

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6320M

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Superseding AMS 6320L

Steel Bars, Forgings, and Rings
0.50Cr - 0.55Ni - 0.25Mo (0.33 - 0.38C) (SAE 8735)

(Composition similar to UNS G87350)

RATIONALE

AMS 6320M results from a Five Year Review and update of this specification.

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, 0.75 inch (19.0 mm) and under in nominal section thickness at time of heat treatment, requiring a through-hardening steel capable of developing hardness as high as 40 HRC when properly hardened and tempered and for parts of greater thickness but requiring proportionally 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 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 724-776-4970 (outside USA), www.sae.org.

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

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AMS 7496	Rings, Flash Welded Carbon and Low-Alloy Steels
AS1182	Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Products

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 A 255	Determining Hardenability of Steel
ASTM A 370	Mechanical Testing of Steel Products
ASTM E 112	Determining 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, Steel Bars, Billets, Blooms, and Forgings
ASTM E 384	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 E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Carbon	0.33	0.38
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 (12.70 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides

Annealed and cold finished having tensile strength not higher than 120 ksi (827 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 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 (See 8.3).

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, rings 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

Section Size Square Inches	Section Size Square Centimeters	Macrographs
Up to 36, incl	Up to 232, incl	S2 - R1 - C2
Over 36 to 100, incl	Over 232 to 645, incl	S2 - R2 - C3

3.3.2 Average Grain Size

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112 (See 8.4).

3.3.3 Hardenability

Shall be J 5/16 inch (7.9 mm) = 45 HRC minimum and J 6/16 inch (9.52 mm) = 41 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at 1700 °F ± 10 (927 °C ± 6) and the test specimen austenitized at 1500 °F ± 10 (816 °C ± 6).

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 3.

TABLE 3A - MAXIMUM 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 - MAXIMUM 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
Over	76.20 to 101.60, incl	1.14

3.3.4.4 Decarburization shall be measured by the metallographic method, by the HR30N scale hardness testing method, or by a traverse method using microhardness testing in accordance with ASTM E 384. The hardness method(s) shall be conducted 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 any 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 (0.13 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.

3.4.2 Bars 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 reentrant grain flow.

3.5 Tolerances

Bars shall conform to all applicable requirements of AMS 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 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), tensile strength or hardness (3.2.1) as applicable, 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 a frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be as follows:

4.3.1 Bars, Flash Welded Rings, Forging Stock and Stock for Flash Welded Rings

In accordance with AMS 2370.

4.3.2 Forgings and Forging Stock

In accordance with AMS 2372.

4.4 Reports

4.4.1 The vendor of bars, forgings, and flash welded rings shall furnish with each shipment a report showing the results of composition, macrostructure, hardenability, and frequency-severity cleanliness rating of each heat and for tensile strength or hardness 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, AMS 6320M, product form, size, 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 The vendor of stock for forging or flash welded rings shall furnish with each shipment a report showing the results of tests for composition and frequency-severity cleanliness rating of each heat. This report shall include the purchase order number, heat number, AMS 6320M, product form, size, and quantity.

4.5 Resampling and Retesting

Shall be In accordance with the following:

4.5.1 Bars, Flash Welded Rings, Forging Stock, and Stock for Flash Welded Rings

In accordance with AMS 2370.