



AEROSPACE MATERIAL SPECIFICATION	AMS6302™	REV. L
	Issued 1953-06 Reaffirmed 2000-09 Revised 2023-03	
Superseding AMS6302K		
Low-Alloy Steel, Heat-Resistant, Bars, Forgings, Mechanical Tubing and Forging Stock 0.65Si - 1.25Cr - 0.50Mo - 0.25V (0.28 - 0.33C) (Composition similar to UNS K23015)		

RATIONALE

AMS6302L is the result of a Five-Year Review and update of the specification. The revision updates the title to match the scope, updates reporting requirements for composition (3.1.1), updates the prohibition of unauthorized exceptions (Table 2, 3.6, 4.4.5, 8.7), updates macrostructure requirements (3.3.1, 8.9), revises decarburization tests (3.3.3.5), acknowledges testing requirements in AMS2301 (4.2.1, 4.4.4), adds note on stock removal (8.8), and allows prior revision (8.6).

1. SCOPE

1.1 Form

This specification covers an aircraft-quality, low-alloy, heat-resistant steel in the form of bars, forgings, mechanical tubing, and forging stock.

1.2 Application

These products have been used typically for parts such as shafts and fasteners, in service up to 1000 °F (538 °C), 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

AMS2253 Tolerances, Carbon and Alloy Steel Tubing

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

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For more information on this standard, visit
<https://www.sae.org/standards/content/AMS6302L/>

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
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
AMS2808	Identification, Forgings
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	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 purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.28	0.33
Manganese	0.45	0.65
Silicon	0.55	0.75
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	1.00	1.50
Molybdenum	0.40	0.60
Vanadium	0.20	0.30
Nickel	--	0.25
Copper	--	0.35

3.1.1 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.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.2.1 Bars

Bar shall not be cut from plate (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 having tensile strength not higher than 125 ksi (862 MPa) or equivalent hardness (see 8.2).

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

Hot finished, unless otherwise specified, having hardness not higher than 241 HBW, or equivalent (see 8.3). Bars ordered cold finished may have hardness as high as 248 HBW, or equivalent (see 8.3).

3.2.2 Forgings

Annealed having hardness not higher than 241 HBW, or equivalent (see 8.3).

3.2.3 Mechanical Tubing

Cold finished unless otherwise specified, having hardness not higher than 25 HRC, or equivalent (see 8.3). Tubing ordered hot finished shall have hardness not higher than 99 HRB, or equivalent (see 8.3).

3.2.4 Forging Stock

As ordered by the forging manufacturer.

3.3 Properties

3.3.1 The product shall conform to the following requirements:

3.3.1.1 Macrostructure

Visual examination of transverse full cross-sections from bars, billets, tube rounds (solid, not hollow), and forging stock, 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.

3.3.1.2 Macrostructure examination is not required for bored/hollow forgings (including ring forgings) and mechanical tubes that are produced directly from ingots or large blooms unless otherwise agreed upon by purchaser and the producer (see 8.9).

3.3.1.3 If mechanical tubing is produced directly from ingots or large blooms, transverse sections may be taken from the tubing. Macrostructure standards for such tubes shall be as agreed upon by purchaser and producer (see 8.9).

3.3.2 Average Grain Size of Bars, Forgings, and Tubing

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

3.3.3 Decarburization

3.3.3.1 Bars and tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization on tubing ID shall not exceed the maximum depth specified in Table 4.

3.3.3.2 Allowable decarburization of bars, billets, tube rounds, and tubing ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by purchaser and producer.

3.3.3.3 Where 3.3.3.1 or 3.3.3.2 are not applicable, decarburization of bars 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	0.015
Over 0.375 to 0.500, incl	0.017
Over 0.500 to 0.625, incl	0.019
Over 0.625 to 1.000, incl	0.022
Over 1.000 to 1.500, incl	0.025
Over 1.500 to 2.000, incl	0.030
Over 2.000 to 2.500, incl	0.035
Over 2.500 to 3.000, incl	0.040
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	Total Depth of Decarburization Millimeters
Up to 9.52, incl	0.38
Over 9.52 to 12.70, incl	0.43
Over 12.70 to 15.88, incl	0.48
Over 15.88 to 25.40, incl	0.56
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 76.20, incl	1.02
Over 76.20 to 101.60, incl	1.14

3.3.3.4 Where 3.3.3.1 or 3.3.3.2 are not applicable, decarburization of tubing shall be not greater than shown in Table 4.

