AEROSPACE MATERIAL SPECIFICATION

AMS6360™	REV. R

Issued 1939-12
Reaffirmed 2009-06
Revised 2023-12

Superseding AMS6360P

Steel Mechanical Tubing, Seamless, 0.95Cr - 0.20Mo (0.28 - 0.33C) (4130), Aircraft Quality, Normalized and Tempered, or Stress Relieved (Composition similar to UNS G41300)

RATIONALE

AMS6360R is the result of a Five-Year Review and update of the specification. The revision updates the Title to clarify form, quality and condition, clarifies strength (see 1.2), updates composition reporting (see 3.1.2), updates decarburization testing (see 3.3.3.4), clarifies test requirements (see 4.2), adds periodic testing requirements per AMS2301 requirements (see 4.2.1 and 4.4.3) and prohibits exceptions without authorization (see 3.6 and 8.5).

1. SCOPE

1.1 Form

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

1.2 Application

This tubing has been typically used in thin-walled sections where a minimum tensile strength of 90-95 ksi (620-655 MPa) as received. or up to 160 ksi (1103 MPa) after heat treatment is required and where parts may be welded during fabrication, 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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6360R

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

AS7766 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 E1077 Standard Test Methods for Estimating the Depth of Decarburization of Steel Specimens

ASTM E1444/E1444M Magnetic Particle Testing for Aerospace

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

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 the 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 (niobium) are optional grain refining elements and need not be determined or reported unless used to satisfy the average grain size requirements of 3.3.2.2.

3.1.2 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.3 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

The tubing shall be supplied cold finished, normalized, and tempered. Alternately tubing shall be cold finished and stress relieved. The purchaser shall specify if other conditions are desired (see 8.6).

3.3 Properties

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

3.3.1 Tensile Properties

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 or 4D % 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	10	-
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 mm or 4D % Full Tube	Elongation in 50 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	10	-
12.70 and over	Up to 4.78, incl	655	517	12	7
12.70 and over	Over 4.78	621	483	15	10

3.3.1.1 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 and 0.5 in/in (0.05 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 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min).

3.3.2 Average Grain Size

Average grain size shall be determined by either 3.3.2.1 or 3.3.2.2.

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

3.3.2.2 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 8.3):

- A total aluminum content of 0.020 to 0.050%
- An acid soluble aluminum content of 0.015 to 0.050%
- A vanadium content of 0.02 to 0.08%
- A columbium (niobium) content of 0.02 to 0.05%

3.3.3 Decarburization

3.3.3.1 Tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization on tubing ID shall not exceed the maximum depth specified in Table 3.

3.3.3.2 Allowable decarburization of pierced billets, of tubing for redrawing, or of tubing ordered to specified microstructural requirements, shall be as agreed upon by the purchaser and producer.

3.3.3.3 Where 3.3.3.1 or 3.3.3.2 are not applicable, tubing shall be free from complete decarburization. Partial decarburization shall not exceed the limits specified in Table 3.

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

Nominal Wall Thickness (T) Inches	Depth of Partial Decarburization Inches ID	Depth of Partial Decarburization Inches OD	Depth of Partial Decarburization Inches ID+OD
Up to 0.040, incl	0.18T	0.18T	0.25T
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 depth of decarburization, SI units

Nominal Wall Thickness (T) Millimeters	Depth of Partial Decarburization Millimeters ID	Depth of Partial Decarburization Millimeters OD	Depth of Partial Decarburization Millimeters ID+OD
Up to 1.02, incl	0.18T	0.18T	0.25T
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

3.3.3.4 Decarburization

Decarburization shall be evaluated by one of the two methods of 3.3.3.4.1 or 3.3.3.4.2.

3.3.3.4.1 Metallographic Method

A cross section of the surface shall be prepared in accordance with ASTM E1077 and examined metallographically at a magnification not to exceed 200X. The product shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.3.3.4.2 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened and protected during heat treatment to prevent changes in surface carbon content. Samples may be tempered at the option of the producer. 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.

3.3.3.4.3 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 inch (0.13 mm) and the

width is 0.065 inch (1.65 mm) or less.

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

3.4 Quality

Tubing, as received by the 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.

3.4.1 Steel shall be aircraft quality conforming to AMS2301.

3.4.2 When specified (see 8.6), the tubing, either with or without machining of the surface, shall be subjected to magnetic particle inspection in accordance with ASTM E1444/E1444M. Standards for acceptance shall be as agreed upon by the purchaser and producer.

3.5 Tolerances

Tubing tolerances shall conform to all applicable requirements of AMS2253 for aircraft tubing.

3.6 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 the producer's tests and shall be responsible for the performance of all required tests. The 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 Testing

Composition (see 3.1), tensile (see 3.3.1), average grain size (see 3.3.2), decarburization (see 3.3.3), frequency-severity cleanliness (see 3.4.1), and tolerances (see 3.5) are acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (see 3.3.2.2) are not present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on each lot. If process qualification in accordance with AMS2301 has been met, the frequency-severity cleanliness rating shall be conducted on a periodic basis as defined in AMS2301.

4.2.2 Periodic Testing

If grain refining elements (see 3.3.2.2) are present, the ASTM E112 grain size test (see 3.3.2.1) 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 the purchaser.

4.3 Sampling and Testing

Sampling and testing shall be in accordance with AMS2370.