AEROSPACE MATERIAL SPECIFICATION

AMS4951™	REV. K
Issued 1958-03 Revised 2022-05 Superseding AMS4951J	

Titanium Welding Wire
Commercially Pure
Environment Controlled Packaging
(Composition similar to UNS R50120)

RATIONALE

AMS4951K results from a Five-Year Review and update of this specification with changes to update general agreement language related to unauthorized exceptions (3.8, 4.4.1, 5.3, 8.5), update applicable documents (Section 2, 8.2), composition (3.1), and allow the use of the immediate prior specification revision (8.4).

1. SCOPE

1.1 Form

This specification covers one grade of commercially pure titanium in the form of wire for welding filler metal.

1.2 Application

This wire has been used typically as filler metal for gas-metal-arc and gas-tungsten-arc welding with chemistry matched to unalloyed titanium UNS R50400, but usage is not limited to such applications.

1.3 Classification

Product covered by this specification is classified by melting practice as follows:

Type I: Multiple melted with vacuum arc remelting as the last melting cycle.

Type II: Single melted using either the electron beam cold hearth or plasma arc cold hearth method.

1.3.1 Unless a specific type is ordered, either type may be supplied.

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.

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/AMS4951K/

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.

AMS2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

AMS2814 Packaging and Marking of Packages of Welding Wire Premium Quality

AMS2816 Identification, Welding Wire, Tab Marking Method

AMS2819 Identification, Welding Wire Direct Color Code System

ARP1876 Weldability Test for Weld Filler Metal Wire

ARP4926 Alloy Verification and Chemical Composition Inspection of Welding Wire

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 E539 Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry

ASTM E1409 Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion

ASTM E1447 Determination of Hydrogen in Titanium and Titanium Alloys by Inert Gas Fusion Thermal Conductivity/Infrared Detection Method

ASTM E1941 Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis

ASTM E2371 Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Test Methodology)

ASTM E2994 Analysis of Titanium and Titanium Alloys by Spark Atomic Emission Spectrometry and Glow Discharge Atomic Emission Spectrometry (Performance-Based Test Method)

3. TECHNICAL REQUIREMENTS

3.1 Wire Composition

Shall conform to the percentages by weight shown in Table 1; carbon shall be determined in accordance with ASTM E1941, hydrogen in accordance with ASTM E1447, oxygen and nitrogen in accordance with ASTM E1409, and other elements in accordance with ASTM E539, ASTM E2371, or ASTM E2994. Other analytical methods may be used if acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Iron	--	0.12
Oxygen (3.1.1.1)	0.08	0.16
Carbon (3.1.1.1)	--	0.03
Nitrogen (3.1.1.1)	--	0.015
Hydrogen (3.1.1.1)	--	0.005 (50 ppm)
Yttrium (3.1.1.2)	--	0.005 (50 ppm)
Other Elements, each (3.1.1.2)	--	0.05
Other Elements, total (3.1.1.2)	--	0.20
Titanium	remainder	

3.1.1 Except for carbon, oxygen, nitrogen, and hydrogen, chemical analysis of initial ingot, bar, or rod stock before drawing is acceptable provided the processes used for drawing or rolling, annealing, and cleaning are controlled to ensure continued conformance to composition requirements.

3.1.1.1 Carbon, oxygen, nitrogen, and hydrogen shall also be determined on each lot of finished wire.

3.1.1.2 Determination not required for routine acceptance.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2249.

3.2 Melting Practice

Type I shall be multiple melted with the last melting cycle under vacuum. When multiple melted, melting cycle(s) prior to the final melting cycle shall be made using vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice(s). The final melting cycle shall be made using vacuum arc remelting (VAR) practice with no alloy additions permitted.

Type II shall be single melted using electron beam cold hearth or plasma arc cold hearth melting practice.

3.2.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be inert gas at a pressure not higher than 1000 mm of mercury (Hg).

3.2.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.3 Condition

As drawn, having tensile strength not higher than 130 ksi (896 MPa), determined in accordance with ASTM E8/E8M, and descaled.

3.4 Fabrication

3.4.1 Wire shall be rolled or drawn from rod or bar descaled by a process that does not affect the composition of the wire. Surface irregularities inherent with a forming process that does not tear the wire surface are acceptable provided the wire conforms to the tolerances of 3.7.

3.4.2 In-process annealing, if required between cold rolling or drawing operations, shall be performed after cleaning the material and in a vacuum or in protective inert atmosphere to avoid surface oxidation and adsorption of other extraneous elements unless the contaminated surface is subsequently removed mechanically or chemically.

