

AEROSPACE MATERIAL SPECIFICATION



AMS 6322L

Issued
Revised

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Superseding AMS 6322K

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

UNS G87400

1. SCOPE:

1.1 Form:

This specification covers an aircraft-quality, low-alloy steel in the form of bars, forgings, flash welded rings, and stock for forging or flash welded rings.

1.2 Application:

These products have been used typically for parts, with section thickness of 0.375 inch (9.50 mm) and under at the 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 parts of greater thickness but 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 form 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AMS 2251 Tolerances, Low-Alloy Steel Bars
- MAM 2251 Tolerances, Metric, Low-Alloy Steel Bars
- AMS 2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
- AMS 2301 Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure
- MAM 2301 Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
- AMS 2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel, Wrought Products and Forging Stock

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2.1 (Continued):

- AMS 2372 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings
 AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
 AMS 2808 Identification, Forgings
 AMS 7496 Rings, Flash Welded, Carbon and Low-Alloy Steels
- AS1182 Standard Machining Allowance, Aircraft Quality and Premium Quality Steel Bars and Mechanical Tubing

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

- ASTM A 255 End-Quench Test for Hardenability of Steel
 ASTM A 370 Mechanical Testing of Steel Products
 ASTM E 112 Determining the Average Grain Size
 ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
 ASTM E 381 Macroetch Testing, Inspection, and Rating Steel Products Comprising Bars, Billets, Blooms, and Forgings

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 E 350 or by spectrographic or other analytical methods approved by 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 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

3.2 Condition:

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A 370:

3.2.1 Bars:

3.2.1.1 Bars 0.500 Inch (12.50 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides: Cold finished having tensile strength not higher than 120.0 ksi (825 MPa) or equivalent hardness (See 8.2).

3.2.1.2 Bars Over 0.500 Inch (12.50 mm) in Nominal Diameter or Least Distance Between Parallel Sides: Hot finished and annealed, unless otherwise ordered, having hardness not higher than 229 HB, or equivalent (See 8.3). Bars ordered cold finished may have hardness as high as 241 HB, or equivalent.

3.2.2 Forgings and Flash Welded Rings: As ordered.

3.2.2.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, they shall be manufactured in accordance with AMS 7496.

3.2.3 Stock for Forging or Flash Welded Rings: As ordered by the forging or flash welded ring manufacturer.

3.3 Properties:

The product shall conform to the following requirements; hardness testing shall be performed in accordance with ASTM A 370:

3.3.1 Macrostructure: Visual examination of transverse full cross-sections from bars, billets, and stock for forging or flash welded rings, etched in hot hydrochloric acid in accordance with ASTM E 381, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E 381 shown in Table 2.

TABLE 2 - Macrostructure Limits

Square Inches	Square Centimeters	Macrographs
Up to 36, incl	Up to 230, incl	S2 - R1 - C2
Over 36 to 100, incl	Over 230 to 645, incl	S2 - R2 - C3

3.3.2 Average Grain Size: Shall be ASTM 5 or finer determined in accordance with ASTM E 112 (See 8.4).

3.3.3 Hardenability: Shall be J5/16 (7.5 mm) = HRC 49 min and J8/16 (12 mm) = HRC 40 min (See 8.5), determined on the standard end-quench test specimen in accordance with ASTM A 255, except that the steel shall be normalized at $1600\text{ }^{\circ}\text{F} \pm 10$ ($870\text{ }^{\circ}\text{C} \pm 5$) and the test specimen austenitized at $1550\text{ }^{\circ}\text{F} \pm 10$ ($845\text{ }^{\circ}\text{C} \pm 5$).

3.3.4 Decarburization:

3.3.4.1 Bars and flash welded rings 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 forging or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

3.3.4.3 Decarburization of bars and flash welded rings to which 3.3.4.1 or 3.3.4.2 is not applicable shall be not greater than shown in Table I.

TABLE 3A - 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
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 - Decarburization Limits, SI Units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 9.50, incl	0.25
Over 9.50 to 12.50, incl	0.30
Over 12.50 to 15.50, incl	0.35
Over 15.50 to 25.00, incl	0.42
Over 25.00 to 37.50, incl	0.50
Over 37.50 to 50.00, incl	0.62
Over 50.00 to 62.50, incl	0.75
Over 62.50 to 75.00, incl	0.88
Over 75.00 to 100.00, incl	1.12

3.3.4.4 Decarburization shall be measured by the microscopic method, by HR30N scale hardness testing method, or by the microhardness traverse method on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by decarburization on the adjacent surface. In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.

3.3.4.4.1 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 (0.12 mm) and the width is 0.065 inch (1.65 mm) or less.

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 AMS 2301 or MAM 2301.

3.4.2 Bars and tubing ordered hot rolled or cold drawn, or ground, turned, or polished, shall, after removal of the standard machining allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the ground, turned, or polished surface.

3.4.3 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 re-entrant flow.

3.5 Tolerances:

Bars shall conform to all applicable requirements of AMS 2251 or MAM 2251.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and 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), average grain size (3.3.2), hardenability (3.3.3), decarburization (3.3.4), frequency-severity cleanliness rating (3.4.1) and tolerances (3.5) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Grain flow of die forgings (3.4.3) is a periodic test and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 Bars, Flash Welded Rings, and Stock for Flash Welded Rings and Forging Stock: In accordance with AMS 2370.

4.3.2 Forgings: In accordance with AMS 2372.

4.4 Reports:

The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, macrostructure, hardenability and frequency-severity cleanliness rating of each heat and for tensile strength or hardness (as applicable) and the average grain size of each lot, and stating that the product conforms to all other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS 6322L, size and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.5 Resampling and Retesting:

Shall be as follows:

4.5.1 Bars, Flash Welded Rings, Forging Stock, and Stock for Flash Welded Rings: In accordance with AMS 2370.

4.5.2 Forgings: In accordance with AMS 2372.

5. PREPARATION FOR DELIVERY:

5.1 Sizes:

Except when exact lengths or multiples of exact lengths are ordered, straight bars will be acceptable in mill lengths of 6 to 20 feet (2 to 6 m), but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

5.2 Identification:

Shall be as follows:

5.2.1 Bars: In accordance with AMS 2806.

5.2.2 Forgings: In accordance with AMS 2808.

5.2.3 Flash Welded Rings and Stock for Forging or Flash Welded Rings: As agreed upon by purchaser and vendor.

5.3 Packaging:

The product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.3.1 Bars and flash welded rings ordered cold drawn, cold rolled, ground, turned, or polished shall be coated with a corrosion-preventive compound prior to shipment.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTION:

Material not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.



- 8.2 Tensile strength to hardness conversions are presented in ASTM A 370.
- 8.3 Hardness conversion tables for metals are presented in ASTM E 140.
- 8.4 The phrase "occasional grains as large as 3 permissible" has been deleted to clarify the intended use of ASTM E 112.
- 8.5 This new expression of the Jominy hardenability has been introduced to be consistent with the wording in ASTM A 255. This has not introduced a technical change unless indicated so by a change bar symbol.
- 8.6 Terms used in AMS are clarified in ARP1917.
- 8.7 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.
- 8.8 Purchase documents should specify not less than the following:
- AMS 6322L
Form and size of the product desired
Quantity of product desired

PREPARED UNDER THE JURISDICTION OF AMS COMMITTEE "E"

