



# AEROSPACE MATERIAL SPECIFICATION

AMS4920

REV. F

Issued 1984-07  
Revised 2015-02

Superseding AMS4920E

Titanium Alloy, Forgings  
6Al - 4V  
Alpha-Beta or Beta Processed, Annealed  
(Composition similar to UNS R56400)

## RATIONALE

AMS4920F results from a Five Year Review and update of this specification that includes the removal of sample size allowance for hydrogen of Table 1 (covered by ASTM E1447) and allowance of higher hydrogen for forgings, requires agreement on mechanical property values for material outside specification ranges (3.5.1.1.1 and 8.7), the addition of AS6279 (3.7) and revises the report paragraph (4.4).

### 1. SCOPE

#### 1.1 Form

This specification covers a titanium alloy in the form of forgings, 6.000 inches (152.40 mm) and under in cross-sectional thickness and forging stock of any size.

#### 1.2 Application

These forgings have been used typically for parts that do not require heat treatment but require high mechanical properties in the annealed condition and for which processing above the beta transus is permissible, but usage is not limited to such applications. This alloy exhibits high strength-to-weight ratios up to 750 °F (399 °C).

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](http://www.sae.org).

AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2750	Pyrometry
AMS2808	Identification, Forgings
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products
AS6279	Industry Standard Practices for Production, Distribution, and Procurement of Metal Stock

## 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](http://www.astm.org).

ASTM E8 / E8M	Tension Testing of Metallic Materials
ASTM E539	Analysis of Titanium Alloys by X-Ray Fluorescence Spectrometry
ASTM E1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
ASTM E1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
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

## 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 or ASTM E2371. 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 (3.1.3)	--	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 Check Analysis

Composition variations shall meet the applicable requirements of AMS2249. Variation over maximum is not permitted for yttrium.

3.2 Melting Practice

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 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 Forgings

Annealed and descaled.

3.3.2 Forging Stock

As ordered by the forging manufacturer.

3.4 Annealing

Forgings shall be annealed by heating to a temperature within the range 1300 to 1400 °F (704 to 760 °C), holding at the selected temperature within  $\pm 25$  °F ( $\pm 14$  °C) for a time commensurate with section thickness and the heating equipment and procedure used, and cooling at a rate that will produce forgings meeting the requirements of 3.5.1. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 Forgings

3.5.1.1 Tensile Properties

Forgings, 6.000 inches (152.40 mm) and under in cross-sectional thickness, shall have the properties shown in Table 2, determined in accordance with ASTM E8 / E8M on specimens as in 4.3.1.2 with the rate of strain set at 0.005 inch/inch/minute (0.005 mm/mm/minute) and maintained within a tolerance of  $\pm 0.002$  inch/inch/minute (0.002 mm/mm/minute) through the 0.2% offset yield strain.

**Table 2 - Minimum tensile properties**

Property	Value
Tensile Strength	130 ksi (896 MPa)
Yield Strength at 0.2% Offset	120 ksi (827 MPa)
Elongation in 4D	8%
Reduction of Area	15%

3.5.1.1.1 Mechanical property requirements for product outside the range covered by 3.5.1.1 shall be agreed upon between purchaser and producer.

### 3.5.1.2 Microstructure

Shall be that structure resulting from alpha-beta or beta processing, as specified by purchaser (See 8.7). When no structure is specified, alpha-beta processing shall be performed. Standards for acceptance shall be as agreed upon by purchaser and producer.

### 3.5.1.3 Surface Contamination

Except as permitted by 3.5.1.3.1, forgings 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 by other method acceptable to purchaser.

3.5.1.3.1 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.

### 3.5.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.4, specimens taken from the heat treated coupon shall conform to the requirements of 3.5.1.1. If specimens taken from the stock after heat treatment as in 3.4 conform to the requirements of 3.5.1.1, the tests shall be accepted as equivalent to tests of a forged coupon.

## 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.

3.6.1 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.7 Production, distribution, and procurement of metal stock shall comply with AS6279. This requirement becomes effective August 01, 2016.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer'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 Hydrogen content (3.1), tensile properties (3.5.1.1), microstructure (3.5.1.2), and surface contamination (3.5.1.3) of each lot of forgings.

#### 4.2.2 Periodic Tests

Tests for ability of forging stock to develop required properties (3.5.2) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.