SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS4934 REV. F

Issued 1975-06
Revised 2011-05

Superseding AMS4934E

Titanium Alloy, Extrusions and Flash Welded Rings
6Al - 4V
Solution Heat Treated and Aged

(Composition similar to UNS R56400)

RATIONALE

AMS4934F 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, and shapes, flash welded rings, and stock for flash welded rings.

1.2 Application

These products have 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 750 °F (399 °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 724-776-4970 (outside USA), www.sae.org.

AMS2245	Tolerances, Titanium and Titanium Alloy Extruded Bars, Rods, and Shapes
AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2750	Pyrometry
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
AMS7498	Rings, Flash Welded, Titanium and Titanium Alloys

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS4934F

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 539	X-Ray Emission Spectrometric Analysis of 6Al-4V Titanium Alloy
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 539 or ASTM E 2371. Other analytical methods may be used if acceptable to the purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Aluminum	5.50	6.75
Vanadium	3.50	4.50
Iron	--	0.30
Oxygen	--	0.20
Carbon	--	0.10
Nitrogen	--	0.05 (500 ppm)
Hydrogen (3.1.2)	--	0.0125 (125 ppm)
Yttrium	--	0.005 (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 Sample size may be as large as 0.35 gram when ASTM E 1447 is used for hydrogen determination.

3.1.3 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 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 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 Bars and Shapes

Extruded, solution heat treated, aged, and descaled. Cut plate shall not be substituted for bar.

3.3.2 Flash Welded Rings

Fabricated in accordance with AMS7498, solution heat treated, and aged.

3.3.3 Stock for Flash Welded Rings

As ordered by the flash welded ring manufacturer.

3.4 Heat Treatment

Bars, shapes, and flash welded rings shall be solution treated by heating in a suitable atmosphere to a temperature within the range 1700 to 1750 °F (927 to 954 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with section thickness, and quenching in water and aged by heating to a temperature within the range 950 to 1050 °F (510 to 566 °C), holding at the selected temperature within ±15 °F (±8 °C) for a suitable time, and cooling as required. Extrusions shall be descaled by wet or dry abrasive blasting, by chemical procedures, or by other methods approved by purchaser. Extrusions may be straightened cold prior to aging or at 950 to 1050 °F (510 to 566 °C) after aging. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

Extrusions and flash welded rings shall conform to the following requirements:

3.5.1 Tensile Properties

Shall be as specified in Table 2 (See 8.2) for product 3.000 inches (76.20 mm) and under, in nominal diameter or least distance between parallel sides, determined in accordance with ASTM E 8 / E 8M on specimens selected in either the long-transverse or the longitudinal direction 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 Diameter or Least Distance Between Parallel Sides Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %	Reduction of Area %
Up to 0.500, incl	160	150	6	12
Over 0.500 to 0.750, incl	155	145	6	12
Over 0.750 to 1.000, incl	150	140	6	12
Over 1.000 to 2.000, incl	140	130	6	12
Over 2.000 to 3.000, incl	130	120	6	12

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Diameter or Least Distance Between Parallel Sides mm	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %	Reduction of Area %
Up to 12.70, incl	1103	1034	6	12
Over 12.70 to 19.05, incl	1069	1000	6	12
Over 19.05 to 25.40, incl	1034	965	6	12
Over 25.40 to 50.80, incl	965	896	6	12
Over 50.80 to 76.20, incl	896	827	6	12

3.5.1.1 Tests in the transverse direction are not required on product tested in the longitudinal direction.

3.5.2 Compressive Properties

Extrusions shall show a longitudinal compressive yield strength equal to or greater than the specified yield strength in tension.

3.5.3 Surface Contamination

The product shall be free of any oxygen-rich layer (See 8.3), such as alpha case, or other surface contamination.

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.

4.2 Classification of Tests

4.2.1 Acceptance Tests

The following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Tensile properties (3.5.1) and surface contamination (3.5.3) of each lot of extrusions and flash welded rings.

4.2.2 Periodic Tests

Compressive properties of extrusions and flash welded rings (3.5.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be in accordance with 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 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 and Surface Contamination

At least one sample from each lot.

4.3.1.2.1 Tensile specimens shall be taken from the center of the cross-section of the predominant or thickest portion of product 1.500 inches (38.10 mm) and under in nominal diameter or distance between parallel sides. Tensile specimens shall be taken midway between center and surface of product over 1.500 inches (38.10 mm) in nominal diameter or distance between parallel sides.

4.4 Reports

The vendor shall provide a copy of the original material manufacturer's (producer's) report (material certification), including: producer name, and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations). This report shall document the results of tests for composition of each heat and for the hydrogen content and tensile properties of each lot, and state that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot number, AMS4934F, product form and size (and/or part number, if applicable), specific heat treatment used, and quantity.

4.5 Resampling and Retesting

If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.