

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Superseded by MIL-T-81556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has been declared "CANCELLED" by the Aerospace Materials Division, SAE, as of February, 2005, and has been superseded by MIL-T-81556.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will remain listed in the Numerical Section of the Index of Aerospace Material Specifications, noting that it has been superseded by MIL-T-81556.

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NOTICE

This document has been taken directly from U.S. Military Specification MIL-T-81556A, Amendment 1, Notice 1, and contains 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 is intended to replace MIL-T-81556A, Amendment 1, Notice 1. Any part numbers established by the original specification remain unchanged.

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.

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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.

- 4.4.2.2 Microstructure: In addition to the microstructure examination required by AMS 2643, conformance to the microstructure (see 3.8) and freedom from surface contamination (see 3.10) requirements shall be determined by examining at least one polished and etched specimen from each sample selected in accordance with Table VII. Examination for surface contamination shall be made at a magnification of 100X to 200X and for general microstructure at 200X to 250X. Other magnifications shall be used, as required, to ensure acceptable quality.
- 4.4.3 Dimensional inspection: Samples selected in accordance with Table VII for dimensional inspection shall be measured for conformance to the specified shape or dimensions (see 6.2.1) and dimensional tolerance (see 3.9) requirements.
- 4.4.4 Ultrasonic inspection: Ultrasonically inspected product shall be identified as agreed upon by the acquiring activity and the contractor (see 6.2.1).
- 4.4.4.1 Inspection personnel: Inspection shall be performed only by personnel qualified and certified to Level II or higher in accordance with MIL-STD-410.
- 4.4.4.2 Inspection of billets: Ultrasonic inspection of billets may be performed in lieu of ultrasonic inspection of extruded product. The surface roughness shall not exceed 250 Ra. The billets shall conform to the ultrasonic quality requirements of 3.7.
- 4.4.4.3 Inspection of extruded product: Ultrasonic inspection of extruded product shall only be required if the billet has not been ultrasonically inspected. Ultrasonic inspection shall be applicable for extruded product 0.500 inch, or greater, in section thickness and a surface roughness no greater than 250 Ra. The extruded product shall conform to the ultrasonic quality requirements of 3.7.
- 4.4.5 Packaging: Each shipment shall be inspected for conformance to the packing and marking requirements specified in 3.11.1 and Section 5.
- 4.4.6 Chemical analysis: Conformance with the chemical composition requirements shall be determined either by heat or lot analysis of samples selected in accordance with Table VII using ASTM E 120 methods of chemical analysis or FED-STD-151, Method 112.2 of spectrochemical analysis. Hydrogen shall be analyzed by the hot extraction method specified in ASTM E 146 and shall be determined on each lot as shipped. Other analytical methods may be used with the written approval of the acquiring activity.
- 4.4.6.1 Referee: In case of dispute, the results of referee chemical analysis, by the ASTM E 120 method, shall govern.
- 4.4.7 Mechanical property tests: Conformance to the mechanical property requirements shall be determined by testing at least one tensile specimen and, in the case of alpha-beta alloys, also one compression specimen from the back end of each sample selected in accordance with Table VII. The product shall be in the heat treat condition ordered (see 6.2.1), except that for products supplied in the solution treated (ST) condition, the ends cut from the test samples shall be aged to the STA condition prior to excising the test specimens therefrom.

