



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

AEROSPACE MATERIAL SPECIFICATION

AMS 5588C

Superseding AMS 5588B

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

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 (980°C) and oxidation resistance up to 2200°F (1205°C).

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 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 - Estimating the Average Grain Size of Metals
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

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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	0.05 -	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
Boron	--	0.010
Copper	--	0.30
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 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 $2150^{\circ}\text{F} \pm 25$ ($1175^{\circ}\text{C} \pm 15$), holding at heat for not more than 30 min., and cooling rapidly. In no case shall the solution heat treatment temperature be lower than 2100°F (1150°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 3.00 in. (75 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 3.00 in. (75 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 on tubing having nominal OD of 0.125 in. (3.12 mm) and over with nominal wall thickness of 0.015 in. (0.38 mm) and over:

Tensile Strength, min	100,000 psi (690 MPa)
Yield Strength at 0.2% Offset, min	45,000 psi (310 MPa)
Elongation in 2 in. (50 mm), min	
Strip Specimens	20%
Full-Section Specimens	25%

- 3.4.1.1 Tensile property requirements for tubing under 0.125 in. (3.12 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 Grain Size: Tubing 0.125 in. (3.12 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 in. (3.12 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 of 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 deg 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, or other defects when subjected to an internal hydrostatic pressure of 5,000 psig (34.5 MPa) or pressure sufficient to cause a tensile stress of 40,000 psi (276 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 (276 MPa) tensile stress

t = Minimum wall thickness (nominal thickness minus maximum negative tolerance)

D = Nominal OD

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 surface imperfections is not required.

3.5.2 If beads are present at the weld on the inner surface of tubing over 3.00 in. (75 mm) in nominal OD, such beads shall be not thicker than 0.010 in. (0.25 mm), unless otherwise specified. The outer surface of all tubing and the inner surface of tubing 3.00 in. (75 mm) and under in nominal OD shall be free from beads.

3.5.3 When specified by purchaser, tubing shall be subjected to nondestructive testing. Methods of testing and 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 ft (1.8 - 7.3 m) but not more than 25% of any shipment shall be supplied in lengths of 6 - 9 ft (1.8 - 2.7 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 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 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 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 lot.

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.

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

4.3.1 Specimens for flarability test (3.4.3) 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:

Ø 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 the results of tests of each lot to determine conformance to the other acceptance test requirements and, when performed, to the periodic test requirements of this specification. This report shall include the purchase order number, heat number, AMS 5588C, size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 5588C, contractor or other direct supplier of tubing, part number, and quantity. When tubing for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of tubing to determine conformance to the requirements of this specification, and shall include in the report a statement that the tubing conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

Ø 4.5 Resampling and Retesting: Shall be in accordance with AMS 2371.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Tubing shall be identified as follows:

5.1.1 Straight Tubes 0.029 In. (0.75 mm) and Over in Wall Thickness and 0.500 In. (12.50 mm) and Over in Nominal OD, Minor Axis, or Least Width of Flat Surface: Shall be marked in a row of characters recurring at intervals not greater than 3 ft (900 mm) with AMS 5588C, heat number, manufacturer's identification, and nominal wall thickness. The characters shall be of such size as to be clearly legible, shall be applied using a suitable marking fluid, and shall be removable in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the tubing or its performance and shall be sufficiently stable to withstand normal handling.

5.1.2 Straight Tubes Under 0.029 In. (0.75 mm) in Wall Thickness or Under 0.500 In. (12.50 mm) in Nominal OD, Minor Axis, or Least Width of Flat Surface: Shall be securely bundled and identified by a durable tag marked with the information of 5.1.1 and the nominal OD and attached to each bundle or shall be boxed and the box marked with the same information.

5.1.3 Coiled Tubing: Shall be securely bundled and identified by a durable tag marked with the purchase order number, AMS 5588C, heat number, nominal OD and wall thickness, and manufacturer's identification and attached to each coil or shall be boxed and the box marked with the same information.

5.2 Packaging:

5.2.1 Tubing shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the tubing to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.