SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 6479B

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Superseding AMS 6479A

Steel, Bars, Forgings, and Tubing
1.45Cr (0.98 - 1.10C) (SAE 52100)
Special Aircraft-Quality Cleanliness

(Composition similar to UNS G52986)

RATIONALE

AMS 6479B results from a Five Year Review and update of this specification.

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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 724-776-4970 (outside USA), www.sae.org.

AMS 2251	Tolerances, Low-Alloy Steel Bars
AMS 2253	Tolerances, Carbon and Alloy Steel Tubing
AMS 2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2304	Steel Cleanliness, Special Aircraft-Quality Magnetic Particle Inspection Procedure
AMS 2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock
AMS 2372	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings
AMS 2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys

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AMS 2808 Identification, Forgings

AS1182 Standard Machining 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 370 Mechanical Testing of Steel Products
ASTM E 45 Determining the Inclusion Content of Steel
ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E 381 Macrotech Testing Steel Bars, Billets, Blooms, and Forgings
ASTM E 384 Microindentation 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	0.98	1.10
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)

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3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS 2259.

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 A 370.

3.3.1 Bars

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 specified, with microstructure of spheroidized cementite in a ferrite matrix, having hardness no higher that 248 HB or equivalent (See 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 207 HB, 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 A 370.

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 E 381, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E 381 ratings S1, R1, and C1 for plate 1 and acceptable macrographs of plates 2 or 3 or as agreed upon by purchaser and vendor.

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3.4.2 Micro-Inclusion Rating

No specimen shall exceed the limits shown in Table 2, determined in accordance with ASTM E 45, 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 which has a type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with the Jernkontoret chart, Plate I-r, ASTM E 45 (See 8.4).

3.4.3 Response to Heat Treatment

Specimens as in 4.3.3, protected by suitable means or treated in a neutral atmosphere 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 (829 °C ± 6), held at heat for 20 minutes ± 2, and quenched in commercial paraffin oil [100 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.

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 vendor.

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

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TABLE 3A - MAXIMUM DECARBURIZATION, INCH/POUND UNITS

Nominal Thickness or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inch
Up to 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.020
Over 1.000 to 1.500, incl	0.025
Over 1.500 to 2.000, incl	0.030
Over 2.000 to 2.500, incl	0.035
Over 2.500 to 3.000, incl	0.040
Over 3.000	0.045

TABLE 3B - MAXIMUM DECARBURIZATION, SI UNITS

Nominal Thickness or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.51
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 76.20, incl	1.02
Over 76.20	1.14

3.4.4.4 Decarburization on the ID and OD of all tubing to which 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than 0.025 inch (0.64 mm).

3.4.4.5 Decarburization shall be measured by the metallographic method, by the HR30N scale hardness test 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.

3.4.4.5.1 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.

3.5 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 AMS 2304.

3.5.2 Bars and mechanical tubing ordered hot rolled or cold drawn, ground, turned, or polished shall, after removal of the standard machining allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the ground, turned, or polished surface.

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

3.6 Tolerances

Shall be as follows:

3.6.1 Bars

In accordance with AMS 2251.

3.6.2 Mechanical Tubing

In accordance with AMS 2253.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the product 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 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 vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be as follows:

4.3.1 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS 2370.

4.3.2 Forgings

In accordance with AMS 2372.

4.3.3 Samples for response to heat treatment (3.4.3) shall be as follows:

4.3.3.1 Specimens from bars shall be full cross-sections of the bar, except length and width need not exceed 1.5 inches (38 mm) respectively, ground on both faces normal to the axis so that length is 0.50 inch ± 0.010 (12.7 mm ± 0.25).

4.3.3.2 Specimens from mechanical tubing shall be full cross-sections of the tubing, shall have wall thickness not over 0.625 inch (15.88 mm) with wall thicknesses over 0.625 inch (15.88 mm) being turned to 0.625 inch ± 0.010 (15.88 mm ± 0.25), and shall be ground on both faces so that length is 0.50 inch ± 0.010 (12.7 mm ± 0.25).

4.4 Reports

The vendor of the product shall furnish with each shipment a report showing the results of tests for composition, macrostructure, inclusion rating, and frequency-severity cleanliness rating of each heat and for the condition and response to heat treatment of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 6479B, product form, size, and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

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