SAE The Engineering Society For Advancing Mobility Land Sea Air and Space

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4959B

Issued 7-1-76
Revised 7-1-87

Superseding AMS 4959A

TITANIUM ALLOY WIRE
13.5V - 11Cr - 3Al
Spring Temper

UNS R58010

1. SCOPE:

1.1 Form: This specification covers a titanium alloy in the form of cold drawn wire.

1.2 Application: Primarily for springs requiring corrosion resistance and high tensile strength.

1.3 Classification: Wire shall be classified as follows:

Type 1 - Centerless ground

Type 2 - As drawn

1.3.1 Either Type 1 or Type 2 may be supplied unless a specific type is ordered.

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 2249 - Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS 2350 - Standards and Test Methods

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 E120 - Chemical Analysis of Titanium and Titanium 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, Ø determined by wet chemical methods in accordance with ASTM E120 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Vanadium	12.50 -	14.50
Chromium	10.00 -	12.00
Aluminum	2.50 -	3.50
Iron	--	0.35
Oxygen	--	0.17
Carbon	--	0.05
Nitrogen	--	0.050 (500 ppm)
Hydrogen	--	0.030 (300 ppm)
Yttrium (3.1.1)	--	0.005 (50 ppm)
Residual Elements, each (3.1.1)	--	0.10
Residual Elements, total (3.1.1)	--	0.40
Titanium	remainder	

3.1.1 Determination not required for routine acceptance.

3.1.2 Check Analysis: Composition variations shall meet the requirements of AMS 2249.

3.2 Condition: Spring temper, cold drawn to required size. When Type 1 is supplied, wire shall be centerless ground to size after the final cold drawing operation.

3.2.1 Wire ordered in coil form shall be coated with a lubricant suitable for use on automatic spring winding machines.

3.3 Properties: Wire shall conform to the following requirements:

3.3.1 As Cold Drawn:

3.3.1.1 Wrapping: Wire shall withstand, without cracking, wrapping at room temperature one full turn around a diameter equal to the nominal diameter of the wire.

3.3.1.2 Coiling: Wire shall show a uniform pitch with no splits or fractures when wound in a tightly closed coil on an arbor having a diameter as specified in Table I and the resultant coil stretched to a permanent set of four times its wound length.

TABLE I

Nominal Diameter (D) Inch	Arbor Diameter Inch
Up to 0.034, incl	0.102
Over 0.034 to 0.045, incl	0.145
Over 0.045 to 0.055, incl	0.212
Over 0.055 to 0.125, incl	0.250
Over 0.125	2D

TABLE I (SI)

Nominal Diameter (D) Millimetres	Arbor Diameter Millimetres
Up to 0.85, incl	2.55
Over 0.85 to 1.12, incl	3.60
Over 1.12 to 1.38, incl	5.30
Over 1.38 to 3.12, incl	6.25
Over 3.12	2D

3.3.2 After Aging: Wire shall have the following properties after being aged by heating to 800°F ± 10 (425°C ± 5), holding at heat for 10 hr ± 0.25, and cooling in air:

3.3.2.1 Tensile Properties: Shall be as specified in Table II, determined in accordance with ASTM E8:

Ø

TABLE II

Nominal Diameter Inch	Tensile Strength psi	Elongation in 4D %, min	Reduction of Area %, min
Up to 0.065, incl	250,000 - 300,000	4	17
Over 0.065 to 0.100, incl	240,000 - 290,000	5	17
Over 0.100 to 0.160, incl	230,000 - 280,000	5	18
Over 0.160 to 0.225, incl	220,000 - 270,000	6	18
Over 0.225 to 0.376, incl	210,000 - 260,000	6	20
Over 0.376 to 0.500, incl	200,000 - 240,000	6	20
Over 0.500 to 0.561, incl	180,000 - 220,000	6	20

TABLE II (SI)

Nominal Diameter Millimetres	Tensile Strength MPa	Elongation in 4D %, min	Reduction of Area %, min
Up to 1.62, incl	1725 - 2070	4	17
Over 1.62 to 2.50, incl	1655 - 2000	5	17
Over 2.50 to 4.00, incl	1585 - 1930	5	18
Over 4.00 to 5.62, incl	1515 - 1860	6	18
Over 5.62 to 9.40, incl	1450 - 1795	6	20
Over 9.40 to 12.50, incl	1380 - 1655	6	20
Over 12.50 to 14.00, incl	1240 - 1515	6	20

3.4 Quality:

3.4.1 Alloy shall be produced by multiple melting using consumable electrode practice. At least one of the melting cycles shall be under vacuum.

3.4.2 Wire, 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 wire.

3.4.2.1 The surface of the wire shall have a smooth finish free from pits and abrasions, and shall be cylindrical, clean, and free from kinks, twists, scrapes, splits, and other imperfections.

3.5 Tolerances: Wire shall conform to the tolerances shown in 3.5.1 and 3.5.2.

3.5.1 Diameter: Shall be as specified in Table III.

TABLE III

Nominal Diameter Inch	Tolerance, Inch plus and minus
Up to 0.032, incl	0.0005
Over 0.032 to 0.042, incl	0.00075
Over 0.042 to 0.312, incl	0.001
Over 0.312	0.0015

TABLE III (SI)

Nominal Diameter Millimetres	Tolerance, Millimetre plus and minus
Up to 0.80, incl	0.012
Over 0.80 to 1.05, incl	0.019
Over 1.05 to 7.80, incl	0.025
Over 7.80	0.038

3.5.2 Length: Shall be +2.00 in. (+50.0 mm), -0.

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 performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the wire conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling: Shall be in accordance with the following; a lot shall be all wire of the same nominal size from the same heat processed at one time:

4.3.1 Composition: One sample from each heat except that for hydrogen determinations one sample from each lot, obtained after thermal and chemical processing is completed.