AEROSPACE MATERIAL SPECIFICATION

AMS6324	REV. J

Issued 1945-05
Reaffirmed 2000-09
Revised 2014-08

Superseding AMS6324H

Steel Bars, Forgings, and Tubing
0.65Cr - 0.70Ni - 0.25Mo (0.38 - 0.43C) (8740 Modified)
(Composition similar to UNS K11640)

RATIONALE

AMS6324J results from a Five Year Review and update of this specification that revises the title, macrostructure, decarburization and reporting requirements.

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, 0.750 inch (19.05 mm) and under in section 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 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

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/AMS6324J

AMS2301 Steel Cleanliness, Aircraft-Quality, Magnetic Particle Inspection

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 Internatonal, 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 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 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	0.55	0.75
Nickel	0.55	0.85
Molybdenum	0.20	0.30
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

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

Cold finished having tensile strength not higher than 130 ksi (896 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 229 HB, or equivalent (See 8.2). Bars ordered cold finished may have hardness as high as 248 HB, or equivalent (See 8.2).

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

3.2.2 Forgings

As ordered.

3.2.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 25 HRC, or equivalent (See 8.2). Tubing ordered hot finished and annealed shall have hardness not higher than 99 HRB, 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; 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-Section Area Square Inches	Cross-Section Area 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 producer and purchaser. The purchaser shall have written approval of the agreement from the cognizant engineering organization.

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 J7/16 inch (11 mm) = 50 HRC minimum and J10/16 inch (16 mm) = 45 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 1525 °F ± 10 (829 °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 TOTAL DEPTH OF DECARBURIZATION, 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	0.040

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

Nominal Wall Thickness Inches					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 4B - MAXIMUM TOTAL DEPTH OF 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

3.3.4.5 Decarburization shall be measured by the metallographic method or by a traverse method using microhardness testing in accordance with ASTM E 384. The microhardness method 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 the microhardness method, is defined as the perpendicular distance from the surface to the depth under that surface where 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 inches (1.65 mm) or less.

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 machined, 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), 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, Mechanical Tubing, and Forging Stock:

Shall be in accordance with AMS2370.

4.3.2 Forgings

Shall be in accordance with AMS2372.

4.4 Reports

4.4.1 The producer of bars, forgings, and mechanical tubing shall furnish with each shipment a report showing the producer identity and country where the metal was melted (e. g., final melt in the case of metal processed by multiple melting operations) and the results of tests for composition, macrostructure, hardenability, and frequency-severity cleanliness rating of each heat, and for 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, AMS6324J, product form and size (and/or part number, if applicable) and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.4.2 Report the nominal metallurgically worked cross sectional size and the cut size, if different (Also see 3.2.1.3).

4.4.3 The vendor of forging stock shall furnish with each shipment a report showing the producer identity and country where the metal was melted (e. g., final melt in the case of metal processed by multiple melting operations) and the results of tests for composition macrostructure, hardenability, and frequency-severity cleanliness rating of each heat. This report shall include the purchase order number, heat number, AMS6324J, size and quantity.

4.5 Resampling and Retesting

4.5.1 Bars, Mechanical Tubing, and Forging Stock

Shall be in accordance with AMS2370.