



AEROSPACE MATERIAL SPECIFICATION	AMS6349™	REV. F
	Issued 1979-10 Revised 2024-03	
	Superseding AMS6349E	
Steel Bars 0.95Cr - 0.20Mo (0.38 to 0.43C) (SAE 4140) Normalized (Composition similar to UNS G41400)		

RATIONALE

AMS6349F is the result of a Five-Year Review and update of the specification. The revision updates composition testing and reporting (see 3.1 and 3.1.2), addresses hardness requirements for normalized product (see 3.2.2), updates specimen requirements (see 3.3.3), revises decarburization methods (see 3.3.4.4), addresses updates in AMS2301 (see 4.2.1 and 4.4.4), adds product guidance (see 8.6) prohibits unauthorized exceptions, (see 3.6 and 8.8) and allows prior revisions (see 8.7).

1. SCOPE

1.1 Form

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

1.2 Application

These bars have been used typically for parts 0.50 inch (12.7 mm) and under in section thickness at time of heat treatment requiring a through-hardening steel capable of developing hardness as high as 50 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 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.

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<https://www.sae.org/standards/content/AMS6349F>

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2251	Tolerances, Low-Alloy Steel Bars
AMS2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS2301	Steel Cleanliness, Aircraft Quality, Magnetic Particle Inspection Procedure
AMS2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock
AMS2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels, and Corrosion and Heat-Resistant Steels and Alloys
AS1182	Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel, Bars and Mechanical Tubing
AS7766	Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A255	Determining Hardenability of Steel
ASTM A370	Mechanical Testing of Steel Products
ASTM A751	Chemical Analysis of Steel Products
ASTM E112	Determining Average Grain Size
ASTM E381	Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings
ASTM E1077	Estimating the Depth of Decarburization of Steel Specimens

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.38	0.43
Manganese	0.75	1.00
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.80	1.10
Molybdenum	0.15	0.25
Nickel	--	0.25
Copper	--	0.35

3.1.1 Aluminum, vanadium, and columbium (niobium) are optional grain refining elements and need not be determined or reported unless used to satisfy the average grain size requirements of 3.3.2.2.

3.1.2 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.3 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

Bars shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370. Bars shall not be cut from plate (see 4.4.2).

3.2.1 Bars 0.500 Inch (12.70 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides

Normalized and cold finished having tensile strength not higher than 125 ksi or equivalent hardness (see 8.2).

3.2.2 Bars Over 0.500 Inch (12.70 mm) in Nominal Diameter or Least Distance Between Parallel Sides

Hot finished and normalized or normalized and cold finished.

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 E381, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E381 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 133, incl	Over 232 to 858, incl	S2 - R2 - C3
Over 133	Over 858	Note 1
Note 1: Limits for larger sizes shall be agreed upon by the purchaser and producer.		

3.3.2 Average Grain Size

Average grain size shall be determined by either 3.3.2.1 or 3.3.2.2.

3.3.2.1 Shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.3.2.2 The product of a heat shall be considered to have an ASTM No. 5 or finer austenitic grain size if one or more of the following are determined by heat analysis (see 8.5):

3.3.2.2.1 A total aluminum content of 0.020 to 0.050%.

3.3.2.2.2 An acid soluble aluminum content of 0.015 to 0.050%.

3.3.2.2.3 A vanadium content of 0.02 to 0.08%.

3.3.2.2.4 A columbium (niobium) content of 0.02 to 0.05%.

3.3.3 Hardenability of Each Heat

Shall be J 6/16 inch (9.5 mm) = 50 HRC minimum and J 9/16 inch (14 mm) = 44 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A255, except that the steel shall be normalized at 1700 °F ± 10 °F (927 °C ± 6 °C) and the test specimen austenitized at 1550 °F ± 10 °F (843 °C ± 6 °C). Cast specimens do not need to be normalized.

3.3.4 Decarburization

3.3.4.1 Bars ordered ground, turned, or polished shall be free from decarburization on the ground, 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 the purchaser and producer.

3.3.4.3 Decarburization of bars that 3.3.4.1 or 3.3.4.2 is not applicable shall be not greater than shown in Table 3.

Table 3A - Maximum depth of decarburization, inch/pound units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inches
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 depth of decarburization, SI units

Nominal Diameter 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 38.10, 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 shall be evaluated by one of the two methods of 3.3.4.4.1 or 3.3.4.4.2.

3.3.4.4.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be etched and examined metallographically at a magnification not to exceed 200X in accordance with ASTM E1077. The product shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.3.4.4.2 Hardness Traverse (Microindentation) Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened in a protective atmosphere to prevent changes in surface carbon content. Samples may be tempered at the option of the producer. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Table 3.

3.3.4.4.3 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.

3.3.4.4.4 In case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

3.4 Quality

Bars, as received by the 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 aircraft quality conforming to AMS2301.

3.4.2 Bars shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

3.5 Tolerances

Shall conform to all applicable requirements of AMS2251.

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.3.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of bars shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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

Tests for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (see 3.3.2.2) are not present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on each lot. If process qualification in accordance with AMS2301 has been met, the frequency-severity cleanliness rating shall be conducted on a periodic basis as defined in AMS2301.

4.2.2 Periodic Tests

If grain refining elements (see 3.3.2.2) are present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on a periodic basis and shall be performed at a frequency selected by the producer (not to exceed 1 year) unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

In accordance with AMS2370.

4.4 Reports

4.4.1 The producer of the product shall furnish with each shipment a report showing producer identity; country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations); the results of composition, macrostructure, hardenability, and frequency-severity cleanliness rating for each heat (see 4.4.4) and average grain size (if measured) 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, AMS6349F, size, and quantity. If the grain size requirement of 3.3.2 is met by the aluminum, vanadium, and/or columbium (niobium) content, the aluminum, vanadium, and/or columbium (niobium) content shall be reported and a statement that the chemistry satisfies the grain size requirement shall be included.

4.4.2 If the ship size/shape is cut from a larger cross section, report the nominal metallurgically worked size (see 3.2).

4.4.3 When material produced to this specification has exceptions taken to the technical requirements listed in Section 3 (see 5.2.1), the report shall contain a statement "This material is certified as AMS6349F(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.4.4 Reduced Testing

If the producer has qualified for periodic testing for frequency-severity cleanliness rating in accordance with AMS2301, then the frequency-severity cleanliness rating is not required to be reported for each shipment. In this circumstance, the report shall read, "Process qualification in accordance with AMS2301 has been completed."

4.5 Resampling and Retesting:

In accordance with AMS2370.