AERONAUTICAL
MATERIAL SPECIFICATIONS
SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York 17, N.Y.

# AMS 5558

Issued 1-15-58
Revised

## STEEL TUBING, WELDED, CORROSION AND HEAT RESISTANT
## 18Cr - 11Ni - (Cb+Ta) (SAE 30347)
## Thin Wall

1. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

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.

3. COMPOSITION:

| | | Check Analysis Under Min | Check Analysis Over Max |
|---|---|---|---|
| Carbon | 0.08 max | -- | 0.01 |
| Manganese | 2.00 max | -- | 0.04 |
| Silicon | 0.50 - 1.00 | 0.05 | 0.05 |
| Phosphorus | 0.040 max | -- | 0.005 |
| Sulfur | 0.030 max | -- | 0.005 |
| Chromium | 17.00 - 19.00 | 0.20 | 0.20 |
| Nickel | 9.00 - 12.00 | 0.15 | 0.15 |
| Columbium + Tantalum | 10xC - 1.10 | 0.05 | 0.05 |
| Molybdenum | 0.50 max | -- | 0.03 |
| Copper | 0.50 max | -- | 0.03 |

4. CONDITION: Unless otherwise specified, 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.

4.1 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 weld bead.

5. TECHNICAL REQUIREMENTS:

5.1 Tensile Properties:

| | |
|---|---|
| Tensile Strength, psi | 75,000 - 105,000 |
| Yield Strength at 0.2% Offset or at 0.0065 in. in 2 in. Extension Under Load (E = 28,000,000), psi | 35,000 min |
| Elongation, % in 2 in. | |
| Strip | 35 min |
| Full Section | 40 min |

5.1.1 Strip specimens shall be taken parallel to the tubing axis, shall have a 2 in. gage length, and shall not include the weld bead.

5.2 Bending: A specimen 2 in. square or larger cut from tubing and through the weld shall withstand, without showing cracks or other imperfections when inspected 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.

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

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

5.3.2 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 in or adjacent to the weld bead.

5.4 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.
S = 20,000 psi tensile stress.
t = Minimum wall thickness in inches.
D = Nominal OD in inches.

5.5 Weld Strength: Shall be not lower than 75,000 psi, determined in accordance with 5.5.1 or 5.5.2.

5.5.1 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 or 6 times the nominal OD, whichever is greater. An internal hydrostatic pressure (P) calculated from the formula in 5.4 sufficient to cause a tensile stress (S) of 75,000 psi in the tube wall, shall be applied gradually in 1/2 - 1 min., at a temperature not lower than 60 F. Specimen shall withstand this pressure for not less than 1 min. without rupture.

5.5.2 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 E8-54T insofar as practicable.

5.6 Embrittlement: Tubing shall be capable of meeting the following test:

5.6.1 Specimens of tubing taken to include the weld, after being heated at 1200 F ± 10 for 2 hr and air cooled, shall withstand immersion for 48 hr in a boiling aqueous solution containing 100 g of $CuSO_4.5H_2O$ and 100 ml of $H_2SO_4$ (sp gr 1.84) per liter of solution under a reflux condenser without evidence of intercrystalline surface attack. After such immersion, the specimens shall withstand, without cracking, bending at room temperature through an angle of 180 deg. around a diameter equal to the nominal thickness of the specimen, with axes of bends both perpendicular and parallel to the axis of the tubing.

6. QUALITY:

6.1 Tubing shall have a good workmanlike finish conforming to the best practice for high quality aircraft material. Tubing shall be uniform in contour, quality, and condition, 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.

6.2 Unless otherwise specified, the weld in each length of tubing shall be subjected to radiographic inspection 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.

6.2.1 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.

6.2.2 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.

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

6.3 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.

6.4 The weld bead shall not extend in height beyond the contour of the adjacent metal more than 0.0025 in. on either outside or inside of the tubing, and the sum of both outside and inside weld bead heights shall not exceed 0.004 inch.

7. TOLERANCES: Unless otherwise specified, the following tolerances shall apply.

7.1 Diameter:

| Nominal OD Inches | Tolerance, Inch 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 |

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

7.2 Wall Thickness:

| Nominal Wall Thickness Inch | Tolerance, Inch 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 |

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

| Nominal OD Inches | Tolerance % of OD |
|---|---|
| 1.000 to 1.250, incl | 5.0 |
| Over 1.250 to 1.500, incl | 4.0 |
| Over 1.500 to 1.750, incl | 3.5 |
| Over 1.750 to 2.000, incl | 3.0 |
| Over 2.000 to 2.500, incl | 2.5 |
| Over 2.500 to 7.000, incl | 2.0 |

7.3.1 Ovality is obtained by dividing the difference between the maximum and minimum OD of any one station along the tube by the nominal OD, and multiplying by 100.

7.4 Length: Cut-to-length tubing shall not vary from the length specified by more than +1/8 in., -0.

7.5 Straightness: When measured using a 3 ft straight-edge touching tube at two points, the perpendicular distance from the straight-edge to the tube shall not exceed 0.030xL/3 in. at any point between the two points of contact, where "L" is the distance between points of contact.

8. SAMPLING: Specimens to determine conformance to tensile, bending, weld crack susceptibility, and weld strength requirements shall be taken from at least one length of tubing from each production lot.

8.1 A lot shall consist of no more than one continuous production run of tubing of one diameter and wall thickness from a single heat of steel.