 50 mm %	Reduction of Area %
Up to 63.5, excl	1172	793	18	18
63.5 to 101.6, excl	1172	793	15	15

3.4.1.2.3 Hardness shall be 302 to 401 HBW, or equivalent (see 8.2), determined in accordance with ASTM E10.

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 3.4.1.2.3. 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 3.4.1.2.3, 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 3.4.1.2.3.

3.5 Quality

The product, as received by the 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 reentrant grain flow.

3.6 Tolerances

Bars shall conform to all applicable requirements of AMS2261.

3.7 Any exceptions shall be authorized by the purchaser and reported as in 4.4.6.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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 requirements are acceptance tests and shall be performed on each heat or lot as applicable:

Composition (see 3.1) of each heat
Hardness (see 3.4.1.1.1) of each lot of bars, forgings, and flash-welded rings as solution heat treated
Tensile properties (see 3.4.1.2.1) and hardness (see 3.4.1.2.3) of each lot of bars, forgings, and flash-welded rings after precipitation heat treatment
Tolerances (see 3.6) of bars

4.2.2 Periodic Tests

Tests of forging stock (see 3.4.2) and of stock for flash-welded rings or heading (see 3.4.3) to demonstrate ability to develop required properties and grain flow of die forgings (see 3.5.1) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

4.3.1 Bars, Flash-Welded Rings, and Stock for Forging, Flash-Welded Rings, or Heading

Sampling and testing for bars, flash-welded rings, and stock shall be in accordance with AMS2371.

4.3.2 Forgings

Sampling and testing for forgings shall be in accordance with AMS2374.

4.4 Reports

The producer of the product shall furnish with each shipment a report showing the producer’s name and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the following results of tests and relevant information.

4.4.1 For each heat:

Composition.