SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York, N.Y. 10017

AEROSPACE MATERIAL SPECIFICATIONS

AMS 5589

Issued 9-30-66
Revised

ALLOY TUBING, SEAMLESS, CORROSION AND HEAT RESISTANT
Nickel Base - 19Cr - 3.1Mo - 5.1(Cb + Ta) - 0.90Ti - 0.50Al
Consumable Electrode or Vacuum Induction Melted
1750 F (954.4 C) Solution Treated

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

2. APPLICATION: Primarily for fluid lines and structural components requiring resistance to creep and stress-rupture up to 1300 F (704 C) and oxidation resistance up to 1800 F (982 C), particularly those which are formed or welded and then heat treated to develop required properties.

3. COMPOSITION:

	min	max
Carbon	--	0.08
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	17.00	21.00
Nickel	50.00	55.00
Cobalt	--	1.00
Molybdenum	2.80	3.30
Columbium + Tantalum	4.75	5.50
Titanium	0.65	1.15
Aluminum	0.20	0.80
Boron	--	0.006
Copper	--	0.30
Iron	remainder	

3.1 Check Analysis: Composition variations shall meet the requirements of the latest issue of AMS 2269.

4. CONDITION: Unless otherwise specified, cold drawn, solution heat treated, and descaled. A light polish to improve surface appearance may be utilized after the descaling operation.

5. TECHNICAL REQUIREMENTS:

5.1 Solution Heat Treatment: Unless otherwise specified, tubing shall conform to the requirements of 5.2 and shall be capable of meeting the requirements of 5.3. No specific heat treating instructions are specified but it is recommended that the tubing be solution heat treated by heating in a suitable protective atmosphere to 1750 F ± 25 (954.4 C ± 14), holding at heat for approximately 30 min., and cooling at a rate equivalent to air cool or faster.

5.2 Properties After Solution Heat Treatment:

5.2.1 Tensile Properties: Tubing having OD of 0.125 in. and over with wall thickness 0.015 in. and over shall conform to the following requirements:

Tensile Strength, psi	155,000 max
Yield Strength at 0.2% offset, psi	95,000 max
Elongation, % in 2 in.	30 min

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

5.2.2 Flarability: Tubing 0.188 to 2.00 in., incl, in OD 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 74 deg included angle to produce a flare having a permanent expanded OD not less than 1.25 times the original nominal diameter.

5.2.2.1 Tubing with nominal OD greater than 2.00 in. or less than 0.188 in. shall have flarability as agreed upon by purchaser and vendor.

5.2.3 Pressure Test: Tubing shall show no bulges, leaks, or other defects when subjected to an internal hydrostatic pressure of 5000 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:

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

where, S = 40,000 psi tensile stress
t = Minimum wall thickness (nominal thickness minus maximum negative tolerance) in inches
D = Nominal OD in inches.

5.2.4 Grain Size: Shall be predominantly 5 or finer with occasional grains as large as 3 permissible as determined by comparison of a polished and etched specimen with the chart in the issue of ASTM E112 listed in the latest issue of AMS 2350.

5.3 Properties After Precipitation Heat Treatment: Tubing precipitation heat treated by heating to 1325 F ± 15 (718.3 C ± 8.3), holding at heat for 8 hr, furnace cooling to 1150 F ± 15 (621.1 C ± 8.3), holding at 1150 F ± 15 (621.1 C ± 8.3) until a total precipitation time of 18 hr has been reached, and cooling at a rate equivalent to air cool or faster shall conform to the following requirements. The product shall also be capable of meeting the following requirements after being re-solution heat treated by heating to 1750 F ± 25 (954.4 C ± 14), holding at heat for not less than 30 min., and cooling at a rate equivalent to air cool or faster and then being precipitation heat treated as above.

5.3.1 Tensile Properties at Room Temperature: The following requirements apply to tubing having OD of 0.125 in. and over with wall thickness 0.015 in. and over.

Tensile Strength, psi	185,000 min
Yield Strength at 0.2% Offset or at 0.0141 in. in 2 in. Extension Under Load (E = 29,600,000), psi	150,000 min
Elongation, % in 2 in.	12 min

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

5.3.2 Stress Rupture Test at 1300 F (704.4 C): A tensile test specimen from tubing having OD of 0.125 in. and over with wall thickness 0.015 in. and over, maintained at 1300 F ± 3 (704.4 C ± 1.7) while an axial stress of 72,500 psi 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 not less than 5% in 4D.

5.3.2.1 Tubing less than 0.125 in. OD or under 0.015 in. wall thickness shall have stress-rupture properties as agreed upon by purchaser and vendor.