- 4.4.7.1 Tension test: Tension tests shall be accomplished in accordance with ASTM E 8 using tension specimens conforming to Table VIII, except that the rate of strain shall be 0.003 to 0.007 inch per inch per minute through the yield strength and then is increased so as to produce failure in approximately one additional minute. In case of dispute, the results of referee tension tests performed on a tensile machine having a strain pacer and using a strain rate of 0.005 inch per inch per minute through the yield strength and a minimum cross-head speed of 0.10 inch per minute above the yield strength shall govern.
- 4.4.7.2 Compression test: When compression properties meeting the requirements of Table III are specified (see 6.2.1), tests shall conform to the requirements of ASTM E 9. The strain rates shall be those specified in 4.4.7.1.
- 4.5 Rejection and retests:
- 4.5.1 Rejection: Failure of the test samples to meet the applicable requirements of this specification shall be cause for rejection of the represented lot. Retesting in accordance with 4.5.2 shall be permitted in the case of conformance to the mechanical property requirements. Retesting shall be at the discretion of the producer.
- 4.5.2 Retest: The sampling and test specimen requirements specified in Table VII and 4.4.7, respectively, shall be tripled for tensile or compression retest, as applicable. The retest samples shall include a sample from each of the extruded lengths that failed to meet properties in the original sampling. If one retest specimen fails, the lot shall be rejected and no further retesting shall be permitted.
- 4.5.3 Replacement of test specimens: Replacement of test specimens for reasons other than inferior or defective material shall be in accordance with FED-STD-151.
5. PACKAGING:
- 5.1 Preservation/packaging:
- Not applicable.
- 5.2 Packing:
- Packing shall be Level A or C, as specified (see 6.2.1).
- 5.2.1 Sorting: Unless otherwise specified, products shall be separated by size, heat, composition and condition when packed for shipment.
- 5.2.2 Level A - for domestic shipment and storage, and overseas shipment: Products shall be packed in accordance with the requirements of MIL-STD-163, as referenced for stainless steel.

5.2.3 Level C - minimum military pack (for domestic shipment) with immediate use at initial destination: Packages which require overpacking for acceptance by the carrier shall be packed in exterior-type shipping containers in a manner that will assure safe transportation at lowest rate to the point of delivery. Container shall meet, as a minimum, the requirements of rules and regulations applicable to the mode of transportation.

5.3 Marking of shipments:

In addition to any special marking required by the contract or order (see 6.2.1), shipping containers shall be marked in accordance with MIL-STD-129. The identification shall be composed of the following information listed in the order shown:

- a. National stock no. or other identification number as specified in the acquisition document. 1/
 - b. TITANIUM OR TITANIUM ALLOY, EXTRUDED METAL BARS, OR SPECIAL SHAPES, AIRCRAFT QUALITY (as applicable)
 - c. Size (inches) (cross-section by length)
 - d. Shape no. (if applicable)
 - e. MIL-T-81556A
 - f. Composition heat no.
 - g. Heat treatment condition.
 - h. Lot no.
 - i. Gross weight (lbs)
 - j. Manufacturer's name or trademark
- 1/ The contractor shall enter the national stock no. specified in the acquisition document or as furnished by the acquiring activity. When the national stock no. is not provided or available from the acquiring activity, leave space therefore and enter the stock no. or other identification when provided by the acquiring activity.

6. NOTES:

6.1 Intended use:

The products acquired under this specification are intended for structural applications in airborne vehicles and equipment.

6.2 Ordering data:

6.2.1 Acquisition requirements: Acquisition documents should specify the following:

- a. Title, number, revision letter, date and amendment number (if any) of this specification.
- b. Composition (see 1.2.1).
- c. Product (bar or shape) size, length, and quantity desired.
- d. Melting practice of initial and intermediate melts if other than consumable electrode under vacuum (see 3.1).
- e. Heat treat condition (see 1.2.2).
- f. Finish (see 3.10).
- g. Heat treat response verification (see 3.4.2).
- h. Dimensional tolerances, special sizes (see 3.9).
- i. Whether ultrasonic quality (see 3.7) and ultrasonic inspection (see 4.4.4), as applicable, is waived, when conformance to either one or the other, or both, is not desired.
- j. Metallographic examination (see 3.8, 3.10, 3.12 and 4.4.2).
- k. Marking requirements (see 3.11).
- l. Inspection lot consistency (see 4.3.1.1).
- m. Selection of applicable level of packing, i.e., whether domestic or overseas Level A or C packing is required (see 5.2).
- n. Additional marking, if necessary (see 4.4.4 and 5.3).
- o. Whether compression properties are required (see 3.4 and 4.4.7).

6.4 Definitions:

- 6.4.1 Extruded bar: A solid section, long in relation to its cross sectional dimensions, having a symmetrical cross section that is round, square or rectangular (excluding flattened wire) with sharp or rounded corners or edges; or is a regular hexagon or octagon, and whose width or greatest distance between parallel faces is 3/8 inch or greater.
- 6.4.2 Extruded shape: A section produced by extrusion that is long in relation to its cross sectional dimension and has a cross section of other than that of bar.

