SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS6423 REV. F

Issued 1958-08
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Revised 2010-04

Superseding AMS6423E

Steel Bars, Forgings, and Tubing
0.92Cr - 0.75Ni - 0.52Mo - 0.003B - 0.04V (0.40 - 0.46C) (Modified 96BV40)

(Composition similar to UNS K24336)

RATIONALE

AMS6423F 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 bars, forgings, mechanical tubing, and forging stock.

1.2 Application

These products have been used typically for parts, 3.5 inches (89 mm) and under in nominal thickness at time of heat treatment, requiring a through-hardening steel capable of developing minimum hardness of 30 HRC when properly hardened and tempered and also for parts of greater 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.

AMS2251	Tolerances, Low-Alloy Steel Bars
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
AMS2310	Qualification Sampling and Testing of Steels for Transverse Tensile Properties
AMS2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS6423F

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 A 255 Determining Hardability of Steel
ASTM A 370 Mechanical Testing of Steel Products
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 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	0.40	0.46
Manganese	0.75	1.00
Silicon	0.50	0.80
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.80	1.05
Nickel	0.60	0.90
Molybdenum	0.45	0.60
Boron	0.0005	0.005
Vanadium	0.01	0.06
Copper	--	0.35

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A 370:

3.2.1 Bars

Bar shall not be cut from plate, larger bar or another product form.

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

Annealed and cold finished having tensile strength not higher than 135 000 psi (931 MPa).

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

Hot finished and annealed unless otherwise ordered, having hardness not higher than 241 HB, or equivalent (See 8.2). Bars ordered cold finished may have hardness as high as 269 HB, or equivalent (See 8.2).

3.2.2 Forgings

Normalized and tempered having hardness not higher than 302 HB, or equivalent (See 8.2).

3.2.3 Mechanical Tubing

Annealed and cold finished unless otherwise ordered, having hardness not higher than 30 HRC, or equivalent (See 8.2). Tubing ordered hot finished and annealed shall have hardness not higher than 25 HRC, or equivalent (See 8.2).

3.2.4 Forging Stock

As ordered by the forging manufacturer.

3.3 Properties

The product shall conform to the following requirements; tensile and hardness testing shall be performed in accordance with ASTM A 370:

3.3.1 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 shown in Table 2.

TABLE 2 - MACROSTRUCTURE LIMITS

Cross-Sectional Area Square Inches	Cross-Sectional Area Square Centimeters	Macrographs
Up to 36, incl	Up to 232, incl	S2 - R1 - C2
Over 36 to 100, incl	Over 232 to 645, incl	S2 - R2 - C3

3.3.2 Average Grain Size of bars, forgings, and mechanical tubing

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

3.3.3 Hardenability of each heat

Shall be J20/16 inch (32 mm) = 55 HRC minimum and J32/16 inch (51 mm) = 53 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at 1600 °F ± 10 (871 °C ± 6) and the test specimen austenitized at 1550 °F ± 10 (843 °C ± 6).

3.3.4 Decarburization

3.3.4.1 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 4.

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

3.3.4.3 Decarburization of bars 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 DECARBURIZATION, BARS, INCH/POUND UNITS

Nominal Diameter or Distance Between Parallel Sides Inches					Total Depth of Decarburization Inch
	Up	to	0.375,	incl	0.010
Over	0.375	to	0.500,	incl	0.012
Over	0.500	to	0.625,	incl	0.014
Over	0.625	to	1.000,	incl	0.017
Over	1.000	to	1.500,	incl	0.020
Over	1.500	to	2.000,	incl	0.025
Over	2.000	to	2.500,	incl	0.030
Over	2.500	to	3.000,	incl	0.035
Over	3.000	to	4.000,	incl	0.045

TABLE 3B - MAXIMUM DECARBURIZATION, BARS, SI UNITS

Nominal Diameter or Distance Between Parallel Sides Millimeters					Total Depth of Decarburization Millimeters
	Up	to	9.52,	incl	0.25
Over	9.52	to	12.70,	incl	0.30
Over	12.70	to	15.88,	incl	0.36
Over	15.88	to	25.40,	incl	0.43
Over	25.40	to	38.10,	incl	0.51
Over	38.10	to	50.80,	incl	0.64
Over	50.80	to	63.50,	incl	0.76
Over	63.50	to	76.20,	incl	0.89
Over	76.20	to	101.60,	incl	1.14

3.3.4.4 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 4.

TABLE 4A - MAXIMUM DECARBURIZATION, TUBES, INCH/POUND UNITS

Nominal Wall Thickness Inches					Total Depth of Decarburization, Inch	
					ID	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 4B - MAXIMUM DECARBURIZATION, TUBES, SI UNITS

Nominal Wall Thickness Millimeters					Total Depth of Decarburization, Millimeters	
					ID	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

3.3.4.5 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.

3.3.4.5.1 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.

3.3.5 Transverse Tensile Properties

Specimens, selected and tested in accordance with AMS2310, shall have tensile strength not lower than 280 000 psi (1931 MPa) and reduction of area not lower than 5% after being normalized by heating to 1600 °F ± 10 (871 °C ± 6), holding at heat for not less than 60 minutes, and cooling in air; hardened by heating to 1550 °F ± 10 (843 °C ± 6), holding at heat for 60 minutes ± 10, and quenching in oil, and tempered by heating to a temperature within the range 450 to 550 °F (232 to 288 °C), holding at the selected temperature within ±10 °F (±6 °C) for 2 to 3 hours, and cooling in air.

3.4 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.

3.4.1 Steel shall be aircraft-quality conforming to AMS2301.

3.4.2 Bars and 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 ground, turned, or polished surface.

3.4.3 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.

3.5 Tolerances

3.5.1 Bars

Shall be in accordance with AMS2251.

3.5.2 Mechanical Tubing

Shall be in accordance with AMS2253.

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 (3.2), macrostructure (3.3.1), average grain size (3.3.2), hardenability (3.3.3), decarburization (3.3.4), transverse tensile properties (3.3.5), frequency-severity cleanliness (3.4.1), and tolerances (3.5) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Grain flow of die forgings (3.4.3) is a periodic test and shall be performed at a frequency selected by the vendor unless a frequency of testing is specified by purchaser.

4.3 Sampling and Testing

4.3.1 Bars, Forging Stock, and Mechanical Tubing

Shall be in accordance with AMS2370.

4.3.2 Forgings

Shall be in accordance with AMS2372.