

# AEROSPACE MATERIAL SPECIFICATION



AMS 6423D

Issued AUG 1958  
Revised JAN 1990  
Reaffirmed OCT 2000

Superseding AMS 6423C

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

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.

## 2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be as specified in AMS 2350.

### 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

#### 2.1.1 Aerospace Material Specifications:

AMS 2251	Tolerances, Low-Alloy Steel Bars
MAM 2251	Tolerances, Metric, Low-Alloy Steel Bars
AMS 2253	Tolerances, Carbon and Alloy Steel Tubing
MAM 2253	Tolerances, Metric, Carbon and Alloy Steel Tubing
AMS 2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2301	Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure

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## 2.1.1 (Continued):

AMS 2310	Qualification Sampling of Steels, Transverse Tensile Properties
AMS 2350	Standards and Test Methods
AMS 2370	Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock
AMS 2372	Quality Assurance Sampling of Carbon and Low-Alloy Steels, Forgings and Forging Stock
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

## 2.1.2 Aerospace Standards:

AS1182	Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Products
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## 2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM A 255	End-Quench Test for 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

## 2.3 U.S. Government Publications:

Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

## 2.3.1 Military Standards:

MIL-STD-163	Steel Mills Products, Preparation for Shipment and Storage
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### 3. TECHNICAL REQUIREMENTS:

#### 3.1 Composition:

Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	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 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 Distance Between Parallel Sides: Hot finished and annealed having hardness not higher than 241 HB, or equivalent, except that bars ordered cold finished may have hardness as high as 269 HB, or equivalent.

3.2.2 Forgings: Normalized and tempered having hardness not higher than 302 HB, or equivalent.

3.2.3 Mechanical Tubing: Annealed and cold finished having hardness not higher than 30 HRC, or equivalent, except that tubing ordered hot finished and annealed shall have hardness not higher than 25 HRC, or equivalent.

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 sections as in 4.3.3 from bars, billets, tube rounds or tubes, and forging stock, etched in accordance with ASTM E 381, shall show no pipe or cracks. Except as specified in 3.3.1.1, porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM E 381:

Section Size			Macrographs
Square Inches	Square Centimeters		
Up to 36, incl	Up to 232, incl		S2 - R1 - C2
Over 36 to 100, incl	Over 232 to 645, incl		S2 - R2 - C3
Over 100	Over 645		As agreed upon

- 3.3.1.1 If tubes are produced directly from ingots or large blooms, transverse sections may be taken from tubes rather than tube rounds. Macrostructure standards for such tubes shall be as agreed upon by purchaser and vendor.
- 3.3.2 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E 112.
- 3.3.3 Hardenability: Shall be J55=20 minimum and J53=32 minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at  $1600^{\circ}\text{F} \pm 10$  ( $871^{\circ}\text{C} \pm 6$ ) and the test specimen autenitized at  $1550^{\circ}\text{F} \pm 10$  ( $843^{\circ}\text{C} \pm 6$ ) and the test is not required on a product which will not yield a suitable specimen but the steel from which the product is made shall conform to the hardenability specified.
- 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 II
- 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 I.

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	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 I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Depth of Decarburization Millimetres
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

3.3.4.3.1 Limits for depth of decarburization of bars over 4.000 inches (101.60 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.

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 II.

TABLE II

Nominal Wall Thickness Inches	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 II (SI)

Nominal Wall Thickness Millimetres	Depth of Decarburization Millimetres	
	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 microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on 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 or lack of decarburization thereon.

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 ± 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° - 550°F (232° - 288°C), holding at the selected temperature within ±10°F (±6°C) for 2 - 3 hours, and cooling in air.

#### 3.4 Quality:

3.4.1 Steel shall be aircraft quality conforming to AMS 2301.

3.4.2 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.:

3.4.2.1 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.

3.4.2.2 Product ordered to surface conditions other than ground, turned, or polished shall, after removal of the standard machining allowance, be free from seams, laps, tears, cracks, and other defects exposed to the machined surfaces. Standard machining allowance shall be in accordance with AS1182.

3.4.3 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 re-entrant grain flow.

#### 3.5 Sizes:

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

#### 3.6 Tolerances:

Shall conform to all applicable requirements of the following:

3.6.1 Bars: AMS 2251 or MAM 2251.

3.6.2 Mechanical Tubing: AMS 2253 or MAM 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 performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

##### 4.2 Classification of Tests:

Tests for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

##### 4.3 Sampling and Testing:

Shall be in accordance with the following; the number of specimens to be sampled shall be the minimum number of specimens tested:

4.3.1 Bars and Mechanical Tubing: AMS 2370.

4.3.2 Forgings and Forging Stock: AMS 2372.

4.3.3 Samples for macrostructure rating (3.3.1) shall be full cross-sectional specimens obtained from the finished billet or suitable rerolled product representing the top and bottom of at least the first, middle, and last usable ingot of each heat.

##### 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 chemical composition, macrostructure, grain size, hardenability, and frequency-severity cleanliness rating of each heat and stating that the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 6423D, size, and quantity. If forgings are supplied, the part number and 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 chemical composition and frequency-severity cleanliness rating of each heat. This report shall include the purchase order number, heat number, and 6423D, size, and quantity.

##### 4.5 Resampling and Retesting:

Shall be in accordance with the following:

4.5.1 Bars and Mechanical Tubing: AMS 2370.