Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 5581

Issued 1-15-77
Revised

UNS N06625

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

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 (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2263 - Tolerances, Nickel, Nickel-Base, and Cobalt-Base Alloy Tubing
AMS 2269 - Chemical Check Analysis Limits, Wrought Nickel and Nickel Base Alloys
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

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 - Estimating the Average Grain Size of Metals
ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt-Base Alloys

2.3 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 approved analytical methods:

		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	Present but not exceeding		0.40
Aluminum	Present but not exceeding		0.40
Cobalt (3.1.1)		--	1.00
Iron		--	5.00
Nickel		remainder	

3.1.1 Determination not required for routine acceptance.

3.1.2 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 (827 MPa)
Yield Strength at 0.2% Offset, min	60,000 psi (414 MPa)
Elongation in 2 in. (50.8 mm), min	35%

3.4.2 Flarability: Tubing 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 (1.29 rad) 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
3.18	5.08	19.05	23.80
4.78	7.37	25.40	30.15
6.35	9.12	31.75	38.10
7.92	10.69	38.10	43.71
9.52	12.29	44.45	53.49
12.70	16.66	50.80	59.84
15.88	19.84		

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 Tubing with nominal OD greater than 2.000 in. (50.80 mm) or less than 0.125 in. (3.18 mm) shall have flarability 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 = Yield Strength from 3.4.1
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 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 shall be uniform in quality and condition and shall have a finish conforming to the best practice for high quality tubing. It shall be smooth, clean, and free from heavy scale or oxide, burrs, seams, tears, grooves, laminations, slivers, pits, and other injurious conditions. 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 (1.8 - 6.1 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.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of tubing shall supply all samples 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 perform such confirmatory testing as he deems 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 composition (3.1), tensile property (3.4.1), pressure test (3.4.3), microstructure (3.4.4), grain size (3.4.5), quality (3.5), and tolerance (3.7) requirements are classified as acceptance tests.

4.2.2 Periodic Tests: Tests to determine conformance to flarability (3.4.2) requirements are classified as periodic tests.

4.3 Sampling: Shall be in accordance with AMS 2371 and the following:

4.3.1 Specimens for flarability test shall be full tubes or sections cut from tubes. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded.

4.4 Reports:

4.4.1 The vendor of tubing shall furnish with each shipment three copies of a report showing the results of tests for chemical composition of each heat and for tensile properties and grain size of each size from each heat, and stating that the tubing conforms to the other technical requirements of this specification. This report shall include the purchase order number, heat number, material specification number, size, and quantity from each heat.