AEROSPACE MATERIAL SPECIFICATION

AMS4916	REV. K

Issued 1966-03
Revised 2010-04
Reaffirmed 2014-02

Superseding AMS4916J

Titanium Alloy Sheet, Strip, and Plate
8Al - 1Mo - 1V
Duplex Annealed
(Composition similar to UNS R54810)

RATIONALE

AMS4916K has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet, strip, and plate.

1.2 Application

These products have been used typically for parts requiring strength and fracture toughness up to 800 °F (427 °C), but usage is not limited to such applications.

1.2.1 Certain processing procedures and service conditions may cause these products to become subject to stress-corrosion cracking; ARP982 recommends practices to minimize such conditions.

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**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS4916K

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), or www.sae.org.

AMS2242	Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2631	Ultrasonic Inspection, Titanium and Titanium Alloy Bar and Billet
AMS2750	Pyrometry
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

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, or www.astm.org.

ASTM E 8 / E 8M	Tension Testing of Metallic Materials
ASTM E 290	Bend Testing Material for Ductility
ASTM E 384	Microindentation Hardness of Materials
ASTM E 1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
ASTM E 1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E 1941	Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys
ASTM E 2371	Standard Test Method for Analysis of Titanium and Titanium Alloys by Atomic Emission Plasma Spectrometry

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1; carbon shall be determined in accordance with ASTM E 1941, hydrogen in accordance with ASTM E 1447, oxygen and nitrogen in accordance with ASTM E 1409, and other elements in accordance with ASTM E 2371. Other analytical methods may be used if acceptable to the purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Aluminum	7.35	8.35
Molybdenum	0.75	1.25
Vanadium	0.75	1.25
Iron	--	0.30
Oxygen	--	0.12
Carbon	--	0.08
Nitrogen	--	0.05 (500 ppm)
Hydrogen	--	0.015 (150 ppm)
Yttrium (3.1.1)	--	0.005 (50 ppm)
Other Elements, each (3.1.1)	--	0.10
Other 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 applicable requirements of AMS2249.

3.1.3 For hydrogen analysis, conducted in accordance with ASTM E 1447, sample size may be as large as 0.35 gram.

3.2 Melting Practice

3.2.1 Alloy shall be 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 under vacuum using vacuum arc remelting (VAR) practice with no alloy additions permitted.

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

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

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Sheet and Strip

Hot rolled with or without subsequent cold reduction, duplex annealed, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish (See 8.3).

3.3.2 Plate

Hot rolled, duplex annealed, descaled, and flattened, having a surface appearance comparable to a commercial corrosion-resistant steel No. 1 finish (See 8.3). Plate product shall be produced using standard industry practices designed strictly for the production of plate stock to the procured thickness. Bar, billet, forgings, or forging stock shall not be supplied in lieu of plate.

3.4 Annealing

The product shall be duplex annealed by heating to a temperature within the range 1400 to 1450 °F (760 to 788 °C), holding at the selected temperature within ±25 °F (±14 °C) for 1 to 8 hours, cooling at a rate not faster than 100 °F (56 °C) degrees per hour to below 900 °F (482 °C), cooling to room temperature, reheating to 1450 °F ± 25 (788 °C ± 14), holding at heat for not less than 15 minutes, and cooling in air to room temperature. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 Tensile Properties

Shall be as specified in Table 2, determined in accordance with ASTM E 8 / E 8M with the rate of strain set at 0.005 inch/inch/minute (0.005 mm/mm/minute) and maintained within a tolerance of ±0.002 inch/inch/minute (0.002 mm/mm/minute) through the 0.2% offset yield strain.

TABLE 2A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inches					Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 inches or 4D %
	0.008	to	0.014,	incl	135	120	6
Over	0.014	to	0.025,	incl	135	120	8
Over	0.025	to	0.187,	incl	135	120	10
Over	0.187	to	1.000,	incl	130	120	10
Over	1.000	to	2.000,	incl	125	115	10
Over	2.000	to	4.000,	incl	120	110	8

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness Millimeters					Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
	0.20	to	0.36,	incl	931	827	6
Over	0.36	to	0.64,	incl	931	827	8
Over	0.64	to	4.75,	incl	931	827	10
Over	4.75	to	25.40,	incl	896	827	10
Over	25.40	to	50.80,	incl	862	793	10
Over	50.80	to	101.60,	incl	827	758	8

3.5.2 Bending

Product under 0.1875 inch (4.762 mm) in nominal thickness shall have a test sample prepared nominally 0.750 inch (19.06 mm) in width, with its axis of bending parallel to the direction of rolling. The sample shall be bend tested in conformance with the guided bend test defined in ASTM E 290 through an angle of 105 degrees. The test fixture supports shall have a contact radius 0.010 minimum, and the plunger shall have a radius equal to the bend factor shown in Table 3 times the nominal thickness. Examination of the bent sample shall not show evidence of cracking when examined at 15 to 25X magnification.

TABLE 3 - BEND FACTORS

Nominal Thickness Inch					Nominal Thickness Millimeters					Bend Factor
	Up	to	0.070,	incl		Up	to	1.78,	incl	4
Over	0.070	to	0.1875,	excl	Over	1.78	to	4.762,	excl	4.5

3.5.3 Microstructure

Shall be that structure resulting from processing within the alpha-beta phase field. Microstructure shall conform to 3.5.3.1 or 3.5.3.2 (See 8.2).

3.5.3.1 Equiaxed and/or elongated primary alpha in a transformed beta matrix with no continuous network of alpha at prior beta grain boundaries.

3.5.3.2 Essentially complete field of equiaxed and/or elongated alpha with or without intergranular beta with no continuous network of alpha at prior beta grain boundaries.

3.5.4 Surface Contamination

The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined as in 3.5.4.1, 3.5.4.2, 3.5.4.3, or by other method acceptable to purchaser.

3.5.4.1 The bend test of 3.5.2.

3.5.4.2 Microscopic examination at 400X magnification.

3.5.4.3 Hardness differential; a surface hardness more than 40 points higher than the subsurface hardness, determined in accordance with ASTM E 384 on the Knoop scale using a 200-gram load, being evidence of unacceptable surface contamination.

3.6 Quality

3.6.1 The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from “oil cans” (See 8.4.1) with depth in excess of flatness tolerances, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.6.2 Plate 0.500 to 4.000 inches (12.70 to 101.60 mm), incl, in nominal thickness, ultrasonically inspected in accordance with AMS2631, shall meet Class A1 of that specification.

3.7 Tolerances

Shall conform to the following:

3.7.1 Thickness, Width, Length, and Straightness

All applicable requirements of AMS2242.

3.7.2 Flatness

Flatness tolerance for product 36 inches (914 mm) and under in width shall be 5% if nominal thickness is under 0.025 inch (0.64 mm) and 3% if nominal thickness is 0.025 to 0.1875 inch (0.64 to 4.762 mm), exclusive. Flatness tolerance for product under 0.1875 inch (4.762 mm) in nominal thickness and over 36 inches (914 mm) in nominal width and for product 0.1875 inch (4.762 mm) and over in nominal thickness in all widths shall be as agreed upon by purchaser and vendor.

3.7.2.1 Flatness shall be determined from the expression 100H/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.

3.7.2.2 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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.