AEROSPACE MATERIAL SPECIFICATION

AMS5565™	REV. M

Issued 1944-11
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Revised 2022-08

Superseding AMS5565L

Steel, Corrosion-Resistant, Welded Tubing
19Cr - 9.5Ni (304)
Solution Heat Treated
(Composition similar to UNS S30400)

RATIONALE

AMS5565M is the result of a Five-Year Review and update of the specification. The revision prohibits unauthorized exceptions (3.7. 4.4.1, 5.2.1, 8.4), revises composition and updates analysis standards (3.1, 3.1.1), revises condition and fabrication (3.2, 3.3), updates tensile tests and notes (3.4.1, 3.4.1.1), incorporates standard hydrostatic test (3.4.4), updates quality (3.5, 4.2), adds country of origin (4.4), clarifies tolerances and identification (3.6, 5.2), adds definitions (2.3), and allows prior revisions (8.3).

1. SCOPE

1.1 Form

This specification covers a corrosion-resistant steel in the form of welded tubing.

1.2 Application

This tubing has been used typically for parts, such as fluid-conducting lines not subjected to high pressure, requiring good corrosion resistance, but usage is not limited to such applications. Welding, brazing, or other exposure to temperatures over 800 °F (427 °C) during fabrication may impair corrosion resistance.

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.

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.

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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5565M/

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
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
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.

ASTM A249/A249M	Welded Austenitic Steel Boiler, Superheater, Heat Exchanger, and Condenser Tubes
ASTM A262	Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A370	Mechanical Testing of Steel Products
ASTM A751	Chemical Analysis of Steel Products
ASTM A1016/A1016M	General Requirements for, Ferritic Alloy, Austenitic Alloy Steel and Stainless Steel Tubes
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 cleaning method that is used in the bore of tubing to improve the final surface appearance, with no resultant dimensional change.

SOLUTION HEAT TREATMENT: The 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 in accordance with ASTM A751 or by other analytical methods acceptable to purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	--	0.08
Manganese	--	2.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.03
Chromium	18.00	20.00
Nickel	8.00	11.00
Molybdenum	--	0.75
Copper	--	0.75

3.1.1 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 Condition

3.2.1 Solution heat treated. Solution heat treatment shall be performed in an atmosphere yielding a bright finish. Alternately, finished product may be passivated in accordance with AMS2700 to produce a uniform finish. It is permissible to pickle prior to passivation. Passivation, if performed, shall be after any final finishing (see 3.3.4).

3.3 Fabrication

3.3.1 Tubing 2.00 inches (50.8 mm) and under in nominal OD shall be cold finished after welding to remove any dimensional indication of the presence of the weld. Larger diameter tubing shall be cold finished sufficiently to ensure proper weld reinforcement (3.5.1) and roundness in the weld area (3.7).

3.3.2 Finishing operations shall be performed prior to final solution heat treatment. Tubing shall not be centerless ground. A light polish to improve external surface appearance or meet surface finish requirements may be employed after solution heat treatment and, if performed, the product shall be subsequently passivated.

3.3.3 Bore conditioning is permitted after final heat treatment providing 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 remnant material, neither metallic nor nonmetallic in nature.

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

3.4 Properties

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

3.4.1 Tensile Properties

Shall be as specified in Table 2.

Table 2A - Tensile properties, inch/pound units

Nominal OD Inches	Nominal Wall Thickness Inches	Tensile Strength ksi	Yield[1][2] Strength at 0.2% Offset Min ksi	Elongation in 2 Inches %, Min Strip	Elongation in 2 Inches %, Min Full Tube
Up to 0.188, incl	Up to 0.016, incl	75 to 115	30.0	--	35
	Over 0.016	75 to 100	30.0	--	40
Over 0.188 to 0.500, incl	Up to 0.010, incl	75 to 110	30.0	32	37
	Over 0.010	75 to 100	30.0	35	40
Over 0.500	Up to 0.010, incl	75 to 100	30.0	27	32
	Over 0.010	75 to 100	30.0	30	35

(1) Minimum yield strength from ASTM A249/A249M. The above properties are not based on AMS statistical guidelines.
(2) 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 (0.38 mm).

