AEROSPACE MATERIAL SPECIFICATION

AMS5699™	REV. H

Issued 1953-06
Reaffirmed 2007-08
Revised 2022-05

Superseding AMS5699G

Nickel Alloy, Corrosion and Heat-Resistant, Wire
72Ni - 15.5Cr - 0.95Cb - 2.5Ti - 0.70Al - 7.0Fe
Solution Heat Treated, Precipitation Hardenable
(Composition similar to UNS N07750)

RATIONALE

AMS5699H is the result of a Five-Year Review and update of the specification. The revision includes an update to the Title, Scope and Response to Heat Treatment (1.1, 3.3.4) to clarify the purchased condition, prohibits unauthorized exceptions (3.3.5, 3.6, 4.4.2, 5.2.3, 8.7), updates composition reporting (3.1.1), adds continuous heat treatment and pyrometry control (3.2), clarifies reduction requirements (3.2.2, 3.2.3) adds strain rate requirements for tensile testings (3.3.1), adds country of origin requirements (4.4.1), updates definitions (8.4), and allows prior revisions (8.6).

1. SCOPE

1.1 Form

This specification covers a corrosion and heat-resistant nickel alloy in the form of round, square, and flat wire 0.625 inch (15.88 mm) and under in nominal diameter or thickness capability tested in a Spring Temper condition.

1.2 Application

This wire has been used typically for helical springs for service at elevated temperatures (see 8.2 and 8.3), 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.

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

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/AMS5699H/

AMS2750 Pyrometry

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 E354 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 in accordance with ASTM E354, or by other analytical methods acceptable to purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	--	0.08
Manganese	--	1.00
Silicon	--	0.50
Sulfur	--	0.010
Chromium	14.00	17.00
Nickel	70.00	--
Columbium	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 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

Cold drawn from hot finished wire or rod which has had suitable surface preparation for removal of scale, seams, or other injurious surface imperfections. Wire shall be solution heat treated by heating within the range 2000 to 2200 °F (1093 to 1204 °C) before reducing to the size ordered. Pyrometry shall be in accordance with AMS2750.

3.2.1 Continuous Heat Treatment

When continuous heat treating is used process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat treating lines shall be established by the material producer and validated by testing of product to the requirements of 3.3.

3.2.2 Wire 0.250 inch (6.35 mm) and under in nominal diameter or thickness shall be cold reduced between 50% and 65% (in cross sectional area) following solution heat treatment.

3.2.3 Wire over 0.250 to 0.625 inch (6.35 to 15.88 mm) in nominal diameter or thickness shall be cold reduced not less than 30% (in cross sectional area) following solution heat treatment.

3.2.4 All traces of lubricant shall be removed after cold reduction.

3.3 Properties

Wire shall conform to the following requirements; tensile testing shall be performed in accordance with ASTM E8/E8M.

3.3.1 Unless otherwise specified, the strain rate 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. The strain rate after yield may be increased to any value up to 0.5 in/in/min (or mm/mm/min) or equivalent crosshead speed as a function of gage length. The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

3.3.2 As Received

3.3.2.1 Tensile Properties

Shall be as shown in Table 2.

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

Nominal Diameter or Thickness Inches	Tensile Strength ksi Round Wire	Tensile Strength ksi Square or Flat Wire
Up to 0.250, incl	190	175
Over 0.250 to 0.625, incl	160	160

Table 2B - Minimum tensile properties, SI units

Nominal Diameter or Thickness Millimeters	Tensile Strength MPa Round Wire	Tensile Strength MPa Square or Flat Wire
Up to 6.35, incl	1310	1207
Over 6.35 to 15.88, incl	1103	1103

3.3.2.2 Wrapping

Wire shall withstand, without cracking, wrapping at room temperature five full, closely-spaced turns around a diameter as shown in Table 3.

Table 3 - Wrapping parameters

Wire Shape	Wrapping Diameter
Round	4X Nominal Diameter of Wire
Square	4X Nominal Diagonal of Wire
Flat	4X Nominal Width of Wire

3.3.3 Response to Precipitation Heat Treatment (see 8.2):

3.3.3.1 Tensile Properties:

Shall be as shown in Table 4, determined on wire precipitation heat treated by heating to 1200 °F ± 25 °F (649 °C ± 14 °C), holding at heat for 4 hours ± 0.25 hour, and cooling at a rate equivalent to air cooling.

