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SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 6426D

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Superseding AMS 6426C

STEEL BARS, FORGINGS, AND TUBING
0.75Si - 1.0Cr - 0.58Mo (0.80 - 0.90C)
Consumable Electrode Vacuum Melted

UNS K18597

1. SCOPE:

1.1 Form: This specification covers a premium aircraft-quality, low-alloy steel in the form of bars, forgings, mechanical tubing, and forging stock.

1.2 Application: Primarily for parts, such as bearing components, for service up to 500°F (260°C) and requiring a through-hardening steel capable of developing hardness not lower than 60 HRC in cross-sections 3 inches (76 mm) and under.

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.

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 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
MAM 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
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

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM A 370 - Mechanical Testing of Steel Products
ASTM A 604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 45 - Determining the Inclusion Content of Steel
ASTM E 350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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 Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø 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	0.80	0.90
Manganese	0.20	0.50
Silicon	0.60	0.90
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	0.85	1.15
Molybdenum	0.50	0.65
Nickel	--	0.15
Copper	--	0.15

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: Hot finished and annealed, with microstructure Ø of spheroidized cementite in ferrite matrix, and having tensile strength not higher than 105,000 psi (724 MPa) except that bars ordered annealed and cold finished may have tensile strength as high as 125,000 psi (862 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, with microstructure of spheroidized cementite in ferrite matrix, and having hardness not higher than 207 HB, or equivalent, except that bars ordered annealed and cold finished may have hardness as high as 248 HB, or equivalent.

3.2.2 Forgings: As ordered.

3.2.3 Mechanical Tubing: Annealed and cold finished, with microstructure of spheroidized cementite in ferrite matrix, and having hardness not higher than 24 HRC, or equivalent, except that tubing ordered hot finished and annealed shall have hardness not higher than 95 HRB, 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 Ø from bars, billets, tube rounds or tubes, and forging stock, etched in accordance with ASTM A 604, shall show no pipe or cracks. Except as specified in 3.3.1.1, porosity, segregation, inclusions, and other imperfections for product 36 square inches (232 cm^2) and under in nominal cross-sectional area shall be no worse than the following macrographs of ASTM A 604; macrostructure standards for product over 36 square inches (232 cm^2) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor:

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	B
4	Ring Pattern	B

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 Micro-Inclusion Rating: No specimen as in 4.3.4 shall exceed the following limits, determined in accordance with ASTM E 45, Method D:

	A		B		C		D	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency, maximum	*	1	*	1	*	1	3	1
Total Rateable Fields, Frequency, maximum	**	1	**	1	**	1	8	1

* Combined A+B+C, not more than 3 fields
** Combined A+B+C, not more than 8 fields

3.3.2.1 A rateable field is defined as one which has a type A, B, C, or D inclusion rating of at least No. 1.0 thin or heavy in accordance with the Jernkontoret Chart, Plate III, ASTM E 45.

3.3.3 Response to Heat Treatment: Specimens as in 4.3.5, protected by suitable means or treated in a neutral atmosphere to minimize scaling and prevent either carburization or decarburization, shall have substantially uniform hardness not lower than 66 HRC at any point below any permissible decarburization after being placed in a furnace which is at 1600°F ± 10 (871°C ± 6), allowed to heat to 1600°F ± 10 (871°C ± 6), held at heat for 20 minutes ± 2, and quenched in commercial paraffin oil (100 SUS at 100°F (38°C)) at room temperature.

3.3.4 Hardness Retention: Specimens as in 4.3.5, hardened as in 3.3.3, shall have room temperature hardness not lower than 60 HRC after being heated for 400 hours ± 1 at 500°F ± 10 (260°C ± 6). The specimens may be the same specimens used for the test of 3.3.3.

3.3.5 Decarburization:

3.3.5.1 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 3.3.5.4.

3.3.5.2 Allowable decarburization of bars, billets, and tube rounds ordered for redrawing or forging or to specified microstructural requirements other than spheroidized cementite in a ferrite matrix shall be as agreed upon by purchaser and vendor.

3.3.5.3 Decarburization of bars to which 3.3.5.1 or 3.3.5.2 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 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.020
Over 1.000 to 1.500, incl	0.025
Over 1.500 to 2.000, incl	0.030
Over 2.000 to 2.500, incl	0.035
Over 2.500 to 3.000, incl	0.040
Over 3.000	0.045

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Depth of Decarburization Millimetres
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.51
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 76.20, incl	1.02
Over 76.20	1.14

3.3.5.4 Decarburization of tubing to which 3.3.5.1 or 3.3.5.2 is not applicable shall be not greater than 0.025 inch (0.64 mm) on the ID and 0.025 inch (0.64 mm) on the outside diameter.

3.3.5.5 Decarburization shall be measured by the microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on hardened but untempered specimens 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.

3.3.5.5.1 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.

3.4 Quality:

3.4.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or Ø MAM 2300 except that a maximum average frequency (F) rating of 0.10 and a maximum average severity (S) rating of 0.20 shall apply. Steel shall be multiple melted using consumable electrode vacuum practice in the remelt cycle.

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 not 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:

4.2.1 Acceptance Tests: Tests for the following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Condition of each lot of bars (3.2.1) and mechanical tubing (3.2.3).

4.2.1.3 Macrostructure (3.3.1), micro-inclusion rating (3.3.2), response to heat treatment (3.3.3), and frequency-severity cleanliness rating (3.4.1) of each heat.

4.2.1.4 Decarburization (3.3.5) of each lot of bars and mechanical tubing.

4.2.1.5 Tolerances of bars and mechanical tubing (3.6).

4.2.2 Periodic Tests: Tests for hardness retention (3.3.4) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing: Shall be in accordance with the following; the number Ø of specimens to be sampled shall be the minimum number of specimens tested. A heat shall be the consumable electrode vacuum remelted ingots produced from steel originally melted as a single furnace charge:

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.

4.3.4 Samples for micro-inclusion rating (3.3.2) shall consist of not less than six specimens obtained from the full cross-section of billet stock representing the top and bottom of at least the first, middle, and last usable ingot from each heat.

4.3.5 Specimens for response to heat treatment (3.3.3) and hardness retention (3.3.4) tests shall be as follows:

4.3.5.1 Specimens from bars shall be full cross-sections of the bar, ground on both faces normal to the axis so that length is 0.500 inch ± 0.010 (12.70 mm ± 0.25).

4.3.5.2 Specimens from mechanical tubing shall be full cross-sections of the tubing, shall have wall thickness not over 0.500 inch (12.70 mm) with wall thicknesses over 0.500 inch (12.70 mm) being turned to 0.500 inch ± 0.010 (12.70 mm ± 0.25), and shall be ground on both faces so that length is 0.625 inch ± 0.010 (15.88 mm ± 0.25).

4.3.5.3 Specimens from forgings shall be sections of the forgings ground on both faces so that thickness is 0.500 inch ± 0.010 (12.70 mm ± 0.25), or less if necessary; specimens need not have surface area of one face greater than 25 square inches (161 cm^2).

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, micro-inclusion rating, response to heat treatment, and frequency-severity cleanliness rating of each heat and, when performed, the results of tests for hardness retention. This report shall include the purchase order number, lot number, AMS 6426D, 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.