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AEROSPACE MATERIAL SPECIFICATION

AMS4945™ REV. H

Issued 1989-01
Revised 2020-02

Superseding AMS4945G

Titanium Alloy Tubing, Seamless, Hydraulic 3Al - 2.5V, Controlled Contractile Strain Ratio Cold Worked, Stress Relieved (Composition similar to UNS R56320)

RATIONALE

AMS4945H results from a Five-Year Review and update of this specification that adds additional controls on produced material (8.6).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of seamless tubing.

1.2 Application

This tubing has been used typically for parts, such as hydraulic lines, requiring high fatigue strength and oxidation resistance up to 600 °F (316 °C) and weldability, but usage is not limited to such applications.

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.

AMS2244 Tolerances, Titanium and Titanium Alloy Tubing

AMS2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

AMS2634 Ultrasonic Inspection, Thin Wall Metal Tubing

AMS2750 Pyrometry

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AMS2809 Identification, Titanium and Titanium Alloy Wrought Products

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

AS4076 Contractile Strain Ratio Testing of Titanium Hydraulic Tubing

AS33611 Tube Bend Radii

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 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 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 Atomic Emission Spectrometry

ASTM E2994 Analysis of Titanium and Titanium Alloys by Spark Atomic Emission Spectrometry and Glow Discharge Atomic Emission Spectrometry

2.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B46.1 Surface Texture (Roughness, Waviness and Lay)

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	2.50	3.50
Vanadium	2.00	3.00
Iron	--	0.30
Oxygen	--	0.12
Carbon	--	0.05
Nitrogen	--	0.020 (200 ppm)
Hydrogen	--	0.005 (50 ppm)
Yttrium (3.1.1)	--	0.005 (50 ppm)
Other Elements, each (3.1.1)	--	0.10
Other Elements, total (3.1.1)	--	0.40
Titanium	remainder	

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3.1.1 Determination not required for routine acceptance.

3.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2249.

3.3 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 using vacuum arc remelting (VAR) practice. Alloy additions are not permitted in the final melt cycle.

3.3.1 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.

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

3.4 Condition

Cold worked and stress relieved by heating to a temperature not lower than 700 °F (371 °C) and holding at heat for not less than 30 minutes. Tubing that is rotary straightened after final reduction shall be stress relieved at a minimum temperature of 700 °F (371 °C) for not less than 2 hours after straightening. Pyrometry shall be in accordance with AMS2750.

3.4.1 Furnaces shall meet the requirements of AMS2750. Furnaces shall be a minimum Class 5 (±25 °F/±14 °C) with a minimum of Type D instrumentation.

3.4.2 Heat treatment operations shall be performed under vacuum or inert gas.

3.5 Properties

Tubing shall conform to the following requirements:

3.5.1 Tensile Properties

Shall be as shown in Table 2, determined in accordance with ASTM E8/E8M 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 2 - Minimum tensile properties

Property	Value
Tensile Strength	125 ksi (862 MPa)
Yield Strength at 0.2% Offset	105 ksi (724 MPa)
Elongation in 2 Inches (50.8 mm)	
Nominal Wall Thickness	
Up to 0.016 Inch (0.41 mm), incl	8%
Over 0.016 Inch (0.41 mm)	10%

3.5.2 Flarability

Specimens as in 4.3.3 shall withstand flaring at room temperature, without formation of cracks or other visible defects, by being forced axially with steady pressure, over a hardened and polished tapered steel pin having 74 degree included angle to produce a flare having a permanent expanded OD not less than 1.20 times the original nominal OD.