# AEROSPACE MATERIAL SPECIFICATION

| AMS5564™ | REV. D |
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Issued 1985-07
Reaffirmed 2013-04
Revised 2023-05

Superseding AMS5564C

Steel, Corrosion Resistant, Tubing
19Cr - 10Ni
High-Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless
Cold Drawn, One Eighth - Hard Temper
(Composition similar to UNS S30400)

RATIONALE

AMS5564D 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, and 8.4), revises composition testing (3.1, 3.1.1), updates condition and fabrication requirements (3.2, 3.3), controls tensile testing (3.4.1.1), updates hydrostatic testing consistent with other committees (3.4.3), updates inspection (3.5), clarifies tolerances and identification (3.6, 5.2), requires country of origin (4.4), and allows prior revisions (8.3).

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 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.





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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

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 A262 Practices for 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 E112 Determining the Average Grain Size

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

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.

ANSI B46.1 Surface Texture

2.4 Definitions

Terms used in AMS are defined in AS7766 and the following:

2.4.1 Solution Heat Treatment

Solution treatment is 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 the 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 The 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 requirements of AMS2248.

### 3.2 Condition

Solution heat treated (see 2.4), cold drawn pickled as required, and passivated in accordance with AMS2700 or pickled. Passivation shall be performed after final finishing.

### 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. Surface finishes shall not be rougher than 32 µin (0.8 µm) for OD and 63 µin (1.6 µm) for ID, determined in accordance with ASME 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 or meet surface finish requirements may be employed after solution treatment.

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

3.3.2 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 A370.

3.4.1 Tensile Properties

Shall be as shown in Table 2.

***Table 2A - Tensile properties, inch/pound units***

| Nominal OD Inches | Nominal Wall Thickness Inches | 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 Millimeters | Tensile Strength MPa | Yield Strength at 0.2% Offset MPa | Elongation in 50 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 |

3.4.1.1 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. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced parallel section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min). 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 that shown in Table 3.

***Table 3A - Minimum 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 | 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 Hydrostatic Test

Tubing shall withstand an internal hydrostatic pressure (P), based on equation 1, without developing leaks, cracks, or local 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 in ksi (MPa)
S = Minimum 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.

3.4.4 Susceptibility to Intergranular Attack

Specimens from tubing shall be immersed as required by ASTM A262, 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 E112.

3.4.6 Macro-Etching

Tubing, 0.625 inch (15.88 mm) and under in nominal OD, shall withstand immersion for 1 hour in a solution containing 10% nitric acid and 2% hydrofluoric acid by weight at 140 °F ± 5 °F (60 °C ± 3 °C) 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 the 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, 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 A clean white cloth or plug drawn or blown through the length of the bore of a test sample at least 12 inches (30cm) 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. Alternate methods for evaluating tube cleanliness may be used for tubing 0.500 inch (12.7mm) and under ID.

3.5.3 Class 2 tubing shall be subjected to ultrasonic inspection in accordance with AMS2634, Class Level AI except that the length of the notch in the reflector is to be 0.250 inch (6.36 mm).

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 E426 using calibration notches specified in ASTM A1016/A1016M.

3.6 Tolerances

Shall conform to all applicable requirements of AMS2243 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 the producer's tests and shall be responsible for the performance of all required tests. The purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to specified requirements.