SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5558F

Issued JAN 1958
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Superseding AMS 5558E

Steel, Corrosion and Heat-Resistant, Welded Tubing
18Cr - 10.5Ni - 0.70Cb (SAE 30347)
Thin Wall
Solution Heat Treated

(Composition similar to UNS S34700)

1. SCOPE:

1.1 Form:

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

1.2 Application:

This tubing has been used typically for high-pressure air ducting requiring both corrosion and heat resistance, especially when such ducting is welded during fabrication, and when the wall thickness is approximately 2% or less of the OD, but usage is not limited to such applications.

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.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

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

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: http://www.sae.org

2.1 (Continued):

AMS 2634	Ultrasonic Inspection, Thin Wall Metal Tubing
AMS 2807	Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing
AS4194	Sheet and Strip Surface Finish Nomenclature

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM A 262	Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A 370	Mechanical Testing of Steel Products
ASTM A 480/A 480M	Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM E 353	Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E 1742	Radiographic Examination

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	0.30	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	17.00	19.00
Nickel	9.00	12.00
Columbium	10xC	1.10
Molybdenum	--	0.75
Copper	--	0.75

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

3.2 Condition:

Solution heat treated, and, unless solution heat treatment is performed in an atmosphere yielding a bright finish, pickled as required or passivated. Tubing shall have been cold worked sufficiently to meet the dimensional requirements of 3.5.4 and 3.6.3.

3.3 Fabrication:

Tubing shall be machine fusion welded, shall contain no more than one longitudinal weld, and shall contain no circumferential welds. Tube ends shall be cut square and deburred. Tubing, except for the weld reinforcement, shall have a surface appearance in accordance with ASTM A 480/A 480M and AS4194 comparable to a No. 2D sheet finish..

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 shown in Table 2.

TABLE 2A - Tensile Properties, Inch/Pound Units

Tensile Strength ksi	Minimum Yield Strength at 0.2% Offset ksi	Minimum Elongation in 2 Inches, % Strip Specimen (4.3.1)	Minimum Elongation in 2 Inches. % Full SectIon
75 to 105	35.0	35	40

TABLE 2B - Tensile Properties, SI Units

Tensile Strength MPa	Minimum Yield Strength at 0.2% Offset MPa	Minimum Elongation in 50.8 mm, % Strip Specimen (4.3.1)	Minimum Elongation in 50.8 mm. % Full Section
517 to 724	241	35	40

3.4.2 Bending: A specimen as in 4.3.2 shall withstand, without showing cracks or other imperfections when examined using 8 to 12X 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: A specimen as in 4.3.3 shall withstand, without evidence of cracks occurring on, or adjacent to, the weld bead when examined using 8 to 12X magnification, being pulled parallel to the direction of the weld bead until rupture occurs.

3.4.4 Susceptibility to Intergranular Attack: Specimens of tubing taken to include the weld, after sensitization treatment, shall pass the intergranular corrosion test performed in accordance with ASTM A 262, Practice E.

3.4.5 Weld Strength: Shall be as follows, determined in accordance with 3.4.5.1 or 3.4.5.2.

3.4.5.1 Hydrostatic Pressure Test: A specimen as in 4.3.4 shall withstand, without rupture, an internal hydrostatic pressure which will produce a hoop tensile stress of 75.0 ksi (517 MPa) in the tubing wall for not less than 60 seconds. Hydrostatic pressure (P) shall be calculated using Equation 1 and shall be applied gradually in 30 to 60 seconds at a temperature not lower than 60 °F (16 °C).

$$P = S\frac{D_2 - d_2}{D_2 + d_2} \qquad \text{(Eq. 1)}$$

where,

P = Test pressure in ksi (MPa)
S = 75.0 ksi (517 MPa) tensile stress
D = Nominal OD in inches (mm) (nominal OD plus tolerance)
d = Nominal ID in inches (mm) (nominal OD minus twice the minimum wall thickness)

3.4.5.2 Tensile Strength: Shall be not lower than 75 ksi (517 MPa), determined on specimens as in 4.3.5.

3.5 QUALITY:

3.5.1 Tubing, as received by purchaser, shall be uniform in contour, quality, and condition and shall have a finish conforming to the best practice for high quality aircraft tubing. It shall be 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 usage of the tubing.

3.5.2 The weld in each length of tubing, prior to cold working, shall be subjected to radiographic inspection in accordance with ASTM E 1742. Imperfections in or adjacent to the weld, porosity, pinholes, entrapped slag, cracks, mismatches, lack of fusion, undercutting, or other imperfections which cause sharp notches or a reduction of thickness greater than 10% of parent metal wall thickness are not acceptable.