6.4.3 Capability: The words "shall be capable of" are used to indicate characteristics or properties required in the product but for which testing of each lot is not required. However, if such testing is performed, products not conforming to the requirements of this specification shall be subject to rejection.

6.5 Cross-reference:

Table IX shows the correlation between the composition classifications used in this specification and the previous classifications used in MIL-T-81556.

6.6 Revised classification coding system:

The classification coding system introduced in this specification (see 1.2.1) is designed to satisfy the following criteria:

- a. Brevity, the importance of which is emphasized by the fifteen (15) digit restriction of the federal system for product identification, ordering and cataloging.
- b. Adaptability across a range of specifications and other documents, such as, MIL-T-9046, MIL-R-81588, MIL-T-9047 and MIL-HDBK-5.
- c. Ease of recognition of grade of purity and alloy composition.

6.6.1 Design of coding system:

6.6.1.1 Identification of type classes: The coding system uses one or two letters to identify the type class into which each grade or alloy falls. These letters are keyed to the four class names which are in wide use. Such coding is brief and makes for easier recognition than coding through the use of Roman numerals. Thus, "CP" is used to identify titanium of commercial purity grades; "A" identifies all ALPHA titanium alloys; "AB" identifies ALPHA-BETA alloys; and "B" identifies all BETA alloys.

6.6.1.2 Number coding of CP grades and alloys:

6.6.1.2.1 Numbering of CP grades: The order of numbering CP titanium grades follow directly the order of increasing purity with respect to oxygen concentration. This sequence is the reverse of the order of changes in yield strength. Such numerical sequencing was selected because the thrust of development of the CP grades has generally been in the direction of increased purity, for example, the two grades of weld filler metal (see MIL-R-81588). It does not appear that there will be any additional effort to strengthen CP titanium by increasing oxygen concentration beyond that of CP-1.

6.6.1.2.2 Number of alloys: The order of numbering alloys, generally follows the historical and present breadth and volume of usage of each alloy. Thus, 5A1-2.5Sn is coded A-1 and 6Al-4V is coded AB-1. The 8Mn alpha-beta alloy, although of greater age than AB-1, has not enjoyed the usage of AB-1 and is assigned a higher number such as AB-6.

6.6.2 UNS coding system: This coding system has been considered for adoption into the subject specification. However, the system has not been adopted because its products code designations are not brief and make product identification difficult and subject to error without the use of a catalog.

6.7 Changes from previous issue:

Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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TABLE I. Chemical composition, percent by weight (see 3.3).

Classi- fication	Nominal compo- sition or min ys 6/	Elements										Total other elements 3/	
		Al	Sn	Mo	V	Cu	Fe 1/	C (max)	N (max)	H (max) 2/	O (max)		Ti (max) 3/
Commercially pure titanium													
CP-4	30	-	-	-	-	-	0.20	0.08	0.05	0.015	0.15	Bal	0.30
CP-3	40	-	-	-	-	-	0.30	0.08	0.05	0.015	0.20	Bal	0.30
CP-2	55	-	-	-	-	-	0.30	0.08	0.05	0.015	0.30	Bal	0.30
CP-1	70	-	-	-	-	-	0.50	0.08	0.05	0.015	0.40	Bal	0.30
Alpha titanium alloy 9/													
A-1	5Al- 2.5Sn	4.50- 5.75	2.00- 3.00	-	-	-	0.50	0.08	0.05	0.020	0.20	Bal	0.40
A-2 8/	5Al- 2.5Sn (ELI) 7/	4.50- 5.75	2.00- 3.00	-	-	-	0.25 4/	0.05	0.035	0.0125 4/	0.12	Bal	0.30 5/
A-4	8Al-1Mo- 1V	7.35- 8.35	-	0.75- 1.25	0.75- 1.25	-	0.30	0.08	0.05	0.015	0.15	Bal	0.40
Alpha-beta titanium alloy 9/													
AB-1	6Al-4V	5.50- 6.75	-	-	3.50- 4.50	-	0.30	0.08	0.05	0.0125	0.20	Bal	0.40
AB-2	6Al-4V (ELI)	5.50- 6.50	-	-	3.50- 4.50	-	0.25	0.08	0.05	0.0125	0.13	Bal	0.30 5/
AB-3	6Al-6V- 2Sn	5.00- 6.00	1.50- 2.50	-	5.00- 6.00	0.35- 1.00	0.35- 1.00	0.05	0.04	0.015	0.20	Bal	0.30
AB-4	6Al-2Sn- -4Zr- 2Mo + Si	5.50- 6.50	1.80- 2.20	1.80- 2.20	-	-	0.25	0.05	0.04	0.015	0.15	Bal	0.30 10/ 11/

