

AEROSPACE MATERIAL SPECIFICATION

SAE AMS5668

REV. J

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Superseding AMS5668H	

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

RATIONALE

AMS5668J 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, flash welded rings, and stock 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 724-776-4970 (outside USA), www.sae.org.

AMS 2261	Tolerances, 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

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on this Technical Report, please visit
<http://www.sae.org/technical/standards/AMS5668J>**

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 International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

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 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	--	0.08
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 Check Analysis

Composition variations shall meet the applicable 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 and precipitation heat treated.

3.2.1.1 Bars shall be hot finished; round bars shall be ground or turned.

3.2.1.2 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.

3.2.2 Stock for Forging, Flash Welded Rings, or Heading

As ordered by the forging, flash welded ring, or heading manufacturer.

3.3 Heat Treatment

Shall be as follows; pyrometry shall be in accordance with AMS 2750:

3.3.1 Solution Heat Treatment

3.3.1.1 Bars and Forgings Other Than Seamless Rolled Rings

Shall be solution heat treated by heating to $2100^{\circ}\text{F} \pm 25$ ($1149^{\circ}\text{C} \pm 14$), holding at heat for 2 to 4 hours, and cooling in air.

3.3.1.2 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 $\pm 25^{\circ}\text{F}$ ($\pm 14^{\circ}\text{C}$) 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 $1550^{\circ}\text{F} \pm 25$ ($843^{\circ}\text{C} \pm 14$), holding at heat for 24 hours ± 1 , cooling to 1300°F (704°C) or lower in two hours or less, either in air or in the furnace, and then heating to, or continuing at, $1300^{\circ}\text{F} \pm 25$ ($704^{\circ}\text{C} \pm 14$), holding at heat for 20 hours ± 1 , and cooling in air.

3.4 Properties

Product 10.0 inches (254 mm) and under in nominal diameter or distance between parallel sides 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 E 8 or ASTM E 8M.

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	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	8.0%	8.0%
Reduction of Area	8.0%	8.0%

3.4.1.2 Hardness

Shall be 262 to 341 HB, or equivalent (See 8.2), determined in accordance with ASTM E 10.

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

A tensile specimen maintained at 1350 °F $\pm$ 5 (732 °C $\pm$ 3), 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 E 139.

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.

3.4.2 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 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 shall conform to all applicable requirements of AMS 2261.

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

4.2.1.3 Tolerances (3.7) of bars.

4.2.2 Periodic Tests

The ability of forging stock (3.4.2) and stock for flash welded rings or heading (3.4.3) to develop required properties and grain flow of die forgings (3.5.1) 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 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 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, AMS 5668J, 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.

4.4.2 The vendor of stock for forging, flash welded rings, or heading shall furnish with each shipment a report showing the results of tests for composition of each heat. This report shall include the purchase order number, heat number, AMS 5668J, size, and quantity.

4.5 Resampling and Retesting

Shall be in accordance with the following:

4.5.1 Bars, Flash Welded Rings, and Stock for Forging, Flash Welded Rings, or Heading

AMS 2371.

4.5.2 Forgings

AMS 2374.