3.5.2.1 Metal thinning in, or adjacent to, the weld shall be permissible if not greater than 10% of parent metal 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 metal wall thickness may be reinspected radiographically after cold working. If cold working 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 As an alternate to use of radiographic inspection, tubing shall be subjected to ultrasonic inspection in accordance with AMS 2634, Class Level A1, except that the length of the notch in the reflector specified in Table 1A is to be 0.250 inches.

3.5.4 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 metal wall thickness.

3.5.5 The weld reinforcement shall not extend in height beyond the contour of the adjacent metal more than 0.0025 inch (0.064 mm) on either outside or inside of the tubing, and the sum of both outside and inside weld reinforcement heights shall not exceed 0.004 inch (0.10 mm).

3.6 Tolerances:

Unless otherwise specified, the following tolerances shall apply:

3.6.1 Diameter: Shall be as shown in Table 3.

TABLE 3A - Diameter Tolerances, Inch/Pound Units

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

TABLE 3B - Diameter Tolerances, SI Units

Nominal OD Millimeters	Tolerance, Millimeter Minus Only
25.40 to 63.50, incl	0.13
Over 63.50 to 88.90, incl	0.18
Over 88.90 to 114.30, incl	0.23
Over 114.30 to 177.80, incl	0.30

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

3.6.2 Wall Thickness: Shall be as shown in Table 4.

TABLE 4A - Wall Thickness Tolerances, Inch/Pound Units

Nominal Wall Thickness Inches	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

TABLE 4B - Wall Thickness Tolerances, SI Units

Nominal Wall Thickness Millimeters	Tolerance, Millimeter Plus and Minus
0.25 to 0.41, incl	0.05
Over 0.41 to 0.66, incl	0.08
Over 0.66 to 1.02, incl	0.10
Over 1.02 to 1.47, incl	0.13
Over 1.47 to 1.83, incl	0.15

3.6.3 Ovality: For tubing having nominal wall thickness of 0.040 inch (1.02 mm) and under, ovality shall not exceed 6% of the nominal OD. For tubing having nominal wall thickness over 0.040 inch (1.02 mm), the tolerances shown in Table 5 shall apply.

TABLE 5 - Maximum Ovality

Nominal OD Inches	Nominal OD Millimeters	Tolerance % of OD
1.000 to 1.250, incl	25.40 to 31.75, incl	5.0
Over 1.250 to 1.500, incl	Over 31.75 to 38.10, incl	4.0
Over 1.500 to 1.750, incl	Over 38.10 to 44.45, incl	3.5
Over 1.750 to 2.000, incl	Over 44.45 to 50.80, incl	3.0
Over 2.000 to 2.500, incl	Over 50.80 to 63.50, incl	2.5
Over 2.500 to 7.000, incl	Over 63.50 to 177.80, incl	2.0

3.6.3.1 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.

3.6.4 Length: Cut-to-length tubing shall not vary from the length ordered by more than +1/8 inch (+3.2 mm), -0.

3.6.5 Straightness: When measured using a 3-foot (914-mm) straight-edge touching the tube at two points, the perpendicular distance from the straight-edge to the tube at any point between the two points of contact, shall not exceed 0.030 x L/3 inch, where "L" is the distance in feet between points of contact or shall not exceed 0.83 x L mm, where "L" is the distance in meters between points of contact.

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), bending (3.4.2), weld crack susceptibility (3.4.3), weld strength (3.4.5), radiographic (3.5.2) or ultrasonic (3.5.3) inspection, and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Susceptibility to intergranular attack (3.4.4) is a periodic test 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:

4.3.1 Strip specimens for tensile testing (3.4.1) shall be taken parallel to the tubing axis, shall have a 2-inch (50.8-mm) gage length, and shall not include the weld reinforcement.

4.3.2 Specimens for bending (3.4.2) shall be at least 2 inches (50.8 mm) long when measured parallel to the weld direction. Additionally, the sample shall contain the full width of the weld plus 0.10 inches (2.5 mm) minimum on either side of the weld toe.

4.3.3 Specimens for weld crack susceptibility (3.4.3) shall be cut from a tube in such a manner as to include at least 6 inches (152 mm) of weld bead and 1/4 inch (6.4 mm) of tube wall on each side of the weld. The edges shall be smooth and free from burrs.

4.3.4 Specimens for weld strength hydrostatic pressure test (3.4.5.1) shall be full cross-section of the tubing, the unsupported length of which shall be not less than 2 feet (610 mm) or six times the nominal OD, whichever is greater.

4.3.5 Specimens for weld strength tensile test (3.4.5.2) shall be taken perpendicular to the direction of the weld and shall include the weld near the center of the gage length.

4.4 Reports:

The vendor of the product shall furnish with each shipment a report showing the following results of tests and relevant information:

4.4.1 For each heat:

Composition.

4.4.2 For each lot:

Tensile properties
Bending property
Weld crack susceptability
Weld strength
Radiographic (or ultrasonic) inspection.