



AEROSPACE MATERIAL SPECIFICATION	AMS4899™	REV. F
	Issued	1996-04
	Revised	2025-03
Superseding AMS4899E		
Titanium Alloy, Sheet, Strip, and Plate, 4.5Al - 3V - 2Fe - 2Mo, Annealed (Composition similar to UNS R54700)		

RATIONALE

AMS4899F results from a Five-Year Review and update of this specification with changes to relocate Definitions (see 2.3), add standard note regarding alpha case (see 8.3), and update Applicable Documents (see Section 2), Bending (see 3.5.2), and Ordering Information (see 8.6).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet, strip, and plate up through 4.000 inches (101.60 mm), inclusive (see 8.6).

1.2 Application

These products have been used typically for parts requiring high fracture toughness, fatigue strength, formability, and strength up to 480 °F (249 °C), but usage is not limited to such applications. This alloy is superplastic between 1330 and 1520 °F (721 and 827 °C) and hot formable from 1200 to 1560 °F (649 to 849 °C).

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

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For more information on this standard, visit
<https://www.sae.org/standards/content/AMS4899F/>

AMS2368	Sampling and Testing of Wrought Titanium Raw Material, Except Forgings and Forging Stock
AMS2631	Ultrasonic Inspection, Titanium and Titanium Alloy Bar, Billet, and Plate
AMS2750	Pyrometry
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
AS1814	Terminology for Titanium Microstructures
AS6279	Standard Practice for Production, Distribution, and Procurement of Metal Stock
AS7766	Terms Used in Aerospace Metals Specifications

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 A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
ASTM E8/E8M	Tension Testing of Metallic Materials
ASTM E290	Bend Testing Material for Ductility
ASTM E384	Microindentation Hardness of Materials
ASTM E539	Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry
ASTM E1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion
ASTM E1447	Determination of Hydrogen in Reactive Metal and Reactive Metal Alloys by Inert Gas Fusion with Detection by Thermal Conductivity or Infrared Spectrometry
ASTM E1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
ASTM E2371	Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Test Methodology)
ASTM E2994	Analysis of Titanium and Titanium Alloys by Spark Atomic Emission Spectrometry and Glow Discharge Atomic Emission Spectrometry (Performance-Based Method)

2.3 Definitions

Terms used in AMS are defined in AS7766 and as follows:

2.3.1 Terminology relating to titanium microstructures is presented in AS1814.

2.3.2 Commercial corrosion-resistant steel finishes are defined in ASTM A480/A480M.

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 E539, ASTM E2371, or ASTM E2994. Other analytical methods may be used if acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Aluminum	4.00	5.00
Vanadium	2.50	3.50
Molybdenum	1.80	2.20
Iron	1.70	2.30
Oxygen	--	0.15
Carbon	--	0.08
Nitrogen	--	0.05 (500 ppm)
Hydrogen	--	0.015 (150 ppm)
Yttrium (3.1.1)	--	0.005 (50 ppm)
Other Elements, each (see 3.1.1)	--	0.10
Other Elements, total (see 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

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 using vacuum arc remelting (VAR) practice. Alloy additions are not permitted in the final melt cycle.

3.2.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be argon and/or helium at an absolute pressure not higher than 1000 mm of mercury.

3.2.2 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, annealed, descaled, and leveled, having a surface appearance comparable to the following commercial corrosion-resistant steel finishes as applicable (see 2.3.2):

3.3.1.1 Sheet

Shall be No. 2D finish.

3.3.1.2 Strip

Shall be No. 1 finish.

3.3.2 Plate

Hot rolled, annealed, descaled, and flattened, having a surface appearance comparable to a commercial corrosion-resistant steel No. 1 finish or No. 2D finish (see 2.3.2). 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 substituted for plate.

3.4 Annealing

The product shall be annealed by heating to a temperature within the range 1260 to 1400 °F (682 to 760 °C), holding at the selected temperature within ± 25 °F (± 14 °C) for a time commensurate with product thickness and the heating equipment and procedure used, and cooling at a rate that will produce product meeting the requirements of 3.5. Pyrometry shall be in accordance with AMS2750.

3.4.1 When continuous annealing is used for sheet and strip, process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat-treating lines shall be established by the material producer and validated by testing of product to the requirements of 3.5.

3.5 Properties

The product shall conform to the following requirements and shall meet the requirements of 3.5.1 and 3.5.2 after being reheated to 1325 °F \pm 25 °F (718 °C \pm 14 °C), held at heat for 20 minutes \pm 5 minutes, and cooled at a rate equivalent to an air cool or slower.

