

AEROSPACE MATERIAL SPECIFICATION

Issued AUG 1958
Reaffirmed OCT 2000
Revised JUL 2004
Superseding AMS 6423D

Steel Bars, Forgings, and Tubing
0.92Cr - 0.75Ni - 0.52Mo - 0.003B - 0.04V (0.40 - 0.46C)
(Composition similar to UNS K24336)

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:

Primarily 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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or 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 2301	Steel Cleanliness, Aircraft Quality, Magnetic Particle Inspection Procedure
AMS 2310	Qualification Sampling of Steels, Transverse Tensile Properties
AMS 2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

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2.1 (Continued):

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
AMS 2808	Identification, Forgings
AS1182	Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Products

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or 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, Inspection, and Rating Steel Products, Comprising 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 AMS 2259.

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: 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: Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112 (See 8.3).

3.3.3 Hardenability: Shall be J20/16 inch (32 mm) = 55 HRC minimum and J32/16 inch (51 mm) = 53 HRC minimum (See 8.4), 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		Total Depth of Decarburization
Inches		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		Total Depth of Decarburization
Millimeters		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 AMS 2310, 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 $\pm$ 10 (871 °C $\pm$ 6), holding at heat for not less than 60 minutes, and cooling in air; hardened by heating to 1550 °F $\pm$ 10 (843 °C $\pm$ 6), holding at heat for 60 minutes $\pm$ 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 $\pm$ 10 °F ($\pm$ 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 AMS 2301.

3.4.2 Bars and tubing ordered ground, turned, or polished shall be free from seams, laps, tears, and cracks open to the ground, turned, or polished surfaces.

3.4.3 Product ordered to surface conditions other than ground, turned or polished shall, after removal of the standard machining allowance in accordance with AS 1182, be free from seams, laps, tears, cracks and other defects exposed to the machined surface.

3.4.4 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.

3.5 Tolerances:

Shall conform to all applicable requirements of the following:

3.5.1 Bars: In accordance with AMS 2251.

3.5.2 Mechanical Tubing: In accordance with AMS 2253.

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:

Shall be in accordance with the following:

4.3.1 Bars, Forging Stock, and Mechanical Tubing: In accordance with AMS 2370.

4.3.2 Forgings: In accordance with AMS 2372.

4.4 Reports:

4.4.1 The vendor of bars, forgings, and mechanical tubing shall furnish with each shipment a report showing the results of tests for composition, macrostructure, hardenability, and frequency-severity cleanliness rating of each heat and for the average grain size and tensile properties 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, AMS 6423E, size, 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 The vendor of forging stock shall furnish with each shipment a report showing the results of tests for composition and frequency-severity cleanliness rating of each heat. This report shall include the purchase order number, heat number, AMS 6423E, size and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with the following:

4.5.1 Bars, Forging Stock and Mechanical Tubing: In accordance with AMS 2370.

4.5.2 Forgings: In accordance with AMS 2372.

5. PREPARATION FOR DELIVERY:

5.1 Sizes:

Except when exact lengths or multiples of exact lengths are ordered straight bars and tubing will be acceptable in mill lengths of 6 to 20 feet (1.8 to 6.1 m) but more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).