AEROSPACE MATERIAL SPECIFICATION

AMS5584™	REV. B

Issued 1993-07
Reaffirmed 2012-02
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Superseding AMS5584A

Steel, Corrosion and Heat Resistant, Seamless and Welded Hydraulic Tubing
17Cr - 12Ni - 1.5Mo - 0.03C max
Cold Drawn, 1/8 Hard Temper

UNS S31603

RATIONALE

AMS5584B 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, 8.5), updates composition testing (3.1), updates condition and fabrication requirements adding AMS2700 (3.2, 3.3) updates tensile testing (3.4.1.1), updates hydrostatic testing consistent with other committees (3.4.5), deletes passivity test (3.4.5), now covered in 3.2 and 3.3, updates inspection (3.5.2, 3.5.4), updates testing (4.2.1, 4.2.2), requires country of origin (4.4), adds definition (8.2.1), and allows prior revisions (8.4).

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 tubing 0.125 to 2.00 inches (3.18 to 50.8 mm), inclusive, in nominal OD.

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

The tubing covered by this specification is classified as follows:

Class 1 - Seamless and Drawn
Class 2 - Welded and Drawn

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

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.

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/AMS5584B/

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.

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

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 Specification

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/ASTM A1016M General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

ASTM E112 Determining the Average Grain Size

ASTM E426 Electromagnetic (Eddy Current) Examination of Seamless and Welded Tubular Products, Titanium, Austenitic Stainless Steel and Similar Alloys

ASTM E1417E1417M Liquid Penetrant Examination

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

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	--	0.03
Manganese	--	2.00
Silicon	--	1.00
Phosphorus	--	0.04
Sulfur	--	0.03
Chromium	16.0	18.0
Nickel	10.0	14.0
Molybdenum	2.0	3.0
Copper	--	0.75

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Condition

Solution heat treated (8.2.1), cold drawn, and passivated in accordance with AMS2700. It is permissible to pickle prior to passivation. Passivation may take place after any final finishing (3.3.5).

3.3 Fabrication

3.3.1 Class 1

Tubing shall be produced by a seamless process.

3.3.2 Class 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.

3.3.3 Tensile properties shall be obtained by cold working and not by heat treatment. A minimum reduction of 30% is recommended for Class 2 tubing.

3.3.4 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 B 46.1, and may be produced by any method yielding the specified surface condition that will not affect limits of wall thickness or corrosion resistance, with the exception that centerless grinding is not acceptable. A light polish to improve surface appearance or meet surface finish requirements may be employed.

3.3.5 Tubing shall be passivated in accordance with AMS2700 after any ID or OD finishing that occurs after cold drawing.

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 shown in Table 2 and 3.4.1.1.

Table 2 - Tensile properties

Property	Value
Tensile Strength	105-140 ksi (724-965 MPa)
Yield Strength at 0.2% Offset	75-100 ksi (517-689 MPa)
Elongation, minimum	
Full Section	20%
Strip	15%

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 mm/mm/min) or equivalent crosshead speed as a function of gage length.

3.4.1.2 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.

3.4.2 Bending

Tubes shall show no evidence of cracking or splitting when bent cold 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 Class 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
0.25 to 1.00, incl	6.4 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:

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

3.4.3 Susceptibility to Intergranular Attack

Tubing shall pass the copper-copper sulfate-sulfuric acid test of ASTM A262, Practice E. Samples shall be taken from tubing after final annealing, but prior to 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.

3.4.5 Hydrostatic Test

When specified, tubing shall withstand for not less than one minute, an internal hydrostatic pressure (P) as defined below, or 15.0 ksi, whichever is less. Tubing shall withstand the required internal hydrostatic pressure (P), without developing leaks, cracks or local bulges and without an increase in mean diameter of more than 0.2% (Equation 2).

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

where:

P = test pressure in ksi (MPa)

S = 75 ksi (517 MPa) yield strength from Table 2

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.

3.4.6 Flarability

Tubing shall withstand flaring at room temperature, without the 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 shown in Table 4.

Table 4A - Minimum flarability, inch/pound units

Nominal OD Inches	Expanded OD Inches	Nominal OD Inches	Expanded OD Inches
0.250	0.359	0.750	0.937
0.312	0.421	1.000	1.187
0.375	0.484	1.250	1.500
0.500	0.656	1.500	1.721
0.625	0.871	1.750	2.106
		2.000	2.356

Table 4B - Minimum flarability, SI units

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

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.

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, 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

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 in Table 5 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 by a clean white cloth or wad of cotton drawn through the length of the bore of a test sample at least 12 inches (30cm) in length. Discoloration of the cloth or wad of cotton, 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 (12.7mm) and under ID.

3.5.3 When standards for acceptance are specified by purchaser, tubing shall be subjected to fluorescent penetrant inspection in accordance with AMS2645 or ASTM E1417.

3.5.4 Class 1 tubing shall be eddy current inspected in accordance with ASTM E426 using calibration notches specified in ASTMA1016/A1016M, except that the standard used shall contain simulated flaws not greater than those shown in Table 5 of this specification.

3.5.5 Class 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 confirmation testing deemed necessary to ensure that the tubing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), surface finish (3.3.4), tensile properties (3.4.1), bending (3.4.2), average grain size (3.4.4), flarability (3.4.7), quality (3.5.1), cleanliness (3.5.2), fluorescent penetrant inspection when specified (3.5.3), eddy current (3.5.4) or ultrasonic inspection (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 hydrostatic testing (3.4.6) 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 class 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 hydrostatic testing is specified, the unsupported length shall be not less than 2 feet (0.6 m) or 6 times the nominal OD, whichever is greater.

4.3.3 Each length of tubing shall be visually examined for compliance to surface condition (3.3.4) and quality (3.5).

4.3.4 Sampling for dimensional tolerances shall be shown in Table 6. The tubing shall be measured at three orientations, 60 degrees apart, at one end of each tube.

Table 6 - Sampling

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

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

4.3.5 Average Grain Size and Bending

Shall be determined on at least one section of tube from each lot.