



AEROSPACE MATERIAL SPECIFICATION

AMS6373™**REV. J**

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Superseding AMS6373H

Steel, Welded Tubing
0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
(Composition similar to UNS G41300)

RATIONALE

AMS6373J is a Five-Year Review and update of this specification that revises analytical methods (3.1), adds tensile strain rates (3.4.1.1), revises decarburization (3.3.4.4), prohibits unauthorized exceptions (3.7), and revises reporting and marking (4.4.2, 5.2).

1. SCOPE

1.1 Form

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

1.2 Application

This tubing has been used typically for general use where welding and moderate tensile properties are required and especially when a minimum tensile strength of 160 ksi (1103 MPa) is required after heat treatment, 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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2253	Tolerances, Carbon and Alloy Steel Tubing
AMS2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS2301	Steel Cleanliness, Aircraft-Quality Magnetic Particle Inspection Procedure

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SAE WEB ADDRESS:

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS6373J>

- AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock
- AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys, Sheet, Strip, Plate and Aircraft Tubing
- ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

- ASTM A370 Mechanical Testing of Steel Products
- ASTM A751 Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- ASTM E112 Determining Average Grain Size
- ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
- ASTM E384 Microindentation Hardness of Materials
- ASTM E1444 Magnetic Particle Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods acceptable to purchaser.

Table 1 - Composition

Element	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 Aluminum, vanadium, and columbium are optional grain refining elements and need not be determined or reported unless used to satisfy the average grain size requirements of 3.4.3.2.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

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 grinding is not acceptable. A light polish to improve surface appearance may be employed.

3.3.1 Tubing shall be processed to completely remove the weld reinforcement 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 shown in Table 2.

Table 2A - Minimum tensile properties, inch/pound units

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

Table 2B - Minimum tensile properties, SI units

Nominal OD Millimeters	Nominal Wall Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm % Full Tube	Elongation in 50.8 mm % Strip
Up to 12.70, excl	Up to 4.78, incl	655	517	10	--
Up to 12.70, excl	Over 4.78	621	483	12	--
12.70 and over	Up to 4.78, incl	655	517	12	7
12.70 and over	Over 4.78	621	483	15	10

3.4.1.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min).

3.4.2 Crushing

Specimens as in 4.3.1.1 shall withstand, without failure of the weld, crushing axially 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 Average Grain Size

Average grain size shall be determined by either 3.4.3.1 or 3.4.3.2.

3.4.3.1 Shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.4.3.2 The product of a heat shall be considered to have an ASTM No. 5 or finer austenitic grain size if one or more of the following are determined by heat analysis (see 8.4):

3.4.3.2.1 A total aluminum content of 0.020 to 0.050%.

3.4.3.2.2 An acid soluble aluminum content of 0.015 to 0.050%.

3.4.3.2.3 A vanadium content of 0.02 to 0.08%.

3.4.3.2.4 A columbium content of 0.02 to 0.05%.

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.

3.4.4.2 Tubing to which 3.4.4.1 is not applicable shall be free from complete decarburization. Partial decarburization shall not exceed the limits specified in Table 3.

Table 3A - Maximum total depth of decarburization, inch/pound units

Nominal Wall Thickness (T) Inches	Depth of Partial Decarburization	Depth of Partial Decarburization	Depth of Partial Decarburization
	Inches ID	Inches OD	Inches 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 3B - Maximum total depth of decarburization, SI units

Nominal Wall Thickness (T) Millimeters	Depth of Partial Decarburization	Depth of Partial Decarburization	Depth of Partial Decarburization
	Millimeters ID	Millimeters OD	Millimeters ID+OD
Up to 1.02, incl	0.25T	0.25T	0.30T
Over 1.02 to 1.27, incl	0.23	0.23	0.30
Over 1.27 to 1.78, incl	0.25	0.25	0.36
Over 1.78 to 2.03, incl	0.30	0.30	0.41
Over 2.03 to 2.29, incl	0.36	0.36	0.46
Over 2.29 to 2.54, incl	0.38	0.38	0.51
Over 2.54 to 3.81, incl	0.43	0.43	0.56
Over 3.81 to 5.08, incl	0.51	0.51	0.66

3.4.4.3 Decarburization shall be evaluated by one of the two methods of 3.4.4.3.1 or 3.4.4.3.2.

3.4.4.3.1 Metallographic Method

A cross section taken perpendicular to the surface shall be prepared in accordance with ASTM E1077 and visually examined metallographically at a magnification not to exceed 100X. Optical indications of decarburization (including complete decarburization [ferrite] plus partial decarburization) shall not exceed the limits of Table 3.

3.4.4.3.2 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E384 conducted on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization is defined as the perpendicular distance from the surface to the depth under that surface where there is not further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Table 3.

3.4.4.3.3 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the limits of Table 3 by more than 0.005 inch (0.13 mm) and the width is 0.065 inches (1.65 mm) or less.

3.4.4.3.4 In case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

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 degree included angle to produce a flare having not less than the permanent percentage OD increase shown in Table 4. 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.

Table 4 - Minimum OD increase

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

3.5 Quality

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.

3.5.1 Steel shall be aircraft-quality conforming to AMS2301.

3.5.2 When specified, the tubing, either with or without machining of the surface, shall pass magnetic particle inspection in accordance with ASTM E1444. Standards for acceptance shall be as agreed upon by purchaser and producer (see 8.5).

3.6 Tolerances

Shall conform to all applicable requirements of AMS2253.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of tubing shall supply all samples for producer'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 product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

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), magnetic particle inspection (when specified) (3.5.2), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (3.4.3.2) are not present, the ASTM E112 grain size test (3.4.2.1) shall be conducted on each lot.

4.2.2 Periodic Tests

If grain refining elements (3.4.3.2) are present, the ASTM E112 grain size test (3.4.3.1) shall be conducted on a periodic basis and shall be performed at a frequency selected by the producer (not to exceed 1 year) unless frequency of testing is specified by purchaser. Flarability (3.4.5) is a periodic test and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

4.3.1 For Acceptance Tests

Shall be in accordance with AMS2370 and the following:

At least one sample for the crushing test of 3.4.2 shall be selected from each 1000 feet (305 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 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 producer shall furnish with each shipment a report showing producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), results of tests for composition, frequency-severity cleanliness rating of each heat, and for tensile properties, and, if measured, average grain size of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS6373J, size, and quantity. If the grain size requirement of 3.4.3.2 is met by the aluminum, vanadium, and/or columbium content, the aluminum, vanadium, and/or columbium content shall be reported and a statement that the chemistry satisfies the grain size requirement shall be included.

4.4.2 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions are taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS6373J(EXC) because of the following exceptions:" and the specific exceptions shall be listed (also see 5.2).

4.5 Resampling and Retesting

Shall be in accordance with AMS2370.