

AEROSPACE MATERIAL SPECIFICATIONS

AMS 5586

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

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Revised

ALLOY TUBING, WELDED, CORROSION AND HEAT RESISTANT
Nickel Base - 19.5Cr - 13.5Co - 4.3Mo - 2.9Ti - 1.4Al
Annealed

Consumable Electrode or Vacuum Induction Melted

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

2. APPLICATION: Primarily for parts requiring high strength up to 1500 F (815 C) and oxidation resistance up to 1750 F (955 C).

3. COMPOSITION:

	min	max
Carbon	0.04	0.10
Manganese	--	0.10
Silicon	--	0.15
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	18.00	21.00
Cobalt	12.00	15.00
Molybdenum	3.50	5.00
Titanium	2.50	3.25
Aluminum	1.20	1.60
Zirconium	0.02	0.15
Boron (See 3.1)	0.003	0.010
Iron	--	2.00
Copper	--	0.10
Nickel	remainder	

3.1 Boron may be less than 0.003 as determined on tubing having wall thickness less than 0.050 in. provided specified requirement is met on the stock from which sheet or strip for making tubing is rolled.

3.2 Check Analysis: Composition variations shall meet the requirements of the latest issue of AMS 2269; check analysis limits for zirconium shall be 0.01 under min or over maximum.

4. CONDITION: Annealed and descaled. Annealing shall be performed in suitable protective atmosphere at such temperature and for such time as will produce material meeting all requirements of Section 5. Cooling from the annealing temperature shall be at a rate equivalent to air cool or faster.

4.1 Tubing 2.00 in. and under in nominal OD shall be cold drawn after welding.

Section 8.3 of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no obligation to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and applying technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

5. TECHNICAL PROPERTIES:

5.1 Properties After Annealing: Tubing in the annealed condition shall conform to the following requirements:

5.1.1 Tensile Properties:

Tensile Strength, psi	145,000 max
Yield Strength at 0.2% Offset or at 0.0092 in. in 2 in. Extension Under Load (E = 31,000,000), psi	80,000 max
Elongation, % in 2 in.	35 min

5.1.1.1 Tubing under 0.125 in. in OD or under 0.015 in. in wall thickness shall have properties as agreed upon by purchaser and vendor.

5.1.2 Flarability: 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 74 deg included angle, to produce a flare having a permanent expanded OD not less 1.2 times the nominal diameter.

5.1.3 Pressure Test: Tubing shall show no bulges, leaks, or other defects when subjected to an internal hydrostatic pressure of 15,000 psig or pressure sufficient to cause a tensile stress of 40,000 psi in the tubing wall, whichever is less. The hydrostatic pressure (P) shall be based on:

$$P = \frac{2St}{D}$$

Where, S = 40,000 psi tensile stress

t = minimum wall thickness (nominal thickness minus maximum negative tolerance) in inches

D = Nominal OD in inches

5.1.4 Grain Size: Material shall have substantially uniform grain size without pronounced segregation of fine and coarse grain areas, in accordance with standards agreed upon by purchaser and vendor.

5.2 Heat Treatment: When solution, stabilization, and precipitation heat treatments are specified, operations shall be performed as follows:

5.2.1 Solution Heat Treatment: Heat to 1825 F \pm 25 (996.1 C \pm 14) in suitable protective atmosphere, hold at heat for 2 hr, and cool at a rate equivalent to air cool or faster.

5.2.2 Stabilization Heat Treatment: Heat to 1550 F \pm 15 (843.3 C \pm 8.3), hold at heat for 4 hr, and cool in air.

5.2.3 Precipitation Heat Treatment: Heat to 1400 F \pm 15 (760 C \pm 8.3), hold at heat for approximately 16 hr, and cool in air.

5.3 Properties After Heat Treatment: Tubing solution, stabilization, and precipitation heat treated as in 5.2 shall conform to the following requirements.

5.3.1 Tensile Properties at Room Temperature:

Tensile Strength, psi	160,000 min
Yield Strength at 0.2% Offset or at 0.0108 in. in 2 in. Extension Under Load (E = 31,000,000), psi	105,000 min
Elongation, % in 2 in.	15 min

5.3.1.1 Tubing under 0.125 in. in OD or under 0.015 in. in wall thickness shall have properties as agreed upon by purchaser and vendor.

5.3.2 Hardness: Rockwell C 34 - 44 or equivalent.

5.3.3 Stress-Rupture Test: Tubing 0.125 in. and over in OD and 0.015 in. and over in wall thickness shall be capable of meeting the requirements of 5.3.3.1 and 5.3.3.2. The test of 5.3.3.2 need be run only if failure occurs in the test of 5.3.3.1; if material meets the requirements of 5.3.3.2, it shall be considered satisfactory.

5.3.3.1 At 1350 F (732.2 C): A tensile test specimen, maintained at $1350\text{ F} \pm 5$ ($732.2\text{ C} \pm 2.8$) while the axial stress specified below is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture. Elongation after rupture, measured at room temperature, shall be as specified below:

Nominal Wall Thickness Inches	Stress, psi	Elongation % in 2 in., min
0.015 to 0.020, incl	62,500	4
Over 0.020 to 0.030, incl	65,000	4
Over 0.030 to 0.050, incl	67,500	4
Over 0.050	70,000	5

5.3.3.2 At 1500 F (815.6 C): A tensile test specimen, maintained at $1500\text{ F} \pm 5$ ($815.6\text{ C} \pm 2.8$) under continuously applied axial stress of 37,500 psi, shall not rupture in less than 23 hours. The test shall be continued to rupture. Elongation after rupture, measured at room temperature, shall be not less than 5% in 2 inches.

5.3.3.2.1 The test of 5.3.3.2 may be conducted at a stress higher than 37,500 psi but stress shall not be changed while test is in process, unless otherwise specified or permitted. Time to rupture and elongation requirements of 5.3.3.2 shall be met.

6. QUALITY:

- 6.1 Material shall be produced by multiple melting using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum, unless otherwise permitted. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used for remelting.
- 6.2 Tubing shall have a finish conforming to the best practice for high quality aircraft material. Tubing shall be uniform in quality and condition, clean, sound, and free from grease or other foreign matter, and from burrs, seams, tears, grooves, laminations, slivers, pits, and other injurious imperfections. External and internal surface imperfections such as handling marks, straightening marks, light mandrel and die marks, shallow pits, seams, scores, and scale pattern will not be considered as injurious, provided the imperfections are removable within the tolerances specified herein for diameter and wall thickness.
- 6.3 If beads are present at the weld on the inner surface of tubing over 2.00 in. in nominal OD, such beads shall be not thicker than 0.010 in., unless otherwise specified. The outer surface of all tubing and the inner surface of tubing 2.00 in. and under in nominal OD shall be free from beads.

7. **TOLERANCES:** Unless otherwise specified, tolerances shall conform to all applicable requirements of the latest issue of AMS 2263.

8. REPORTS:

- 8.1 Unless otherwise specified, the vendor of tubing 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 technical requirements of this specification. This report shall include the purchase order number, heat number, material specification number, size, and quantity from each heat.
- 8.2 Unless otherwise specified, the vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number, contractor or other direct supplier of tubing, part number, and quantity. When tubing for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of tubing to determine conformance to the requirements of this specification, and shall include in the report a statement that the tubing conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.