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AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5699D

Issued 6-15-53
Revised 1-1-87

Superseding AMS 5699C

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

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 in. (15.50 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 (370°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 (540° - 705°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E354 - 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 E354 or by spectrographic or other analytical methods approved by purchaser:

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	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 (3.1.1)	--	1.00
Copper	--	0.50

3.1.1 Determination not required for routine acceptance.

3.1.2 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

3.2 Condition: Cold drawn from hot finished wire or rod which has been previously ground or has had surface preparation (other than by pickling) for removal of seams or other injurious surface imperfections. Wire shall be heat treated by heating to 2100°F (1150°C) or higher before reducing to the size ordered. Sizes 0.250 in. (6.25 mm) and under in nominal diameter or thickness shall be copper coated and reduced 50% to 65%. Sizes over 0.250 in. (6.25 mm) in nominal diameter or thickness shall be copper coated and reduced not less than 30%.

3.3 Properties: Wire shall conform to the following requirements; tensile testing shall be performed in accordance with ASTM E8:

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, min	
	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, min	
	Round Wire	Square or Flat Wire
Up to 6.25, incl	1310	1205
Over 6.25 to 15.50, incl	1105	1105

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°F ± 25 (650°C ± 15), holding at heat for 4 hr ± 0.25, and cooling in air.

TABLE II

Nominal Diameter or Thickness Inch	Tensile Strength psi, min
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, min
0.30 to 6.25, incl	1515
Over 6.25 to 10.50, incl	1380
Over 10.50 to 15.50, incl	1240

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°F + 25 (1150°C + 15), holding at heat for 2 hr ± 0.25 and cooling in air and precipitation heat treated by heating to 1550°F ± 25 (845°C ± 15), holding at heat for 24 hr ± 0.5, air cooling, reheating to 1300°F ± 25 (705°C ± 15), holding at heat for 20 hr ± 0.5, and cooling in air.

TABLE III

Nominal Diameter or Thickness Inch	Tensile Strength psi, min
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, min
0.30 to 6.25, incl	1035
Over 6.25 to 15.50, incl	1000

3.4 Quality: Wire, as received by purchaser, shall be uniform in quality and condition, sound, free from foreign materials, kinks, twists, scrapes, splits, cold shuts, and other imperfections detrimental to usage of the wire.

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 0.12, excl	0.003
0.12 to 0.20, excl	0.005
0.20 to 0.30, excl	0.008
0.30 to 0.60, excl	0.010
0.60 to 0.82, excl	0.012
0.82 to 1.10, excl	0.020
1.10 to 7.80, excl	0.025
7.80 to 12.50, excl	0.038
12.50 to 15.50, incl	0.050

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 In. (1.55 to 9.50 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