

AEROSPACE MATERIAL SPECIFICATION



AMS-T-9046B

Issued JUL 1999
Revised JUL 2002
Cancelled MAY 2006

Superseding AMS-T-9046A

Titanium and Titanium Alloy,
Sheet, Strip, and Plate

CANCELLATION NOTICE

This specification has been declared "CANCELLED" by the Aerospace Materials Division, SAE, as of May, 2006 and has been superseded by the applicable AMS specification listed in Figure 1 below. The requirements of the latest issue of the AMS listed in Figure 1 shall be fulfilled whenever reference is made to the cancelled AMS-T-9046 for those materials. By this action, AMS-T-9046 will remain listed in the Numerical Section of the Index of Aerospace Material Specifications, noting that it has been superseded by the applicable AMS.

Alloys covered by AMS-T-9046 determined to be 'no longer produced' are listed in Figure 2. Where available, specifications with similar but not necessarily identical technical requirements are listed in Figure 2. However, this listing is provided for information only and does not constitute authority to substitute these specifications for the "CANCELLED" products listed in Figure 2.

AMS-T-9046 was a word-for-word translation of MIL-T-9046 that was cancelled on September 17, 1999.

Cancelled AMS specifications are available from SAE.

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TYPE	AMS-T-9046 MATERIAL DESIGNATION	ALLOY	CONDITION	SUPERCEDING SPECIFICATION
Commercially Pure Titanium	CP-1	Commercially Pure	70 ksi Yield Strength	AMS 4901
	CP-2		55 ksi Yield Strength	AMS 4900
	CP-3		40 ksi Yield Strength	AMS 4902
	CP-4		25 ksi Yield Strength	AMS 4940
Alpha Titanium Alloys	A-1	5Al-2.5Sn	Annealed	AMS 4910
	A-2	5Al-2.5Sn (ELI)	Annealed	AMS 4909
	A-4	8Al-1Mo-1V	Annealed	AMS 4915
			Duplex Annealed	AMS 4916
Alpha-Beta Titanium Alloys	AB-1	6Al-4V	Annealed	AMS 4911
			Solution Treated	AMS 4903
			STA	AMS 4904
	AB-2	6Al-4V (ELI)	Annealed	AMS 4907
	AB-3	6Al-6V-2Sn	Annealed	AMS 4918
			Solution Treated	AMS 4988
			STA	AMS 4990
	AB-4	6Al-2Sn-4Zr-2Mo	Duplex Annealed	AMS 4919
	AB-5	3Al-2.5V	Annealed	AMS 4989
Beta Titanium Alloys	B-1	13V-11Cr-3Al	Solution Treated	AMS 4917
	B-3	3Al-8V-6Cr-4Mo-4Zr	Solution Treated	AMS 4939

FIGURE 1 – ALLOYS AND TEMPERS WITH SUPERCEDING AMS SPECIFICATIONS

TYPE	AMS-T-9046 MATERIAL DESIGNATION	ALLOY	CONDITION	SIMILAR SPECIFICATION
Alpha Titanium Alloy	A-3	6Al-2Cb-1Ta-0.8Mo	Annealed	NONE
Alpha-Beta Titanium Alloy	AB-4	6Al-2Sn-4Zr-2M	Triplex Annealed	NONE
	AB-6	8Mn	Annealed	AMS 4908 (Noncurrent)
Beta Titanium Alloys	B-1	13V-11Cr-3Al	STA	NONE
	B-2	11.5Mo-6Zr-4.5Sn	ST	NONE
			STA (1000)	NONE
			STA (925)	NONE
	B-3	3Al-8V-6Cr-4Mo-4Zr	STA	ASTM B265 Grade 20
	B-4	8Mo-8V-2Fe-3Al	ST	NONE
			STA (1100)	NONE
			STA (1000)	NONE

FIGURE 2 – ALLOYS AND TEMPERS WITHOUT SUPERCEDING SPECIFICATIONS

NOTICE

This document was originally taken directly from U.S. Military Specification MIL-T-9046J, Amendment 2, and contained only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document was intended to replace MIL-T-9046J, Amendment 2. Revisions made to the document since the original publication are intended to conform to current industrial practice.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

1. SCOPE:

1.1 Scope:

This specification covers aircraft quality titanium and titanium alloy metal sheet, strip and plate products.

