SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6472D

Issued FEB 1965
Revised SEP 2001
Reaffirmed FEB 2006

Superseding AMS 6472C

Steel, Bars and Forgings, Nitriding
1.6Cr - 0.35Mo - 1.1Al (0.38 - 0.43C)
Hardened and Tempered, 112 ksi (772 MPa) Tensile Strength

(Composition similar to UNS K24065)

1. SCOPE:

1.1 Form:

This specification covers an aircraft-quality, low-alloy steel in the form of heat treated bars and forgings, and of forging stock.

1.2 Application:

This material has been used typically for nitrided parts requiring high surface hardness, resistance to heat, and less distortion than parts made from steel requiring quenching to case harden, but usage is not limited to such applications. This steel may be case hardened in dissociated ammonia gas to give a minimum case hardness of 900 HV.

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 canceled 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.

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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1 (Continued):

MAM 2301	Steel Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
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 2750	Pyrometry
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 Bars and Mechanical Tubing

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor, West Conshohocken, PA 19428-2959.

ASTM A 370	Mechanical Testing of Steel Products
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	0.38	0.43
Manganese	0.50	0.80
Silicon	0.20	0.40
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	1.40	1.80
Molybdenum	0.30	0.40
Aluminum	0.95	1.30
Nickel	--	0.25
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:

3.2.1 Bars and Forgings: Hardened and tempered.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment:

Bars and forgings shall be hardened by quenching from 1700 °F ± 25 (927 °C ± 14) and tempered to meet the tensile property requirements of 3.4.2. Pyrometry shall be in accordance with AMS 2750.

3.4 Properties:

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

3.4.1 Macrostructure: Visual examination of transverse full cross sections from bars 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

Section Size Square Inches	Section Size 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

3.4.2 Tensile Properties: Shall be as shown in Table 3.

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	112 ksi (772 MPa)
Yield Strength at 0.2% Offset	90 ksi (620 MPa)
Elongation in 4D	16%
Reduction of Area	50%

3.4.3 Hardness: Shall be as shown in Table 4.

TABLE 4 - Hardness

Nominal Diameter or Least Section Thickness Inches	Nominal Diameter or Least Section Thickness Millimeters	Hardness Brinell
Up to 3.125, incl	Up to 79.38, incl	241 to 285
Over 3.125 to 6.000, incl	Over 79.38 to 152.40, incl	229 to 285

3.4.3.1 Brinell hardness or equivalent (See 8.2), shall be determined midway between surface and center of bars.

3.4.4 Decarburization:

3.4.4.1 Bars 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 and billets ordered for redrawing or forging or to specified microstructural requirements 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 5.

TABLE 5A - Maximum Decarburization Limits, Inch/Pound Units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inch
Up to 0.500, incl	0.030
Over 0.500 to 1.000, incl	0.035
Over 1.000 to 1.500, incl	0.040
Over 1.500 to 2.000, incl	0.050
Over 2.000 to 2.500, incl	0.060
Over 2.500 to 3.000, incl	0.070

TABLE 5B - Maximum Decarburization Limits, SI Units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.76
Over 12.70 to 25.40, incl	0.89
Over 25.40 to 38.10, incl	1.02
Over 38.10 to 50.80, incl	1.27
Over 50.80 to 63.50, incl	1.52
Over 63.50 to 76.20, incl	1.78

3.4.4.4 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.

3.4.4.4.1 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 aircraft-quality conforming to AMS 2301 or MAM 2301.

3.5.2 Bars ordered hot rolled or cold drawn or 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:

Bars shall conform to all applicable requirements of AMS 2251 or MAM 2251.

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 (3.4.1), tensile properties (3.4.2), hardness (3.4.3), decarburization (3.4.4), frequency-severity cleanliness ratings (3.5.2) and tolerances (3.6), are acceptance tests and shall be performed on each heat or lot as applicable.