Table 2B - Tensile properties, SI units

Nominal OD Millimeters	Nominal Wall Thickness Millimeters	Tensile Strength MPa	Yield[1][2] Strength at 0.2% Offset Min MPa	Elongation in 50 mm %, Min Strip	Elongation in 50 mm %, Min Full Tube
Up to 4.78, incl	Up to 0.41, incl	517 to 793	207	--	35
	Over 0.41	517 to 689	207	--	40
Over 4.78 to 12.70, incl	Up to 0.25, incl	517 to 758	207	32	37
	Over 0.25	517 to 689	207	35	40
Over 12.70	Up to 0.25, incl	517 to 689	207	27	32
	Over 0.25	517 to 689	207	30	35

(1) Minimum yield strength from ASTM A249/A249M. The above properties are not based on AMS statistical guidelines.
(2) 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 (0.38 mm).

3.4.1.1 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. The strain rate after yield may be increased to any value up to 0.5 in/in/min (or 0.5 mm/mm/min) or equivalent crosshead speed as a function of gage length. The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

3.4.2 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 specified in Table 3.

Table 3A - Flarability, inch/pound units

Nominal OD Inches	Expanded OD Inches	Nominal OD Inches	Expanded OD Inches
0.125	0.200	0.750	0.937
0.188	0.302	1.000	1.187
0.250	0.359	1.250	1.500
0.312	0.421	1.500	1.721
0.375	0.484	1.750	2.106
0.500	0.656	2.000	2.356
0.625	0.781		

Table 3B - Flarability, SI units

Nominal OD Millimeters	Expanded OD Millimeters	Nominal OD Millimeters	Expanded OD Millimeters
3.18	5.08	19.05	23.80
4.78	7.67	25.40	30.15
6.35	9.12	31.75	38.10
7.92	10.69	38.10	43.71
9.52	12.29	44.45	53.49
12.70	16.66	50.80	59.84
15.88	19.84		

3.4.2.1 Tubing with nominal OD between any two standard sizes given in Table 3 shall take the same percentage flare as shown for the larger of the two sizes.

3.4.3 Susceptibility to Intergranular Attack

Specimens from tubing, as received, taken to include the weld, shall pass the copper-copper sulfate-sulfuric acid immersion test of ASTM A262, Practice E.

3.4.4 Hydrostatic Strength

Tubing shall withstand an internal hydrostatic pressure (P), based on Equation 1, without developing leaks, cracks, or bulges, and without an increase in mean diameter of more than 0.2%.

$$P = S \frac{(D^2 - d^2)}{(D^2 + d^2)} \quad \text{(Eq. 1)}$$

where:

P = test pressure ksi (MPa)

S = specification minimum yield strength at 0.2% offset

D = maximum OD in inches (mm), defined as nominal (i.e., ordered or specified OD) plus tolerance

d = maximum ID in inches (mm), maximum OD (D) minus twice the minimum wall thickness

Mean diameter is the average of two diameters at right angles to each other in the same transverse plane; measurements before and after testing should be taken at substantially the same location.

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 grease, oil, and other foreign 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.

3.5.1 If weld reinforcement is present at the welds on the inner surfaces of tubing over 2.00 inches (50.8 mm) in nominal OD, such weld reinforcement shall be not thicker than 0.010 inch (0.25 mm). The outer surfaces of the tubing shall be free from weld reinforcement.

3.5.2 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. When approved by the purchaser, alternate methods for evaluating tube cleanliness may be used for tubing 0.500 inch (12.7 mm) and under ID.

3.5.3 When no inspection is specified, tubing shall be subjected to either ultrasonic or eddy current inspection in accordance with AMS2634 or 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. When approved by the purchaser, alternate methods of inspection may be used for tube 0.25 inch (0.64 cm) and under in nominal diameter.

3.5.4 When specified by 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 requirements of 3.5 and other acceptance criteria established by the cognizant engineering organization (see 8.5).

3.6 Tolerances

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

3.7 Exceptions

Any exception shall be authorized by purchaser and reported as in 4.4.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

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

4.2 Classification of Tests

4.2.1 Acceptance Tests

4.2.1.1 Composition (3.1), tensile properties (3.4.1), cleanliness (3.5.2), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.2 Nondestructive testing (3.5.3 or 3.5.4, when applicable) shall be performed on each finished tube to assure the requirements of 3.5 are met. Inspection to 3.5.3 shall become effective one year after publication of this document.

4.2.2 Periodic Tests

Flarability (3.4.2), susceptibility to intergranular attack (3.4.3), and hydraulic test (3.4.4) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.