NOTICE OF ADOPTION

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AMS 5564B

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Society of Automotive Engineers Inc.
400 Commonwealth Drive
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Title of Document: AMS 5564B, Steel, Corrosion Resistant, Tubing 19Cr – 10Ni (SAE 30304) High–Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless.

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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5564B

Issued 1 JUL 1985
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Superseding AMS 5564A

Submitted for recognition as an American National Standard

STEEL, CORROSION RESISTANT, TUBING
19Cr - 10Ni (SAE 30304)
High-Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless

UNS S30400

1. SCOPE:

1.1 Form:

This specification covers a corrosion-resistant steel in the form of tubing produced by drawing seamless hollows or welded hollows.

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
Class 2 - Welded and drawn

1.3.1 Either Class 1 or Class 2 may be supplied unless a specific class is ordered.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

Printed in U.S.A.
91-0942/ EG

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, Wrought 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 2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 262 Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A 370 Mechanical Testing of Steel Products
ASTM A 450 General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes
ASTM E 112 Determining 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 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

2.4 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:
(R)

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.

3.3 Fabrication:

Tubing shall be produced by a seamless or a welded and 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 surface appearance may be employed. Passivation shall follow any polishing treatment.

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 and bend testing shall be performed in accordance with ASTM A 370:

3.4.1 Tensile Properties: Shall be as specified 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 (Full Tube) %, min
Up to 0.125, incl	All	95.0 - 130	--	--
Over 0.125 to 0.188, incl	Up to 0.016, incl	95.0 - 130	60.0 - 90.0	20
	Over 0.016	95.0 - 130	60.0 - 90.0	25
Over 0.188	All	105 - 140	75.0 - 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 (Full Tube) %, min
Up to 3.18, incl	All	655 - 896	--	--
Over 3.18 to 4.78, incl	Up to 0.41, incl	655 - 896	414 - 621	20
	Over 0.41	655 - 896	414 - 621	25
Over 4.78	All	724 - 965	517 - 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 specified in Table 3.

TABLE 3A - 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 - 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.

3.4.2.2 Flarability requirements for tubing over 3.000 inches (76.20 mm) or under 0.125 inch (3.18 mm) in nominal OD shall be as agreed upon by purchaser and vendor.

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 determined from Equation 1:

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

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

3.4.4 Susceptibility to Intergranular Attack: Tubing, as received, shall pass the intergranular corrosion test performed in accordance with ASTM A 262, Practice E. After exposure, full cross-sectional specimens of tubing 0.625 inch (15.88 mm) and under in nominal OD shall be flattened to a total thickness under load of three times the wall thickness of the tubing, and 1-inch (25-mm) long specimens of tubing over 0.625 inch (15.88 mm) in nominal OD shall be split and bent 180 degrees, with outside surface of tube on inside of bend, around a diameter equal to four times the nominal wall thickness without showing cracks or other defects. In either flattening or bending, the fold shall be made parallel to the axis of the tube and shall coincide with the weld in welded (Class 2) tubing if the weld is visible.

3.4.4.1 Care should be exercised in differentiating between cracks caused by intergranular attack and cracks resulting from superficial yielding or rupturing of the surface of the specimens. Doubt as to whether superficial cracking is caused by intergranular attack should be resolved by metallographic examination.

3.4.5 Microstructure: Tubing shall reveal no continuous intergranular carbide precipitation when electrolytically etched in a 10% sodium cyanide solution and examined microscopically at 500X magnification. The presence of some discontinuous intergranular carbide precipitation shall not be considered detrimental if the technical requirements of this specification are met.

3.4.6 Grain Size: Shall be 5 or finer, including the weld region of Class 2 tubing, determined by comparison of a specimen, polished and electrolytically etched in a 10% oxalic acid solution, with the chart in ASTM E 112, using 100X magnification.

3.4.7 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 when it is drawn through the length of the bore of a test sample. 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. Ultrasonic inspection indications for Class 2 tubing shall be not greater than those from the calibration notch when the signal amplitude from the calibration notch is set at not less than 50% of full scale. The noise amplitude during inspection of tubes shall be not greater than 25% of full scale. Ultrasonic inspection shall be conducted as follows:

3.5.3.1 Tubing shall be inspected by ultrasonic, immersion, pulse echo methods. A calibration shall be performed at the start of operations and periodically reestablished at least once each hour of continuous operation. Separate calibration standards as in 3.5.3.2 shall be used for each tubing size. The arrangement of transducers shall be such that no cross-talk is encountered. Tube supporting equipment shall provide in-line stability throughout the complete length of each tube. For the disclosure of discontinuities, a shear mode shall be employed. The equipment shall be such that transducers functioning in a clockwise and counterclockwise direction may be separately gated and recorded. The pulse rate of the equipment shall provide 100% coverage at maximum tube rotational rates. The helix feed angle shall be such that a rejectable signal from the longitudinal calibration notch is produced by both transducers.

3.5.3.2 Calibration Standards: Longitudinal calibration notches for the shear mode shall have a depth not greater than 0.002 inch (0.05 mm) or 5% of the nominal wall thickness, whichever is greater. The length of the calibration notches on both ID and OD surfaces parallel to the tube axis shall be 0.250 inch ± 0.010 (6.35 mm ± 0.25).

3.5.3.2.1 The placement of calibration notches in each standard shall be such that water-travel-distance, shear-angle, helix-angle, and equipment gain as established during calibration, remain identical during production applications. Calibration notches may be produced by electrodischarge machining.