

AEROSPACE MATERIAL SPECIFICATION



AMS-T-81556A

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Superseded by MIL-T-81556

Titanium and Titanium Alloys, Extruded Bars and Shapes, Aircraft Quality

CANCELLATION NOTICE

This specification has been declared "CANCELLED" by the Aerospace Materials Division, SAE, as of February, 2005, and has been superseded by MIL-T-81556. The requirements of the latest issue of MIL-T-81556 shall be fulfilled whenever reference is made to the cancelled AMS-T-81556. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications, noting that it has been superseded by MIL-T-81556.

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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 extruded metal bar and shape products.

1.2 Classification:

Products shall be of the following compositions and conditions, as specified (see 6.2.1, 6.5 and Tables I and IX):

1.2.1 Composition:

Commercially pure titanium (CP)

Yield strength (Ksi)	Code designation
70	CP-1
55	CP-2
40	CP-3
30	CP-4

Alpha titanium alloy

Nominal composition	Code designation ^{1/}
5A1-2.5Sn	A-1
5A1-2.5Sn (ELI)	A-2
8A1-1Mo-1V	A-4

Alpha-beta titanium alloy

Nominal composition	Code designation
6A1-4V	AB-1
6A1-4V (ELI)	AB-2
6A1-6V-2Sn	AB-3
6A1-2Sn-4Zr-2Mo	AB-4

^{1/} A-3 has nominal composition 6A1-2Cb-1Ta-0.8Mo and is not subject to this specification.

^{2/} ELI means "extra low interstitials."

1.2.2 Condition:

Condition	Description (treatment)
F	As fabricated
A	Annealed
DA	Duplex annealed
ST	Solution treated
STA	Solution treated and aged.

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.

MIL-H-81200 Heat Treatment of Titanium and Titanium Alloys

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)

MIL-STD-2154 Inspection, Ultrasonic, Wrought Metals, Process for

2.2 SAE Publications:

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

AMS 2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

AMS 2631 Ultrasonic Inspection of Titanium Alloys

AMS 2643 Structural Examination of Titanium Alloys, Chemical Etch Inspection Procedure

ARP982 Minimizing Stress Corrosion in Wrought Titanium Alloy Products

2.3 ASTM Publications:

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

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 9	Compression Testing of Metallic Materials at Room Temperature
ASTM E 120	Titanium and Titanium Alloys, Chemical Analysis of
ASTM E 146	Zirconium and Zirconium Alloys, Chemical Analysis of

2.4 Order of precedence:

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

3. REQUIREMENTS:

3.1 Material:

Material for products supplied in accordance with this specification shall be multiple melted. The final melting cycle shall be consumable electrode practice under vacuum. The initial and intermediate melting cycles shall be consumable electrode practice under vacuum, unless otherwise specified (see 6.2.1). When specified (see 6.2.1), the first melting cycle shall be nonconsumable electrode practice under vacuum or inert gas at a pressure no greater than 250 mm of mercury and shall employ an electrode tip of either graphite or water-cooled copper.

3.2 Condition:

Unless otherwise specified, extrusions shall be furnished in the as extruded and annealed (A) condition, with or without subsequent straightening (see 6.2.1).

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 conform to the requirements of AMS 2249.

3.4 Mechanical properties:

3.4.1 Products supplied: Products supplied in the A, DA, or STA conditions (see 1.2.2 for definitions) shall conform to the tensile property requirements of Tables II and III, as applicable. When specified (see 6.2.1), alpha-beta titanium alloy products in the A or STA conditions shall conform to the compressive property requirements of Table III, as applicable.

3.4.2 Heat-treatment capability: Products supplied in the F or A condition (see 1.2.2) shall be capable of being heat-treated in accordance with MIL-H-81200 to the tensile property, and, when specified (see 6.2.1), to the compressive property requirements of Tables II and III, as applicable to composition and condition. Such capability shall be demonstrated when specified (see 6.2.1).

3.4.3 Mechanical properties of alpha-beta alloys after aging: Alpha-beta alloys supplied in the ST condition (see 1.2.2) shall conform to the tensile property, and, when specified (see 6.2.1), to the compressive property requirements of Table III as applied to the STA condition when "aged" or "re-solution treated and aged" in accordance with MIL-H-81200.

