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400 COMMONWEALTH DRIVE WARRENDALE PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 5581B
Superseding AMS 5581A

Issued 1-15-77
Revised 4-1-85

ALLOY TUBING, SEAMLESS OR WELDED, CORROSION AND HEAT RESISTANT
62Ni - 21.5Cr - 9.0Mo - 3.7(Cb + Ta)
Annealed

UNS N06625

1. SCOPE:

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

1.2 Application: Primarily for fluid lines requiring high strength and corrosion resistance at temperatures from cryogenic to 1800°F (980°C).

1.3 Classification: The tubing covered by this specification is classified as follows:

Type 1 - Seamless
Type 2 - Welded

1.3.1 Unless a specific type is specified, either Type 1 or Type 2 may be supplied.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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.

REAFFIRMED 10/91

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

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E112 - Determining Average Grain Size
ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt 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 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 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, determined by wet chemical methods in accordance with ASTM E354, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	--	0.10
Manganese	--	0.50
Silicon	--	0.50
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	20.00	23.00
Molybdenum	8.00	10.00
Columbium + Tantalum	3.15	4.15
Titanium (3.1.1)	--	0.40
Aluminum (3.1.1)	--	0.40
Cobalt (3.1.2)	--	1.00
Iron	--	5.00
Nickel	remainder	

3.1.1 Shall be present but not in excess of specified maximum.

3.1.2 Determination not required for routine acceptance.

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

3.2 Condition: Annealed and descaled.

3.3 Fabrication: Tubing shall be produced by a seamless or a welded and drawn process. The external and internal surface finishes may be produced by pickling, bright annealing, or any method which will provide the required surface condition and which will not affect limits of wall thickness or corrosion resistance, with the exception that centerless ground finish is not acceptable. A light polish to improve surface appearance may be employed.

3.3.1 Welded (Type 2) tubing shall be processed to remove the bead and any dimensional indication of the presence of welds.

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:

Tensile Strength, min	120,000 psi (825 MPa)
Yield Strength at 0.2% Offset, min	60,000 psi (415 MPa)
Elongation in 2 in. (50 mm), min	35%

3.4.2 Flarability: Specimens as in 4.3.1 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 a 74 deg included angle to produce a flare having a permanent expanded OD not less than specified in Table I.

TABLE I

Nominal OD Inches	Expanded OD Inches	Nominal OD Inches	Expanded OD Inches
0.125	0.200	0.750	0.937
0.188	0.290	1.000	1.187
0.250	0.359	1.250	1.500
0.312	0.421	1.500	1.721
0.375	0.484	1.750	2.106
0.500	0.656	2.000	2.356
0.625	0.781		

TABLE I (SI)

Nominal OD Millimetres	Expanded OD Millimetres	Nominal OD Millimetres	Expanded OD Millimetres
3.00	4.76	18.75	23.42
4.75	7.25	25.00	29.68
6.25	8.98	31.25	37.50
7.75	10.52	37.50	43.00
9.50	12.13	43.75	52.65
12.50	16.40	50.00	58.90
15.50	19.50		

3.4.2.1 Tubing with nominal OD between any two standard sizes given in 3.4.2 shall take the same percentage flare as shown for the larger of the two sizes.

3.4.2.2 Flarability requirements for tubing over 2.000 in. (50.00 mm) or under 0.125 in. (3.00 mm) in nominal OD shall be as agreed upon by purchaser and vendor.

3.4.3 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 in. per in. (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 = 60,000 psi (415 MPa)
D = Nominal OD
d = Nominal ID

3.4.4 Microstructure: Tubing shall reveal no continuous intergranular carbide precipitation when suitably etched and examined microscopically at 500X magnification. The presence of some discontinuous intergranular carbide precipitation shall not be considered detrimental if the other technical requirements of this specification are met. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.4.5 Grain Size: Shall be 5 or finer, determined by comparison of a specimen, polished and electrolytically etched in 10% oxalic acid, with the chart in ASTM E112, using 100X magnification.

3.5 Quality:

3.5.1 Tubing, as received by purchaser, shall be uniform in quality and condition Ø and shall have a finish conforming to the best practice for high quality aircraft tubing. It shall be smooth, clean, 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 Tubing shall be free from grease or other foreign matter. No metallic flakes or particles shall be collected by a clean white cloth when it is drawn through the length of the bore of a test sample. Discoloration of the cloth, without the presence of flakes or grit, is acceptable.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight tubing will be acceptable in mill lengths of 6 - 20 ft (2 - 6 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 m).

3.7 Tolerances: Unless otherwise specified, 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 Ø 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 this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for Ø composition (3.1), tensile properties (3.4.1), pressure test (3.4.3), microstructure (3.4.4), grain size (3.4.5), 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 requirements for Ø flarability (3.4.2) are classified as periodic tests and shall be determined at a frequency selected by the vendor unless frequency of testing is specified by purchaser.