

AMS 5591G

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Superseding AMS 5591F

STEEL TUBING, SEAMLESS, CORROSION AND MODERATE HEAT RESISTANT
12.5Cr (SAE 51410)
Annealed

UNS S41000

1. SCOPE:

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

1.2 Application: Primarily for parts requiring corrosion resistance and oxidation resistance up to 1000°F (540°C) but useful at the higher temperatures only when stresses are low. Certain design and processing procedures may cause this tubing to become susceptible to stress-corrosion cracking after heat treatment; ARP 1110 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 Aerospace Material Specifications and Aerospace Recommended Practices 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 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 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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2.1.2 Aerospace Recommended Practices:

ARP 1110 - Minimizing Stress Corrosion Cracking in Heat Treatable Wrought Low Alloy and Martensitic Corrosion Resistant Steels

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A370 - Mechanical Testing of Steel Products

ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron 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 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, \emptyset determined by wet chemical methods in accordance with ASTM E353 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Carbon	--	0.15
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	11.50 -	13.50
Nickel	--	0.75
Molybdenum	--	0.60
Aluminum	--	0.05
Nitrogen (3.1.1)	--	0.08
Copper	--	0.50
Tin	--	0.05

3.1.1 Determination not required for routine acceptance.

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

3.2 Condition: Cold drawn, annealed, and descaled.

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 centerless ground finish is not acceptable. A light polish to improve surface appearance may be employed after the final anneal. Passivation shall follow any polishing treatment.

- 3.4 Properties: Tubing shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:
- 3.4.1 Tensile Properties: Shall be as follows:
- | | |
|----------------------------------|-----------------------|
| Tensile Strength, max | 100,000 psi (690 MPa) |
| Elongation in 2 in. (50 mm), min | |
| Strip | 20% |
| Full Section | 25% |
- 3.4.2 Response to Heat Treatment: Full sections of tubing or specimens cut from tubing shall have tensile strength not lower than 150,000 psi (1035 MPa) or equivalent hardness after being heated to 1750°F \pm 10 (955°C \pm 5), held at heat for 30 min. \pm 3, and cooled in still air.
- 3.4.3 Flarability: Specimens as in 4.3.1 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 1.35 times the nominal outside diameter.
- 3.5 Quality: 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, straight tubing will be acceptable in mill lengths of 6 - 20 ft (2 - 6 m) but not more than 10% 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 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. 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 composition (3.1), tensile properties (3.4.1), response to heat treatment (3.4.2), 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 flarability (3.4.3) 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 (3.4.3) 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.

4.4 Reports:

- 4.4.1 The vendor of tubing shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for tensile properties and response to heat treatment of each lot. This report shall include the purchase order number, heat number, AMS 5591G, size, and quantity.
- 4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 5591G, 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: Shall be 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 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 5591G, heat number, manufacturer's identification, and wall thickness. The characters shall be of such size as to be 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.