3.5 Heat treatment:

The heat treatment of products supplied in accordance with this specification shall conform to MIL-H-81200.

3.6 Stress relieving:

3.6.1 Stretching or straightening: Products which are stretched or straightened in Condition A, DA or STA shall be stress relieved in accordance with Table IV if the stretching or straightening is performed below the applicable stress relieving temperature specified in Table IV.

3.6.2 Straightening and stretching after solution treatment: Products supplied in Condition ST, if straightened or stretched after being heat treated to this condition, shall not be stress relieved; however, such products shall be subject to the mechanical property requirements specified herein for material supplied in Condition ST.

3.7 Ultrasonic quality:

Unless otherwise specified (see 6.2.1), products shall conform to the ultrasonic quality requirement of Table V and Table Va.

3.8 Microstructure:

Products shall have a microstructure characteristic of extruding above the beta transus temperature.

3.9 Dimensional tolerances:

Unless otherwise specified (see 6.2.1), dimensional tolerances shall conform to Table VI.

3.10 Finish:

Unless otherwise specified (see 6.2.1), the product shall conform to the following finish requirements:

- a. The surface shall be free of contamination from oxygen (alpha case), hydrogen, nitrogen, or other surface contamination determined in accordance with 4.4.2.2. When permitted by the contracting agency, extrusions which will be machined all over may have an oxygen rich layer, 0.007 inch maximum, provided that such a layer is removable within the machining allowance.
- b. The depth of surface imperfections (laps, die lines, dents, gouges, etc.) shall be contained within the dimensional tolerances and shall not extend beyond the minimum section thickness allowed per table IV.

3.11 Identification of product:

Each straight product 0.5 inch and greater in outside diameter or least width of flat surface, where such flat surface is accessible to a marking tool at least 0.5 inch wide and recesses not more than 1.0 inch below the outline of the product, shall be marked in a row of characters recurring at intervals not greater than three feet. Marking shall include the basic number and revision letter of this specification, producer's name or trademark, and product composition, heat or lot number and heat treat condition. The characters shall be of such size and clarity as to be legible with unaided normal vision. The marking fluid residue shall contain not more than traces of halogen-bearing compounds. Such markings shall have no deleterious effect on the product or its performance and shall be sufficiently stable to withstand normal handling, but shall be capable of being removed in hot alkaline cleaning solution without rubbing.

- 3.11.1 Sizes and shapes: Products of a size and shape, other than described in 3.11, shall be securely bundled or containerized (crated, boxed, etc.) for shipping. Each bundle or container shall be marked at both ends with the identification specified in 3.11. This identification shall be marked on the container or embossed on metal or plastic tags securely attached to the bundle or container.

3.12 Workmanship:

The product, when visually examined (see 4.4.1), shall be uniform in quality and condition, sound, and free from cracks, seams, foreign materials and other defects detrimental to the fabrication or performance of parts. In addition, visual examination of transverse cross sections shall show no pipe or cracks and shall show no segregation determined in accordance with 4.4.2.1. (See 3.10 for requirements regarding surface contamination.)

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection:

The inspection specified herein is classified as quality conformance inspection.

4.3 Quality conformance inspection:

The quality conformance inspection shall consist of all the inspections and tests specified herein.

4.3.1 Sampling:

4.3.1.1 Inspection lot: Unless otherwise specified (see 6.2.1), a lot shall consist of products of the same heat, composition, size, shape and condition processed at the same time.

4.3.1.2 Procedure: The procedure for sampling each heat or lot for determining conformance to the requirements of this specification shall be as specified in Table VII.

4.4 Methods of inspection and test:

4.4.1 Visual examination: Samples selected in accordance with Table VII shall be visually examined for conformance to the surface imperfections (see 3.10), identification (see 3.11) and workmanship (see 3.12) requirements.

4.4.2 Metallographic examination:

4.4.2.1 Macrostructure: A specimen, at least 0.5 inch long by full cross-section from the back end of each extruded length, shall be examined for conformance to the macrostructure workmanship (see 3.12) requirements. Unless otherwise specified (see 6.2.1), macrostructural examination shall be performed in accordance with AMS 2643.