



AEROSPACE MATERIAL SPECIFICATION

AMS4934™

REV. J

Issued 1975-06
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Superseding AMS4934H

Titanium Alloy, Extrusions and Flash Welded Rings,
6Al - 4V,
Solution Heat Treated and Aged
(Composition similar to UNS R56400)

RATIONALE

AMS4934J results from a Five-Year Review and update of this specification with changes to update wording to prohibit unauthorized exceptions (see 3.5.1.2 and 8.6), relocate Definitions (see 2.3), and update Applicable Documents (see Section 2) and ordering information (see 8.7).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of extruded bars, shapes, and flash-welded rings up through 3.000 inches (76.20 mm), inclusive, in nominal diameter or least distance between parallel sides, and stock for flash-welded rings of any size (see 8.7).

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 +1 724-776-4970 (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

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SAE WEB ADDRESS:

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
AS6279	Standard Practice for Production, Distribution, and Procurement of Metal Stock
AS7766	Terms Used in Aerospace Metals Specifications

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 E8/E8M	Tension Testing of Metallic Materials
ASTM E539	Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry
ASTM E1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion
ASTM E1447	Determination of Hydrogen in Reactive Metals and Reactive Metal Alloys by Inert Gas Fusion with Detection by Thermal Conductivity or Infrared Spectrometry
ASTM E1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
ASTM E2371	Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Test Methodology)
ASTM E2994	Analysis of Titanium and Titanium Alloys by Spark Atomic Emission Spectrometry and Glow Discharge Atomic Emission Spectrometry (Performance-Based Method)

2.3 Definitions

Terms used in AMS are defined in AS7766.

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 E1941, hydrogen in accordance with ASTM E1447, oxygen and nitrogen in accordance with ASTM E1409, and other elements in accordance with ASTM E539, ASTM E2371, or ASTM E2994. 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	--	0.0125 (125 ppm)
Yttrium	--	0.005 (50 ppm)
Other Elements, each (see 3.1.1)	--	0.10
Other Elements, total (see 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.

3.2 Melting Practice

The alloy shall be multiple melted. The first melt shall be made by vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice. The subsequent melt or melts shall be made 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 of 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 of 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 the purchaser. Extrusions may be straightened cold prior to aging or at 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 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 up through 3.000 inches (76.20 mm), inclusive, in nominal diameter or least distance between parallel sides, determined in accordance with ASTM E8/E8M on specimens selected in either the long-transverse or the longitudinal direction with the rate of strain set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (± 0.002 mm/mm/min) 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 Millimeters	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.

3.5.1.2 Mechanical property requirements for product outside the range covered by 3.5.1 and Table 2 shall be agreed upon between the purchaser and producer and reported per 4.4.4 (see 8.7).

3.5.2 Compressive Properties

Extrusions shall show 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 determined by metallographic examination at not less than 400X or by other method agreed upon by the purchaser and producer.

3.6 Quality

The product, as received by the 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.

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279.

3.9 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.4.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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 (see 3.1) of each heat.

4.2.1.2 Tensile properties (see 3.5.1) and surface contamination (see 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 (see 3.5.2) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Shall be in accordance with AMS2368 and 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.