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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5590B

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Superseding AMS 5590A

ALLOY TUBING, SEAMLESS, CORROSION AND HEAT RESISTANT
52.5Ni - 19Cr - 3.0Mo - 5.1(Cb + Ta) - 0.90Ti - 0.50Al - 18Fe
Consumable Electrode or Vacuum Induction Melted
1950°F (1065°C) Solution Heat Treated UNS N07718

1. SCOPE:

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

1.2 Application: Primarily for fluid lines and structural components requiring high strength at cryogenic temperatures and for short-time service up to 1000°F (540°C) and oxidation resistance up to 1800°F (980°C), particularly those parts which are formed or welded and then heat treated to develop desired properties.

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.

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, 0.5 Inch (13 mm) and Thinner
AMS 2645 - Fluorescent Penetrant Inspection

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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 E18 - Rockwell Hardness and Rockwell Superficial Hardness 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.

2.3.2 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 or by spectrochemical or other analytical methods approved by purchaser:

	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
Molybdenum	2.80	3.30
Columbium + Tantalum	4.75	5.50
Titanium	0.65	1.15
Aluminum	0.20	0.80
Cobalt	--	1.00
Boron	--	0.006
Copper	--	0.30
Iron	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 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 1950°F ± 25 (1065°C ± 15), holding at heat for not more than 30 min., and cooling at a rate equivalent to air cool or faster.

3.3 Fabrication: Tubing shall be produced by a seamless 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 a centerless-ground finish is not acceptable. A light polish to improve surface appearance may be employed.

3.4 Properties: Tubing shall conform to the following requirements:

3.4.1 As Solution Heat Treated:

3.4.1.1 Tensile Properties: Tubing having nominal OD of 0.125 in. (3.00 mm) and over with nominal wall thickness of 0.015 in. (0.38 mm) and over shall have the following properties, determined in accordance with ASTM E8:

Tensile Strength, max	145,000 psi (1000 MPa)
Yield Strength at 0.2% Offset, max	85,000 psi (585 MPa)
Elongation in 2 in. (50 mm), min	30%

3.4.1.1.1 Tensile property requirements for tubing under 0.125 in. (3.00 mm) in nominal OD or under 0.015 in. (0.38 mm) in nominal wall thickness shall be as agreed upon by purchaser and vendor.

3.4.1.2 Grain Size: Shall be predominantly 3 or finer with occasional grains as large as 2 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.4.1.3 Flarability: Specimens as in 4.3.1 from tubing 0.188 to 2.000 in. (4.70 to 50.00 mm), incl, in nominal OD 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 1.25 times the original nominal outside diameter.

3.4.1.3.1 Flarability requirements for tubing with nominal OD under 0.188 in. (4.70 mm) or over 2.000 in. (50.00 mm) shall be as agreed upon by purchaser and vendor.

3.4.1.4 Pressure Test: Tubing shall show no bulges, leaks, pinholes, cracks, or other defects when subjected to an internal hydrostatic pressure of 5000 psi (35 MPa) or pressure sufficient to cause a tensile stress of 40,000 psi (275 MPa) in the tubing wall, whichever is less. The hydrostatic pressure (P) shall be calculated from the following equation:

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

where, S = 40,000 psi (275 MPa) tensile stress
t = Minimum wall thickness (nominal thickness minus maximum negative tolerance)
D = Nominal OD

3.4.2 After Precipitation Heat Treatment: Tubing shall meet the requirements of 3.4.2.1 and 3.4.2.2 after being precipitation heat treated by heating to 1400°F + 15 (760°C + 8), holding at heat for 10 hr + 0.5, furnace cooling to 1200°F + 15 (650°C + 8), holding at 1200°F + 15 (650°C + 8) until a total precipitation time of 20 hr has been reached, and cooling at a rate equivalent to air cool or faster.

3.4.2.1 Tensile Properties: Shall be as follows for tubing 0.125 in. (3.00 mm) and over in nominal OD with nominal wall thickness of 0.015 in. (0.38 mm) and over, determined in accordance with ASTM E8:

Tensile Strength, min	170,000 psi (1170 MPa)
Yield Strength at 0.2% Offset, min	145,000 psi (1000 MPa)
Elongation in 2 in. (50 mm), min	15%

3.4.2.1.1 Tensile property requirements for tubing under 0.125 in. (3.00 mm) in nominal OD or under 0.015 in. (0.38 mm) in nominal wall thickness shall be as agreed upon by purchaser and vendor.

3.4.2.2 Hardness: Should be not lower than 36 HRC, or equivalent, determined in accordance with ASTM E18, but the tubing shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.2.1 are met.

3.5 Quality:

3.5.1 Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used for remelting.

3.5.2 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.

3.5.3 Ø When specified by purchaser, tubing shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645, to ultrasonic inspection in accordance with AMS 2632, or to both.

3.5.4 Ø Tubing shall be free from grease or other foreign materials. A clean cloth shall not collect metallic flakes or particles when it is drawn through 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 - 24 ft (2 - 7.5 m) but not more than 25% of any shipment shall be supplied in lengths shorter than 10 ft (3 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 this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Tensile properties (3.4.1.1) and grain size (3.4.1.2) of each lot as solution heat treated.

4.2.1.3 Tensile properties (3.4.2.1) of each lot after precipitaton heat treatment.

4.2.1.4 Quality (3.5.2) and tolerances (3.7) of each lot.

4.2.2 Periodic Tests: Tests to determine conformance to the following requirements are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser:

4.2.2.1 Flarability (3.4.1.3) and pressure test (3.4.1.4) of tubing as solution heat treated.

4.2.2.2 Hardness (3.4.2.2) of tubing after precipitation heat treatment.

4.3 Sampling: Shall be in accordance with AMS 2371 and the following; when consumable electrode remelted alloy is supplied, a heat shall be the consumable electrode remelted ingots produced from alloy originally melted as a single furnace charge or the ingots produced from a single vacuum induction melt.

4.3.1 Specimens for flarability test (3.4.1.3) shall be full tubes or sections cut from a tube. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded.