SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS5564 | REV. C

Issued 1985-07
Revised 2000-02
Reaffirmed 2013-04

Superseding AMS5564B

Steel, Corrosion Resistant, Tubing
19CR - 10Ni (SAE 30304)
High-Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless
Cold Drawn, One Eighth - Hard Temper

UNS S30400

RATIONALE

AMS5564C has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Form:

This specification covers a corrosion-resistant steel in the form of welded and drawn or seamless and drawn tubing.

1.2 Application:

This tubing has been used typically for high-pressure hydraulic lines requiring corrosion resistance, but usage is not limited to such applications. Maximum service temperature should not exceed 700 °F (371 °C).

1.3 Classification:

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 1 or Class 2 may be supplied.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order form 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**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5564C

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, 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 2634	Ultrasonic Inspection, Thin Wall Metal Tubing
AMS 2807	Identification, Carbon and Low-Alloy Steels, Corrosion and Heat Resistant Steels, Sheet, Strip, Plate, and Aircraft Tubing

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 262	Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A 370	Mechanical Testing of Steel Products
ASTM A 450	Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes
ASTM E 112	Determining the Average Grain Size
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 ANSI Publications:

Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1	Surface Texture

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 E 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	--	0.08
Manganese	--	2.00
Silicon	--	1.00
Phosphorus	--	0.045
Sulfur	--	0.030
Chromium	18.00	20.00
Nickel	8.00	12.00
Molybdenum	--	0.75
Copper	--	0.75

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition:

Cold drawn and passivated or pickled.

3.3 Fabrication:

Tubing shall be produced by a seamless and cold drawn, or a welded and cold drawn process. The specified tensile properties shall be obtained by cold working and not by heat treatment (annealing). Surface finishes shall be not rougher than 32 microinches (0.8 µm) for OD and 63 microinches (1.6 µm) for ID, determined in accordance with ANSI B46.1, and may be produced by 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 external surface appearance may be employed after solution treatment and, if performed, the product shall be subsequently passivated.

3.3.1 Welded (Class 2) tubing shall be processed to eliminate any dimensional indication of the weld and shall be ultrasonically tested to detect and discard any tubing containing defects exceeding calibration notches (See 3.5.3).

3.4 Properties:

Tubing shall conform to the following requirements; tensile testing shall be performed in accordance with ASTM A 370.

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

TABLE 2A - Tensile Properties, Inch/Pound Units

Nominal OD Inch	Nominal Wall Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches %, min Full Tube
Up to 0.125, incl	All	95.0 to 130	--	--
Over 0.125 to 0.188, incl	Up to 0.016, incl	95.0 to 130	60.0 to 90.0	20
	Over 0.016	95.0 to 130	60.0 to 90.0	25
Over 0.188	All	105 to 140	75.0 to 110	20

TABLE 2B - Tensile Properties, SI Units

Nominal OD Millimeters	Nominal Wall Thickness Millimeter	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm %, min Full Tube
Up to 3.18, incl	All	655 to 896	--	--
Over 3.18 to 4.78, incl	Up to 0.41, incl	655 to 896	414 to 621	20
	Over 0.41	655 to 896	414 to 621	25
Over 4.78	All	724 to 965	517 to 758	20

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 that shown in Table 3.

TABLE 3A - Minimum Flarability, Inch/Pound Units

Nominal OD Inch	Expanded OD Inch	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	2.500	2.856
		3.000	3.356

TABLE 3B - Minimum 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	63.50	72.54
		76.20	85.24

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

3.4.3 Pressure Resistance: Tubing shall show no bulges, leaks, pinholes, cracks, or other defects when subjected to an internal hydrostatic pressure (P), except that a diametric permanent set of 0.002 inch per inch (0.002 mm/mm) of diameter is acceptable. The hydrostatic pressure (P) shall be calculated using Equation 1:

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

where:

P = Test pressure in ksi (MPa)
S = Minimum yield strength from Table 2
D = Nominal OD in inches (mm)
d = Nominal ID in inches (mm)

3.4.4 Susceptibility to Intergranular Attack: Specimens from tubing shall be immersed as required by ASTM A 262, Practice E. After immersion, tubing shall not exhibit intergranular attack or cracks when tested in accordance with the following:

3.4.4.1 Examination of OD Surface: Shall be performed after flattening a 1-inch (25 mm) long specimen to a total thickness under load of three times the wall thickness.

3.4.4.2 Examination of ID Surface: Shall be performed after splitting a 1-inch (25-mm) long specimen and folding the split specimen, with ID surfaces on the outside of fold, around a mandrel having a diameter equal the nominal wall thickness of the tube.

3.4.4.2.1 Tubing Over 0.625 Inch (15.88 mm) in OD: The axis of the fold shall be parallel to the axis of the tube.

3.4.4.2.2 Tubing 0.625 Inch (15.88 mm) and Under in OD: The axis of the fold shall be either parallel or transverse to the axis of the tube.

3.4.4.3 If a weld is visible. flattening and/or folding parallel to the tube axis shall be oriented so as to apply maximum tension to the weld.

3.4.5 Average Grain Size: Shall be ASTM No. 5 or finer, including the weld region of Class 2 tubing, determined in accordance with ASTM E 112.

3.4.6 Macro-Etching: Tubing, 0.625 inch (15.88 mm) and under in nominal OD, shall withstand immersion for one hour in a solution containing 10% nitric acid and 2% hydrofluoric acid by weight at 140 °F ± 5 (60 °C ± 3) without formation of a pebbly appearance on either ID or OD surface. In case of question as to the acceptability of the surface appearance produced by etching, the tubing shall be considered satisfactory if the requirements of 3.4.4, 3.4.5, and 3.4.6 are met.

3.5 Quality:

3.5.1 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.

3.5.2 Tubing shall be free from grease or other foreign matter. Metallic flakes or particles shall not be collected by a clean, white cloth drawn through the bore of a sample tube. Discoloration of the cloth, without the presence of flakes or particles, is acceptable.

3.5.3 Class 2 tubing shall be subjected to ultrasonic inspection in accordance with AMS 2634, Class Level AI except that the length of the notch in the reflector specified in Table 1A is to be 0.250 inches.

3.5.4 Class 1 tubing shall be either ultrasonically inspected as in 3.5.3 or shall be eddy current inspected in accordance with ASTM E 426 using calibration notches specified in ASTM A 450.

3.6 Tolerances:

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

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of tubing shall supply all samples for vendor'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 (3.1), tensile properties (3.4.1), susceptability to intergranular attack (3.4.4), grain size (3.4.6), ultrasonic quality of Class 2 tubing (3.5.3), nondestructive inspection of Class 1 tubing (3.5.4), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Surface roughness (3.3), flarability (3.4.2), pressure resistance (3.4.3), and macro-etching (3.4.7) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2371 and the following; a lot shall be all tubing of one class and size made from one heat of steel and presented for vendor's inspection at one time.

4.3.1 Specimens for flarability test (3.4.2) shall be full tubes or sections cut from a tube. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded.

4.4 Reports:

The vendor of tubing shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for tensile properties and grain size of each lot, and stating that the tubing conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS 5564C, size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2371.