



<b>AEROSPACE MATERIAL SPECIFICATION</b>	<b>AMS5578™</b>	<b>REV. H</b>
	Issued 1969-11 Reaffirmed 2014-12 Revised 2023-08	
Superseding AMS5578G		
(R) Steel, Corrosion- and Heat-Resistant, Welded Tubing 12Cr - 8.5Ni - 0.30Cb - 1.1Ti - 2.0Cu Vacuum Induction Plus Consumable Electrode Vacuum Melted Solution Heat Treated, Precipitation Hardenable (Composition similar to UNS S45500)		

### RATIONALE

AMS5578H is the result of a Five-Year Review and update of this specification. The revision prohibits unauthorized exceptions (see 3.9, 4.4.5, 5.2.1, and 8.5), updates composition testing and reporting (see 3.1 and 3.1.1), revises condition and fabrication requirements (see 3.3 and 3.4) updates tensile testing (see 3.6.1), revises inspection (see 3.7), adds NDT acceptance testing (see 4.2.1 and 4.4), clarifies tolerances and identification (see 3.8 and 5.2), adds country of origin requirement (see 4.4), adds definition of new term (see 2.3), and allows prior revisions (see 8.4).

## 1. SCOPE

### 1.1 Form

This specification covers a premium-quality corrosion- and heat-resistant steel in the form of welded and drawn tubing.

### 1.2 Application

This tubing has been used typically for parts requiring corrosion resistance and high strength up to 800 °F (427 °C) after precipitation heat treatment, but 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 precipitation heat treatment; ARP1110 recommends practices to minimize such conditions.

## 2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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## 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AMS2243	Tolerances, Corrosion and Heat-Resistant Steel Tubing
AMS2248	Chemical Check Analysis Limits, Corrosion- and Heat-Resistant Steels and Alloys, Maraging and Other Highly Alloyed Steels, and Iron Alloys
AMS2300	Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure
AMS2371	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS2634	Ultrasonic Inspection, Thin Wall Metal Tubing
AMS2700	Passivation of Corrosion Resistant Steels
AMS2750	Pyrometry
AMS2761	Heat Treatment of Steel Raw Materials
AMS2807	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 Wrought Forms of Steels, and Corrosion Resistant Steels and Alloys
AS7766	Terms Used in Aerospace Metals Specifications

## 2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

ASTM A370	Mechanical Testing of Steel Products
ASTM A751	Chemical Analysis of Steel ProductsASTM A1016/1016MGeneral Requirements for, Ferritic Alloy, Austenitic Alloy, Steel and Stainless Steel Tubes
ASTM E140	Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
ASTM E426	Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys
ASTM E1417/E1417M	Liquid Penetrant Testing

## 2.3 Definitions

Terms used in AMS are defined in AS7766 and the following:

**BORE CONDITIONING:** Any mechanical method that is used in the bore of tubing to improve the final surface appearance, with no resultant change in tubing size beyond the allowable tolerances.

**SOLUTION HEAT TREATMENT:** Heating of an alloy to a suitable temperature, holding it at that temperature long enough to cause one or more constituents to enter into a solid solution, and then cooling it rapidly enough to keep these constituents in solution. AMS2761 provides guidance but refers to this process as “annealing with a quenching treatment.”

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM A751 or by other analytical methods acceptable to the purchaser.

**Table 1 - Composition**

Element	Min	Max
Carbon	--	0.005
Manganese	--	0.50
Silicon	--	0.50
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	11.00	12.50
Nickel	7.50	9.50
Columbium	0.10	0.50
Titanium	0.80	1.40
Copper	1.50	2.50
Molybdenum	--	0.50

3.1.1 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection, unless limits of acceptability are specified by the purchaser.

### 3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

## 3.2 Melting Practice

Steel shall be multiple melted using vacuum induction melting followed by consumable electrode vacuum remelting.

## 3.3 Condition

Solution heat treated. Solution heat treatment shall be performed in an atmosphere yielding a bright finish. Alternately, product shall be passivated in accordance with AMS2700 to produce a uniform finish. It is permissible to pickle prior to passivation. Passivation shall be performed after final finishing (see 3.4.2). Tubing shall have been cold worked sufficiently to ensure proper weld reinforcement height and roundness in the weld reinforcement area.

## 3.4 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 external surface appearance may be employed after solution heat treatment.

3.4.1 Bore conditioning is permitted after final heat treatment, provided the tubing is not sized by metal removal methods beyond the allowable tolerances. If bore conditioning is used, 100% visual inspection of each tube shall be performed. The tube ID shall be uniformly shiny with no evidence of metallic or nonmetallic remnant material.

3.4.2 Tubing shall be passivated in accordance with AMS2700 after any ID or OD finishing that occurs after solution heat treatment.