1.2 Classification:

Products shall be of the following compositions and conditions, as specified (see 6.3.1, 6.6 and Tables I and IX):

1.2.1 Composition:

Commercially pure titanium (CP)

Code designation	Yield strength minimum, ksi <u>1/</u>
CP-1	70.0
CP-2	55.0
CP-3	40.0
CP-4	25.0

Alpha titanium alloys (A)

Code designation	Composition
A-1	5Al-2.5Sn
A-2	5Al-2.5Sn (ELI) <u>2/</u>
A-3	6Al-2Cb-1Ta-0.8Mo
A-4	8Al-1Mo-1V

Alpha-beta titanium alloys (AB)

Code designation	Composition
AB-1	6Al-4V
AB-2	6Al-4V (ELI)
AB-3	6Al-6V-2Sn
AB-4	6Al-2Sn-4Zr-2Mo
AB-5	3Al-2.5V
AB-6	8Mn

Beta titanium alloys (B)

Code designation	Composition
B-1	13V-11Cr-3Al
B-2	11.5Mo-6Zr-4.5Sn
B-3	3Al-8V-6Cr-4Mo-4Zr
B-4	8Mo-8V-2Fe-3Al

1/ 1.0 ksi = 1000 psi

2/ ELI means "extra low interstitials."

1.2.2 Condition:

Code	Description (treatment)
A	Annealed
DA	Duplex annealed
TA	Triplex annealed
ST	Solution treated
STA	Solution treated and aged. (When multiple STA conditions are specified herein for a given alloy, as in table IV, the applicable aging temperature shall be added in parentheses as a suffix.)

2. APPLICABLE DOCUMENTS:

The following publications, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094 (See 6.8).

FED-STD-151 Metals, Test Methods

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-129 Marking for Shipment and Storage

MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic)

2.2 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2242 Tolerances - Corrosion and Heat Resistant Steel and Iron Base Alloy Sheet, Strip and Plate and Titanium and Titanium Alloy Sheet, Strip and Plate
AMS 2249 Chemical Check Analysis Limits - Titanium and Titanium Alloys
AMS 2631 Ultrasonic Inspection of Titanium Alloys
ARP982A Minimizing Stress Corrosion in Wrought Heat Treatable Titanium Alloys
AMS-H-81200 Heat Treatment of Titanium and Titanium Alloys

2.3 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 480 General Requirements for Flat-Rolled Stainless and Heat Resisting Steels in Form of Plate, Sheet and Strip
ASTM E 8 Tension Testing of Metallic Materials
ASTM E 120 Titanium and Titanium-Base Alloys, Chemical Analysis of
ASTM E 290 Semi-Guided Bend Test for Ductility of Metallic Materials
ASTM E 1447 Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Technique

2.4 Order of precedence:

In the event of a conflict between the text of the specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS:

3.1 Material:

- 3.1.1 Commercially pure alloys: The material shall be produced by either electron beam melting or by multiple melting under vacuum or inert atmosphere.
- 3.1.2 Alpha alloys, alpha-beta alloys and beta alloys: The material shall be produced by multiple melting.
- 3.1.3 Melting controls:
 - 3.1.3.1 Multiple melting: The first melt and any intermediate melts shall be made by consumable electrode, non-consumable electrode, electron beam melting or other vacuum melting process, or the plasma arc melting process with the final melt being by consumable electrode arc melting under vacuum or inert atmosphere with no alloy additions made in the last consumable electrode melt.

3.1.3.2 Non-consumable electrode melting: The atmosphere shall be vacuum or inert gas at a pressure not higher than 250 mm of mercury. The electrode tip for nonconsumable electrode melting shall be watercooled copper.

3.2 Finish:

3.2.1 Sheet and strip: Sheet and strip shall have a surface finish comparable to corrosion resisting steel number 2D finish in accordance with ASTM A 480. Product shall be free of surface contamination by oxygen (alpha case), hydrogen, nitrogen or other such harmful contaminants.

3.2.2 Plate: Unless otherwise specified, plate shall have a surface finish comparable to corrosion resisting steel number 1 finish in accordance with ASTM A 480. Product shall be free of surface contamination by oxygen (alpha case), hydrogen, nitrogen or other such harmful contaminants.

3.3 Chemical composition:

The chemical composition, as determined by heat or lot analysis, shall be as specified in Table I.

3.3.1 Check analysis: Chemical composition variations shall meet the requirements of AMS 2249.

3.4 Tensile properties:

3.4.1 Commercially pure and alpha-titanium alloys: Tensile properties shall conform to Table II.

3.4.2 Alpha-beta titanium alloys: Tensile properties shall conform to Table III for the condition ordered.

3.4.2.1 Property capabilities: Any specified property capability shall be demonstrated when specified (see 6.3.1).

3.4.2.1.1 Solution treated and aged: Except for composition 6Al-2Sn-4Zr-2Mo, products supplied in the annealed condition shall be capable of meeting the solution treated (ST) and solution treated and aged (STA) tensile properties specified in table III, when heat treated to these conditions in accordance with AMS-H-81200.

3.4.2.1.2 Aged: Products supplied in the solution treated (ST) condition shall meet the solution treated and aged (STA) tensile properties, when aged to this condition in accordance with AMS-H-81200.

3.4.2.2 Composition 6Al-2Sn-4Zr-2Mo (AB-4):

3.4.2.2.1 Property capability: Any specified property capability shall be demonstrated when specified (see 6.3.1).

3.4.2.2.1.1 Triplex annealed: Sheet and strip supplied in the duplex annealed (DA) condition shall meet the triplex annealed (TA) tensile properties, when heat treated to this condition in accordance with AMS-H-81200.

3.4.2.2.1.2 Duplex annealed: Plate supplied in the annealed (A) condition shall meet the duplex annealed (DA) tensile properties, when heat treated to this condition in accordance with AMS-H-81200.

3.4.2.3 Composition 6Al-4V (AB-1):

3.4.2.3.1 Property capability - sheet, strip and plate: Sheet, strip and plate supplied in the annealed condition shall meet the minimum tensile properties of Condition A, Table III, after exposure to a temperature of $718^{\circ} \pm 14^{\circ}\text{C}$ ($1325^{\circ} \pm 25^{\circ}\text{F}$) for a period of 20 ± 2 minutes, such exposure to be followed by cooling in air. After temperature exposure and cooling, a minimum of 0.001 inch shall be removed from all surfaces of the sample prior to testing. Sufficient material shall be removed so as to insure compliance of the sample with the requirements of 3.2.1 and 3.2.2. Property capability shall be demonstrated when specified (see 6.3.1).

3.4.3 Beta titanium alloys: Tensile properties shall conform to Table IV for the condition ordered.

3.4.3.1 Property capability - solution treated and aged: Products supplied in the solution treated (ST) condition shall meet the solution treated and aged (STA) tensile properties specified in Table IV, when aged to this condition in accordance with AMS-H-81200. Property capability shall be demonstrated when specified (see 6.3.1).

3.5 Bending:

Sheet and strip products supplied in the annealed or solution treated condition shall withstand transverse bending at room temperature to an angle of 105-degrees on a radius equal to the "bend factor" times the nominal product thickness without evidence of cracking when examined at 20X magnification. Bend factors shall be as specified in Table V. Transverse bending shall consist of bends where the centerline of the bend is parallel to the principal rolling direction of the product.

3.6 Heat treatment:

Products shall be heat treated in accordance with AMS-H-81200.

3.7 Ultrasonic quality:

3.7.1 Alpha and alpha-beta titanium plate: Unless otherwise specified (see 6.3.1), alpha and alpha-beta titanium plate, 0.500 to 4.000 inches thick, shall meet the Class A1 requirements of AMS 2631.

3.7.2 Commercially pure and beta titanium alloy plate: When specified (see 6.3.1), commercially pure and beta titanium alloy plate shall meet ultrasonic quality standards agreed upon by the acquiring activity and producer (see 6.3.1).