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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 6373C

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Superseding AMS 6373B

STEEL TUBING, WELDED
0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)

UNS G41300

1. SCOPE:

1.1 Form: This specification covers an aircraft-quality, low-alloy steel in the form of welded tubing.

1.2 Application: Primarily for general use where welding and moderate tensile properties are required. Extensively used when a minimum tensile strength of 160,000 psi (1130 MPa) is required after proper heat treatment.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material 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 2253 - Tolerances, Carbon and Alloy Steel Tubing
MAM 2253 - Tolerances, Metric, Carbon and Alloy Steel Tubing
AMS 2259 - Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2301 - Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
AMS 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock
AMS 2640 - Magnetic Particle Inspection

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

ASTM A370 - Mechanical Testing of Steel Products
ASTM E112 - Determining Agerage Grain Size
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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, determined by wet chemical methods in accordance with ASTM E350 or by spectrochemical or other analytical methods approved by purchaser:

	min	max
Carbon	0.28	0.33
Manganese	0.40	0.60
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.80	1.10
Molybdenum	0.15	0.25
Nickel	--	0.25
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

3.2 Condition: Cold finished and either normalized and tempered, stress relieved, or otherwise heat treated.

3.3 Fabrication: Tubing shall be produced by a welded and drawn process. The external finishes may be produced by any method which will provide the required surface condition and not affect the limits of wall thickness, with the exception that centerless ground finish is not acceptable. A light polish to improve surface appearance may be employed.

3.3.1 Tubing shall be processed to remove completely the weld bead and any dimensional indication of the presence of welds.

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

3.4.1 Tensile Properties: Shall be as specified in Table I.

TABLE I

Nominal OD Inches	Nominal Wall Thickness Inch	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. %, min	
				Full Tube	Strip
Up to 0.500, excl	Up to 0.188, incl	95,000	75,000	10	--
Up to 0.500, excl	Over 0.188	90,000	70,000	12	--
0.500 and over	Up to 0.188, incl	95,000	75,000	12	7
0.500 and over	Over 0.188	90,000	70,000	15	10

TABLE I (SI)

Nominal OD Millimetres	Nominal Wall Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50 mm %, min	
				Full Tube	Strip
Up to 12.50, excl	Up to 4.75, incl	655	515	10	--
Up to 12.50, excl	Over 4.75	620	485	10	--
12.50, and over	Up to 4.75, incl	655	515	12	7
12.50, and over	Over 4.75	620	485	15	10

3.4.2 Crushing: Specimens as in 4.3.1.1 shall withstand, without failure of the weld, crushing under a gradually applied load until the cross-sectional dimension is increased in one zone by 20% or until one complete fold is formed, or until the specimen is reduced in length to two-thirds of the original length.

3.4.3 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E112.

3.4.4 Decarburization:

3.4.4.1 Tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization of tubing ID shall not exceed the maximum depth specified in Table II.

3.4.4.2 Allowable decarburization of tubing ordered for redrawing or of tubing ordered to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

3.4.4.3 Tubing to which 3.4.4.1 or 3.4.4.2 is not applicable shall be free from complete decarburization. Partial decarburization shall not exceed the limits specified in Table II.

TABLE II

Nominal Wall Thickness (T), Inch	Depth of Partial Decarburization, Inch		
	ID	OD	ID + OD
Up to 0.040, incl	0.25T	0.25T	0.30T
Over 0.040 to 0.050, incl	0.009	0.009	0.012
Over 0.050 to 0.070, incl	0.010	0.010	0.014
Over 0.070 to 0.080, incl	0.012	0.012	0.016
Over 0.080 to 0.090, incl	0.014	0.014	0.018
Over 0.090 to 0.100, incl	0.015	0.015	0.020
Over 0.100 to 0.150, incl	0.017	0.017	0.022
Over 0.150 to 0.200, incl	0.020	0.020	0.026

TABLE II (SI)

Nominal Wall Thickness (T), Millimetres	Depth of Partial Decarburization, Millimetres		
	ID	OD	ID + OD
Up to 1.00, incl	0.25T	0.25T	0.30T
Over 1.00 to 1.25, incl	0.22	0.22	0.30
Over 1.25 to 1.75, incl	0.25	0.25	0.35
Over 1.75 to 2.00, incl	0.30	0.30	0.40
Over 2.00 to 2.25, incl	0.35	0.35	0.45
Over 2.25 to 2.50, incl	0.38	0.38	0.50
Over 2.50 to 3.75, incl	0.42	0.42	0.55
Over 3.75 to 5.00, incl	0.50	0.50	0.65

3.4.4.3.1 Limits for depth of partial decarburization of tubing over 0.200 in. (5.00 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.4.4 Decarburization shall be measured by the microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on hardened but untempered specimens protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon.

3.4.4.4.1 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the above limits by more than 0.005 in. (0.12 mm) and the width is 0.065 in. (1.65 mm) or less.

3.4.5 Flarability: Tubing 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 deg included angle to produce a flare having not less than the following permanent percentage OD increase. After flaring, the inside surface of the tubing shall be smooth and shall show no evidence of a bead that might prevent the assembly of pressure tight joints.

Nominal Wall Thickness % of OD	OD Increase %
Up to 7, incl	35
Over 7	45

3.5 Quality:

3.5.1 Steel shall be aircraft quality conforming to AMS 2301.

3.5.2 Tubing, as received by 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, shallow pits, 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.

3.5.2.1 When specified, the tubing, either with or without machining of the surface, shall pass magnetic particle inspection in accordance with AMS 2640. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight tubing will be acceptable in mill lengths of 6 - 20 ft (2 - 6 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 m).

3.7 Tolerances: Shall conform to all applicable requirements of AMS 2253 or MAM 2253.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the 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 product conforms 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), crushing (3.4.2), grain size (3.4.3), decarburization (3.4.4), frequency-severity cleanliness rating (3.5.1), 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 flarability (3.4.5) and, when specified, magnetic particle inspection (3.5.2.1) 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:

4.3.1 For Acceptance Tests: Shall be in accordance with AMS 2370 and the following; a lot shall be all tubing of the same size from a single heat of steel, heat treated as a batch or sequentially heat treated in a continuous furnace:

4.3.1.1 At least one sample for the crushing test of 3.4.2 shall be selected from each 1000 ft (300 m) or less of tubing from each lot. Specimens shall have length equal to 1.5 times the nominal OD of the tube.

4.3.2 For Periodic Tests: As agreed upon by purchaser and vendor.

4.3.2.1 Specimens for flarability test shall be full tubes or sections cut from a tube. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded.

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, grain size, and frequency-severity cleanliness rating of each heat and for tensile properties of each lot. This report shall include the purchase order number, heat number, AMS 6373C, 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 6373C, 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 2370.

5. PREPARATION FOR DELIVERY: