

ALLOY TUBING, SEAMLESS, CORROSION AND HEAT RESISTANT
72Ni - 15.5Cr - 0.95(Cb + Ta) - 2.6Ti - 0.70Al - 7.0Fe
Solution Heat Treated

UNS N07750

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-conducting lines requiring high strength up to 1100°F (595°C) where parts may be formed, welded or brazed if required, and heat treated to improve strength at elevated temperatures.

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

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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.

2.3.1 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 E351, 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	--	0.08
Manganese	--	0.35
Silicon	--	0.35
Phosphorus (3.1.1)	--	0.015
Sulfur	--	0.010
Chromium	14.00 -	17.00
Nickel + Cobalt	70.00	--
Columbium + Tantalum	0.70 -	1.20
Titanium	2.25 -	2.75
Aluminum	0.40 -	1.00
Iron	5.00 -	9.00
Cobalt (3.1.1)	--	1.00
Copper	--	0.50

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: Solution heat treated and descaled.

3.3 Heat Treatment: Tubing shall be solution heat treated by heating to a temperature not lower than 1800°F (980°C), holding at the selected temperature within +25°F (+15°C) for the time necessary to complete the reaction, and cooling at a rate equivalent to air cool or faster.

3.4 Properties: Tubing shall conform to the following requirements:

3.4.1 As Solution Heat Treated:

3.4.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, max	140,000 psi (965 MPa)
Yield Strength at 0.2% Offset, max	80,000 psi (550 MPa)
Elongation in 2 in. (50 mm), min	
Strip Specimen	30%
Full Tube	35%

3.4.1.2 Grain Size: Shall average 0.0025 in. (0.064 mm) or smaller in diameter (Grain Size No. 5), 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 - 2.000 in. (4.70 - 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 permanent expanded OD not less than 1.20 times the original nominal OD.

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

3.4.1.4 Pressure Test: Tubing shall show no bulges, leaks, pin holes, cracks, or other defects when subjected to an internal hydrostatic pressure (P) sufficient to cause a tensile stress of 20,000 psi (140 MPa) in the tubing wall. The hydrostatic pressure (P) shall be calculated from the equation:

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

where,

S = 20,000 psi (140 MPa)
D = Nominal OD in inches (mm)
d = Nominal ID in inches (mm)
P = Test pressure in psi (MPa)

3.4.2 After Precipitation Heat Treatment: Tubing shall have the following properties after being precipitation heat treated by heating to $1350^{\circ}\text{F} \pm 25$ ($730^{\circ}\text{C} \pm 15$), holding at heat for not less than 8 hr, cooling at a rate of 100 F (55 C) deg per hr to $1150^{\circ}\text{F} \pm 25$ ($620^{\circ}\text{C} \pm 15$), holding at $1150^{\circ}\text{F} \pm 25$ ($620^{\circ}\text{C} \pm 15$) for 8 hr \pm 0.5, and air cooling. Instead of the 100 F (55 C) deg per hr cooling rate to $1150^{\circ}\text{F} \pm 25$ ($620^{\circ}\text{C} \pm 15$), tubing may be furnace cooled at any rate provided the time at $1150^{\circ}\text{F} \pm 25$ ($620^{\circ}\text{C} \pm 15$) is adjusted to give a total precipitation heat treatment time of not less than 18 hours.

3.4.2.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, min	170,000 psi (1170 MPa)
Yield Strength at 0.2% Offset, min	115,000 psi (795 MPa)
Elongation in 2 in. (50 mm), min	
Strip Specimen	12%
Full Tube	15%

3.4.2.2 Hardness: Should be not lower than 30 HRC, or equivalent, determined in accordance with ASTM E18 but 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. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used.

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.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, 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 of 6 - 9 ft (2 - 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
Ø 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 requirements for
Ø composition (3.1), tensile properties (3.4.1.1 and 3.4.2.1), grain size
(3.4.1.2), pressure test (3.4.1.4), 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
Ø flarability (3.4.1.3) and hardness (3.4.2.2) are classified as periodic
tests and shall be performed at a frequency selected by the vendor unless
frequency of testing is specified by purchaser.

4.3 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 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.

4.4 Reports:

4.4.1 The vendor of tubing shall furnish with each shipment a report of the
Ø results of tests for chemical composition of each heat and the results of
tests on each lot to determine conformance to the other acceptance test
requirements and, when performed, to the periodic test requirements. This
report shall include the purchase order number, heat number, AMS 5583A,
size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each
shipment a report showing the purchase order number, AMS 5583A, 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 either
a statement that the tubing conforms or copies of laboratory reports
showing the results of tests to determine conformance.

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: