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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS-4920 REV A

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Superseding AMS-4920

Submitted for recognition as an American National Standard

TITANIUM ALLOY FORGINGS
6Al - 4V
Alpha-Beta or Beta Processed, Annealed

UNS R56400

1. SCOPE:

1.1 Form: This specification covers a titanium alloy in the form of forgings and forging stock.

1.2 Application: Primarily for parts that do not require heat treatment but requiring high mechanical properties in the annealed condition and for which processing above the beta transus is permissible. This alloy exhibits high strength-to-weight ratios up to 750°F (399°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

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

2.1.1 Aerospace Material Specifications:

AMS-2249 - Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS-2808 - Identification, Forgings

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8 - Tension Testing of Metallic Materials
ASTM E 8M - Tension Testing of Metallic Materials (Metric)
ASTM E 120 - Chemical Analysis of Titanium and Titanium Alloys

2.3 U.S. Government Publications: Available from Naval Publications and Forms Center, Attn: NPODS, 5801 Tabor Avenue, Philadelphia, PA 19120-5099.

2.3.1 Military Specifications:

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

2.3.2 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E 120, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	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 (3.1.1)	--	0.0125	(125 ppm)
Yttrium (3.1.2)	--	0.005	(50 ppm)
Residual Elements, each (3.1.2)	--	0.10	
Residual Elements, total (3.1.2)	--	0.40	
Titanium	remainder		

3.1.1 Hydrogen content of forgings may be as high as 0.0150 (150 ppm).

3.1.2 Determination not required for routine acceptance.

3.1.3 Check Analysis: Composition variations shall meet the requirements of AMS-2249.

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Forgings: Annealed and descaled.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Annealing: Forgings shall be annealed by heating to a temperature within the range 1300° - 1400°F (704° - 760°C), holding at the selected temperature within ±25°F (±14°C) for a time commensurate with section thickness and the heating equipment and procedure used, and cooling at a rate which will produce forgings meeting the requirements of 3.4.1. Furnace surveys and calibration of temperature controllers and recorders shall be in accordance with MIL-H-81200.

3.4 Properties: The product shall conform to the following requirements:

3.4.1 Forgings:

3.4.1.1 Tensile Properties: Forgings, 6.000 inches (152.40 mm) and under in cross-sectional thickness, shall have the following properties determined in accordance with ASTM E 8 or ASTM E 8M on specimens as in 4.3.1.2 with the rate of strain maintained at 0.003 - 0.007 inch/inch/minute (0.003 - 0.007 mm/mm/minute) through the yield strength and then increased so as to produce failure in approximately one additional minute. When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer, using a rate of 0.005 inch/inch/minute (0.005 mm/mm/minute) through the yield strength and a minimum cross head speed of 0.10 inch (2.5 mm) per minute above the yield strength.

Tensile Strength, minimum	130,000 psi (896 MPa)
Yield Strength at 0.2% Offset, minimum	120,000 psi (827 MPa)
Elongation in 4D, minimum	8%
Reduction of Area, minimum	15%

3.4.1.1.1 Tensile property requirements for forgings over 6.000 inches (152.40 mm) in cross-sectional thickness shall be as agreed upon by purchaser and vendor.

3.4.1.1.2 Ø Tensile property requirements apply in both longitudinal and transverse directions, but testing in the transverse direction need be done only on product from which a specimen not less than 2.50 inches (63.5 mm) in length can be taken. Tests in the longitudinal direction are not required on product tested in the transverse direction.

3.4.1.2 Surface Contamination: Except as permitted by 3.4.1.2.1, forgings shall be free of any oxygen-rich layer, such as alpha case (See 8.2) or other surface contamination, determined by microscopic examination at not lower than 100X magnification or by other method agreed upon by purchaser and vendor.

3.4.1.2.1 When permitted by purchaser, forgings to be machined all over may have an oxygen-rich layer provided such layer is removable within the machining allowance on the forging.

3.4.1.3 Microstructure: Shall be that structure resulting from alpha-beta or beta processing. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.1. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.1.1, the tests shall be accepted as equivalent to tests of a forged coupon.

3.5 Quality:

3.5.1 Alloy shall be multiple melted; at least one of the melting cycles shall be under vacuum. The first melt shall be made by consumable electrode, nonconsumable electrode, electron beam, or plasma arc melting practice. The subsequent melt or melts shall be made using consumable electrode practice with no alloy additions permitted in the last consumable electrode melt.

3.5.1.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be inert gas at a pressure not higher than 250 mm of mercury.

3.5.1.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.5.2 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.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all Ø samples for vendor's test and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for 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 and hydrogen content of each lot.

4.2.1.2 Tensile properties (3.4.1.1), surface contamination (3.4.1.2), and microstructure (3.4.1.3) of each lot of forgings.