Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4956A
Superseding AMS 4956
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UNS R56401

TITANIUM ALLOY WIRE, WELDING
6Al - 4V - Extra Low Interstitial
Environment Controlled

1. SCOPE:

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

1.2 Application: Primarily for premium-quality, gas-tungsten-arc welding of base metal of similar composition intended for cryogenic or elevated temperature applications, particularly for use with equipment providing continuous inert gas shielding of the wire as it passes from the dispenser to the welding arc, where high reliability of joints is required.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 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
AMS 2814 - Packaging of Welding Wire, Premium Quality
AMS 2815 - Identification, Welding Wire, Line Code System
AMS 2816 - Identification, Welding Wire, Color Code System

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

ASTM E120 - Chemical Analysis of Titanium and Titanium Alloys

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

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Specifications:

MIL-W-10430 - Welding Rods and Electrodes, Preparation for Delivery of

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E120, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Aluminum	5.50	6.75
Vanadium	3.50	4.50
Iron	--	0.15
Oxygen	--	0.08
Carbon	--	0.03
Nitrogen	--	0.012 (120 ppm)
Hydrogen	--	0.005 (50 ppm)
Yttrium	--	0.005 (50 ppm)
Residual Elements, each (3.1.1)	--	0.03
Residual Elements, total (3.1.1)	--	0.10
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: Vacuum annealed.

3.2.1 Wire shall be formed from bar descaled by a process which does not affect the composition of the alloy. Surface irregularities inherent with a forming process which does not tear the wire surface are acceptable provided the wire conforms to the tolerances of 3.5 and the irregularities are free from contaminants.

3.2.2 Wire shall be furnished on disposable spools for machine welding or in cut lengths for manual welding, as ordered.

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

3.2.4 Wire shall be vacuum degassed after cleaning as in 3.2.3.

3.3 Properties: Wire shall conform to the following requirements:

3.3.1 Weldability: Melted wire shall flow smoothly and evenly during welding and shall produce acceptable welds, determined by a procedure agreed upon by purchaser and vendor.

3.3.2 Spooled Wire: Shall conform to 3.3.2.1 and 3.3.2.2, unless otherwise agreed upon by purchaser and vendor.

3.3.2.1 Cast: Wire shall have imparted to it a curvature such that a specimen sufficient in length to form one loop, when cut from the spool and laid on a flat surface, shall form a circle not less than 15 in. (380 mm) and not greater than 30 in. (760 mm) in diameter.

3.3.2.2 Helix: The specimen on which cast was determined, when laid on a flat surface and measured between adjacent turns, shall show a vertical separation not greater than 1 in. (25 mm).

3.4 Quality:

3.4.1 Alloy shall be produced by multiple melting using consumable electrode practice, unless otherwise permitted; 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 ø foreign materials and from internal and external imperfections detrimental to welding operations, operation of welding equipment, or properties of the deposited weld metal.

3.5 Sizes and Tolerances: Unless otherwise specified, wire shall be supplied in the sizes and to the tolerances shown in 3.5.1 and 3.5.2.

3.5.1 Diameter:

ø

TABLE I

Form	Nominal Diameter Inch	Tolerance, Inch plus	minus
Cut Lengths	0.030, 0.045, 0.062, 0.078, 0.093, 0.125	0.003	0.003
Spools	0.062, 0.078, 0.093	0.002	0.002
Spools	0.030, 0.035, 0.045	0.001	0.002

TABLE I (SI)

Form	Nominal Diameter Millimetres	Tolerance, Millimetres plus	minus
Cut Lengths	0.75, 1.15, 1.55, 2.00, 2.35, 3.20	0.08	0.08
Spools	1.55, 2.00, 2.35	0.05	0.05
Spools	0.75, 0.90, 1.15	0.03	0.05

3.5.2 Length: Cut lengths shall be furnished in 18, 27, or 36 in. (455, 685, or 915 mm) lengths, as ordered, and shall not vary more than +0, -0.5 in. (-13 mm) from the length ordered.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of wire shall supply all samples and shall be responsible ø for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the wire conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for composition (3.1) and ø tolerances (3.5) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for weldability (3.3.1), cast ø (3.3.2.1), and helix (3.3.2.2) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the first-article ø shipment of wire to a purchaser, when a change in material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, pre-production test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be as follows; a lot shall be all wire of the same nominal size from the same heat processed at the same time:

4.3.1 Acceptance Tests:

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

4.3.1.2 Other Requirements: As agreed upon by purchaser and vendor.

4.3.2 Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample wire shall be approved by purchaser before wire for production use is supplied, unless such approval be waived. Results of tests on production wire shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use materials, manufacturing procedures and processes, and methods of inspection on production wire which are essentially the same as those used on the approved sample wire. If any change is necessary in materials or in manufacturing procedures and processes, vendor shall submit for reapproval a statement of the proposed changes in material and processing and, when requested, sample wire. Production wire made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Reports:

4.5.1 The vendor of wire shall furnish with each shipment three copies of a report showing the results of tests for chemical composition of each heat and for the hydrogen content of each lot, and stating that the wire conforms to the other technical requirements of this specification. This report shall include the purchase order number, lot number, material specification number and its revision letter, nominal size, and quantity from each heat.

4.5.2 When parts made of this wire or assemblies requiring use of this welding wire are supplied, the part or assembly manufacturer shall inspect each lot of wire to determine conformance to the requirements of this specification and shall furnish with each shipment three copies of a report stating that the wire conforms. This report shall include the purchase order number, material specification number and its revision letter, part or assembly number, and quantity.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the wire may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the wire represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Layer Winding: Wire furnished on spools shall be closely wound in layers but adjacent turns within a layer need not necessarily be touching; shall be wound so as to avoid producing kinks, waves, and sharp bends; and shall be free to unwind without restriction caused by overlapping or wedging. The outside end of the spooled wire shall be so treated that it may be readily located.