



AEROSPACE MATERIAL SPECIFICATION

AMS5671™

REV. J

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Revised 2024-12

Superseding AMS5671H

Nickel Alloy, Corrosion- and Heat-Resistant, Bars, forgings, Rings and Forging Stock
72Ni - 15.5Cr - 0.95Cb - 2.5Ti - 0.70Al - 7.0Fe
Consumable Electrode or Vacuum Induction Melted,
1800 °F (982 °C) Solution Heat Treated, Precipitation Hardenable (X750)
(Composition similar to UNS N07750)

RATIONALE

AMS5671J is the result of a Five-Year Review and update of the specification. The revision updates the Title to match the Scope and adds the common name, clarifies size limits (see 1.1, 3.5.1.2.1.1, and 3.5.1.2.1.2), updates composition testing and reporting (see 3.1 and 3.1.1), adds finish (see 3.3.1.1), adds minimum time and pyrometry control to response to heat treatment (see 3.5.1.2), adds strain rate control (see 3.5.1.2.1.6), provides for forging stock properties (see 4.4.7 and 8.6), and updates the exclusion 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 up to 4.00 inches (101.6 mm), exclusive, in least distance between parallel sides (thickness) or diameter, and stock of any size for forging or flash-welded rings.

1.2 Application

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

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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 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 | -- | 0.35 |
| Silicon | -- | 0.35 |
| 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 |
| Tantalum | -- | 0.05 |
| 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 Melting Practice

Alloy shall be multiple melted using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum. If consumable electrode remelting is not performed in vacuum, electrodes that have been produced by vacuum induction melting shall be used for remelting.

3.3 Condition

3.3.1 Bars, forgings, and Flash-Welded Rings

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

3.3.1.1 Bars shall be hot or cold finished unless otherwise ordered; round bars shall be ground or turned.

3.3.1.2 Bars shall not be cut from plate (see 4.4.2.1).

3.3.1.3 forgings shall be descaled.

3.3.1.4 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).

3.3.2 Stock for Forging or Flash-Welded Rings

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

3.4 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.

3.5 Properties

3.5.1 Bars, forgings, and flash-welded rings

3.5.1.1 As solution heat treated

3.5.1.1.1 Hardness

3.5.1.1.1.1 Bar hardness shall not be higher than 320 HBW, or equivalent (see 8.2), determined approximately midway between outer surface and center.

3.5.1.1.1.2 forgings and flash-welded rings hardness shall not be higher than 320 HBW, or equivalent (see 8.2).

3.5.1.2 Response to heat treatment

Samples from product shall have the following properties after being precipitation heat treated by heating to $1350^{\circ}\text{F} \pm 15^{\circ}\text{F}$ ($732^{\circ}\text{C} \pm 8^{\circ}\text{C}$), holding at heat for 8 hours ± 0.25 hour, cooling at a rate of $100^{\circ}\text{F} \pm 15^{\circ}\text{F}$ ($56^{\circ}\text{C} \pm 8^{\circ}\text{C}$) per hour to $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ ($621^{\circ}\text{C} \pm 8^{\circ}\text{C}$), holding at $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ ($621^{\circ}\text{C} \pm 8^{\circ}\text{C}$) for 8 hours ± 0.25 hour, and air cooling. Instead of the 100°F (56°C) per hour cooling rate to $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ ($621^{\circ}\text{C} \pm 8^{\circ}\text{C}$), product may be furnace cooled at any rate provided the time at $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ ($621^{\circ}\text{C} \pm 8^{\circ}\text{C}$) is adjusted to give a total precipitation heat-treatment time of 18 hours minimum. Pyrometry shall be in accordance with AMS2750.

3.5.1.2.1 Room-temperature tensile properties

3.5.1.2.1.1 Room-temperature tensile properties for bars, forgings, and flash-welded rings under 2.50 inches (63.5 mm), exclusive, in nominal diameter or least distance between parallel sides (thickness) shall be as shown in Table 2. Testing shall be in accordance with ASTM E8/E8M.

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

| Specimen Orientation | Tensile Strength ksi | Yield Strength at 0.2% Offset ksi | Elongation in 4D or 2 inches % | Reduction of Area % |
|----------------------|----------------------|-----------------------------------|--------------------------------|---------------------|
| Longitudinal | 170 | 115 | 18 | 18 |
| Transverse | 165 | 110 | 15 | 15 |

Table 2B - Minimum tensile properties, SI units

| Specimen Orientation | Tensile Strength MPa | Yield Strength at 0.2% Offset MPa | Elongation in 4D or 50 mm % | Reduction of Area % |
|----------------------|----------------------|-----------------------------------|-----------------------------|---------------------|
| Longitudinal | 1172 | 793 | 18 | 18 |
| Transverse | 1138 | 758 | 15 | 15 |

3.5.1.2.1.2 Room-temperature tensile properties for bars, forgings, and flash-welded rings 2.50 to 4.00 inches (63.5 to 101.6 mm), exclusive, in nominal diameter or least distance between parallel sides (thickness) shall be as shown in Table 3. Testing shall be in accordance with ASTM E8/E8M.

