

Titanium Alloy Sheet, Strip, and Plate  
8A1 - 1Mo - 1V  
Duplex Annealed

(Composition similar to UNS R54810)

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.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or [www.sae.org](http://www.sae.org).

AMS 2242	Tolerances, 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 2631	Ultrasonic Inspection, Titanium and Titanium Alloy Bar and Billet

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**SAE WEB ADDRESS:**

## 2.1 (Continued):

AMS 2750	Pyrometry
AMS 2809	Identification, Titanium and Titanium Alloy Wrought Products
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

## 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or [www.astm.org](http://www.astm.org).

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 120	Chemical Analysis of Titanium and Titanium Alloys
ASTM E 290	Bend Testing of Material for Ductility
ASTM E 384	Microhardness of Materials
ASTM E 1409	Determination of Oxygen 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 Method

## 3. TECHNICAL REQUIREMENTS:

## 3.1 Composition:

Shall conform to the percentages by weight shown in Table 1; oxygen shall be determined in accordance with ASTM E 1409, hydrogen in accordance with ASTM E 1447, and other elements in accordance with ASTM E 120, by spectrochemical methods, or by other analytical methods acceptable to 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)
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.

3.1.3 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 cold arc cold hearth melting practice. 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 8.4).

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 8.4).

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  $\pm 25$  °F ( $\pm 14$  °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  $\pm 25$  (788 °C  $\pm 14$ ), holding at heat for not less than 15 minutes, and cooling in air to room temperature. Pyrometry shall be in accordance with AMS 2750.

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 or ASTM E 8M with the rate of strain maintained at 0.003 to 0.007 inch/inch/minute (0.003 to 0.007 mm/mm/minute) through the yield strength and then increased so as to produce failure in approximately one additional minute. 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 inch/inch/minute (0.005 mm/mm/minute) through the yield strength and a minimum cross head speed of 0.10 inch (2.5 mm) per minute above the yield strength.

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 0.1875 inch (4.762 mm) and under 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 the angle indicated in Table 3. The test fixture supports shall have a contact radius 0.010 minimum, and the plunger shall have a radius equal to the bend factor times the nominal thickness. Examination of the bent sample shall show no evidence of cracking when examined at 15 to 25X magnification.

TABLE 3 - Bend Factors

Nominal Thickness Inches	Nominal Thickness Millimeters	Bend Factor
Up to 0.070, incl	Up to 1.78, incl	8
Over 0.070 to 0.1875, excl	Over 1.78 to 4.762, excl	9

- 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, 3.5.3.2, or 3.5.3.3 (See 8.3).

- 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, or by other method agreed upon by purchaser and vendor.
- 3.5.4.1 The bend test of 3.5.2.
- 3.5.4.2 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.
- 3.5.4.3 Microscopic examination at 400X magnification.
- 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 8.2.1) 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 AMS 2631, 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 AMS 2242.
- 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 the specified requirements.

##### 4.2 Classification of Tests:

All technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

##### 4.3 Sampling and Testing:

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 and duplex annealed in the same heat treat batch.

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, Bending, Microstructure, and Surface Contamination: One or more samples from each lot.

4.3.2.1 Specimens for tensile tests of widths 9 inches (229 mm) and over shall be taken with the axis of the specimen perpendicular to the direction of rolling; for widths under 9 inches (229 mm), specimens shall be taken with the axis parallel to the direction of rolling.

4.3.2.2 Bend Specimens: Whenever possible, the specimen shall be long enough to permit two separate bends so that each surface is tested in tension.

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

##### 4.4 Reports:

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 hydrogen content, tensile and bending properties, and surface contamination of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 4916G, size, and quantity.