Table 4A - Minimum tensile strength, inch/pound units

Nominal Diameter or Thickness Inches	Tensile Strength ksi
0.012 to 0.250, incl	220
Over 0.250 to 0.418, incl	200
Over 0.418 to 0.625, incl	180

Table 4B - Minimum tensile strength, SI units

Nominal Diameter or Thickness Millimeters	Tensile Strength MPa
0.30 to 6.35, incl	1517
Over 6.35 to 10.62, incl	1379
Over 10.62 to 15.88, incl	1241

3.3.4 Response to Solution and Precipitation Heat Treatment (Spring Temper, see 8.3)

3.3.4.1 Tensile Properties

Shall be as shown in Table 5, determined on wire solution heat treated by heating to 2100 °F ± 25 °F (1149 °C ± 14 °C), holding at heat for 2 hours ± 0.25 hour, and cooling at a rate equivalent to air cooling, and precipitation heat treated by heating to 1550 °F ± 25 °F (843 °C ± 14 °C), holding at heat for 24 hours ± 0.5 hour, cooling at a rate equivalent to air cooling, reheating to 1300 °F ± 25 °F (704 °C ± 14 °C), holding at heat for 20 hours ± 0.5 hour, and cooling at a rate equivalent to air cooling.

Table 5A - Minimum tensile strength, inch/pound units

Nominal Diameter or Thickness Inches	Tensile Strength ksi
0.012 to 0.250, incl	150
Over 0.250 to 0.625, incl	145

Table 5B - Minimum tensile strength, SI units

Nominal Diameter or Thickness Millimeters	Tensile Strength MPa
0.30 to 6.35, incl	1034
Over 6.35 to 15.88, incl	1000

3.3.5 Mechanical property requirements for product outside the size range covered by 1.1 shall be agreed upon between purchaser and producer and reported per 4.4.2.

3.4 Quality

Wire, as received by purchaser, shall be uniform in quality and condition and free from kinks, twists, scrapes, splits, cold shuts, and other imperfections detrimental to usage of the wire. The surface of the wire shall be free from lubricant and have a bright, smooth finish free from pits, abrasions, and other defects.

3.5 Tolerances

Shall be as follows:

3.5.1 Round and Square Wire

Shall be as shown in Table 6.

Table 6A - Round and square wire tolerance, inch/pound units

Nominal Diameter or Thickness Inches	Tolerance, Inches Plus and Minus
0.003 to 0.005, excl	0.0001
0.005 to 0.008, excl	0.0002
0.008 to 0.012, excl	0.0003
0.012 to 0.024, excl	0.0004
0.024 to 0.033, excl	0.0005
0.033 to 0.044, excl	0.0008
0.044 to 0.312, excl	0.0010
0.312 to 0.500, excl	0.0015
0.500 to 0.625, incl	0.0020

Table 6B - Round and square wire tolerance, SI units

Nominal Diameter or Thickness Millimeters	Tolerance Millimeter Plus and Minus
0.08 to 0.13, excl	0.003
0.13 to 0.20, excl	0.005
0.20 to 0.30, excl	0.008
0.30 to 0.61, excl	0.010
0.61 to 0.84, excl	0.013
0.84 to 1.12, excl	0.020
1.12 to 7.92, excl	0.025
7.92 to 12.70, excl	0.038
12.79 to 15.88, incl	0.051

3.5.2 Out-of-Roundness

Round wire shall not be out-of-round by more than one-half the total permissible tolerance in 3.5.1.

3.5.3 Flat Wire 0.062 to 0.375 Inch (1.57 to 9.52 mm), Inclusive, in Nominal Width

Shall be as shown in Table 7:

Table 7A - Flat wire tolerances, inch/pound units

Nominal Thickness Inches	Tolerance, Inches Plus and Minus Thickness	Tolerance, Inches Plus and Minus Width
Up to 0.028, excl	0.0010	0.005
0.029 to 0.035, excl	0.0015	0.005
0.035 to 0.3125, incl	0.0020	0.005

Table 7B - Flat wire tolerances, SI units

Nominal Thickness Millimeters	Tolerance, Millimeters Plus and Minus Thickness	Tolerance, Millimeters Plus and Minus Width
Up to 0.74, excl	0.025	0.13
0.74 to 0.89, excl	0.038	0.13
0.89 to 7.94, incl	0.051	0.13

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of wire 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 wire conforms to specified requirements.

4.2 Classification of Tests

All technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling and Testing

Shall be in accordance with AMS2371.

4.4 Reports

4.4.1 The vendor of wire shall furnish with each shipment a report showing the vendor'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 results of tests for composition of each heat and for tensile properties and wrapping as supplied, tensile properties after precipitation heat treatment, tensile properties after solution and precipitation heat treatment of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot number, AMS5699H, size, and quantity.

4.4.2 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions are taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS5699H(EXC) because of the following exceptions:" and the specific exceptions shall be listed (also see 5.2.3).

4.5 Resampling and Retesting

Shall be in accordance with AMS2371.

5. PREPARATION FOR DELIVERY

5.1 Wire shall be supplied on spools or in coils except when straight lengths are ordered.

5.2 Identification

5.2.1 Spools and Coils

Shall each be legibly marked, on a durable tag or label, with not less than the manufacturer's identification, purchase order number, AMS5699H, nominal size, and quantity; boxes or drums shall be marked with the same information.