



# AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.  
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

## AMS 6442D

Superseding AMS 6442C

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### STEEL BARS AND FORGINGS 0.50Cr (0.98 - 1.10C) (SAE 50100) Bearing Quality

#### 1. SCOPE:

- 1.1 Form: This specification covers a bearing-quality, low-alloy steel in the form of bars, forgings, and forging stock.
- 1.2 Application: Primarily for parts of small cross-section, such as needle bearings, requiring a through hardening steel usually with hardness of approximately 60 HRC and subject to very rigid inspection standards.

#### 2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Standards (AS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers Inc., Two Pennsylvania Plaza, New York, New York 10001.

##### 2.1.1 Aerospace Material Specifications:

AMS 2251 - Tolerances, Alloy Steel Bars  
AMS 2259 - Chemical Check Analysis Limits, Wrought Low Alloy and Carbon Steels  
AMS 2350 - Standards and Test Methods  
AMS 2370 - Quality Assurance Sampling of Carbon and Low Alloy Steels, Wrought Products Except Forgings  
AMS 2372 - Quality Assurance Sampling of Carbon and Low Alloy Steels, Forgings and Forging Stock  
AMS 2375 - Approval and Control of Critical Forgings  
AMS 2808 - Identification, Forgings

##### 2.1.2 Aerospace Standards:

AS 1182 - Standard Machining Allowance, Aircraft Quality and Premium Quality Steel Products

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products  
ASTM E45 - Determining the Inclusion Content of Steels  
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron  
ASTM E381 - Rating Macroetched Steel

- 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

##### 2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

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3. TECHNICAL REQUIREMENTS:

- 3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E350, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

|            | min         | max   |
|------------|-------------|-------|
| Carbon     | 0.98 - 1.10 |       |
| Manganese  | 0.25 - 0.45 |       |
| Silicon    | 0.20 - 0.35 |       |
| Phosphorus | --          | 0.025 |
| Sulfur     | --          | 0.025 |
| Chromium   | 0.40 - 0.60 |       |
| Nickel     | --          | 0.25  |
| Molybdenum | --          | 0.06  |
| Copper     | --          | 0.35  |

- 3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2259, paragraph titled "Low Alloy Steels".

- 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:

- 3.2.1.1 Bars 0.500 In. (12.70 mm) and Under in Diameter or Distance Between Parallel Sides: Cold finished, with microstructure of spheroidized cementite in ferrite matrix, having tensile strength not higher than 120,000 psi (827 MPa) or equivalent hardness.

- 3.2.1.2 Bars Over 0.500 In. (12.70 mm) in Diameter or Distance Between Parallel Sides: Hot finished, with microstructure of spheroidized cementite in ferrite matrix, having hardness not higher than 207 HB or equivalent except that bars ordered cold finished may have hardness as high as 248 HB or equivalent.

- 3.2.2 Forgings: As ordered.

- 3.2.3 Forging Stock: As ordered by the forging manufacturer.

- 3.3 Properties: The product shall conform to the following requirements; hardness testing shall be performed in accordance with ASTM A370:

- 3.3.1 Inclusion Rating: Steel from which the product is produced shall be subjected to the macrostructure test and to either the fracture or microscopic test as agreed upon by purchaser and vendor. If agreement is not reached by purchaser and vendor, the microscopic test shall be performed.

- 3.3.1.1 Macrostructure: Visual examination of transverse sections from bars, billets, and forging stock, etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at 160 - 180 F (71.1 - 82.2 C) for sufficient time to develop a well defined macrostructure, shall show no injurious imperfections such as pipe, cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure standards shall be as agreed upon by purchaser and vendor.

- 3.3.1.2 Fracture: Specimens approximately 0.375 in. (9.52 mm) in thickness, shall be normalized, annealed, hardened, and fractured through the approximate center of the cross section. Such specimens shall show no injurious imperfections such as pipe, porosity, and segregation. No nonmetallic streaks over 1/8 in. (3.18 mm) in length and not more than one nonmetallic inclusion 1/16 - 1/8 in. (1.60 - 3.18 mm) in length shall be evident on the fractured surfaces of two or fewer specimens.

- 3.3.1.3 Microscopic Test: Radial specimens, approximately 0.28 sq in. (1.8 cm<sup>2</sup>) in surface area taken midway between center and surface of hardened fracture samples, shall be polished, on a face longitudinal to the direction of rolling, for micro-inclusion rating in accordance with the Jernkontoret chart, Method A, Plate I of ASTM E45. Two-thirds of all specimens and at least one from each ingot tested, as well as the average of all specimens, shall not exceed the following limits:

| Type  | Inclusion Rating, Worst Field |     |     |     |
|-------|-------------------------------|-----|-----|-----|
|       | A                             | B   | C   | D   |
| Thin  | 2.0                           | 2.0 | 2.0 | 1.5 |
| Heavy | 1.5                           | 1.5 | 1.5 | 1.5 |

- 3.3.2 Response to Heat Treatment: Specimens shall be protected by suitable means or treated in a neutral atmosphere to minimize scaling and prevent either carburization or decarburization during heat treatment. The specimens shall be placed in a furnace which is at 1525 F  $\pm$  10 (829.4 C  $\pm$  5.6), allowed to heat to 1525 F  $\pm$  10 (829.4 C  $\pm$  5.6), held at heat for 20 min., and quenched in commercial paraffin oil (100 SUS at 100 F (37.8 C)) at room temperature. The hardened specimens shall have substantially uniform hardness not lower than 60 HRC at any point below any permissible decarburization.

