

Submitted for recognition as an American National Standard

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Superseding AMS-5578B

STEEL TUBING, WELDED, CORROSION AND HEAT RESISTANT  
12Cr - 8.5Ni - 0.30(Cb+Ta) - 1.1Ti - 2.0Cu  
Vacuum Induction Plus Consumable Electrode Vacuum Melted  
Solution Heat Treated, Precipitation Hardenable UNS S45500

1. SCOPE:

1.1 Form: This specification covers a premium-quality corrosion and moderate heat resistant steel in the form of welded tubing.

1.2 Application: Primarily for parts requiring corrosion resistance and high strength up to 800°F (427°C) after precipitation heat treatment.

1.2.1 Certain design and processing procedures may cause this tubing to become susceptible to stress-corrosion cracking after precipitation heat treatment; ARP1110 recommends practices to minimize such conditions.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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2.1.1 Aerospace Material Specifications:

- AMS-2243 - Tolerances, Corrosion and Heat Resistant Steel Tubing
- MAM-2243 - Tolerances, Metric, Corrosion and Heat Resistant Steel Tubing
- AMS-2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
- AMS-2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
- MAM-2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
- AMS-2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock

2.1.2 Aerospace Recommended Practices:

- ARPI110 - Minimizing Stress Corrosion Cracking in Heat Treatable Wrought Low Alloy and Martensitic Corrosion Resistant Steels

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

- ASTM A 370 - Mechanical Testing of Steel Products
- ASTM E 353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 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 E 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	--	0.05
Manganese	--	0.50
Silicon	--	0.50
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	11.00 -	12.50
Nickel	7.50 -	9.50
Columbium + Tantalum	0.10 -	0.50
Titanium	0.80 -	1.40
Copper	1.50 -	2.50
Molybdenum	--	0.50

- 3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS-2248.

- 3.2 Condition: Solution heat treated and descaled.

- 3.3 Fabrication: Tubing shall be produced by a welded and drawn process. Any finishing operation applied to remove objectionable pits and surface blemishes shall be performed prior to final solution heat treatment. A light polish to improve surface appearance may be employed after solution heat treatment. Passivation treatment shall follow any polishing treatment.

- 3.4 Solution Heat Treatment: Tubing shall be solution heat treated by heating to  $1525^{\circ}\text{F} \pm 25$  ( $829^{\circ}\text{C} \pm 14$ ), holding at heat for a time commensurate with wall thickness and heating equipment and procedure used but not less than 5 minutes, and quenching in water.

- 3.5 Properties: Tubing shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A 370.

- 3.5.1 As Solution Heat Treated:

- 3.5.1.1 Tensile Strength: Shall be not higher than 165,000 psi (1138 MPa).

3.5.1.2 Pressure Testing: Tubing shall show no bulges, leaks, pinholes, cracks, or other defects when subjected to an internal hydrostatic pressure (P), based on nominal dimensions, sufficient to cause a tensile stress of 20,000 psi (138 MPa) in the tubing wall. The hydrostatic pressure (P) shall be calculated from the equation:

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

Where, S = 20,000 psi (138 MPa) tensile stress  
 T = Minimum wall thickness (nominal thickness minus maximum negative tolerance)  
 D = Nominal OD

3.5.2 After Precipitation Heat Treatment: Tubing shall meet the requirements of 3.5.2.1 and 3.5.2.2 after being precipitation heat treated by heating to 950°F ± 10 (510°C ± 6), holding at heat for 4 hours ± 0.25, and cooling in air to room temperature.

3.5.2.1 Tensile Properties:

Tensile Strength, minimum 220,000 psi (1517 MPa)  
 Yield Strength at 0.2% Offset, minimum 205,000 psi (1413 MPa)  
 Elongation in 2 Inches (50.8 mm), minimum

Nominal Wall Thickness		
Inch	Millimetres	
Up to 0.020, excl	Up to 0.51, excl	As agreed upon
0.020 to 0.062, incl	0.51 to 1.57, incl	4%
Over 0.062	Over 1.57	3%

3.5.2.2 Hardness: Should be not lower than 42 HRC, or equivalent, but tubing shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.2.1 are met.

3.5.3 Other Precipitation Heat Treatment: Properties after precipitation heat treatment at temperatures other than 950°F ± 10 (510°C ± 6) shall be as agreed upon by purchaser and vendor.

3.6 Quality:

3.6.1 Steel shall be premium aircraft-quality conforming to AMS-2300 or MAM-2300; it shall be multiple melted using vacuum induction melting followed by consumable electrode vacuum melting.

- 3.6.2 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, 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.
- 3.6.3 If weld flash is present at the welds on the inner surface of the tubing, such flash shall be not thicker than 0.010 inch (0.25 mm). The outer surface of the tubing shall be free from weld flash.
- 3.7 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight tubing will be acceptable in mill lengths of 6 - 20 feet (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).
- 3.8 Tolerances: Shall conform to all applicable requirements of AMS-2243 or MAM-2243.
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. 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 for composition (3.1), tensile properties (3.5.1.1 and 3.5.2.1), hardness (3.5.2.2), frequency-severity cleanliness rating (3.6.1), and tolerances (3.8) are acceptance tests and shall be performed on each heat or lot as applicable.
- 4.2.2 Periodic Tests: Tests of tubing as solution heat treated for pressure test (3.5.1.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.
- 4.3 Sampling and Testing: Shall be in accordance with AMS-2371.
- 4.4 Reports: The vendor of tubing shall furnish with each shipment a report showing the results of tests for chemical composition and frequency-severity cleanliness rating of each heat and for tensile properties and hardness of each lot. This report shall include the purchase order number, lot number, AMS-5578C, size, and quantity.
- 4.5 Resampling and Retesting: Shall be in accordance with AMS-2371.