3.5.1 Tensile Properties

Shall be as shown in Table 2, determined in accordance with ASTM E8/E8M, with the rate of strain set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (± 0.002 mm/mm/min) 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 %
Up to 0.008, excl	134	126	--
Over 0.008 to 0.025, excl	134	126	6
Over 0.025 to 0.063, excl	134	126	8
Over 0.063 to 0.187, excl	134	126	10
Over 0.187 to 4.000, incl	130	120	10

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 %
Up to 0.20, excl	924	869	--
Over 0.20 to 0.64, excl	924	869	6
Over 0.64 to 1.60, excl	924	869	8
Over 1.60 to 4.75, excl	924	869	10
Over 4.75 to 101.60, incl	896	827	10

3.5.1.1 Tensile property requirements apply in both the longitudinal and transverse directions, but tests in the transverse direction need be made only on product that a specimen not less than 8 inches (203 mm) in length for sheet and strip and 2.5 inches (63.5 mm) in length for plate can be taken. Tests in the transverse direction are not required on product tested in the longitudinal direction.

3.5.1.2 Mechanical property requirements for product outside the size range covered by 1.1 shall be agreed upon between the purchaser and producer and reported per 4.4.2 (see 8.6).

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 E290 through an angle of 105 degrees. The test fixture supports shall have a contact radius 0.010 inch (0.254 mm) 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 - Bending factor

Nominal Thickness Inches	Nominal Thickness Millimeters	Bend Factor
Up to 0.070, incl	Up to 1.78, incl	4.5
Over 0.070 to 0.1875, excl	Over 1.78 to 4.762, excl	5

3.5.3 Microstructure

Shall be that structure resulting from alpha-beta processing. Microstructure shall conform to 3.5.3.1, 3.5.3.2, 3.5.3.3, or 3.5.3.4. A microstructure showing a continuous network of alpha in prior beta grain boundaries is not acceptable (see 2.3.1).

3.5.3.1 Lamellar alpha with some equiaxed alpha in a transformed beta matrix.

3.5.3.2 Equiaxed alpha in a transformed beta matrix.

3.5.3.3 Equiaxed alpha and/or elongated alpha in a transformed beta matrix.

3.5.3.4 Partially broken and distorted grain boundary alpha with plate-like alpha.

3.5.4 Surface Contamination

The product shall be free of any oxygen-rich layer, such as alpha case (see 8.3) or other surface contamination, determined as in 3.5.4.1, 3.5.4.2, 3.5.4.3, or other method acceptable to the purchaser (see 8.6).

3.5.4.1 The bend test of 3.5.2.

3.5.4.2 Microscopic examination at 400X minimum.

3.5.4.3 Hardness Difference

A surface hardness more than 40 points higher than the subsurface hardness, determined in accordance with ASTM E384 on the Knoop scale or the Vickers scale using a 200-g load, shall be evidence of unacceptable surface contamination.

3.6 Quality

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

3.6.1 Ultrasonic Inspection

Plate 0.500 inches (12.70 mm) and over in nominal thickness shall be ultrasonically inspected in accordance with AMS2631 and shall meet Class A1 requirements of AMS2631.

3.7 Tolerances

Shall conform to all applicable requirements of AMS2242.

3.7.1 Special flatness may be specified for plate; in such case, the special flatness tolerances of AMS2242 shall apply.

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279.

3.9 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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

4.2.1 Acceptance Tests

Composition (see 3.1), condition (see 3.3), tensile properties (see 3.5.1), bending (see 3.5.2), microstructure (see 3.5.3), surface contamination (see 3.5.4), quality (see 3.6), and tolerances (see 3.7) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.1 Ultrasonic inspection of each plate when required by 3.6.1.

4.2.2 Periodic Tests

Tests of the product after reheating as in 3.5 for tensile properties (see 3.5.1) and bending (see 3.5.2) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Shall be in accordance with AMS2368 and 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 For 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 Tensile Properties, Bending, Microstructure, and Surface Contamination

One or more samples from each lot for each requirement.

4.3.1.2.1 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 between 2 and 8.9 inches (51 and 226 mm), specimens shall be taken with the axis parallel to the direction of rolling. Length requirements of 3.5.1.1 apply in all cases.

4.3.1.3 Ultrasonic Quality

Each plate when required (see 3.6.1).