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400 Commonwealth Dr., Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5588D

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Superseding AMS 5588C

ALLOY TUBING, WELDED AND DRAWN, CORROSION AND HEAT RESISTANT
47.5Ni - 22Cr - 1.5Co - 9.0Mo - 0.60W - 18.5Fe
Solution Heat Treated

UNS N06002

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant nickel alloy in the form of welded and drawn tubing.

1.2 Application: Primarily for fluid lines operating in service under appreciable stresses at elevated temperatures. Alloy has good strength up to 1800°F (982°C) and oxidation resistance up to 2200°F (1204°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2263 - Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Tubing
MAM 2263 - Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Tubing
AMS 2269 - Chemical Check Analysis Limits, Wrought Nickel Alloys and Cobalt Alloys
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock
AMS 2632 - Ultrasonic Inspection of Thin Materials
AMS 2645 - Fluorescent Penetrent Inspection

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E8M - Tension Testing of Metallic Materials (Metric)
ASTM E112 - Determining Average Grain Size
ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
ASTM E426 - Practice for Electromagnetic (Eddy-Current) Testing of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E354, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	0.05	0.15
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	20.50	23.00
Cobalt	0.50	2.50
Molybdenum	8.00	10.00
Tungsten	0.20	1.00
Iron	17.00	20.00
Aluminum	--	0.50
Titanium	--	0.15
Boron	--	0.010
Copper	--	0.50
Nickel	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

3.2 Condition: Cold drawn, solution heat treated, and descaled. No specific Ø solution heat treating instructions are specified but it is recommended that the tubing be solution heat treated by heating in a suitable protective atmosphere to 2150°F ± 25 (1177°C ± 14), holding at heat for a time commensurate with section thickness, and cooling rapidly. In no case shall the solution heat treatment temperature be lower than 2100°F (1149°C).

3.3 Fabrication: Tubing shall be fabricated from hot or cold rolled strip, fusion welded without addition of filler metal, cold drawn, and solution heat treated. The cold drawing operation on tubing 3.0 inches (76.2 mm) and under in nominal OD shall result in not less than 15% reduction in wall thickness; the amount of wall thickness reduction on tubing over 3.0 inches (76.2 mm) in nominal OD shall be as agreed upon by purchaser and vendor.

3.4 Properties: Tubing shall conform to the following requirements:

3.4.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8 or ASTM E8M on tubing having nominal OD of 0.125 inch (3.18 mm) and over with nominal wall thickness of 0.015 inch (0.38 mm) and over:

Tensile Strength, minimum	100,000 psi (689 MPa)
Yield Strength at 0.2% Offset, minimum	45,000 psi (310 MPa)
Elongation in 2 Inches (50.8 mm), minimum	
Strip Specimens	20%
Full-Section Specimens	25%

3.4.1.1 Tensile property requirements for tubing under 0.125 inch (3.18 mm) in nominal OD or under 0.015 inch (0.38 mm) in nominal wall thickness shall be as agreed upon by purchaser and vendor.

3.4.2 Grain Size: Tubing 0.125 inch (3.18 mm) and under in nominal wall thickness shall have an average grain size of 4 or finer, determined in accordance with ASTM E112. Grain size requirements for tubing over 0.125 inch (3.18 mm) in nominal wall thickness shall be as agreed upon by purchaser and vendor.

3.4.3 Flarability: Specimens as in 4.3.1 shall withstand, without formation or cracks or other visible defects, flaring at room temperature by being forced axially with steady pressure over a hardened and polished tapered steel pin having a 74-degree included angle to produce a flare having a permanent expanded OD not less than 1.2 times the original nominal diameter.

3.4.4 Pressure Test: Tubing shall show no bulges, leaks, pinholes, cracks, or other defects when subjected to an internal hydrostatic pressure (P), except that a diametric permanent set of 0.002 inch per inch (0.002 mm/mm) of diameter is acceptable. The hydrostatic pressure (P) shall be determined from the equation:

$$P = S \frac{D^2 - d^2}{D^2 + d^2}$$

where, P = Test pressure in psi (MPa)
S = 45,000 psi (310 MPa)
D = Nominal OD
d = Nominal ID

3.5 Quality:

3.5.1 Tubing, as received by purchaser, shall be uniform in quality and condition and shall have a finish conforming to the best practice for high quality aircraft tubing. It shall be smooth and free from heavy scale or oxide, burrs, seams, tears, grooves, laminations, slivers, pits, and other imperfections detrimental to usage of the tubing. Surface imperfections such as handling marks, straightening marks, light mandrel and die marks, shallow pits, and scale pattern will not be considered injurious if the imperfections are removable within the tolerances specified for wall thickness but removal of such imperfections is not required.

3.5.2 If beads are present at the weld on the inner surface of tubing over 3.0 inches (76.2 mm) in nominal OD, such beads shall be not thicker than 0.010 inch (0.25 mm). The outer surface of all tubing and the inner surface of tubing 3.0 inches (76.2 mm) and under in nominal OD shall be free from beads.

3.5.3 When specified by purchaser, tubing shall be subjected to fluorescent penetrent inspection in accordance with AMS 2645, to ultrasonic inspection in accordance with AMS 2632, to electomagnetic (eddy-current) inspection in accordance with ASTM E426, or to any combination thereof. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight tubing will be acceptable in mill lengths of 6 - 24 feet (1.8 - 7.3 m) but not more than 25% of any shipment shall be supplied in lengths of 6 - 9 feet (1.8 - 2.7 m).

3.7 Tolerances: Shall conform to all applicable requirements of AMS 2263 or MAM 2263.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of tubing shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to the requirements of theis specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for composition (3.1), tensile properties (3.4.1), grain size (3.4.2), quality (3.5), and tolerances (3.7) are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for flarability (3.4.3) and pressure test (3.4.4) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.