



# AEROSPACE MATERIAL

## Society of Automotive Engineers, Inc. SPECIFICATION

TWO PENNSYLVANIA PLAZA, NEW YORK, N. Y. 10001

### AMS 5558A

Superseding AMS 5558

Issued 1-15-58

Revised 5-15-71

### STEEL TUBING, WELDED, CORROSION AND HEAT RESISTANT

18Cr - 11Ni - (Cb + Ta) (SAE 30347)

Thin Wall

#### 1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant steel in the form of welded tubing.

1.2 Application: Primarily for high pressure air ducting requiring both corrosion and heat resistance, especially when such ducting is welded during fabrication, wherein the wall thickness is approximately 2% of the OD or less.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply; the applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

##### 2.1.1 Aerospace Material Specifications:

AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys

AMS 2350 - Standards and Test Methods

AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

AMS 2635 - Radiographic Inspection

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103:

ASTM A370 - Mechanical Testing of Steel Products

ASTM A393 - Conducting Acidified Copper Sulfate Test for Intergranular Attack in Austenitic Stainless Steel

ASTM A353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 Government Publications: Available from Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

##### 2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

#### 3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following in percentages by weight, determined by wet chemical methods in accordance with ASTM E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods.

SAE Technical Board rules provide that: "All technical reports, including standards, approved by the Board and its committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

|                      | min     | max   |
|----------------------|---------|-------|
| Carbon               | --      | 0.08  |
| Manganese            | --      | 2.00  |
| Silicon              | 0.50 -  | 1.00  |
| Phosphorus           | --      | 0.040 |
| Sulfur               | --      | 0.030 |
| Chromium             | 17.00 - | 19.00 |
| Nickel               | 9.00 -  | 12.00 |
| Columbium + Tantalum | 10x C - | 1.10  |
| Molybdenum           | --      | 0.75  |
| Copper               | --      | 0.50  |

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

3.2 Condition: Tubing shall be furnished descaled and passivated. Tubing shall have been rolled only enough to assure proper weld bead height and roundness in the weld bead area.

3.3 Fabrication: Tubing shall be machine fusion welded by inert gas shielded arc process, shall contain no more than one longitudinal weld, and shall contain no circumferential welds. Tube ends shall be cut square and deburred. Tubing shall have a surface appearance as close as possible to a commercial corrosion resistant steel No. 2D Sheet Finish except for the weld bead.

3.4 Properties:

3.4.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM A370:

|                                    |                                                     |
|------------------------------------|-----------------------------------------------------|
| Tensile Strength                   | 75,000 - 105,000 psi (517 - 724 MN/m <sup>2</sup> ) |
| Yield Strength at 0.2% Offset, min | 35,000 psi (241 MN/m <sup>2</sup> )                 |
| Elongation in 2 in. (50.8 mm), min |                                                     |
| Strip Specimen                     | 35%                                                 |
| Full Section                       | 40%                                                 |

3.4.1.1 Strip specimens shall be taken parallel to the tubing axis, shall have a 2 in. (50.8 mm) gage length, and shall not include the weld bead.

3.4.2 Bending: A specimen 2 in. (50.8 mm) square or larger cut from tubing and through the weld shall withstand, without showing cracks or other imperfections when examined at 10X magnification, bending at room temperature flat on itself with axis of bend perpendicular to axis of weld and with inside of tube on either inside or outside of bend.

3.4.3 Weld Crack Susceptibility: Unless otherwise specified, tubing shall not show evidence of cracks when tested as follows:

3.4.3.1 Specimen: The specimen shall be cut from the tube in such a manner as to include at least 6 in. (152.4 mm) of weld bead and 1/4 in. (6.35 mm) of tube wall on each side of the weld. The edges shall be smooth and free from burrs.

3.4.3.2 Test Method: The specimen shall be pulled parallel to the direction of the weld bead until complete rupture of the specimen. The ruptured specimen shall be examined at 10X magnification for cracks occurring on or adjacent to the weld bead.

3.4.4 Embrittlement: Specimens of tubing taken to include the weld, after sensitization treatment, shall be capable of being exposed to acidified copper sulfate in accordance with ASTM A393 without evidence of intercrystalline surface attack. After such exposure, the specimens shall withstand, without cracking, bending at room temperature through an angle of 180 deg (3.14 rad) around a diameter equal to the nominal thickness of the specimen, with axes of bends both perpendicular and parallel to the axes of the tubing.

3.4.5 Pressure Test: After all fabricating and sizing operations, each length of tubing shall withstand a gradually applied internal hydrostatic pressure (P), calculated according to the following formula, for 1 min., without leaking or developing bulges, permanent set, or other imperfections which exceed the allowable tolerances for the finished product.

$$P = \frac{2St}{D}$$

where, P = Test pressure in psi (MN/m<sup>2</sup>)  
 S = 20,000 psi (137.9 MN/m<sup>2</sup>) tensile stress  
 t = minimum wall thickness in in. (mm)  
 D = Nominal OD in in. (mm)

3.4.6 Weld Strength: Shall be not lower than 75,000 psi (517 MN/m<sup>2</sup>), determined in accordance with 3.4.6.1 or 3.4.6.2.

