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400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE MATERIAL SPECIFICATION

**SAE**

**AMS 5591H**

Issued 1 OCT 1945  
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Superseding AMS 5591G

Submitted for recognition as an American National Standard

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

**UNS S41000**

**1. SCOPE:**

**1.1 Form:**

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

**1.2 Application:**

This tubing has been used typically for parts requiring corrosion resistance and oxidation resistance up to 1000 °F (538 °C) but useful at the higher temperatures only when stresses are low; however, usage is not limited to such applications.

- 1.2.1** Certain design and processing procedures may cause this tubing to become susceptible to stress-corrosion cracking after 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.

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## 2.1 SAE Publications:

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

- 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 2371 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steels and Alloys, Wrought Products and Forging Stock
- AMS 2632 Ultrasonic Inspection of Thin Materials, 0.5 Inch (13 mm) and Thinner
- AMS 2645 Fluorescent Penetrant Inspection
- AMS 2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing
- ARP1110 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
- ASTM E 426 Electromagnetic (Eddy-Current) Testing of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

## 2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Composition: (R)

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

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TABLE 1 - Composition

Element	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 A 370:

3.4.1 Tensile Properties: Shall be as shown in Table 2.

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TABLE 2 - Tensile Properties

Property	Value
Tensile Strength, maximum	100 ksi (689 MPa)
Elongation in 2 Inches (50.8 mm), minimum	
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 ksi (1034 MPa) or equivalent hardness after being heated to  $1750\text{ }^{\circ}\text{F} \pm 10$  ( $954\text{ }^{\circ}\text{C} \pm 6$ ), held at heat for 30 minutes  $\pm 3$ , 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-degree 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.

3.5.1 When specified, tubing shall be subjected to fluorescent penetrant (R) inspection in accordance with AMS 2645, to ultrasonic inspection in accordance with AMS 2632, to electromagnetic (eddy-current) inspection in accordance with ASTM E 426, or to any combination thereof. Acceptance standards shall be as established by purchaser.

### 3.6 Tolerances:

Shall conform to all applicable requirements of AMS 2243 or MAM 2243.

## 4. QUALITY ASSURANCE PROVISIONS: