AEROSPACE MATERIAL SPECIFICATION

AMS5897™	REV. C

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Superseding AMS5897B

Steel, Corrosion and Heat-Resistant, Seamless or Welded Hydraulic Tubing 18.5Cr - 11Ni - 0.80Cb (Nb) (SAE 30347) Solution Heat Treated and Cold Drawn, 1/8 Hard Temper (Composition similar to UNS S34700)

RATIONALE

AMS5897C 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, 8.6), updates composition testing (3.1), updates condition adding AMS2700 (3.2) updates tensile testing (3.4.1.2), updates test specification (3.4.3, 3.5.4), updates hydrostatic testing consistent with other committees (3.4.5), deletes passivity test (3.4.5) (now covered in 3.2), updates inspection (3.5.2, 3.5.4), clarifies sampling (4.3.4), requires country of origin (4.4), adds definition (8.3.1), and allows prior revisions (8.5).

1. SCOPE

1.1 Form

This specification covers a corrosion and heat-resistant steel in the form of two types of thin-wall, close-tolerance aircraft hydraulic tubing.

1.2 Application

This tubing has been used typically in high-pressure hydraulic or pneumatic systems assembled with brazed joints, but usage is not limited to such applications.

1.3 Classification

Tubing covered by this specification is classified as follows:

Type 1 - Seamless and drawn

Type 2 - Welded and drawn

1.3.1 Unless a specific type is ordered, either type may be supplied.

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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
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
ARP1917	Clarification of 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 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 Steel, Austenitic Alloy Steel, and Stainless Steel Tubes
ASTM E112	Determining Average Grain Size
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 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B46.1	Surface Texture

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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	--	0.030
Chromium	17.00	20.00
Nickel	9.00	13.00
Columbium (Niobium)	10xC	1.10
Molybdenum	--	0.75
Tantalum (see 3.1.2)	--	0.05
Copper	--	0.75

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.1.2 Determination not required for routine acceptance.

3.2 Condition

Solution heat treated, pickled as required, and cold drawn and passivated in accordance with AMS2700. Passivation shall be performed after final finishing. Tensile properties shall be obtained by cold working and not by heat treatment.

3.3 Fabrication

3.3.1 Type 1

Tubing shall be produced by a seamless process.

3.3.2 Type 2

Tubing shall be produced by the gas-metal-arc, gas-tungsten-arc, or plasma arc process and subsequently drawn. Tubing shall contain no more than one longitudinal weld and no circumferential welds. Tubing shall be processed to remove any dimensional indication of the presence of welds (see 8.2).

3.3.3 The external and internal surface finishes shall not be rougher than 32 µin (0.8 µm) and 63 µin (1.6 µm), respectively, determined in accordance with ASME B46.1, and may be produced by any method yielding the specified surface condition that will not affect limits of wall thickness or corrosion resistance, except that centerless grinding is not acceptable. A light polish to improve surface appearance is acceptable.

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3.4 Properties

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

3.4.1 Tensile Properties

Shall be as shown in Table 2 and specified in 3.4.1.1.

Table 2 - Tensile properties

Property	Value
Tensile Strength	105 to 140 ksi (724 to 965 MPa)
Yield Strength at 0.2% Offset	75 to 110 ksi (517 to 758 MPa)
Elongation in 2 Inches (50 mm), min	
Full Section	20%
Strip	15%

3.4.1.1 Tubing under 0.50 inch (12.7 mm) in nominal OD and having wall thickness of 0.02 inch (0.5 mm) or under may have elongation as low as 16% when tested in full section.

3.4.1.2 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.

3.4.2 Bending

Tubing shall show no evidence of cracking or splitting when bent at room temperature around a suitable mandrel of diameter equal to the bend factor shown in Table 3 times the nominal OD. During test, flattening shall not exceed 5% of the minimum OD. An appropriate internal mandrel may be used. For Type 2 tubing, the weld shall be at the outside of the bend. A suitable etchant may be used to locate the weld.

Table 3 - Bending parameters

Nominal OD Inches	Nominal OD Millimeters	Bend Factor
Up to 1.00, incl	Up to 25.4, incl	3
Over 1.00 to 1.75, incl	Over 25.4 to 44.5, incl	4
Over 1.75 to 2.00, incl	Over 44.5 to 50.8, incl	5

3.4.2.1 Flattening during testing is defined in Equation 1.

$$\% \text{ Flattening} = \frac{(\text{max OD} - \text{min OD})}{\text{nominal OD}} \times 100 \quad \text{(Eq. 1)}$$

3.4.3 Susceptibility to Intergranular Attack

Specimens from tubing, after sensitizing treatment, shall pass the intergranular corrosion test performed in accordance with ASTM A262, Practice E. After exposure, tubing shall be tested in accordance with the flattening test requirements of ASTM A1016/ASTM A1016M. Samples shall be taken from tubing and tested either after final anneal or after cold working.

3.4.4 Average Grain Size

Shall be ASTM No. 6 or finer, determined in accordance with ASTM E112. In case of dispute, the Heyn Intercept method of ASTM E112 shall be used.

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3.4.5 Hydraulic Testing

When specified, tubing shall withstand an internal hydrostatic pressure (P) as defined below, or 14.0 ksi, whichever is less. Tubing shall withstand the required internal hydrostatic pressure (P) without developing local bulges, leaks, or cracks, and without an increase in mean diameter of more than 0.2%.

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

where:

P = test pressure in ksi (MPa)

S = minimum yield strength from Table 2

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

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.

3.4.6 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 the permanent expanded OD not less than shown in Table 4.

Table 4A - 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 4B - 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		

3.4.6.1 Tubing with nominal OD between any two standard sizes given in Table 4 shall take the same percentage flare as shown for the larger of the two sizes.

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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, or other imperfections detrimental to usage of the tubing.

3.5.1 Mechanically-induced isolated minor surface imperfections, such as handling marks or straightening marks, light mandrel or die marks, shall not exceed the values shown in Table 5.

Table 5A - Maximum depth of discontinuity, inch/pound units

Nominal Wall Thickness Inches	Depth of Discontinuity Inches
Up to 0.020, incl	10% of nominal wall thickness
Over 0.020 to 0.030, incl	0.002
Over 0.030 to 0.040, incl	0.0025
Over 0.040 to 0.074, incl	0.003

Table 5B - Maximum depth of discontinuity, SI units

Nominal Wall Thickness Millimeters	Depth of Discontinuity Millimeters
Up to 0.51, incl	10% of nominal wall thickness
Over 0.51 to 0.76, incl	0.05
Over 0.76 to 1.02, incl	0.064
Over 1.02 to 1.88, incl	0.08

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3.5.1.1 Discontinuities having large root radii plainly visible to the unaided eye, whose surfaces blend into the nominal tubing surfaces and whose depths do not exceed the maximum depth of acceptable discontinuity or violate wall thickness tolerances, are acceptable. Other surface discontinuities shall be removed by polishing or buffing within the limits of wall thickness tolerances or maximum depth of acceptable discontinuity.

3.5.2 Tubing shall be free from grease or other foreign matter. Metallic flakes or particles shall not be collected on a clean white cloth or plug drawn through the length of the bore of a test sample at least 12 inches (30 cm) in length. Discoloration of the cloth, without the presence of flakes or particles, is acceptable. Alternate methods, as acceptable to the purchaser, may be used for evaluating tube cleanliness for tubing 0.500 inch (12.7 mm) and under ID.

3.5.3 When specified by the purchaser, tubing shall be subjected to fluorescent penetrant inspection in accordance with ASTM E1417/E1417M. Standards for acceptance shall be as specified by the purchaser.

3.5.4 Type 1 tubing shall be subjected to eddy-current inspection in accordance with ASTM E426 using calibration notches specified in ASTM A1016/1016M, except that the standard used shall contain simulated flaws not greater than those shown in Table 5.

3.5.5 Type 2 tubing shall be subjected to ultrasonic inspection in accordance with AMS2634, Class A1.

3.6 Tolerances

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

3.7 Exceptions

Any exceptions shall be authorized by the 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 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

Composition, except for tantalum (3.1), surface finish (3.3.3), tensile properties (3.4.1), bending (3.4.2), average grain size (3.4.4), flarability (3.4.6), quality (3.5), fluorescent penetrant inspection when specified (3.5.3), eddy-current for Type 1 (3.5.4) or ultrasonic inspection for Type 2 (3.5.5) as applicable, and tolerances (3.6) are acceptance tests and shall be performed on each heat, lot, or tube as applicable.

4.2.2 Periodic Tests

Susceptibility to intergranular attack (3.4.3), and hydraulic testing (3.4.5) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be in accordance with AMS2371 and the following; a lot shall be all tubing of the same type and of one size, made from one heat of steel, and manufactured and presented for producer's inspection at one time:

4.3.1 Each tube shall be tested for flarability. The end of the tube shall be cut square with the tube end smooth and free from burrs, but not rounded. Flared ends need not be removed after test.

4.3.2 When pressure resistance test is specified, the unsupported length shall not be less than 2 feet (610 mm) or six times the nominal OD, whichever is greater.

4.3.3 Each length of tubing shall be visually examined for compliance to quality (3.5).

4.3.4 Each length of tubing shall be nondestructively examined (3.5.4 or 3.5.5).

4.3.5 Sampling for dimensional tolerances and surface finish (3.3.3) shall be as shown in Table 6. The tubing shall be measured at three orientations, 60° apart, at one end of each tube.

Table 6 - Sampling for dimensional tolerances and surface finish

Lot Size	Sample Size
1 to 3	All
4 to 25	4
26 to 65	6
66 to 180	13
181 to 300	20
301 to 800	32
Over 800	50

4.3.5.1 If any tube fails to meet dimensional or surface finish requirements, the entire lot shall be inspected at both ends of each tube.

4.3.6 Average grain size and bending shall be determined on at least one section of tubes from each lot.

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