AEROSPACE MATERIAL SPECIFICATION

AMS6479™	REV. D

Issued 1996-08
Revised 2015-10

Superseding AMS6479C

Steel, Bars, Forgings, and Tubing
1.45Cr (0.93-1.05C) (SAE 52100)
Special Aircraft-Quality Cleanliness
(Composition similar to UNS G52986)

RATIONALE

AMS6479D results from a Five Year Review and update of this specification that revises decarburization requirements and reporting.

1. SCOPE

1.1 Form

This specification covers a special aircraft-quality, low-alloy steel in the form of bars, forgings, mechanical tubing, and forging stock.

1.2 Application

These products have been used typically for parts requiring a through-hardening steel, usually with hardness of approximately 60 HRC in section thicknesses 0.50 inch (12.7 mm) and under, and subject to very rigid inspection standards, 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.

AMS2251 Tolerances, Low-Alloy Steel Bars

AMS2253 Tolerances, Carbon and Alloy Steel Tubing

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

AMS2304 Steel Cleanliness, Special 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**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS6479D

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

AMS2372 Quality Assurance Sampling and Testing Carbon and Low-Alloy Steel Forgings

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

AMS2808 Identification Forgings

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 A370 Mechanical Testing of Steel Products

ASTM E45 Determining the Inclusion Content of Steel

ASTM E350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E381 Macrotech Testing Steel Bars, Billets, Blooms, and Forgings

ASTM E384 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 E350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

Table 1 - Composition

Element	min	max
Carbon	0.93	1. 05
Manganese	0.25	0.45
Silicon	0.15	0.35
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	1.30	1.60
Nickel	--	0.15
Molybdenum	--	0.08
Copper	--	0.15
Titanium	--	0.0030 (30 ppm)
Oxygen	--	0.0015 (15 ppm)
Calcium	--	0.0010 (10 ppm)

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Melting Practice

Steel shall be melted using ladle furnace melting and refining practice or other steel making practices acceptable to purchaser.

3.3 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370.

3.3.1 Bars

Bar shall not be cut from plate (also see 4.4.2).

3.3.1.1 Bars 0.500 Inch (12.70 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides

Cold finished, with microstructure of spheroidized cementite in a ferrite matrix, having tensile strength not higher than 120 ksi (827 MPa) or equivalent hardness (see 8.2).

3.3.1.2 Bars Over 0.500 Inch (12.70 mm) in Nominal Diameter or Least Distance Between Parallel Sides

Hot finished and annealed, unless otherwise ordered, with microstructure of spheroidized cementite in a ferrite matrix, having hardness not higher than 207 HB, or equivalent (see 8.3). Bars ordered cold finished may have hardness as high as 248 HB, or equivalent (see 8.3).

3.3.2 Forgings

As ordered.

3.3.3 Mechanical Tubing

Cold finished, unless otherwise ordered, with microstructure of spheroidized cementite in a ferrite matrix, having hardness no higher than 24 HRC or equivalent (see 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 95 HRB, or equivalent (see 8.3).

3.3.4 Forging Stock

As ordered by the forging manufacturer.

3.4 Properties

The product shall conform to the following requirements; hardness testing shall be performed in accordance with ASTM A370.

3.4.1 Macrostructure

Visual examination of transverse full cross-sections from bars, billets, tube rounds, and forging stock, 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 ratings S1, R1, and C1 for plate 1 and acceptable macrographs of plates 2 or 3 or as agreed upon by purchaser and producer.

3.4.2 Micro-Inclusion Rating

No specimen shall exceed the limits shown in Table 2, determined in accordance with ASTM E45, Method D.

Table 2 - Micro-inclusion rating limits

	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Worst Field Frequency, Maximum	a	1	a	1	a	1	5	3
Total Rateable Fields, Frequency, Maximum	b	1	b	1	b	1	c	3

a - Combined A + B + C, no more than 3 fields
b - Combined A + B + C, not more than 8 fields
c - Any number of lower rateable D-type thin fields per specimen is permissible.

3.4.2.1 Thickness of D-type heavy shall not exceed 0.0005 inch (12.7 µm).

3.4.2.2 A rateable field is defined as one that has a type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with ASTM E45.

