AEROSPACE MATERIAL SPECIFICATION

AMS6281™	REV. K

Issued 1945-10
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Superseding AMS6281J

Steel, Mechanical Tubing
0.50Cr - 0.55Ni - 0.20Mo (0.25 - 0.33C) (SAE 8630)
(Composition similar to UNS G86300)

RATIONALE

AMS6281K results from a Five-Year Review and update of this specification that revises composition analytical methods (3.1), adds grain refiners (3.1.1 and 3.3.2), revises macrostructure of large sections (Table 2 and 3.3.1.1), grain size determination (3.3.2), decarburization (3.3.4.4), and quality (3.4.2), prohibits unauthorized exceptions (3.6), and revises classification of tests (4.2), reporting (4.4), and identification (5.2).

1. SCOPE

1.1 Form

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

1.2 Application

This product has been used typically for parts, with section thickness of 0.50 inch (12.7 mm) and under at time of heat treatment, requiring a through-hardening steel capable of developing hardness as high as 35 HRC, and for parts of greater thickness requiring proportionately lower hardness, 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/AMS6281K

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2806 Identification Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

AS1182 Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing

AS6279 Standard Practice for Production, Distribution, and Procurement of Metal Stock

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 A255 End-Quench Test for Hardenability of Steel

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 E381 Macroetch Testing, Steel Bars, Billets, Blooms, and Forgings

ASTM E384 Microindentation Hardness of Materials

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	0.70	0.90
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.40	0.60
Nickel	0.40	0.70
Molybdenum	0.15	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 3.3.2.2.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

Cold finished, unless otherwise ordered, having hardness not higher than 25 HRC, or equivalent (see 8.2). Tubing ordered hot finished and annealed or tempered shall have hardness not higher than 99 HRB, or equivalent (see 8.2). Hardness shall be determined in accordance with ASTM A370.

3.3 Properties

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

3.3.1 Macrostructure

Visual examination of full cross-sections from billets, or tube rounds, etched in hot hydrochloric acid in accordance with ASTM E381, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E381, shown in Table 2.

Table 2 - Macrostructure limits

Section Size Square Inches	Section Size Square Centimeters	Macrographs
Up to 36, incl	Up to 232, incl	S2 - R1 - C2
Over 36 to 133, incl	Over 232 to 858, incl	S2 - R2 - C3
Over 133	Over 858	Note 1

NOTE 1: Limits for larger sizes shall be agreed upon by purchaser and producer. The purchaser shall have written approval of the agreement from the cognizant organization.

3.3.1.1 Macrostructure examination is not required for tubing that is produced directly from ingots or blooms unless specified by the purchaser, in which case the purchaser shall specify standards to be used.

3.3.2 Average Grain Size of Tubing

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 8.8):

3.3.2.2.1 A total aluminum content of 0.020 to 0.050%.

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

3.3.2.2.3 A vanadium content of 0.02 to 0.08%.

3.3.2.2.4 A columbium content of 0.02 to 0.05%.

3.3.3 Hardenability

Shall be J 5/16 inch (7.9 mm) = 35 HRC minimum and J 8/16 inch (12.7 mm) = 28 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A255, except that the steel shall be normalized at 1650 °F ± 10 °F (899 °C ± 6 °C) and the test specimen austenitized at 1600 °F ± 10 °F (871 °C ± 6 °C). Cast specimen does not need to be normalized.

3.3.4 Decarburization

3.3.4.1 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.

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

3.3.4.3 Where 3.3.4.1 or 3.3.4.2 are not applicable, decarburization of tubing shall not be greater than shown in Table 3.

Table 3A - Maximum decarburization, inch/pound units

Nominal Wall Thickness Inch	Total Depth of Decarburization, Inch ID	Total Depth of Decarburization, Inch OD
Up to 0.109, incl	0.008	0.015
Over 0.109 to 0.203, incl	0.010	0.020
Over 0.203 to 0.400, incl	0.012	0.025
Over 0.400 to 0.600, incl	0.015	0.030
Over 0.600 to 1.000, incl	0.017	0.035
Over 1.000	0.020	0.040

Table 3B - Maximum decarburization, SI units

Nominal Wall Thickness Millimeters	Total Depth of Decarburization, Millimeter ID	Total Depth of Decarburization, Millimeters OD
Up to 2.77, incl	0.20	0.38
Over 2.77 to 5.16, incl	0.25	0.51
Over 5.16 to 10.16, incl	0.30	0.64
Over 10.16 to 15.24, incl	0.38	0.76
Over 15.24 to 25.40, incl	0.43	0.89
Over 25.40	0.51	1.02

3.3.4.4 Decarburization shall be evaluated by one of the two methods of 3.3.4.4.1 or 3.3.4.4.2.

3.3.4.4.1 Metallographic Method

A cross section taken perpendicular to the surface shall be prepared, etched, and visually examined metallographically at a magnification not to exceed 100X. Optical indications of decarburiztion shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.3.4.4.2 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E384, at a magnification not exceeding 100X, 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.

3.3.4.5 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.

3.3.4.6 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, sound, and free from foreign materials and from imperfections detrimental to usage of the tubing.

3.4.1 Steel shall be aircraft-quality conforming to AMS2301.

3.4.2 Mechanical tubing shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

3.5 Tolerances

Shall conform to all applicable requirements of AMS2253.

3.6 Exceptions

Any exceptions shall be authorized by 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 tubing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

All technical requirements are acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (3.3.2.2) are not present, the ASTM E112 grain size test (3.3.2.1) shall be conducted on each lot.

4.2.2 Periodic Tests

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

4.3 Sampling and Testing

Shall be in accordance with AMS2370.

4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing the results of tests for composition, macrostructure, hardenability, and frequency-severity cleanliness rating of each heat, and for hardness and 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, AMS6281K, size, and quantity. If the grain size requirement of 3.3.2 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 has exceptions authorized by purchaser taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS6281K(EXC) because of the following exceptions:" and the specific exceptions shall be listed (see 5.2).