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400 COMMONWEALTH DRIVE WARRENDALE PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4914

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Revised

TITANIUM ALLOY SHEET AND STRIP
15V - 3.0Cr - 3.0Sn - 3.0Al
Solution Heat Treated

1. SCOPE:

1.1 Form: This specification covers a titanium alloy in the form of sheet and strip.

1.2 Application: Primarily for parts to be formed in the solution heat treated condition and subsequently precipitation heat treated. Suitable for parts, such as pressure vessels and aircraft structures, requiring high strength-to-weight ratio and stability up to 550°F (290°C) in the precipitation heat treated condition.

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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2242 - Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
MAM 2242 - Tolerances, Metric, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
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 E112 - Estimating the Average Grain Size of Metals
ASTM E120 - Chemical Analysis of Titanium and Titanium Alloys
ASTM E290 - Semi-Guided Bend Test for Ductility of Metallic Materials

2.3 U.S. 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 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 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	
Vanadium	14.0	16.0	
Chromium	2.5	3.5	
Tin	2.5	3.5	
Aluminum	2.5	3.5	
Iron	--	0.25	
Oxygen	--	0.13	
Carbon	--	0.05	
Nitrogen	--	0.05	(500 ppm)
Hydrogen	--	0.015	(150 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, except that the check analysis tolerance for vanadium shall be 0.50 under min or over maximum.

3.2 Condition: Hot rolled with subsequent cold reduction, solution heat treated, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish.

3.3 Heat Treatment: The product shall be solution heat treated by heating to a temperature within the range 1450° - 1500°F (790° - 815°C), holding at the selected temperature within ±25°F (±15°C) for 3 - 30 min., and cooling at a rate which will produce product meeting the requirements of 3.4 (See 8.1).

3.4 Properties: The product shall conform to the following requirements:

3.4.1 As Solution Heat Treated:

3.4.1.1 Tensile Properties: Shall be as follows on product 0.125 in. (3.00 mm) and under in nominal thickness, determined in accordance with ASTM E8 with the rate of strain maintained at 0.003 - 0.007 in./in. per min. (0.003 - 0.007 mm/mm per min.) through the yield strength and then increased to 0.03 - 0.07 in./in. per min. (0.03 - 0.07 mm/mm per min.) When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer, using a rate of 0.005 in./in. per min. (0.005 mm/mm per min.) through the yield strength and then increased to 0.05 in./in. per min. (0.05 mm/mm per min.) above the yield strength. Tensile property requirements for product over 0.125 in. (3.00 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

Tensile Strength	102,000 - 137,000 psi (705 - 945 MPa)
Yield Strength at 0.2 % offset	100,000 - 121,000 psi (690 - 835 MPa)
Elongation in 2 in. (50 mm) or 4D, min	12%

3.4.1.2 Bending: Product 0.125 in. (3.00 mm) and under in nominal thickness shall withstand, without evidence of cracking when examined at 20X magnification, bending in accordance with ASTM E290 through an angle of 105 deg around a diameter equal to the bend factor times the nominal thickness of the product, using either V-block, U-channel, or free bend procedure with axis of bend parallel to the direction of rolling. Only one of these tests will be required in routine inspection. In case of dispute, results of bend tests using the V-block procedure shall govern.

Nominal Thickness		Bend
Inch	Millimetres	Factor
Up to 0.070, incl	Up to 1.75, incl	4
Over 0.070 to 0.125, incl	Over 1.75 to 3.00, incl	5

3.4.1.2.1 Bending requirements for product over 0.125 in. (3.00 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.1.3 Surface Contamination: The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined by the bend test of 3.4.1.2 or by other method agreed upon by purchaser and vendor.