TABLE I. Chemical composition, percent by weight (see 3.3). - Continued

- 1/ Maximum, unless otherwise specified.
- 2/ Hydrogen shall be determined on each lot of the product as shipped.
- 3/ Need not be determined routinely. Material shall meet stated limits when analyzed. Unless otherwise noted, other elements each shall be 0.10 percent maximum.
- 4/ Iron plus oxygen shall not exceed 0.32 percent.
- 5/ Other elements each shall be 0.05 percent maximum.
- 6/ "Min ys" = minimum yield strength at 0.2 percent offset, Ksi.
- 7/ "ELI" = extra low interstitials.
- 8/ A-3 classification has nominal composition: 6Al-2Cb-1Ta-0.8Mo and is not a subject of this specification (MIL-T-81556A)
- 9/ Yttrium shall not exceed 0.005 percent.
- 10/ Zirconium shall be 3.60 - 4.40 percent.
- 11/ Silicon shall be 0.06 - 0.10 percent.

TABLE II. Tensile properties of commercially pure and alpha titanium alloys.
(see 3.4.1 and 3.4.2)

Alloy (code designation and composition)	Thickness, diameter or distance between flats (inches) 1/	Tensile strength, Ksi (min)	Yield strength at 0.2 percent offset, Ksi (min)	Elongation, percent in 2-inches or 4D (min)
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Commercially pure titanium

CP-1	Condition A			
	0.188 - 1.000	80	70	15
	1.001 - 2.000	80	70	12
	2.001 - 3.000	80	70	10
CP-2	0.188 - 1.000	65	55	18
	1.001 - 2.000	65	55	15
	2.001 - 3.000	65	55	12

TABLE II. Tensile properties of commercially pure and alpha titanium alloys.
(see 3.4.1 and 3.4.2) - Continued

Alloy (code designation and composition)	Thickness, diameter or distance between flats (inches) <u>1/</u>	Tensile strength, Ksi (min)	Yield strength at 0.2 percent offset, Ksi (min)	Elongation, percent in 2-inches or 4D (min)
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Commercially pure titanium - Continued

CP-3	Condition A			
	0.188 - 1.000	50	40	20
	1.001 - 2.000	50	40	18
	2.001 - 3.000	50	40	15
CP-4	0.188 - 1.000	40	30	25
	1.001 - 2.000	40	30	20
	2.001 - 3.000	40	30	18

Alpha titanium alloys

A-1 (5Al-2.5Sn)	Condition A			
	0.188 - 1.000	120	115	10
	1.001 - 2.000	115	110	10
	2.001 - 3.000	115	110	8
	3.001 - 4.000	115	110	6
A-2 (5Al-2.5Sn(ELI))	0.188 - 1.000	100	95	10
A-4 (8Al-1Mo-1V)	0.188 - 0.500	145	135	10
	0.501 - 1.000	140	130	10
	1.001 - 2.500	130	120	10
	2.501 - 4.000	120	110	8
	Condition DA			
	0.188 - 1.000	130	120	10
	1.001 - 2.000	125	115	10
	2.001 - 4.000	120	110	8

1/ Thickness of the cross-section from which the specimen is taken shall determine the applicable tensile properties.

