AEROSPACE MATERIAL SPECIFICATION

AMS6327™	REV. L

Issued 1942-09
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Superseding AMS6327K

Steel Bars and Forgings
0.50Cr - 0.55Ni - 0.25Mo (0.38 - 0.43C) (SAE 8740)
Heat Treated, 125 ksi (862 MPa) Tensile Strength
(Composition similar to UNS G87400)

RATIONALE

AMS6327L results from a Five-Year Review and update of this specification that allows the use of grain refiners (3.1.1), revises decarburizaion testing (3.4.3.3), adds tensile testing strain rate (3.4.4.1) and agreement on properties outside range (3.4.4.2), and revises quality (3.5.2), reporting (4.4), and identification (5.2).

1. SCOPE

1.1 Form

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

1.2 Application

These products have been used typically for parts, such as nuts, bolts, and screws, 1.50 inch (38.1 mm) and under in section thickness, requiring a minimum tensile strength of 125 ksi (862 MPa), 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.

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

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

AMS2370 Quality Assurance Sampling and Testing Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2372 Quality Assurance Sampling and Testing Carbon and Low-Alloy Steel Forgings

AMS2750 Pyrometry

AMS2806 Identification Bars, Wire, Mechanical Tubing, and Extrusions Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys

AMS2808 Identification Forgings

AMS6322 Steel Bars, Forgings, and Rings 0.50Cr - 0.55Ni - 0.25Mo (0.38 - 0.43C) (SAE 8740)

AMS-H-6875 Heat Treatment of Steel Raw Materials

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

AS1182 Standard Stock Removal Allowance Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing

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 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 E350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E381 Macroetch Testing, Inspection, and Rating Steel Products Comprising Bars, Billets, Blooms, and Forgings

ASTM E384 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 E350, 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	--	0.025
Sulfur	--	0.025
Chromium	0.40	0.60
Nickel	0.40	0.70
Molybdenum	0.20	0.30
Copper	--	0.35

3.1.1 Optional grain refining elements aluminum, vanadium and columbium may be added to ensure the average grain size requirement. The ranges of the grain refiners are as follows:

3.1.1.1 A total aluminum content of 0.020 to 0.050%.

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

3.1.1.3 A vanadium content of 0.02 to 0.08%.

3.1.1.4 A columbium content of 0.02 to 0.05%.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

The product shall be supplied in the following condition:

3.2.1 Bars

Bar shall not be cut from plate (also see 4.4.2).

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

Cold finished, hardened, and tempered.

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

Hot finished, or cold finished when so ordered, and hardened and tempered.

3.2.2 Forgings

Hardened and tempered in accordance with AMS-H-6875.

3.2.2.1 Forging stock produced to AMS6322 may be used as starting material for forgings.

3.3 Heat Treatment

Bars shall be hardened by quenching from 1550 °F ± 25 °F (843 °C ± 14 °C) and tempered as required; Pyrometry shall be in accordance with AMS2750.

3.4 Properties

The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.4.1 Average Grain Size

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

3.4.2 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 purchaser and producer. The purchaser shall have written approval of the agreement from the cognizant engineering organization.

3.4.3 Decarburization

3.4.3.1 Bars ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

3.4.3.2 Decarburization of bars that 3.4.3.1 is not applicable shall be not greater than shown in Table 3.

Table 3

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

Nominal Diameter or Distance Between Parallel Sides Inches	Total 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

Table 3B - Maximum depth of decarburization limits, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeter
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

3.4.3.3 Decarburization shall be evaluated by one of the two methods of 3.4.3.3.1 or 3.4.3.3.2, selected at the discretion of the producer.

3.4.3.3.1 Metallographic Method

A cross section taken perpendicular to the surface shall be prepared, etched, and visually examined metallographically at a magnification not to exceed 100X. The product shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.4.3.3.2 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E384, at a magnification not exceeding 100X, conducted on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization is defined as the perpendicular distance from the surface to the depth under that surface where there is not 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. Acceptance shall be as listed in Table 3.

3.4.3.3.3 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.

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

3.4.4 Tensile Properties

Specimens cut from bars 1.500 inches (38.10 mm) and under in nominal diameter or distance between parallel sides and from forgings 1.500 inches (38.10 mm) and under in nominal cross-section shall conform to the requirements of Table 4.

Table 4 - Minimum mechanical properties

Property	Value
Tensile Strength	125 ksi (862 MPa)
Yield Strength at 0.2% Offset	100 ksi (689 MPa)
Elongation in 4D	16%
Reduction of Area	50%

3.4.4.1 Unless otherwise specified, the strain rate shall be set at 0.005 inch/inch/minute (0.005 mm/mm/minute) and maintained within a tolerance of ±0.002 inch/inch/minute (0.002 mm/mm/minute) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 inch/inch (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 and 0.5 inch/inch/min (mm/mm/minute).

3.4.4.2 Mechanical property requirements for product outside the range in 3.4.4 shall be agreed between purchaser and producer.

3.4.5 Hardness

Shall be 252 to 311 HB, or equivalent (see 8.2), but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.4 are acceptable, determined on specimens taken from the same sample as the one with nonconforming hardness or from another sample with similar nonconforming hardness.

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 AMS2301.

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

3.5.3 Forgings shall have substantially uniform macrostructure. Standards for acceptance shall be as agreed upon by purchaser and producer (see 8.5).

3.5.4 Grain flow of die forgings, except in areas that 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 AMS2251.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer'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), average grain size (3.4.1), macrostructure (3.4.2), decarburization (3.4.3), tensile properties (3.4.4), hardness (3.4.5), frequency-severity cleanliness (3.5.1), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Grain flow of die forgings (3.5.4) is a periodic test and shall be performed at a frequency selected by the producer unless a frequency of testing is specified by purchaser.

4.3 Sampling

4.3.1 Bars and Forging Stock

In accordance with AMS2370.

4.3.2 Forgings

In accordance with AMS2372.

4.4 Reports

4.4.1 The producer of bars and forgings 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, and frequency-severity cleanliness rating for each heat and for average grain size, tensile properties and hardness of each lot, and stating that the product conforms to other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS6327L, product form and size (and/or part number, if applicable), and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included. If the aluminum, vanadium and/or columbium content are utilized, the aluminum, vanadium, and/or columbium content shall be reported.

4.4.2 If the ship size/shape is cut from a larger cross section, report the nominal metallurgically worked size (see 3.2.1).

4.4.3 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions are taken to the technical requirements listed in Section 3, (see 5.2) the report shall contain a statement "This material is certified as AMS6327L(EXC) because of the following exceptions:" and the specific exceptions shall be listed.