



AEROSPACE MATERIAL SPECIFICATION

AMS6317™**REV. L**Issued 1939-12
Revised 2022-08

Superseding AMS6317K

Steel Bars and Forgings
1.8Ni - 0.25Mo (0.38 - 0.43C) (4640)
Heat Treated, 125 ksi (862 MPa) Tensile Strength
(Composition similar to UNS K22440)

RATIONALE

AMS6317L is the result of a Five-Year Review and update of the specification. The revision prohibits unauthorized exceptions, including a clarification of the size limits (1.1, Table 2, 3.5, 3.8, 4.4.2, 5.2, 8.7, 8.9), updates composition testing (3.1), incorporates updates to grain refinement requirements (3.1.1, 3.4.2, 4.2.1, 4.2.2, 4.4.1, 8.5), updates decarburization testing (3.4.3.3), adds updates based on changes in AMS2301 (4.2.1, 4.4.1, 4.4.4), provides guidances on use of AS1182 (8.8), and allows for prior revisions (8.6).

1. SCOPE

1.1 Form

This specification covers an aircraft-quality, low-alloy steel in the form of heat treated bars and forgings 1.00 inches (25.4 mm) and under in nominal cross section or diameter and for hexagonal shapes, least distance between parallel sides.

1.2 Application

These products have been used typically for parts with sections 1.0 inch (25 mm) and under in nominal 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

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SAE WEB ADDRESS:

For more information on this standard, visit

<https://www.sae.org/standards/content/AMS6317L/>

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
AMS2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys
AMS2750	Pyrometry
AMS2808	Identification, Forgings
AMS6312	Steel Bars, Forgings, and Tubing 1.8Ni - 0.25Mo (0.38 - 0.43C) (4640)
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 E112	Determining Average Grain Size
ASTM A751	Chemical Analysis of Steel Products
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	Estimating the Depth of Decarburization of Steel Specimens

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 purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.38	0.43
Manganese	0.60	0.80
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Nickel	1.65	2.00
Molybdenum	0.20	0.30
Chromium	--	0.20
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 3.4.2.

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

Bars 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, hardened, and tempered.

3.2.2 Forgings

Hardened and tempered.

3.2.2.1 Forging stock produced to AMS6312 may be used as starting material for forgings.

3.3 Heat Treatment

Bars and forgings shall be hardened by quenching from $1525^{\circ}\text{F} \pm 25^{\circ}\text{F}$ ($843^{\circ}\text{C} \pm 14^{\circ}\text{C}$) and tempered as required to meet the requirements of 3.4.4 and 3.4.5. 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 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.

3.4.2 Average Grain Size of Bars and Forgings

Average grain size shall be determined by either 3.4.2.1 or 3.4.2.2.

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

3.4.2.2 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):

3.4.2.2.1 A total aluminum content of 0.020 to 0.050%.

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

3.4.2.2.3 A vanadium content of 0.02 to 0.08%.

3.4.2.2.4 A columbium content of 0.02 to 0.05%.

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 3.3.3.1 is not applicable shall be not greater than shown in Table 3.

Table 3A - Maximum depth of decarburization limits, 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

Table 3B - Maximum depth of decarburization limits, 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

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.

3.4.3.3.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be prepared, etched, and examined metallographically at a magnification not to exceed 100X in accordance with ASTM E1077. The sample shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.4.3.3.2 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 but untempered and protected during heat treatment to prevent changes in surface carbon content. 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 longitudinally from bars 1.00 inch (25.4 mm) and under in nominal diameter or distance between parallel sides and from forgings 1.00 inch (25.4 mm) and under in nominal cross-section with axis of specimen in area of gage length within 15 degrees of parallel to forging flow lines, shall have the properties shown in Table 4.

Table 4 - Minimum tensile 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 When specified, transverse tensile properties and longitudinal tensile properties of bars over 1.00 inch (25.4 mm) in nominal diameter or distance between parallel sides and of forgings over 1.00 inch (25.4 mm) in nominal cross-section shall be as agreed upon by purchaser and producer.

3.4.4.2 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 (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 (mm/mm/min).

3.4.5 Hardness

Shall be 262 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 3.3.4 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

3.5 Mechanical property requirements for product outside the size range covered by 1.1, shall be agreed upon between purchaser and producer and reported per 4.4.3.

3.6 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.

3.6.1 Steel shall be aircraft-quality conforming to AMS2301.

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

3.6.3 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 reentrant grain flow.

3.7 Tolerances

Bars shall conform to all applicable requirements of AMS2251.

3.8 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 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), macrostructure (3.3.1), average grain size (3.3.2), decarburization (3.3.3), tensile properties (3.3.4), hardness (3.3.5), frequency-severity cleanliness (3.4), and tolerances (3.5) are acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (3.3.2.2) are not present, the ASTM E112 grain size test (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 (3.3.2.2) are present, the ASTM E112 grain size test (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 purchaser. Grain flow of die forgings (3.4.3) 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 and Testing

4.3.1 Bars

In accordance with AMS2370.

4.3.2 Forgings

In accordance with AMS2372.