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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5558D

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Superseding AMS 5558C

STEEL TUBING, WELDED, CORROSION AND HEAT RESISTANT 18Cr - 10.5Ni - 0.70 (Cb + Ta) (SAE 30347) Thin Wall Solution Heat Treated

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: 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 Materials Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly Alloyed Steels, and Iron Alloys
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock
AMS 2635 - Radiographic Inspection
AMS 2750 - Pyrometry

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

ASTM A262 - Detecting Susceptibility to Intergranular Attack in Stainless Steels
ASTM A370 - Mechanical Testing of Steel Products
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E353, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	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 + Tantalum	10xC	1.10
Molybdenum	--	0.75
Copper	--	0.75

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

3.2 Condition: Solution heat treated, descaled and passivated. Tubing shall Ø have been rolled only enough to ensure weld bead height and roundness in the weld bead area. Pyrometry shall be in accordance with AMS 2750.

3.3 Fabrication: Tubing shall be machine fusion welded by gas-metal-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, except for the weld bead, shall have a surface appearance comparable to a commercial corrosion-resistant steel No. 2D sheet finish (See 8.2).

3.4 Properties: Tubing shall conform to the following requirements; tensile and bend testing shall be performed in accordance with ASTM A370:

3.4.1 Tensile Properties: Shall be as follows:

Tensile Strength	75,000 - 105,000 psi (517 - 724 MPa)
Yield Strength at 0.2% Offset, minimum	35,000 psi (241 MPa)
Elongation in 2 Inches (50.8 mm), minimum	
Strip Specimen (See 4.3.1)	35%
Full Section	40%

3.4.2 Bending: A specimen as in 4.3.2 shall withstand, without showing cracks or other imperfections when examined at 10X magnifications, 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 at 10X 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
Ø the weld, after sensitization treatment, shall pass the intergranular corrosion acid test performed in accordance with ASTM A262, Practice E.

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

$$P = S \frac{D^2 - d^2}{D^2 + d^2}$$

where, P = Test pressure in psi (MPa)
S = 20,000 psi (138 MPa) tensile stress
D = Nominal OD
d = Nominal ID

3.4.6 Weld Strength: Shall be as follows, determined in accordance with 3.4.6.1 or 3.4.6.2.

3.4.6.1 Hydrostatic Pressure Test: A specimen as in 4.3.4 shall withstand an
Ø internal hydrostatic pressure which will produce a hoop tensile stress of 75,000 psi (517 MPa) in the tubing wall for not less than 60 seconds without rupture. Hydrostatic pressure (P) shall be calculated from the equation in 3.4.5 and shall be applied gradually in 30 - 60 seconds at a temperature not lower than 60°F (16°C).

3.4.6.2 Tensile Strength: Shall be not lower than 75,000 psi (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 Ø The weld in each length of tubing, prior to rolling, shall be subjected to radiographic inspection in accordance with AMS 2635. 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 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 metal wall thickness.

3.5.4 The weld flash 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 bead heights shall not exceed 0.004 inch (0.10 mm).

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight tubes will be acceptable in mill lengths of 6 - 20 feet (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

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

3.7.1 Diameter:

TABLE I

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 I (SI)

Nominal OD Millimetres	Tolerance, Millimetre 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

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

3.7.2 Wall Thickness:

TABLE II

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

TABLE II (SI)

Nominal Wall Thickness Millimetres	Tolerance, Millimetre 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

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

TABLE III

Nominal OD		% of OD
Inches	Millimetres	
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

3.7.3.1 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.

3.7.4 Length: Cut-to-length tubing shall not vary from the length ordered by more than +1/8 inch (+3 mm), -0.

3.7.5 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 metres 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 performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for composition (3.1), tensile properties (3.4.1), bending (3.4.2), weld crack susceptibility (3.4.3), pressure test (3.4.5), weld strength (3.4.6), quality (3.5.2), and tolerances (3.7) are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for susceptibility to intergranular attack (3.4.4) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling: 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 bead.

4.3.2 Specimens for bending (3.4.2) shall be 2 inches (50.8 mm) square or larger cut from tubing and through the weld.

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 (3.4.6.1) 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 (3.4.6.2) 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:

4.4.1 The vendor of tubing shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for tensile properties and weld strength of each lot, and stating that the tubing conforms to the other acceptance tests requirements of this specification. This report shall include the purchase order number, lot number, AMS 5558D, size, and quantity.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 5558D, contractor or other direct supplier of tubing, part number, and quantity. When tubing for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of tubing to determine conformance to the requirements of this specification and shall include in the report either a statement that the tubing conforms or copies of laboratory reports showing the results of tests to determine conformance.

4.5 Resampling and Retesting: Shall be in accordance with AMS 2371.

5. PREPARATION FOR DELIVERY: