AEROSPACE MATERIAL SPECIFICATION

AMS4990™	REV. C

Issued 2003-04
Revised 2015-12

Superseding AMS4990B

Titanium Alloy Sheet, Strip, and Plate
6Al - 6V - 2Sn
Solution Heat Treated and Aged
(Composition Similar to UNS R56620)

RATIONALE

AMS4990C results from an update of this specification that removes the weight allowance for hydrogen (covered by ASTM E1447) and the grain size requirement, adds AS6279 and revises reporting.

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet, strip, and plate up through 4 inches (101.6 mm).

1.2 Application

This material is typically used for parts requiring high strength-to-weight ratio and stability up to 550 °F (288 °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 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.

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

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/AMS4990C

AMS2631 Ultrasonic Inspection, Titanium and Titanium Alloy Bar, Billet and Plate

AMS2750 Pyrometry

AMS2809 Identification, Titanium and Titanium Alloy Wrought Products

ARP982 Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

AS6279 Industry Standard Practices for Production, Distribution, and Procurement of Metal Stock

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 E290 Bend Testing of Material for Ductility

ASTM E384 Knoop and Vickers Hardness of Materials

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

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

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

ASTM E2371 Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled 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 E1941, hydrogen in accordance with ASTM E1447, oxygen and nitrogen in accordance with ASTM E1409, and other elements in accordance with ASTM E2371. Other analytical methods may be used if acceptable to the purchaser.

Table 1 - Composition

Element	min	max
Aluminum	5.00	6.00
Vanadium	5.00	6.00
Tin	1.50	2.50
Iron	0.35	1.00
Copper	0.35	1.00
Oxygen	--	0.20
Carbon	--	0.05
Nitrogen	--	0.04 (400 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.

3.2 Melting Practice

3.2.1 Alloy shall be multiple melted. The first melt shall be made by vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice. The subsequent melt or melts shall be made under vacuum using vacuum arc remelting (VAR) practice. Alloy additions are not permitted in the final VAR melt.

3.2.1.1 The atmosphere for non-consumable electrode melting shall be vacuum or shall be argon and/or helium at an absolute 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, solution heat treated, descaled, leveled, and precipitation hardened, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish (see 8.3).

3.3.2 Plate

Hot rolled, solution heat treated, flattened, and aged, 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, extrusions, forgings, or forging stock shall not be supplied in lieu of plate.

3.4 Heat Treatment

The product shall be solution heat treated by heating to a temperature 1550 to 1700 °F (843 to 927 °C) holding at the selected temperature within ±25 °F (±14 °C) for 2 to 60 minutes, and cooling at a rate equivalent to an air cool or faster and aged by heating to 875 to 1150 °F ± 15 °F (468 to 621 °C ± 8 °C), holding at heat for 2 to 10 hours, and cooling in air. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

Product shall conform to the following requirements:

3.5.1 Tensile Properties

Shall be as specified in Table 2, determined in accordance with ASTM E8/E8M 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 (see 8.2)

Nominal Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 inches or 4D %
Up to 0.1875, excl	170	160	8 (6) (3.5.1.1)
0.1875 to 1.500, excl	170	160	8
1.500 to 2.500, excl	160	150	6
2.500 to 4.000, incl	150	140	6

Table 2B - Minimum tensile properties, SI units (see 8.2)

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
Up to 4.76, excl	1172	1103	8 (6) (3.5.1.1)
4.76 to 38.10, excl	1172	1103	8
38.10 to 63.50, excl	1103	1034	6
63.50 to 101.60, incl	1034	965	6

3.5.1.1 Elongation value in parentheses is for transverse direction only.

3.5.1.2 Mechanical property requirements for product outside of the range covered by Table 2 shall be agreed upon between purchaser and producer.

3.5.2 Microstructure

Shall be that structure resulting from processing within the alpha-beta phase field. Microstructure shall conform to 3.5.2.1 or 3.5.2.2 (see 8.5).

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

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

3.5.2.3 A microstructure showing a continuous network of alpha in prior beta grain boundaries is not acceptable.

3.5.3 Surface Contamination

The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined as in 3.5.3.1 or 3.5.3.2, or other method acceptable to purchaser.

3.5.3.1 Microscopic examination at 400X minimum.

3.5.3.2 Hardness difference; a surface hardness more than 40 points higher than the subsurface hardness, determined in accordance with ASTM E384 on the Knoop scale using a 200 gram load, being evidence of unacceptable surface contamination.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from “oil cans” (see 8.4) of depth in excess of the flatness tolerances, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.6.1 Ultrasonic Inspection

Plate 0.500 inch (12.70 mm) and over in nominal thickness shall meet Class A1 requirements of AMS2631.

3.7 Tolerances

Shall conform to all applicable requirements of AMS2242.

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279. This requirement becomes effective January 1, 2017.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product 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 product conforms to specified requirements.

4.2 Classification of Tests

Tests for 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 in the same heat treatment 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, Microstructure and Surface Contamination

At least one sample from each lot.

4.3.2.1 Specimens for tensile tests of widths 9 inches (229 mm) and over shall be taken in both the longitudinal and transverse directions; for widths under 9 inches (229 mm), specimens shall be taken in the longitudinal direction.

4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing the producer identity, country where the metal was melted (i.e., final melt in the case of metal processed by multiple melting operations), the results of tests for composition of each heat and for the hydrogen content, tensile properties, surface contamination and ultrasonic quality (if applicable) of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS4990C, specific solution heat and aging treatment use, product form, size, and quantity.

4.4.2 When the product size is outside the range covered by Table 2, the report shall contain a statement to that effect.