3.4.2 After Precipitation Heat Treatment: Product 0.125 in. (3.00 mm) and under in nominal thickness shall conform to the following requirements after being precipitation heat treated by heating to 1000°F ±25 (540°C ±15), holding at heat for 8 hr ±0.5, and cooling in air to room temperature. Precipitation heat treatment shall precede final machining of specimens. Property requirements for product over 0.125 in. (3.00 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.2.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8 with the rate of strain maintained at 0.003 - 0.007 in/in. per. min. (0.003 - 0.007 mm/mm per min.) through the yield strength and then increased to 0.03 - 0.07 in/in. per min. (0.03 - 0.07 mm/mm per min.) When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer, using a rate of 0.005 in/in. per min. (0.005 mm/mm per min.) through the yield strength and then increased to 0.05 in./in. per min. (0.05 mm/mm per min.) above the yield strength.

Tensile Strength, min	145,000 psi (1,000 MPa)
Yield Strength at 0.2 % offset	140,000 - 170,000 (965 - 1,170 MPa)
Elongation in 2 in. (50 mm) or 4D, min	7%

3.4.2.2 Grain Size: Shall be predominantly 6 or finer with occasional grains as large as 2 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.5 Quality:

3.5.1 Alloy shall be produced by multiple melting using consumable electrode practice, unless otherwise specified; at least one of the melting cycles shall be under vacuum.

3.5.2 The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from "oil cans" (See 8.2) of depth in excess of the flatness tolerances, ripples, and foreign materials and from internal and external imperfections detrimental to usage of the product.

3.6 Tolerances: Unless otherwise specified, tolerances shall conform to the following:

3.6.1 Thickness, Width, Length, and Straightness: All applicable requirements of AMS 2242 or MAM 2242, except as modified by 3.6.1.1.

3.6.1.1 For thicknesses up to 0.040 in. (1.00 mm), incl, thickness tolerances shall be 7.5% of the specified thickness.

3.6.2 Flatness: Flatness tolerance for product 36 in. (900 mm) and under in width shall be 3% if nominal thickness is under 0.025 in. (0.62 mm) and 2% if nominal thickness is 0.025 to 0.1875 in. (0.62 to 4.75 mm), exclusive. Flatness tolerance for product under 0.1875 in. (4.75 mm) in nominal thickness and over 36 in. (900 mm) wide and for product 0.1875 in. (4.75 mm) and over in nominal thickness in all widths shall be as agreed upon by purchaser and vendor.

3.6.2.1 Flatness shall be determined from the expression 100 H/L where "H" is the distance from the straight edge to the product at the point of greatest separation and "L" is the distance between contact points of a straight edge laid in any direction on the product.

3.6.2.2 Flatness tolerances do not apply to coiled products.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product 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 product 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 product of the same nominal size from the same heat processed at the same 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.

4.3.2 Tensile Properties and Bending: At least one sample from each lot.

4.3.2.1 Specimens for tensile tests of widths 9 in. (225 mm) and over shall be taken with the axis of the specimen perpendicular to the direction of rolling; for widths less than 9 in. (225 mm), specimens shall be taken with the axis parallel to the direction of rolling.

4.3.2.2 For V-block or U-channel bend tests, specimen width shall be not less than 10 times the nominal thickness or 1 in, (25 mm), whichever is greater. For free bend tests, minimum specimen width shall, when possible, be not less than 10 times the nominal thickness; maximum width need not be greater than 1 in. (25 mm).

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for the hydrogen content and tensile and bending properties and grain size of each lot, and stating the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, heat number, AMS 4914, size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 4914, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification and shall include in the report either a statement that the material conforms or copies of laboratory reports showing the results of tests to determine conformance.

4.5 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product 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 product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each sheet and strip shall be marked on one face, in the respective location indicated below, with AMS 4914, heat number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be legible, shall be applied using a suitable marking fluid whose residue shall contain not more than traces of halogen-bearing compounds, and shall be removable in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the product or its performance and shall be sufficiently stable to withstand normal handling.

5.1.1 Flat Strip 6 In. (150 mm) and Under in Width: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm).

5.1.2 Flat Sheet and Flat Strip Over 6 In. (150 mm) in Width: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm), the rows being spaced not more than 6 in. (150 mm) apart and alternately staggered.