3.4.6.1 Hydrostatic Pressure Test: Test specimen shall consist of a full cross section of tubing, the unsupported length of which is not less than 2 ft (609.6 mm) or 6 times the nominal OD, whichever is greater. An internal hydrostatic pressure (P) calculated from the formula in 3.5 sufficient to cause a tensile stress (S) of 75,000 psi (517 MN/m<sup>2</sup>) in the tube wall, shall be applied gradually in 1/2 - 1 min., at a temperature not lower than 60 F (16 C). Specimen shall withstand this pressure for not less than 1 min. without rupture.

3.4.6.2 Tensile Test: Test specimens shall be taken perpendicular to the direction of weld, shall include the weld near the center of the gage length, and shall be tested in accordance with ASTM A370.

### 3.5 Quality:

3.5.1 Tubing shall be uniform in contour, quality and condition and shall have a workmanlike finish conforming to the best practice for high quality material. It shall be clean, sound, and free from grease, oil, and other foreign matter. It shall be free from burrs, cracks, tears, grooves, seams, laminations, dents, crimps, and other imperfections detrimental to fabrication or to performance of parts.

3.5.2 Unless otherwise specified, the weld in each length of tubing shall be subjected to radiographic inspection in accordance with AMS 2635 prior to rolling, in accordance with standards agreed upon by purchaser and vendor, to guarantee against the shipment of tubing with any of the following imperfections in or adjacent to the weld, porosity, pinholes, entrapped slag, cracks, mismatches, lack of fusion, undercutting, or any other imperfections which cause sharp notches or a reduction of thickness greater than 10% of parent wall thickness.

3.5.2.1 Metal thinning in or adjacent to the weld shall be permissible if not greater than 10% of parent wall thickness, provided also that it presents only gradual transitions.

3.5.2.2 Individual lengths of tubing which contain no weld imperfections other than metal thinning in excess of 10% of parent wall thickness may be reinspected radiographically after rolling. If rolling has reduced the metal thinning to less than 10%, the thinning indicated by the first radiograph will not be cause for rejection.

3.5.2.3 Each length of tubing in a shipment shall be accompanied by its radiographs.

3.5.3 Mechanical imperfections, such as light handling marks and light tool marks, are acceptable provided they have not dented the wall of the tube and are gradual in contour to a maximum depth of 10% of parent wall thickness.

3.5.4 The weld bead shall not extend in height beyond the contour of the adjacent metal more than 0.0025 in. (0.064 mm) on either outside or inside of the tubing, and the sum of both outside and inside weld bead heights shall not exceed 0.004 in. (0.102 mm).

3.6 Tolerances: Unless otherwise specified, the following tolerances shall apply:

3.6.1 Diameter:

TABLE I

| Nominal OD<br>Inches      | Tolerance, Inch<br>Minus Only |
|---------------------------|-------------------------------|
| 1.000 to 2.500, incl      | 0.005                         |
| Over 2.500 to 3.500, incl | 0.007                         |
| Over 3.500 to 4.500, incl | 0.009                         |
| Over 4.500 to 7.000, incl | 0.012                         |

TABLE I (SI)

| Nominal OD<br>Millimeters | Tolerance, Millimeter<br>Minus Only |
|---------------------------|-------------------------------------|
| 25.4 to 63.5, incl        | 0.013                               |
| Over 63.5 to 88.9, incl   | 0.178                               |
| Over 88.9 to 114.3, incl  | 0.229                               |
| Over 114.3 to 177.8, incl | 0.305                               |

3.6.1.1 Outside diameter shall be measured using a periphery or Pi tape.

### 3.6.2 Wall Thickness:

TABLE II

| Nominal Wall Thickness<br>Inch | Tolerance, Inch<br>Plus and Minus |
|--------------------------------|-----------------------------------|
| 0.010 to 0.016, incl           | 0.002                             |
| Over 0.016 to 0.026, incl      | 0.003                             |
| Over 0.026 to 0.040, incl      | 0.004                             |
| Over 0.040 to 0.058, incl      | 0.005                             |
| Over 0.058 to 0.072, incl      | 0.006                             |

TABLE II (SI)

| Nominal Wall Thickness<br>Millimeters | Tolerance, Millimeters<br>Plus and Minus |
|---------------------------------------|------------------------------------------|
| 0.254 to 0.406, incl                  | 0.051                                    |
| Over 0.406 to 0.660, incl             | 0.076                                    |
| Over 0.660 to 1.016, incl             | 0.102                                    |
| Over 1.016 to 1.473, incl             | 0.127                                    |
| Over 1.473 to 1.829, incl             | 0.152                                    |

3.6.3 Ovality: For tubing having nominal wall thickness of 0.040 in. (1.02 mm) or less, ovality shall not exceed 6% of the nominal OD. For tubing having nominal wall thickness greater than 0.040 in. (1.02 mm), the following tolerances shall apply: