SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS6381 REV. H

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Superseding AMS6381G

Steel, Mechanical Tubing
0.95Cr - 0.20Mo (0.38 - 0.43C) (SAE 4140)
(Composition similar to UNS G41400)

RATIONALE

AMS6381H results from a Five Year Review and update of this specification

1. SCOPE

1.1 Form

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

1.2 Application

This tubing has been used typically for parts, 0.500 inch (12.70 mm) and under in nominal wall thickness at time of heat treatment requiring a through-hardening steel capable of developing hardness as high as 50 HRC when properly hardened and tempered and also for parts of greater wall thickness but 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 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

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

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http://www.sae.org/technical/standards/AMS6381H

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

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

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 A 255 Determining Hardenability of Steel

ASTM E 18 Rockwell Hardness of Metallic Materials

ASTM E 112 Determining Average Grain Size

ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E 381 Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

ASTM E 384 Knoop and Vickers Hardness of Materials

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 – COMPOSITION

Element	Min	Max
Carbon	0.38	0.43
Manganese	0.75	1.00
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

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3.1.1 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 E 18.

3.3 Properties

Tubing shall conform to the following requirements.

3.3.1 Macrostructure

Visual examination of transverse full cross-sections from blooms or tube rounds (not hollows), etched in hot hydrochloric acid in accordance with ASTM E 381, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than macrographs of ASTM E 381 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 vendor. The purchaser shall have written approval of the agreement from the cognizant engineering organization.

3.3.2 Average Grain Size

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112.

3.3.3 Hardenability of Each Heat

Shall be J 6/16 inch (9.5 mm) = 50 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at 1700 °F ± 10 (927 °C ± 6) and the test specimen austenitized at 1550 °F ± 10 (843 °C ± 6).

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.

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

3.3.4.3 Decarburization of tubing to which 3.3.4.1 or 3.3.4.2 is not applicable shall be not greater than shown in Table 3.

TABLE 3A - MAXIMUM DEPTH OF DECARBURIZATION, INCH/POUND UNITS

Nominal Wall Thickness Inches	Total Depth ID Inch	Total Depth OD Inch
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

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TABLE 3B - MAXIMUM DEPTH OF DECARBURIZATION, SI UNITS

Nominal Wall Thickness Millimeters	Total Depth ID Millimeter	Total Depth OD Millimeter
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 measured by the metallographic method, by the HR30N scale hardness testing method, or by a traverse method using microhardness testing in accordance with ASTM E 384. The hardness method(s) shall be conducted on a hardened but untempered specimen 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 on the adjacent surface. In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.

3.3.4.4.1 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 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.4 Quality

Tubing, as received by 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 ordered hot rolled or cold drawn, or ground, turned, or polished, shall after removal of the standard stock removal allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the machined, ground, turned, or polished surface.

3.5 Tolerances

Shall conform to all applicable requirements of AMS2253.

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 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

All technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling and Testing

In accordance with AMS2370.

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