

# AEROSPACE MATERIAL SPECIFICATION

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Superseding AMS 6528

Submitted for recognition as an American National Standard

STEEL, BARS  
0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)  
Special Aircraft Quality Cleanliness  
Normalized

UNS G41300

## 1. SCOPE:

### 1.1 Form:

This specification covers a special aircraft-quality, low-alloy steel in the form of bars.

### 1.2 Application:

These bars have been used typically for parts required to meet stringent magnetic inspection criteria, having sections 0.50 inch (12.7 mm) and under in nominal thickness at time of heat treatment, and requiring a through-hardening steel capable of developing hardness as high as 35 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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

### 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 2304 Special Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
- MAM 2304 Special Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement

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## 2.1 (Continued):

- AMS 2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock
- AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels, Corrosion and Heat Resistant Steels and Alloys
- AS1182 Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-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 Steel Bars, Billets, Blooms, and Forgings

## 2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

- MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

## 3. TECHNICAL REQUIREMENTS:

## 3.1 Composition:

(R)

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     | 0.28 | 0.33  |
| Manganese  | 0.40 | 0.60  |
| Silicon    | 0.15 | 0.35  |
| Phosphorus | --   | 0.015 |
| Sulfur     | --   | 0.008 |
| Chromium   | 0.80 | 1.10  |
| Molybdenum | 0.15 | 0.25  |
| Nickel     | --   | 0.25  |
| Copper     | --   | 0.35  |

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

3.2 Condition:

3.2.1 Hot rolled and normalized at 1700 °F ± 25 (927 °C ± 14).

3.2.1.1 When specified, either a cold drawn or cold finished surface shall be supplied.

3.2.1.1.1 Cold finished surface shall be produced by turning, grinding, polishing, or burnishing, or combination thereof; surface hardness shall be not more than 3 points HRC harder than hardness at mid-radius, determined in accordance with ASTM A 370.

3.2.1.2 Cold finished surface may be supplied when cold drawn, hot rolled, or no surface condition is specified.

3.2.1.3 Cold drawn surface may be supplied when hot rolled or no surface condition is specified.

3.3 Properties:

Bars shall conform to the following requirements; hardness testing shall conform to ASTM A 370:

3.3.1 Macrostructure: Visual examination of transverse full cross-sections from bars and (R) billets, 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

| Cross-Sectional Area<br>Square Inches | Cross-Sectional Area<br>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 (R) ASTM E 112 (See 8.2).

3.3.3 Hardenability: Shall be J34=5 minimum and J27=8 minimum, determined in accordance with ASTM A 255 except that the normalizing temperature shall be 1700 °F ± 10 (927 °C ± 6).

## 3.3.4 Decarburization:

- 3.3.4.1 Bars ordered ground, turned, or polished shall be free from decarburization on the (R) ground, turned, or polished surfaces.
- 3.3.4.2 Allowable decarburization of bars and billets ordered for redrawing or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.
- 3.3.4.3 Decarburization of bars 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, Inch/Pound Units

| Nominal Thickness or Distance<br>Between Parallel Sides<br>Inches | Depth of<br>Decarburization<br>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, SI Units

| Nominal Thickness or Distance<br>Between Parallel Sides<br>Millimeters | Depth of<br>Decarburization<br>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 microscopic method or by the HR30N scale (R) 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 decarburization thereon.

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:

Bars, 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 bars.

3.4.1 Steel shall be special aircraft-quality conforming to AMS 2304 or MAM 2304 (See 8.3). (R)

3.4.2 Bars, ordered hot rolled or cold drawn, or ground, turned, or polished, shall, after (R) 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 surfaces.

#### 3.5 Tolerances:

(R) Shall conform to all applicable requirements of AMS 2251 or MAM 2251.

#### 4. QUALITY ASSURANCE PROVISIONS:

##### 4.1 Responsibility for Inspection:

The vendor of bars 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 bars conform 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) hardenability (3.3.3), decarburization (3.3.4), and frequency-severity cleanliness rating (3.4.1) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Cold finished surface hardness (3.2.1.1.1) 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:

(R)

Shall be in accordance with AMS 2370 and the following:

4.3.1 Samples for frequency-severity cleanliness rating (3.4.1) shall conform to AMS 2304 or MAM 2304.

#### 4.4 Reports:

(R)

The vendor of bars shall furnish with each shipment a report showing the results of tests for chemical composition, macrostructure, average grain size, hardenability, and frequency-severity cleanliness rating of each heat. This report shall include the purchase order number, heat and lot number, AMS 6528A, size, and quantity.

#### 4.5 Resampling and Retesting:

Shall be in accordance with AMS 2370 except that resampling for cleanliness shall conform to 4.5.1.

4.5.1 If any specimen fails to meet the specified frequency-severity cleanliness requirements, the entire heat shall be rejected or resampling and retesting shall be performed as follows:

4.5.1.1 Nonconforming Ingot(s): Reject or take additional discard and resample and retest.

4.5.1.2 Ingot(s) Not Originally Sampled: Sample and test material from the respective nonconforming position(s), i.e., top or bottom of two additional ingots for each nonconforming ingot. The ingots selected for additional samples shall be from locations in the pouring plate pattern closest to the nonconforming ingot(s).

4.5.1.3 If the nonconforming ingot fails the retest, repeat 4.5.1.1.

4.5.1.4 If all ingots sampled as in 4.5.1.2 meet the frequency-severity cleanliness requirements, the heat, except for original nonconforming ingot(s), is acceptable.

4.5.1.5 If any of the ingots sampled as in 4.5.1.2 fail to meet the frequency-severity cleanliness requirements, the heat shall be rejected or each ingot shall be tested at the nonconforming positions and acceptance of each ingot shall be based on the tests thereon.

4.5.1.6 All steel shall be either from ingots which successfully met the frequency-severity cleanliness requirements, top and bottom, or from ingots and positions represented by successfully tested ingots.