

AEROSPACE MATERIAL SPECIFICATION

AMS 5699E

Submitted for recognition as an American National Standard

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Superseding AMS 5699D

ALLOY WIRE, CORROSION AND HEAT RESISTANT
72Ni - 15.5Cr - 0.95(Cb+Ta) - 2.5Ti - 0.70Al - 7.0Fe
Spring Temper, Precipitation Hardenable

UNS N07750

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.
- 1.2 Application: Primarily for helical springs for use at elevated temperatures.
- 1.2.1 Direct precipitation hardening as in 3.3.2, after coiling, produces optimum stress and low relaxation up to 700°F (371°C).
- 1.2.2 Solution and precipitation heat treatment as in 3.3.3, after coiling, produces optimum resistance to relaxation combined with fairly fine and uniform grain size for use in service at 1000° - 1300°F (538° - 704°C).

- ## 2. APPLICABLE DOCUMENTS:
- The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

- AMS 2269 - Chemical Check Analysis Limits, Wrought Nickel Alloys and Cobalt Alloys
- AMS 2350 - Standards and Test Methods
- AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock

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2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM E 8 - Tension Testing of Metallic Materials

ASTM E 8M - Tension Testing of Metallic Materials (Metric)

ASTM E 354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and other Similar Iron, Nickel, and Cobalt Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	--	0.08
Manganese	--	1.00
Silicon	--	0.50
Sulfur	--	0.010
Chromium	14.00 -	17.00
Nickel + Cobalt	70.00	--
Columbium + Tantalum	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 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

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° - 2200°F (1093° - 1204°C) before reducing to the size ordered.

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

3.2.2 Wire over 0.250 inch (6.35 mm) in nominal diameter or thickness shall be cold reduced not less than 30% following solution heat treatment.

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

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3.3 Properties: Wire shall conform to the following requirements; tensile testing shall be performed in accordance with ASTM E 8 or ASTM E 8M:

3.3.1 As Received:

3.3.1.1 Tensile Properties: Shall be as specified in Table I.

TABLE I

Nominal Diameter or Thickness Inch	Tensile Strength, psi, minimum	
	Round Wire	Square or Flat Wire
Up to 0.250, incl	190,000	175,000
Over 0.250 to 0.625, incl	160,000	160,000

TABLE I (SI)

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

3.3.1.2 Wrapping: Wire shall withstand, without cracking, wrapping at room temperature, five full closely-spaced turns around a diameter equal to the following:

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

3.3.2 After Precipitation Heat Treatment:

3.3.2.1 Tensile Properties: Shall be as specified in Table II, determined on wire precipitation heat treated by heating to $1200^{\circ}\text{F} \pm 25$ ($649^{\circ}\text{C} \pm 14$), holding at heat for $4 \text{ hours} \pm 0.25$, and cooling in air.

TABLE II

Nominal Diameter or Thickness Inch	Tensile Strength psi, minimum
0.012 to 0.250, incl	220,000
Over 0.250 to 0.418, incl	200,000
Over 0.418 to 0.625, incl	180,000

TABLE II (SI)

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

3.3.3 After Solution and Precipitation Heat Treatment:

- 3.3.3.1 Tensile Properties: Shall be as specified in Table III, determined on wire solution heat treated by heating to $2100^{\circ}\text{F} \pm 25$ ($1149^{\circ}\text{C} \pm 14$), holding at heat for 2 hours ± 0.25 , and cooling in air and precipitation heat treated by heating to $1550^{\circ}\text{F} \pm 25$ ($843^{\circ}\text{C} \pm 14$), holding at heat for 24 hours ± 0.5 , air cooling, reheating to $1300^{\circ}\text{F} \pm 25$ ($704^{\circ}\text{C} \pm 14$), holding at heat for 20 hours ± 0.5 , and cooling in air.

TABLE III

Nominal Diameter or Thickness Inch	Tensile Strength psi, minimum
0.012 to 0.250, incl	150,000
Over 0.250 to 0.625, incl	145,000

TABLE II (SI)

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

- 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:TABLE IV

Nominal Diameter or Thickness Inch	Tolerance, inch 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 IV (SI)

Nominal Diameter or Thickness Millimetres	Tolerance, Millimetre 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
12.70 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), Incl, in Nominal Width:

TABLE V

Nominal Thickness Inch	Tolerance, Inch plus and minus	
	Thickness	Width
Up to 0.029, 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