

AEROSPACE MATERIAL SPECIFICATION

SAE AMS4933

REV. E

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Superseding AMS4933D

Titanium Alloy Extrusions and Flash Welded Rings
8Al - 1Mo - 1V
Solution Heat Treated and Stabilized
(Composition similar to UNS R54810)

RATIONALE

AMS4933E results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of extruded bars, tubes, and shapes, flash welded rings, and stock for flash welded rings up through 4.000 sq. inch (25.81 cm²) cross-section.

1.2 Application

This alloy has been used typically for parts that require high mechanical properties and are machined from product in the heat treated condition but usage is not limited to such applications. This alloy exhibits high strength-to-weight ratios up to 800 °F (427 °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.

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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2245	Tolerances, Titanium and Titanium Extruded Bars, Rods, and Shapes
AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2368	Sampling and Testing of Wrought Titanium Raw Material Except Forgings and Forging Stock
AMS2750	Pyrometry
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
AMS7498	Rings, Flash Welded, Titanium and Titanium Alloys
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

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 E 8 / E 8M	Tension Testing of Metallic Materials
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 292	Conducting Time-for-Rupture Notch Tension Tests of Materials
ASTM E 1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
ASTM E 1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E 1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys
ASTM E 2371	Analysis of Titanium and Titanium Alloys by 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 E 1941, hydrogen in accordance with ASTM E 1447, oxygen and nitrogen in accordance with ASTM E 1409, and other elements in accordance with ASTM E 2371. Other analytical methods may be used if acceptable to the purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Aluminum	7.35	8.35
Molybdenum	0.75	1.25
Vanadium	0.75	1.25
Iron	--	0.30
Oxygen	--	0.12
Carbon	--	0.08
Nitrogen	--	0.05 (500 ppm)
Hydrogen (3.1.3)	--	0.0150 (150 ppm)
Yttrium (3.1.1)	--	0.0050 (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.

3.1.3 Sample size when using ASTM E 1447 for hydrogen may be as large as 0.35 gram.

3.2 Melting Practice

3.2.1 Alloy shall be multiple melted. The first melt shall be made by 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 nonconsumable electrode melting shall be vacuum or shall be inert gas at a 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 Bars, Tubes, and Shapes

Extruded, solution heat treated, stabilized, and descaled.

3.3.2 Flash Welded Rings

Solution heat treated, and stabilized. Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, rings shall be manufactured in accordance with AMS7498.

3.3.3 Stock for Flash Welded Rings

As ordered by the flash welded ring manufacturer.

3.4 Heat Treatment

Bars, tubes, shapes, and flash welded rings shall be heat treated as follows; pyrometry shall be in accordance with AMS2750:

3.4.1 Solution Heat Treatment

Heat to a temperature within the range 1800 to 1850 °F (982 to 1010 °C), hold at the selected temperature within ± 25 °F (± 14 °C) for 1 hour ± 0.1 , and cool at a rate equivalent to an air cool or faster.

3.4.2 Stabilization Heat Treatment

Heat to a temperature within the range 1050° to 1150°F (566 to 621 °C), hold at the selected temperature within ± 15 °F (± 8 °C) for not less than 8 hours, and cool in air.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 Bars, Tubes, Shapes, and Flash Welded Rings

3.5.1.1 Tensile Properties

Shall be as follows for product 4.000 square inches (25.81 cm²) and under in cross-sectional area.

3.5.1.1.1 At Room Temperature

Shall be as specified in Table 2 and 3.5.1.1.3, determined in accordance with ASTM E 8 / E 8M 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, INCH/POUND UNITS

Nominal Cross-Sectional Area Square Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %	Reduction of Area %
Up to 2.500, excl	130	120	10	20
2.500 to 4.000, incl	125	115	10	20

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Cross-Sectional Area Square Centimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %	Reduction of Area %
Up to 16.13, excl	896	827	10	20
16.13 to 25.81, incl	862	793	10	20

3.5.1.1.2 At 800 °F (427 °C)

Shall be as specified in Table 3 and 3.5.1.1.3, determined in accordance with ASTM E 21 on specimens heated to 800 °F ± 5 (427 °C ± 3), held at heat for 20 to 30 minutes before testing, and tested at 800 °F ± 5 (427 °C ± 3).

TABLE 3A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Cross-Sectional Area Square Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %	Reduction of Area %
Up to 2.500, excl	90	70	10	25
2.500 to 4.000, incl	80	60	10	25

TABLE 3B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Cross-Sectional Area Square Centimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %	Reduction of Area %
Up to 16.13, excl	621	483	10	25
16.13 to 25.81, incl	552	414	10	25

3.5.1.1.3 The requirements of Table 2 and Table 3 apply to bars, rods, and shapes tested in the longitudinal direction and to flash welded rings tested in the circumferential direction.

3.5.1.2 Microstructure

Shall be that structure resulting from processing within the alpha-beta phase field. Microstructure shall conform to 3.5.1.2.1.

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

3.5.1.3 Surface Contamination

Except as specified in 3.5.1.3.1, the product shall be free of any oxygen-rich layer (See 8.2), such as alpha case, or other surface contamination, determined by microscopic examination at not lower than 400X magnification or other method agreed upon by purchaser and vendor.

3.5.1.3.1 When permitted by purchaser, flash welded rings to be machined all over may have an oxygen-rich layer (See 8.2) provided such layer is removable within the machining allowance for the part.

3.5.2 Stock for Flash Welded Rings

A sample of stock heat treated as in 3.4 shall conform to the requirements of 3.5.1.1.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances

Extrusions shall conform to all applicable requirements of AMS2245.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the product shall supply all samples for vendor'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.