3.4.3 Butt welding is permissible provided both ends to be joined are from the same heat and lot of material being processed at the same time, or the repair of a wire break is made at the wire processing station, or identity of the ends maintained if the wire break is butt welded away from the wire processing station. The butt weld shall not interfere with the uniform, uninterrupted feeding of the wire in machine welding equipment.

3.4.4 Drawing compounds, oxides, dirt, oil, and other foreign materials shall be removed by cleaning processes which will neither result in pitting, nor cause gas absorption by the wire, nor deposition of substances harmful to welding operations.

3.4.5 Surface contaminants or dissolved hydrogen picked up during wire processing that can adversely affect the welding characteristics, the operation of the equipment, or the properties of the weld metal shall be removed.

3.5 Properties

Wire shall conform to the following requirements:

3.5.1 Weldability

Melted wire shall flow smoothly and evenly during welding and shall produce acceptable welds. ARP1876 may be used to resolve disputes.

3.5.2 Spooled Wire

Shall conform to 3.5.2.1, 3.5.2.2, and 3.5.2.3.

3.5.2.1 Winding

Filler metal in coils and on spools shall be wound so that kinks, waves, sharp bends, overlapping, or wedging are not encountered, leaving the filler metal free to unwind without restriction. The outside end of the electrode (the end where welding is to begin) shall be identified so it can be located readily and shall be fastened to avoid unwinding. The winding shall be level winding.

3.5.2.2 Cast

Wire, wound on standard diameter spools as shown in Table 2 shall have imparted to it a curvature such that a specimen sufficient in length to form one loop with a 1 inch (25 mm) overlap, when cut from the spool and laid on a flat surface, shall form a circle (cast) within the limits shown in Table 2.

3.5.2.3 Helix

The specimen on which cast was determined, when laid on a flat surface and measured between adjacent turns, shall show a vertical separation (helix) not greater than shown in Table 2.

Table 2A - Cast and helix requirements - inch/pound units

Spool Diameter Inches	Cast Inches Min	Cast Inches Max	Helix Inches Max
4	2.5	9	0.50
8	10	20	0.75
12	15	30	1.00

Table 2B - Cast and helix requirements, SI units

Spool Diameter Millimeters	Cast Millimeters Min	Cast Millimeters Max	Helix Millimeters Max
102	64	229	13
203	254	508	19
305	381	762	25

3.6 Quality

Wire, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to welding operations, operation of welding equipment, or properties of the deposited weld metal.

3.7 Sizes and Tolerances

Wire shall be supplied in the sizes and to the tolerances shown in 3.7.1 and 3.7.2.

3.7.1 Diameter

Shall be as shown in Table 3.

Table 3A - Sizes and diameter tolerances, inch/pound units

Form	Nominal Diameter Inches	Tolerance, Inches Plus	Tolerance, Inches Minus
Cut Lengths	0.030, 0.045, 0.062, 0.078	0.002	0.002
Cut Lengths	0.094, 0.125, 0.156, 0.188	0.002	0.002
Spools	0.007, 0.010, 0.015	0.0005	0.0005
Spools	0.020, 0.030, 0.035, 0.045	0.001	0.002
Spools	0.062, 0.078, 0.094	0.002	0.002

Table 3B - Sizes and diameter tolerances, SI units

Form	Nominal Diameter Millimeters	Tolerance, Millimeters Plus	Tolerance, Millimeters Minus
Cut Lengths	0.76, 1.14, 1.57, 1.98	0.05	0.05
Cut Lengths	2.39, 3.18, 3.96, 4.78	0.05	0.05
Spools	0.18, 0.25, 0.38	0.013	0.013
Spools	0.51, 0.76, 0.89, 1.14	0.03	0.05
Spools	1.57, 1.98, 2.39	0.05	0.05

3.7.2 Length

Cut lengths shall be furnished in 36 inch (914 mm) length, unless specified otherwise. Other standard lengths are 12, 18, or 27 inch (305, 457, or 686 mm). Length, as ordered, shall not vary more than +0, -0.5 inch (+0, -13 mm) from the length ordered.

3.8 Exceptions

Any exceptions shall be authorized by purchaser and reported as in 4.4.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of wire shall supply all samples for producer'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

4.2.1 Acceptance Tests

Composition (3.1), condition (3.3), tolerances (3.7), and alloy verification (5.2) are acceptance tests and shall be performed on each heat or lot as applicable.