

# AERONAUTICAL MATERIAL SPECIFICATIONS

AMS 4941

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York 17, N.Y.

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Revised

## TITANIUM TUBING, WELDED Annealed - 40,000 psi Yield

1. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

2. APPLICATION: Primarily for parts requiring strength up to 400 F and oxidation resistance up to 600 F.

3. COMPOSITION: The product shall conform to the following:

|                       |           |
|-----------------------|-----------|
| Carbon                | 0.20 max  |
| Nitrogen              | 0.07 max  |
| Hydrogen              | 0.015 max |
| Other Elements, total | 0.6 max   |
| Titanium              | remainder |

4. CONDITION: Unless otherwise specified, inert gas shielded arc welded, cold drawn, annealed, and descaled.

4.1 Fabrication: Any surface finishing operation applied to remove objectionable pits and surface blemishes shall be performed prior to, and shall be completely removed by, the last drawing operation. A light polish to improve surface appearance may be employed after the last heat treatment.

5. TECHNICAL REQUIREMENTS:

5.1 Tensile Properties: Tubing shall conform to the following requirements, and shall be capable of meeting these requirements after being heated to 1300 F for approximately 2 hr, air cooled, and descaled. These properties apply when the rate of strain is maintained at 0.003 - 0.007 in. per in. per min., through the yield strength and then is 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 in. per in. per min. through the yield strength.

|                                                         |                 |
|---------------------------------------------------------|-----------------|
| Tensile Strength, psi                                   | 50,000 min      |
| Yield Strength at 0.2% Offset or at 0.0092 in.          |                 |
| in 2 in. Extension Under Load ( $E = 15,500,000$ ), psi | 40,000 - 65,000 |
| Elongation, % in 2 in.                                  | 20 min          |

5.2 Flattening: Tubing having nominal wall thickness less than 10% of the nominal  $\odot$  shall withstand, without cracking, flattening sideways under a load applied gradually at room temperature until the outside dimension under load is equal to 5 times the nominal wall thickness.

- 5.2.1 If tubing does not pass the flattening test of 5.2, a section of the tube not less than 1/2 in. in length and embracing 1/3 to 1/2 the circumference of the tube, and including the weld zone in welded tubing, shall withstand, without cracking, bending at room temperature through an angle of 180 deg around a diameter equal to 3 times the nominal wall thickness of the tubing with axis of bend parallel to axis of tube and with inside of tube on inside of bend. Cut edges of the specimen shall be smooth and free from burrs.
- 5.3 Flarability: Tubing shall be capable of being flared without formation of cracks or other visible defects. Specimens for flaring may be cut from any portion of the tube, or an entire tube may be used as a specimen. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded. The specimen shall, at room temperature, be forced axially with steady pressure over a hardened and polished tapered steel pin having a 7 $\frac{1}{4}$  deg included angle, to produce a permanent expanded OD not less than 1.25 times the original nominal OD.
- 5.4 Pressure Testing: The tubing shall show no bulges, leaks, or other defects when subjected to an internal hydrostatic pressure, based on nominal dimensions, sufficient to cause a tensile stress of 20,000 psi in the tubing wall.
6. QUALITY: Tubing shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.
7. TOLERANCES: Unless otherwise specified, the following tolerances apply:

7.1 Diameter:

| Nominal OD<br>Inches | Tolerance, Inch<br>Plus and Minus |
|----------------------|-----------------------------------|
| Under 0.093          | 0.002                             |
| 0.093 to 0.188, excl | 0.003                             |
| 0.188 to 0.500, excl | 0.004                             |
| 0.500 to 1.500, excl | 0.005                             |

Note. The term "excl" is used to apply only to the higher figure of the specified range.

- 7.2 Wall Thickness: Shall not vary more than  $\pm 10\%$  of the nominal wall thickness.

8. REPORTS:

- 8.1 Unless otherwise specified, the vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition of each heat in the shipment and the results of tests on each size from each heat to determine conformance to the tensile requirements of this specification. This report shall include the purchase order number, heat number, material specification number, size, and quantity from each heat.