### 3.5 Solution Heat Treatment

Tubing shall be solution heat treated by heating to 1525 °F ± 25 °F (829 °C ± 14 °C), 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. Pyrometry shall be in accordance with AMS2750.

### 3.6 Properties

Tubing shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.6.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (±0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced parallel section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min). The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

#### 3.6.2 As Solution Heat Treated

##### 3.6.2.1 Tensile Strength

Shall be not higher than 165 ksi (1138 MPa).

#### 3.6.3 Response to Heat Treatment - After Precipitation Heat Treatment

Samples of tubing shall meet the requirements of 3.6.3.1 and 3.6.3.2 after being precipitation heat treated by heating to 950 °F ± 10 °F (510 °C ± 6 °C), holding at heat for 4 hours ± 0.25 hour, and cooling to room temperature at a rate equivalent to air cooling. Pyrometry shall be in accordance with AMS2750.

##### 3.6.3.1 Tensile Properties

Shall be as shown in Table 2.

**Table 2A - Minimum tensile properties – response to heat treatment, inch/pound units**

Nominal Wall Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
Up to 0.020, excl	220	205	--
0.020 to 0.062, incl	220	205	4
Over 0.062	220	205	3

<sup>1</sup> Yield strength is not required to be determined for OD sizes less than 0.125 inch (3.2 mm) or for wall thicknesses less than 0.015 inch (.38 mm)

**Table 2B - Minimum tensile properties – response to heat treatment, SI units**

Nominal Wall Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50 mm or 4D %
Up to 0.51, excl	1517	1413	--
0.51 to 1.57, incl	1517	1413	4
Over 1.57	1517	1413	3

<sup>1</sup> Yield strength is not required to be determined for OD sizes less than 0.125 inch (3.2 mm) or for wall thicknesses less than 0.015 inch (.38 mm).

### 3.6.3.2 Hardness

Shall be not lower than 42 HRC, or equivalent (see 8.2).

### 3.7 Quality

Tubing, as received by the 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 grease, oil and other matter, 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.

3.7.1 Steel shall be premium aircraft-quality conforming to AMS2300.

3.7.2 A clean white cloth or plug drawn or blown through the length of the bore of a test sample at least 12 inches (30 cm) in length, shall show no visual evidence of metallic flakes or particles. Discoloration of the cloth or plug, without the presence of flakes or particles, is acceptable. Alternate methods for evaluating tube cleanliness may be used for tubing 0.500 inch (12.7 mm) and under ID.

3.7.3 When no inspection is specified by the purchaser, tubing shall be subjected to either ultrasonic or eddy current inspection in accordance with ASTM A1016/A1016M except that suspect indications shall not be accepted based on visual observation, i.e., indications must be either rejected or reconditioned and retested to pass the test. Alternate methods of inspection may be used when approved by the cognizant engineering organization for tube 0.25 inch (0.64cm) and under in nominal diameter.

3.7.4 When specified by the purchaser, tubing shall be subjected to fluorescent penetrant inspection in accordance with ASTM E1417/E1417M, to ultrasonic inspection in accordance with AMS2634, to electromagnetic (eddy-current) inspection in accordance with ASTM E426, or to any combination thereof. Tubing shall meet the acceptance criteria established by the cognizant engineering organization.

### 3.8 Tolerances

Shall conform to all applicable requirements of AMS2243 for hydraulic tubing.

### 3.9 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.5.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The producer of tubing shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to specified requirements.

## 4.2 Classification of Tests

### 4.2.1 Acceptance Tests

Tests for the following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (see 3.1) of each heat.

4.2.1.2 Tensile properties (see 3.6.2.1) of each lot as solution heat treated.

4.2.1.3 Tensile properties (see 3.6.3.1) and hardness (see 3.6.3.2) of each lot after precipitation heat treatment at 950 °F (510 °C).

4.2.1.4 Cleanliness of each lot (see 3.7.2).

4.2.1.5 Tolerances (see 3.8) of each lot.

4.2.1.6 Nondestructive testing (see 3.7.3 or 3.7.4 when specified) shall be performed on each finished tube. Inspection per 3.7.3 shall become effective 1 year after the publication of this document.

### 4.2.2 Periodic Tests

Tests for the following requirements are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.2.2.1 Frequency severity cleanliness rating (see 3.7.1).

## 4.3 Sampling and Testing

Shall be in accordance with AMS2371.

## 4.4 Reports

The producer of the tubing shall furnish with each shipment a report showing the producer's name and the country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), and the following results of tests and relevant information:

4.4.1 For each heat:

Composition.

4.4.2 For each lot:

Tensile strength as solution heat treated

Tensile properties after precipitation heat treatment

Hardness after precipitation heat treatment

4.4.3 A statement that the product conforms to the other technical requirements including the NDT method and acceptance standard used.

4.4.4 Purchase order number

Heat and lot numbers

AMS5578H

Size

Quantity