3.4.3 Response to Heat Treatment of Bars, Forgings, and Tubing

Specimens as in 4.3.3, protected by suitable means or treated in a neutral atmosphere or neutral salt to minimize scaling and prevent either carburization or decarburization, shall have substantially uniform hardness not lower than 63 HRC at any point below any permissible decarburization after being heated to 1525 °F ± 10 °F (829 °C ± 6 °C), held at heat for 20 minutes ± 2 minutes, and quenched in commercial paraffin oil (90 to 110 SUS at 100 °F (38 °C)) at room temperature.

3.4.4 Decarburization

3.4.4.1 Bars and 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.

3.4.4.2 Allowable decarburization of bars, billets, and tube rounds ordered for redrawing or forging or to specified microstructural requirements other than spheroidized cementite in a ferrite matrix shall be as agreed upon by purchaser and producer.

3.4.4.3 Decarburization of bars that 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table 3.

3.4.4.4 Decarburization on the ID and OD of tubes that 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than that shown in Table 3.

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

Nominal Diameter or Least Distance Between Parallel Sides Inches	Total Depth of Decarburization Bars Hot Finished Inch	Total Depth of Decarburization Bars Annealed Inch	Total Depth of Decarburization Bars Cold Finished Inch	Total Depth of Decarburization Tubes Annealed Inch	Total Depth of Decarburization Tubes Cold Finished Inch
Up to 0.250, incl	0.005	0.015	0.003	0.012	0.010
Over 0.250 to 0.500, incl	0.006	0.015	0.004	0.012	0.010
Over 0.500 to 0.750, incl	0.008	0.015	0.006	0.012	0.010
Over 0.750 to 1.000, incl	0.010	0.015	0.008	0.012	0.010
Over 1.000 to 2.000, incl	0.017	0.022	0.015	0.020	0.014
Over 2.000 to 3.000, incl	0.025	0.030	0.025	0.030	0.019
Over 3.000 to 4.000, incl	0.035	0.045	0.035	0.035	0.024
Over 4.000 to 5.000, incl	0.055	0.065	0.055	0.040	0.028

Table 3B - Maximum total depth of decarburization limits, SI units

Nominal Diameter or Least Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Bars Hot Finished Millimeter	Total Depth of Decarburization Bars Annealed Millimeter	Total Depth of Decarburization Bars Cold Finished Millimeter	Total Depth of Decarburization Tubes Annealed Millimeter	Total Depth of Decarburization Tubes Cold Finished Millimeter
Up to 6.35, incl	0.13	0.38	0.08	0.30	0.25
Over 6.35 to 12.70, incl	0.15	0.38	0.10	0.30	0.25
Over 12.70 to 19.05, incl	0.20	0.38	0.15	0.30	0.25
Over 19.05 to 25.40, incl	0.25	0.38	0.20	0.30	0.25
Over 25.40 to 50.80, incl	0.43	0.56	0.38	0.51	0.36
Over 50.80 to 76.20, incl	0.64	0.76	0.64	0.76	0.48
Over 76.20 to 101.60, incl	0.89	1.14	0.89	0.89	0.61
Over 101.60 to 127.00, incl	1.40	1.65	1.40	1.02	0.71

3.4.4.5 Decarburization shall be evaluated by one of the methods of 3.4.4.6 or 3.4.4.7,

3.4.4.6 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. The product shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.4.4.7 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microhardness 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. Tempering is generally not recommended, but if tempered, the tempering temperature shall be not higher than 300 °F (149 °C). 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.

3.4.4.8 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.

3.4.4.9 In the case of dispute, the total depth of decarburization determined using the microhardness traverse method shall govern.

3.5 Quality

The product, 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 product.

3.5.1 Steel shall be special aircraft-quality conforming to AMS2304.

3.5.2 Bars and mechanical tubing ordered hot rolled or cold drawn, 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.

3.5.3 Grain flow of die forgings, except in areas that contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.6 Tolerances

3.6.1 Bars

In accordance with AMS2251.

3.6.2 Mechanical Tubing

In accordance with AMS2253.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product 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), condition (3.3), macrostructure (3.4.1), micro-inclusion rating (3.4.2), response to heat treatment (3.4.3), decarburization (3.4.4), frequency-severity cleanliness rating (3.5.1), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Grain flow of die forgings (3.5.3) 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 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.

4.3.2 Forgings

In accordance with AMS2372.