

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS 6529A

Issued APR 1987
Revised JUN 1996

Superseding AMS 6529

STEEL, BARS
0.95Cr - 0.20Mo (0.38 - 0.43C) (SAE 4140)
Special Aircraft-Quality Cleanliness
Normalized

UNS G41400

1. SCOPE:

1.1 Form:

This specification covers a special aircraft-quality, low-alloy steel in the form of bars.

1.2 Application:

These bars have been used typically for parts required to meet stringent magnetic inspection criteria, 0.75 inch (19.0 mm) and under in nominal thickness at time of heat treatment, requiring a through-hardening steel capable of developing hardness as high as 40 HRC when properly hardened and tempered, and also for parts of greater thickness requiring proportionately lower hardness, but usage is not limited to such applications.

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 the issue in effect on the date of the purchase order.

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 2304	Special Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
MAM 2304	Special Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
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 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels, Corrosion and Heat Resistant Steels and Alloys

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 Drive, West Conshohocken, PA 19428-2959.

ASTM A 255 End-Quench Test for Hardenability of Steel

ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

ASTM E 112 Determining the 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

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

(R)

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	--	0.015
Sulfur	--	0.008
Chromium	0.80	1.10
Molybdenum	0.15	0.25
Nickel	--	0.25
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

3.2 Condition:

3.2.1 Hot rolled and normalized at $1650\text{ }^{\circ}\text{F} \pm 25$ ($899\text{ }^{\circ}\text{C} \pm 14$).

3.2.1.1 When specified, either a cold drawn or cold finished surface shall be supplied.

3.2.1.1.1 Cold finished surface shall be produced by turning, grinding, polishing, burnishing, or combination thereof; surface hardness shall be not more than 3 points HRC harder than hardness at mid-radius, determined in accordance with ASTM E 18.

3.2.1.2 Cold finished surface may be supplied when a cold drawn, hot rolled or no surface condition is specified.

3.2.1.3 Cold drawn surface may be supplied when a hot rolled or no surface condition is specified.

3.3 Properties:

Bars shall conform to the following requirements:

3.3.1 Macrostructure: Visual examination of transverse full cross-sections from bars and billets, etched in hot hydrochloric acid in accordance with ASTM E 381, shall show no pipe or cracks. (R) 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 (R) ASTM E 112 (See 8.2).

3.3.3 Hardenability: Shall be J50=6 minimum and J44=9 minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255.

3.3.4 Decarburization:

3.3.4.1 Bars ordered ground, turned, or polished shall be free from decarburization on the ground, (R) turned, or polished surfaces.

3.3.4.2 Allowable decarburization of bars and billets ordered for redrawing 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, Inch/Pound Units

Nominal Thickness 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 3B - Maximum Decarburization, SI Units

Nominal Thickness or Distance Between Parallel Sides Millimeters	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 38.15, incl	0.51
Over 38.15 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 shall be measured by the microscopic method or by the HR30N 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 decarburization thereon.
- 3.3.4.4.1 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.

3.4 Quality:

Bars, 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 bars.

3.4.1 Steel shall be special aircraft-quality conforming to AMS 2304 or MAM 2304 (See 8.3).

(R)

3.4.2 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 surfaces.

3.5 Tolerances:

(R)

Shall conform to all applicable requirements of AMS 2251 or MAM 2251.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of bars 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 bars conform to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition (3.1), macrostructure (3.3.1), average grain size (3.3.2), hardenability (3.3.3) decarburization (3.3.4), and frequency-severity cleanliness rating (3.4.1) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Cold finished surface hardness (3.2.1.1.1) is a periodic test and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

(R)

Shall be in accordance with AMS 2370 and the following:

4.3.1 Samples for frequency-severity cleanliness rating (3.4.1) shall conform to AMS 2304 or MAM 2304.

4.4 Reports:

(R)

The vendor of bars shall furnish with each shipment a report showing the results of tests for chemical composition, macrostructure, average grain size, hardenability, and frequency-severity cleanliness rating of each heat. This report shall include the purchase order number, heat and lot number, AMS 6529A, size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2370 except that resampling for cleanliness shall conform to 4.5.1.

4.5.1 If any specimen fails to meet the specified frequency-severity cleanliness requirements, the entire heat shall be rejected or resampling and retesting shall be performed as follows:

4.5.1.1 Nonconforming Ingot(s): Reject or take additional discard and resample and retest.

4.5.1.2 Ingot(s) Not Originally Sampled: Sample and test material from the respective nonconforming position(s), i.e., top or bottom, of two additional ingots for each nonconforming ingot. The ingots selected for additional samples shall be from locations in the pouring plate pattern closest to the nonconforming ingot(s).

4.5.1.3 If the nonconforming ingot fails the retest, repeat 4.5.1.1.

4.5.1.4 If all ingots sampled as in 4.5.1.2 meet the frequency-severity cleanliness requirements, the heat, except for original nonconforming ingot(s), is acceptable.

4.5.1.5 If any of the ingots sampled as in 4.5.1.2 fail to meet the frequency-severity cleanliness requirements, the heat shall be rejected or each ingot shall be tested at the nonconforming position(s) and acceptance of each ingot shall be based on the tests thereon.

4.5.1.6 All steel shall be either from ingots which successfully met the frequency-severity cleanliness requirements, top and bottom, or from ingots and positions represented by successfully tested ingots.

5. PREPARATION FOR DELIVERY:

5.1 Sizes:

Except when exact lengths or multiples of exact lengths are ordered, straight bars will be acceptable in mill lengths of 6 to 20 feet (1.8 to 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

5.2 Identification:

Shall be in accordance with AMS 2806.

5.3 Packaging:

5.3.1 Bars ordered cold drawn or cold finished shall be coated with a corrosion-preventive compound prior to shipment.

5.3.2 Bars shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the bars to ensure carrier acceptance and safe delivery.