AEROSPACE MATERIAL SPECIFICATION

AMS2368™	REV. E
Issued 1995-04 Revised 2022-07 Superseding AMS2368D	

Sampling and Testing of Wrought Titanium Raw Material Except Forgings and Forging Stock

RATIONALE

AMS2368E results from a Five-Year Review and update of this specification with revisions to fracture toughness to add K_Q invalidity (3.2.5.1), low temperature testing (3.2.12.3), resampling and retesting (3.3), and applicable documents (Section 2, 3.2.8).

1. SCOPE

1.1 Purpose

This specification provides a standard set of procedures for sampling and testing to meet the requirements of material specifications for wrought titanium and titanium alloy products, except forgings and forging stock. It is applicable to the extent specified in a material specification.

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.

AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2631	Ultrasonic Inspection, Titanium and Titanium Alloy Bar, Billet, and Plate
AMS2632	Inspection, Ultrasonic, of Thin Materials 0.50 Inch (12.7 mm) and Under in Cross-Sectional Thickness
AMS2634	Ultrasonic Inspection, Thin Wall Metal Tubing
AMS2801	Heat Treatment of Titanium Alloy Parts
AMS-H-81200	Heat Treatment of Titanium and Titanium Alloys
AS7766	Terms Used in Aerospace Metals Specifications

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS2368E/

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 E10 Brinell Hardness of Metallic Materials

ASTM E18 Rockwell Hardness of Metallic Materials

ASTM E21 Elevated Temperature Tension Tests for Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

ASTM E290 Bend Testing of Material for Ductility

ASTM E292 Conducting Time-for-Rupture Notch Tension Tests of Materials

ASTM E384 Microindentation Hardness of Materials

ASTM E399 Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

ASTM E539 Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry

ASTM E1304 Plane-Strain (Chevron Notch) Fracture Toughness of Metallic Materials

ASTM E1409 Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion

ASTM E1447 Determination of Hydrogen in Titanium and Titanium Alloys by 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 (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 General

3.1.1 Conformance

The producer shall be responsible for furnishing products that conform to all requirements of the material specification. Sampling and testing for any requirements not covered herein or in the material specification shall be optional, unless otherwise specified by purchaser.

3.1.1.1 Tests for properties that are characteristic of the heat, such as composition, hardenability, and cleanliness, need not be repeated on finished product from a heat provided that these tests have been performed on the stock from that heat and that heat identity of the material is maintained.

3.1.2 Lot

A lot shall be all product of the same nominal size and shape, from the same ingot (heat), processed in the same manner, and presented for producer's inspection at one time. When processing includes heat treatment, product shall have been heat treated in one or more furnaces in the same load or sequentially heat treated in a series of furnaces (see 8.2) or a continuous furnace over not more than 48 hours providing there is no interruption in operations or change in furnace temperature setting(s), charge rate, or racking pattern.

3.1.3 Sampling and Testing

3.1.3.1 Composition

Sampling and testing shall conform to 3.2.3.

3.1.3.2 Other Properties

Except as otherwise specified below, at least one test of each type shall be performed on specimens, located and oriented in accordance with 3.1.3.2.1 and 3.1.3.2.2, from a random sample from each lot.

3.1.3.2.1 Location of Specimens

When practical, tests shall be performed on full thickness specimens. When the product is too thick for testing its full thickness, the center of the specimen shall be located at the center of the thickness of the product for sizes less than or equal to 1.5 inches (38 mm) and at the mid-radius or quarter thickness for sizes greater than 1.5 inches (38 mm) or least difference between parallel sides. Short transverse specimens shall be located at the middle of the width of the product. Transverse specimens for rounds shall be radial or tangential (or mid-radius chord) for product that a tensile specimen not less than 2.50 inches (63.5 mm) in length can be obtained. Specimens from flash welded rings shall not include the weld or heat affected zone (see 8.4).

3.1.3.2.2 Orientation of Specimens

Shall be tangential for flash welded rings and longitudinal for other products unless a specific test direction is referenced in the material specification, then the test direction listed in the material specification takes precedence. Stock for flash welded rings shall be tested longitudinally.

3.2 Tests (in Alphabetical Order)

3.2.1 Bending

3.2.1.1 Bend tests shall be performed using the U-channel or free bend procedure in accordance with ASTM E290. In case of dispute, the free bend procedure shall govern. Inspection shall be at either 1X or 10X.

3.2.1.2 The axis of bend shall be parallel to the direction of rolling (transverse specimen).

3.2.1.3 Width of specimens shall be 10 times the nominal thickness of the product or 1 inch (25 mm), whichever is greater, except that for free bend tests the width need not be greater than 1 inch (25 mm).

3.2.2 Coiling

Tests shall be performed on two samples from each lot.

3.2.3 Composition

3.2.3.1 Consumable Melted Ingots and Cold Hearth Melted Ingots

Composition, except for hydrogen, shall be determined at the top and bottom of each ingot in accordance with ASTM E1941 for carbon, ASTM E1409 for oxygen and nitrogen, and other elements by other analytical methods in accordance with ASTM E2371, ASTM E539, or ASTM E2994. Other analytical methods can be used if acceptable to purchaser. Each analysis shall meet the composition requirements; both the top and bottom ingot analyses or average of the analyses shall be reported. Hydrogen content shall be determined, in accordance with ASTM E1447 or other method acceptable to purchaser, on a random sample from each lot after completion of all thermal and chemical processing.

3.2.3.2 Nonconsumable Melted Ingots

Composition shall be determined as specified in 3.2.3.1; it shall also be determined at three additional ingot locations: the middle, midway between the middle and the bottom, and midway between the middle and the top.

3.2.3.3 Check Analysis

Composition variations shall meet the requirements of AMS2249.

3.2.4 Creep

Tests shall conform to ASTM E139.

3.2.5 Fracture Toughness

The product shall be subject to fracture toughness testing on specimens from two locations oriented in the T-L direction. There is no recognized standard for fracture toughness testing of sheet, strip, and plate under 1/2 inch (12.7 mm) thick. Method of test and acceptance standards shall be as specified by the purchaser. Procedure for thicker product shall conform to ASTM E399 or, when permitted by purchaser, ASTM E1304.

3.2.5.1 If a K_Q value is invalid solely on the basis of either W-a is less than 2.5 $(K_Q/TYS)_2$ or P_{max}/PQ is greater than 1.10, or both, and the thickest possible specimen has been used, the K_Q value may be used as K_C to satisfy the requirements of the AMS specification. K_Q values invalid on the basis of criteria other than listed above (e.g., crack front curvature, etc.) shall not be used, but an additional specimen shall be tested for each of these invalid specimens.

3.2.6 Average Grain Size

Shall be determined by comparison of a polished and etched longitudinal specimen in accordance with ASTM E112.

3.2.7 Hardness

Shall be determined in accordance with ASTM E10 or ASTM E18.

3.2.8 Heat Treatment Response

Heat treatment of samples, to confirm that product will develop required properties, shall conform to AMS2801 or AMS-H-81200 when requirements are not designated in the material specification.

3.2.9 Microstructure

Shall be determined by examination of a polished and etched longitudinal or transverse specimen at 100X magnification. Round bar may be examined immediately prior to grinding or turning to final size.

3.2.10 Stress Rupture, Notched

Tests shall conform to ASTM E292.