AEROSPACE MATERIAL SPECIFICATION

AMS6346™	REV. D

Issued 1998-10
Reaffirmed 2009-06
Revised 2023-10

Superseding AMS6346C

Steel Bars
0.95Cr - 0.20Mo (0.28 to 0.33C) (SAE 4130)
Aircraft Quality
Hardened and Tempered, 125 ksi (862 MPa) Tensile Strength
(Composition similar to UNS G41300)

RATIONALE

AMS6346D is the result of a Five-Year review and update of the specification. The revision updates the Title to include product quality, adds composition reporting (3.1.2), incorporates requirements for alternative grain size evaluation method (3.1.1, 3.3.2, 4.2, 8.4), clarifies macrostructure (3.3.1), revises tensile test requirements including note on data source (3.3.3), revises decarburization testing requirements (3.3.4.4), incorporates requirements for periodic testing per AMS2301 (4.2, 4.4.5), clarifies testing requirements (4.2), adds note on bar stock quality (8.5) and updates the requirements for product exceptions (8.6)

1. SCOPE

1.1 Form

This specification covers an aircraft-quality, low-alloy steel in the form of heat-treated bars 1.50 inches (38.1 mm) and less in diameter or least distance between parallel sides.

1.2 Application

These bars have been used typically for parts with sections 1.50 inch (38.1 mm) and under in nominal thickness requiring a minimum tensile strength of 125 ksi (862 MPa), but usage is not limited to such application.

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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For more information on this standard, visit
https://www.sae.org/standards/content/AMS6346D/

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 A370 Mechanical Testing of Steel Products

ASTM A751 Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

ASTM E112 Determining Average Grain Size

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E381 Macroetch Testing, Steel Bars, Billets, Blooms, and Forgings

ASTM E1077 Standard Test Methods for 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	0.28	0.33
Manganese	0.40	0.60
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 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.

3.1.2 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 Conditions

Bars shall be supplied in the following conditions:

3.2.1 Bars 0.500 inch (12.70 mm) and under in nominal diameter or least distance between parallel sides shall be hardened and tempered and cold finished.

3.2.2 Bars over 0.500 inch (12.70 mm) in nominal diameter or least distance between parallel sides shall be hot finished and hardened and tempered, or if specified, hardened and tempered and cold finished.

3.2.3 Bars shall not be cut from plate (see 4.4.2).

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 and tube rounds (solid not hollow), 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

The average grain size shall be determined by either 3.3.2.1 or 3.3.2.2.

3.3.2.1 The average grain size 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 8.4):

- A total aluminum content of 0.020 to 0.050%.
- An acid soluble aluminum content of 0.015 to 0.050%.
- A vanadium content of 0.02 to 0.08%.
- A columbium content of 0.02 to 0.05%.

3.3.3 Tensile Properties

Tensile properties shall be as shown in Table 3 for product 1.50 inches (38.1 mm) and less in diameter or least distance between parallel sides, determined in accordance with ASTM A370.

Table 3 - Longitudinal tensile properties, minimum

Property	Value[1]
Tensile strength	125 ksi (862 MPa)
Yield strength at 0.2% Offset	100 ksi (689 MPa)
Elongation in 4D or 2 inches (50 mm)	17%
Reduction of Area	55%

[1] Properties have been taken from AMS-S-6758, Condition F, and were not independently substantiated in accordance using SAE AMS procedures.

3.3.3.1 Mechanical property requirements for product outside the size range covered by 1.1 shall be agreed upon between the purchaser and producer.

3.3.3.2 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min).

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 ordered to specified microstructural requirements shall be agreed upon by the purchaser and producer.

3.3.4.3 Where 3.3.4.1 or 3.3.4.2 are not applicable, decarburization of bars shall be not greater than shown in Table 4.

Table 4A - 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 4B - Maximum depth of decarburization, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total 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 Method

A cross section taken perpendicular to the surface shall be prepared, etched and visually examined in accordance with ASTM E1077 and at a magnification of 200X unless otherwise agreed on between the purchaser and producer. The sample shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 4.

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 and protected during heat treatment 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 4.

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

Bar 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 of the producer's tests and shall be responsible for the performance of all required tests. The purchaser reserves the right to sample and perform any confirmatory testing deemed necessary to ensure that the bars conform to specified requirements.

4.2 Classification of Tests

Composition (see 3.1), macrostructure (see 3.3.1), average grain size (see 3.3.2), tensile (see 3.3.3), decarburization (see 3.3.4), frequency-severity cleanliness (see 3.4.1), and tolerances (see 3.5) 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.

4.3 Sampling and Testing

Sampling shall be in accordance with AMS2370.

4.4 Reports

4.4.1 The producer of bars shall furnish with each shipment a report showing the producer's identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), results of tests for composition, macrostructure, and frequency-severity cleanliness rating of each heat (see 4.4.4), tensile properties, and average grain size 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, AMS6346D, size, and quantity.

4.4.2 Report the nominal metallurgically worked cross-sectional size and the cut size, if different (see 3.2.3).

4.4.3 When material produced to this specification is beyond the sizes allowed in the scope or other exceptions authorized by the purchaser are taken to the technical requirements listed in Section 3 (see 5.2), the report shall contain a statement "This material is certified as AMS6346D(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."