TABLE III. Tensile and compressive properties of alpha-beta titanium alloys (see 3.4.1, 3.4.2, and 3.4.3)

Alloy (code designation and composition)	Condition	Thickness, diameter or distance between flats (inches) 1/ 1	Compressive yield strength Ksi (min)	Tensile properties			
				Tensile strength, Ksi (min)	Yield strength at 0.2 percent offset, Ksi 2/ 3/	Elongation percent in 2-inches or 4D (min) 5/ 3/	Reduction of area, percent (min) 5/ 3/
AB-1 (6Al-4V)	A	0.188 - 1.249	125	130	120 - 145	10 (8) 5/ 3/	20 (15) 5/ 3/
		1.250 - 2.000	125	130	120 - 145		
		2.001 - 4.000	125	130	120 - 145		
	STA	0.188 - 0.500	155	160	150	8	15
		0.501 - 0.750	150	155	145	8	15
		0.751 - 1.000	145	150	140	6	12
		1.001 - 2.000	140	145	135	6	12
		2.001 - 3.000	135	140	130	6	12
AB-2 (6Al-4V (ELI))	A	0.188 - 1.000	120	125	115 - 145	10	20
		1.001 - 2.000	115	120	110 - 140	10	20
		2.001 - 3.000	115	120	110 - 135	8	15
AB-3 (6Al-6V-2Sn)	A	0.188 - 1.500	145	150	140 - 165	10 (8) 5/ 3/	20 (15) 5/ 3/
		1.501 - 3.000	140	145	135 - 160		
		3.001 - 4.000	135	140	130 - 155		
		0.188 - 0.500	165	170	160	8 (6) 5/ 3/	15 (12) 5/ 3/
		0.501 - 1.500	160	165	155		
AB-4 (6Al-2Sn-4Zr-2Nb)	STA	1.501 - 2.500	155	160	150		
		2.501 - 4.000	145	150	140		
		0.188 - 4.000	125	130	120 - 145	10 (8)	20 (15)
		0.188 - 0.500	145	150	140		
		0.501 - 1.000	140	145	135	10 (8) 5/ 3/	20 (15) 5/ 3/
		1.001 - 3.000	135	140	130		

TABLE III. Tensile and compressive properties of alpha-beta titanium alloys (see 3.4.1, 3.4.2, and 3.4.3) Cont'd

- 1/ Thickness of the cross section from which the specimen is taken shall determine the applicable tensile properties.
- 2/ Minimum yield strength, except where minimum - maximum range is specified.
- 3/ Not applicable to thicknesses under 0.062 inch.
- 4/ Not applicable to thicknesses under 0.375 inch.
- 5/ Values apply to all thickness ranges. First value applies to the longitudinal direction; value in parentheses applies to the transverse direction.

TABLE IV. Stress relieving (see 3.6.1). 1/

Alloy (code designation and composition)	Stress relieving schedule		
	A <u>2/</u>	DA <u>2/</u>	STA <u>2/</u>
Commercially pure titanium			
All	<u>3/</u>	<u>4/</u>	<u>4/</u>
Alpha titanium alloys			
A-1 and A-2 (5Al-2.5Sn and 5Al-2.5Sn (ELI))	1200° ± 25°F for 2 hours, minimum	<u>4/</u>	<u>4/</u>
A-4 (8Al-1Mo-1V)	1100° ± 25°F for 30 to 60 minutes	1000° ± 25°F for 30 to 60 minutes	<u>4/</u>
Alpha-beta titanium alloys			
AB-1 (6Al-4V) AB-2 (6Al-4V (ELI)) AB-3 (6Al-6V-2Sn)	1100° - 1200°F for 1 hour, minimum	<u>4/</u>	975° ± 25°F for 2 to 2-1/2 hours

TABLE IV. Stress relieving (see 3.6.1) - Continued 1/

- 1/ Stress relieving shall conform to MIL-H-81200, except that the stress relieving schedule shall be as specified herein.
- 2/ Heat treat condition of the material.
- 3/ Stress relieve per MIL-H-81200 schedules.
- 4/ Not applicable.

TABLE V. Ultrasonic quality of extruded product

Specified diameter - rod Specified thickness - bar Specified thickness - shape	Ultrasonic class <u>1/</u>
0.500 - 1.500 inches 1.501 - 7.00 inches 7.01 inches and greater	AA A1 A

1/ Classification is in accordance with AMS 2631 (Grade 1 if double melted and Grade 2 if triple melted).

TABLE Va. Ultrasonic quality of billets

Diameter or distance between flats, inches	Ultrasonic class	Specification
5.00 - 10.00 10.01 - 15.00 15.01 and above	A B C	AMS 2631 AMS 2631 MIL-STD-2154