AEROSPACE MATERIAL SPECIFICATION

AMS5668™	REV. L

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Superseding AMS5668K

Nickel Alloy, Corrosion- and Heat-Resistant, Bars, Forgings, Rings, and Forging Stock
72Ni - 15.5Cr - 7.0Fe - 2.5Ti - 1.0Cb (Nb) - 0.70Al (X750)
2100 °F (1149 °C) Solution and Precipitation Heat Treated
(Composition similar to UNS N07750)

RATIONALE

AMS5668L 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 (see 3.1 and 3.1.1), adds standard requirements for bars (see 3.2.1.1 and 3.2.1.2), adds an option for additional forging properties (see 4.4.2 and 8.6), and updates the exceptions 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, flash-welded rings 10.0 inches (254 mm) and under in nominal diameter or distance between parallel sides, and stock of any size for forging, flash-welded rings, or heading.

1.2 Application

These products have been used typically for parts, such as bolts, turbine blades, and turbine seals, requiring oxidation resistance and high strength at 1250 to 1500 °F (677 to 816 °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 +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

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/AMS5668L

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 E139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests 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 by wet chemical methods 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 + Cobalt	70.00	--
Columbium (Niobium)	0.70	1.20
Titanium	2.25	2.75
Tantalum	--	0.05
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

The product shall be supplied in the following condition:

3.2.1 Bars, Forgings, and Flash-Welded Rings

Bars, forgings, and flash-welded rings shall be solution and precipitation 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 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.

3.2.1.3 Bars shall not be cut from plate (see 4.4.1.2).

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.

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 Heat Treatment

Heat treatment shall be as follows; pyrometry shall be in accordance with AMS2750:

3.3.1 Solution Heat Treatment

3.3.1.1 Bars and Forgings Other Than Seamless Rolled Rings

Bars and forgings other than seamless rolled rings shall be solution heat treated by heating to 2100 °F ± 25 °F (1149 °C ± 14 °C), holding at heat for 2 to 4 hours, and cooling in air.

3.3.1.2 Flash-Welded Rings and Seamless Rolled Rings

Flash-welded rings and seamless rolled rings shall be solution heat treated by heating to a temperature within the range 2000 to 2100 °F (1093 to 1149 °C), holding at the selected temperature within ±25 °F (±14 °C) for 2 to 4 hours, and cooling in air or faster.

3.3.2 Precipitation Heat Treatment

Bars, forgings, and flash-welded rings shall be precipitation heat treated by heating to 1550 °F ± 25 °F (843 °C ± 14 °C); holding at heat for 24 hours ± 1 hour; cooling to 1300 °F (704 °C) or lower in 2 hours or less, either in air or in the furnace; and then heating to, or continuing at, 1300 °F ± 25 °F (704 °C ± 14 °C), holding at heat for 20 hours ± 1 hour, and cooling in air.

3.4 Properties

Product 10.0 inches (254 mm) and under in nominal diameter or distance between parallel sides (thickness) shall conform to the following requirements:

3.4.1 Bars, Forgings, and Flash-Welded Rings

3.4.1.1 Tensile Properties

Shall be as specified in Table 2, determined in accordance with ASTM E8/E8M.

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

Property	Flash-Welded Rings and Seamless Rolled Rings	Bars and Forgings Other than Seamless Rolled Rings
Tensile Strength	125 ksi	140 ksi
Yield Strength at 0.2% Offset	80 ksi	80 ksi
Elongation in 4D or 2 inches	8.0%	8.0%
Reduction of Area	8.0%	8.0%

Table 2B - Minimum tensile properties, SI units

Property	Flash-Welded Rings and Seamless Rolled Rings	Bars and Forgings Other than Seamless Rolled Rings
Tensile Strength	862 MPa	965 MPa
Yield Strength at 0.2% Offset	552 MPa	552 MPa
Elongation in 4D or 50 mm	8.0%	8.0%
Reduction of Area	8.0%	8.0%

3.4.1.2 Hardness

Shall be 262 to 341 HBW, or equivalent (see 8.2), determined in accordance with ASTM E10.

3.4.1.3 Stress Rupture Properties at 1350 °F (732 °C)

A tensile specimen maintained at 1350 °F ± 5 °F (732 °C ± 3 °C), while a load sufficient to produce an initial axial stress of 52.5 ksi (362 MPa) 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 less than 5% in 4D. Test shall be conducted in accordance with ASTM E139.

3.4.1.3.1 The test of 3.4.1.3 may be conducted using a load higher than required to produce an initial axial stress of 52.5 ksi (362 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

3.4.1.3.2 The test of 3.4.1.3 may be conducted using incremental loading. In such case the load required to produce an initial axial stress of 52.5 ksi (362 MPa) 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 ksi (34.5 MPa). Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

3.4.1.4 Mechanical properties for product outside the range specified in 1.1 shall be agreed upon between the purchaser and producer.

3.4.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.3, specimens taken from the heat-treated coupon shall conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.3. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.3, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4.3 Stock for Flash-Welded Rings or Heading

Specimens taken from the stock after heat treatment as in 3.3 shall conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.3.

3.5 Quality

The product, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials 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 tolerances shall conform to all applicable requirements of AMS2261.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.1.

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.
Tensile properties (see 3.4.1.1), hardness (see 3.4.1.2), and stress-rupture properties (see 3.4.1.3) of each lot of bars, forgings, and flash-welded rings.
Tolerances (see 3.7) of bars.

4.2.2 Periodic Tests

The ability of forging stock (see 3.4.2) and stock for flash-welded rings or heading (see 3.4.3) 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 Sampling and testing for bars, flash-welded rings, and stock for forging, flash-welded rings, or heading shall be in accordance with AMS2371.

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

4.4 Reports

4.4.1 The producer of bars, forgings, and flash-welded rings shall furnish with each shipment a report showing the producer's name, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), the results of tests for composition of each heat and the results of tests for tensile properties, hardness, and stress-rupture properties of each lot of bars, forgings, and flash-welded rings, and tolerances of each lot of bars, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS5668L, size, product form, 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.

4.4.1.1 When material produced to this specification is outside the size range specified in 1.1, or has exceptions authorized by the purchaser taken to the technical requirements listed in Section 3 (see 5.2.1.1), the report shall contain a statement "This material is certified as AMS5668L(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.4.1.2 Report the nominal metallurgically worked cross sectional size and the cut size, if different (see 3.2.1.3)

4.4.2 The producer of stock for forging, flash-welded rings, or heading shall furnish with each shipment a report showing the producer's name, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), the results of tests for composition of each heat, and the results of any additional property requirements imposed by 8.6. This report shall include the purchase order number, heat number, AMS5668L, size, and quantity.

4.5 Resampling and Retesting

4.5.1 Resampling and retesting of bars, flash-welded rings, and stock for forging, flash-welded rings, or heading shall be in accordance with AMS2371.

4.5.2 Resampling and retesting of forgings shall be in accordance with AMS2374.