Table 3A - Minimum tensile properties, inch/pound units

| Specimen Orientation | Tensile Strength ksi | Yield Strength at 0.2% Offset ksi | Elongation in 4D or 2 inches % | Reduction of Area % |
|----------------------|----------------------|-----------------------------------|--------------------------------|---------------------|
| Longitudinal | 170 | 115 | 15 | 15 |
| Transverse | 160 | 105 | 12 | 12 |

Table 3B - Minimum tensile properties, SI units

| Specimen Orientation | Tensile Strength MPa | Yield Strength at 0.2% Offset MPa | Elongation in 4D or 50 mm % | Reduction of Area % |
|----------------------|----------------------|-----------------------------------|-----------------------------|---------------------|
| Longitudinal | 1172 | 793 | 15 | 15 |
| Transverse | 1103 | 724 | 12 | 12 |

3.5.1.2.1.3 Longitudinal tensile property requirements of 3.5.1.2.1.1 and 3.5.1.2.1.2 apply to specimens taken with the axis approximately parallel to the grain flow, specimens taken in the radial direction and in the tangential direction at the rim of disc forgings, and specimens taken in the circumferential direction from flash-welded rings. All other specimens shall be considered to be in the transverse direction.

3.5.1.2.1.4 Transverse tensile property requirements of 3.5.1.2.1.1 and 3.5.1.2.1.2 apply only to product from which tensile specimens not less than 2.50 inches (63.5 mm) long can be obtained.

3.5.1.2.1.5 Tensile tests in the longitudinal direction are not required from product tested in the transverse direction.

3.5.1.2.1.6 Unless otherwise specified, the strain rate for all room- and elevated-temperature tensile tests, shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (± 0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 in/in (0.05 and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min). The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

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

3.5.1.2.2 Hardness

Precipitation heat-treated hardness shall be 302 to 401 HBW, or equivalent (see 8.2), determined in accordance with ASTM E10. Product shall not be rejected on the basis of hardness if the tensile properties of 3.5.1.2.1 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

3.5.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.4 and 3.5.1.2, specimens taken from the heat-treated coupon shall conform to the requirements of 3.5.1.2.1 and 3.5.1.2.2. If specimens taken from stock after heat treatment as in 3.4 and 3.5.1.2 conform to the requirements of 3.5.1.2.1 and 3.5.1.2.2, the tests shall be acceptable as equivalent to tests of a forged coupon.

3.5.3 Stock for Flash-Welded Rings

Specimens taken from the stock after heat treatment as in 3.4 and 3.5.1.2 shall conform to the requirements of 3.5.1.2.1 and 3.5.1.2.2.

3.6 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.

3.6.1 Grain flow of die forgings, except in areas that contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.7 Tolerances

Bars shall conform to all applicable requirements of AMS2261.

3.8 Exceptions

Any exception shall be authorized by the purchaser and reported as in 4.4.5.

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 3.5.1.1.1) of each lot of bars, forgings, and flash-welded rings as solution heat treated.
- Tensile properties (see 3.5.1.2.1) and hardness (see 3.5.1.2.2) of each lot of bars, forgings, and flash-welded rings after precipitation heat treatment.
- Tolerances (see 3.7) of bars.

4.2.2 Periodic Tests

Tests of forging stock (see 3.5.2) and of stock for flash-welded rings (see 3.5.3) to demonstrate the ability to develop required properties and grain flow of die forgings (see 3.6.1) 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 or flash-welded rings shall be sampled and tested in accordance with AMS2371.

4.3.2 forgings shall be sampled and tested in accordance with AMS2374.

4.3.3 Specific location of tensile specimens from forgings and flash-welded rings shall be as agreed upon by the purchaser and producer (see 8.6).

4.4 Reports

The producer of the product 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), and the following results of tests and relevant information:

4.4.1 For Each Heat

- Composition

4.4.2 For Each Lot of Bars, forgings, and Flash-Welded Rings

- As solution heat treated
 - Hardness
- After precipitation heat treatment
 - Tensile properties
 - Hardness

4.4.2.1 Report the nominal metallurgically worked cross-sectional size and the cut size, if different (see 3.3.1.2).

4.4.3 A statement that the product conforms to the other technical requirements.

4.4.4 Purchase order number

Heat and lot numbers

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Size

Quantity

4.4.5 When material produced to this specification is outside the size range listed in 1.1, or has exceptions 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 AMS5671J(EXC) because of the following exceptions." and the specific exceptions shall be listed.

4.4.6 If forgings are supplied, the size and melt source of stock used to make the forgings.

4.4.7 The producer of stock for forgings 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 and lot number, AMS5671J, size, and quantity.

4.5 Resampling and Retesting

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

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