Table 4A - Maximum depth of decarburization, inch/pound units

Nominal Wall Thickness Inches	Total Depth of Decarburization	Total Depth of Decarburization
	Inches ID	Inches OD
Up to 0.109, incl	0.008	0.020
Over 0.109 to 0.203, incl	0.010	0.025
Over 0.203 to 0.400, incl	0.012	0.030
Over 0.400 to 0.600, incl	0.015	0.035
Over 0.600 to 1.000, incl	0.017	0.040
Over 1.000	0.020	0.045

Table 4B - Maximum depth of decarburization, SI units

Nominal Wall Thickness Millimeters	Total Depth of Decarburization	Total Depth of Decarburization
	Millimeters ID	Millimeters OD
Up to 2.77, incl	0.20	0.51
Over 2.77 to 5.16, incl	0.25	0.64
Over 5.16 to 10.16, incl	0.30	0.76
Over 10.16 to 15.24, incl	0.38	0.89
Over 15.24 to 25.40, incl	0.43	1.02
Over 25.40	0.51	1.14

3.3.3.5 Decarburization shall be evaluated by one of the two methods of 3.3.3.5.1 or 3.3.3.5.2.

3.3.3.5.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be prepared, etched, and examined metallographically at a magnification not to exceed 200X in accordance with ASTM E1077. The sample shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Tables 3 and 4.

3.3.3.5.2 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 Tables 3 and 4.

3.3.3.5.3 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.

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

3.3.4 Response to Heat Treatment of Each Heat.

Specimens as in 4.3.3 heated to 1750 °F ± 25 °F (954 °C ± 14 °C), held at heat for 60 to 90 minutes, and cooled at a rate equivalent to still air cooling, and reheated to 1100 °F ± 15 °F (593 °C ± 8 °C), held at heat for 6 hours ± 0.25 hour, and cooled in air, shall have hardness at the center of the test specimen not lower than 331 HB or equivalent (see 8.3) for sections 2 inches (51 mm) and under, and not lower than 302 HB or equivalent (see 8.3) for up to 4 inch (102 mm) sections.

3.4 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.

3.4.1 Steel shall be aircraft-quality conforming to AMS2301.

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

3.4.3 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.

3.5 Tolerances

3.5.1 Bars

Shall conform to all applicable requirements of AMS2251.

3.5.2 Mechanical Tubing

Shall conform to all applicable requirements of AMS2253.

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.5.

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), condition (3.2), macrostructure (3.3.1), decarburization (3.3.3), response to heat treatment (3.3.4), frequency-severity cleanliness (3.4.1), and tolerances (3.5) are acceptance tests and shall be performed on each heat or lot as applicable. 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

Average grain size (3.3.2) and grain flow of die forgings (3.4.3) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

4.3.1 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.

4.3.2 Forgings

In accordance with AMS2372.

4.3.3 Samples for response to heat treatment (3.3.4) shall be not shorter than twice the nominal diameter or distance between parallel sides or 6 inches (152 mm), whichever is less, and shall have the full cross-section of the product that they were cut, except that sections over 2 to 4 inches (over 51 to 102 mm), inclusive, in nominal diameter or least distance between parallel sides shall be reduced to 2.00 inches \pm 0.01 inch (51 mm \pm 0.3 mm) and sections over 4 inches (102 mm) shall be reduced to 4.00 inches \pm 0.01 inch (101.6 mm \pm 0.3 mm).

4.4 Reports

4.4.1 The producer of bars, forgings and tubing 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), results of tests for composition, macrostructure, response to heat treatment and frequency-severity cleanliness rating of each heat, and for hardness 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, AMS6302L, product form, 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.

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 The producer of forging stock shall furnish with each shipment a report showing the results of tests for composition, macrostructure, response to heat treatment, and the frequency-severity cleanliness rating (see 4.4.5) of each heat and the results of additional property requirements imposed by the purchase order (see 8.9). This report shall include the purchase order number, heat number, AMS6302L, size and quantity.

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."

4.4.5 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 AMS6302L(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.5 Resampling and Retesting

4.5.1 Bars, Mechanical Tubing and Forging Stock

In accordance with AMS2370.

4.5.2 Forgings

In accordance with AMS2372.

5. PREPARATION FOR DELIVERY

5.1 Sizes

Except when exact lengths or multiples of exact lengths are ordered, straight bars and mechanical tubing 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

5.2.1 Bars and Mechanical Tubing

In accordance with AMS2806. When technical exceptions are taken (see 4.4.5), the material shall be identified with AMS6302L(EXC).