3.3.3 Decarburization:

- 3.3.3.1 Bars ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.
- 3.3.3.2 Allowable decarburization of bars ordered for redrawing or forging or to specified microstructural requirements other than spheroidized cementite in ferrite matrix shall be as agreed upon by purchaser and vendor.
- 3.3.3.3 Decarburization of bars for anti-friction balls and rollers to which 3.3.3.1 or 3.3.3.2 is not applicable shall be not greater than shown in Table I.

TABLE I

| Nominal Diameter or Distance<br>Between Parallel Sides<br>Inch | Depth of Decarburization, Inch |                  |
|----------------------------------------------------------------|--------------------------------|------------------|
|                                                                | Hot<br>Finished                | Cold<br>Finished |
| Up to 0.250, incl                                              | 0.005                          | 0.003            |
| Over 0.250 to 0.500, incl                                      | 0.006                          | 0.004            |
| Over 0.500 to 0.750, incl                                      | 0.008                          | 0.006            |
| Over 0.750 to 1.000, incl                                      | 0.010                          | 0.008            |

TABLE I (SI)

| Nominal Diameter or Distance<br>Between Parallel Sides<br>Millimeters | Depth of Decarburization<br>Millimeter |                  |
|-----------------------------------------------------------------------|----------------------------------------|------------------|
|                                                                       | Hot<br>Finished                        | Cold<br>Finished |
| Up to 6.35, incl                                                      | 0.13                                   | 0.08             |
| Over 6.35 to 12.70, incl                                              | 0.15                                   | 0.10             |
| Over 12.70 to 19.05, incl                                             | 0.20                                   | 0.15             |
| Over 19.05 to 25.40, incl                                             | 0.25                                   | 0.20             |

- 3.3.3.4 Decarburization of bars to which 3.3.3.1, 3.3.3.2, or 3.3.3.3 is not applicable shall be not greater than shown in Table II.

TABLE II

| Nominal Diameter or Distance<br>Between Parallel Sides<br>Inches | Depth of Decarburization, Inch |          |                  |
|------------------------------------------------------------------|--------------------------------|----------|------------------|
|                                                                  | Hot<br>Finished                | Annealed | Cold<br>Finished |
| Up to 1.000, incl                                                | 0.012                          | 0.015    | 0.012            |
| Over 1.000 to 2.000, incl                                        | 0.017                          | 0.022    | 0.015            |
| Over 2.000 to 3.000, incl                                        | 0.025                          | 0.030    | 0.025            |
| Over 3.000 to 4.000, incl                                        | 0.035                          | 0.045    | 0.035            |
| Over 4.000 to 5.000, incl                                        | 0.055                          | 0.065    | 0.055            |

TABLE II (SI)

| Nominal Diameter or Distance<br>Between Parallel Sides<br>Millimeters | Depth of Decarburization<br>Millimeters |          |                  |
|-----------------------------------------------------------------------|-----------------------------------------|----------|------------------|
|                                                                       | Hot<br>Finished                         | Annealed | Cold<br>Finished |
| Up to 25.40, incl                                                     | 0.30                                    | 0.38     | 0.30             |
| Over 25.40 to 50.80, incl                                             | 0.43                                    | 0.56     | 0.38             |
| Over 50.80 to 76.20, incl                                             | 0.64                                    | 0.76     | 0.64             |
| Over 76.20 to 101.60, incl                                            | 0.89                                    | 1.14     | 0.89             |
| Over 101.60 to 127.00, incl                                           | 1.40                                    | 1.65     | 1.40             |

- 3.3.3.5 Limits for depth of decarburization of bars over 5.000 in. (127.00 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.
- 3.3.3.6 Decarburization shall be measured by the microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on hardened but untempered specimens 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 or lack of decarburization thereon.
- 3.3.3.6.1 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 in. (0.13 mm) and the width is 0.065 in. (1.65 mm) or less.
- 3.4 Quality: Steel shall be bearing quality. The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.
- 3.4.1 Bars ordered ground, turned, or polished shall be free from seams, laps, tears, and cracks open to the ground, turned, or polished surfaces.
- 3.4.2 Product ordered to surface conditions other than ground, turned or polished shall, after removal of the standard machining allowance, be free from seams, laps, tears, cracks, and other defects exposed to the machined surfaces. Standard machining allowances shall be in accordance with AS 1182.
- 3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, bars will be acceptable in mill lengths of 6 - 20 ft (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 m).
- 3.6 Tolerances: Unless otherwise specified, tolerances for bars shall conform to all applicable requirements of AMS 2251.