

# AEROSPACE MATERIAL SPECIFICATION



**AMS 6424D**

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Superseding AMS 6424C

Steel Bars, Forgings, and Tubing  
0.80Cr - 1.8Ni - 0.25Mo (0.49 - 0.55C)

K22950

## 1. SCOPE:

### 1.1 Form:

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

### 1.2 Application:

These products have been used primarily for parts 3.5 in. (90 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 and also for parts with thicker cross-section which require 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 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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or [www.sae.org](http://www.sae.org).

AMS 2251 Tolerances, Low-Alloy Steel Bars  
AMS 2253 Tolerances, Carbon and Alloy Steel Tubing  
AMS 2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels  
AMS 2301 Steel Cleanliness, Aircraft Quality, Magnetic Particle Inspection Procedure

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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 2372 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steels, Forgings
- AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Heat Corrosion Resistant Steels and Alloys
- AMS 2808 Identification, Forgings
- 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 or [www.astm.org](http://www.astm.org).

- ASTM A 255 Determining Hardenability of Steels
- 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, 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      | 0.49 | 0.55  |
| Manganese   | 0.65 | 0.85  |
| Silicon     | 0.15 | 0.35  |
| Phosphorous | -    | 0.025 |
| Sulfur      | -    | 0.025 |
| Chromium    | 0.70 | 0.90  |
| Nickel      | 1.65 | 2.00  |
| Molybdenum  | 0.20 | 0.30  |
| Copper      | -    | 0.35  |

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259, except that variations for carbon shall apply to over max only.

### 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 135 ksi (930 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 255 HB, or equivalent (See 8.3). Bars ordered cold finished may have hardness as high as 277 HB, or equivalent.

3.2.2 Forgings: As ordered

3.2.3 Mechanical Tubing: Cold finished, unless otherwise ordered, having hardness not higher than 28 HRC, or equivalent (See 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 23 HRC, or equivalent.

3.2.4 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 A 370:

3.3.1 Macrostructure: Visual examination of transverse full cross-sections from bars, billets, tube rounds, and forging stock, etched in hot hydrochloric acid in accordance with ASTM E 381 for sufficient time to develop a well-defined macrostructure, 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 | Cross-Sectional Area<br>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 No. 5 or finer determined in accordance with ASTM E 112.

3.3.3 Hardenability: Shall be J 2/16 inch (3.175 mm) = 62 HRC min and J 12/16 inch (19.050 mm) = 55 HRC min, 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 (925 °C ± 5) and the test specimen austenitized at 1525 °F ± 10 (830 °C ± 5).

3.3.4 Decarburization:

3.3.4.1 Bars and tubing 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, billets, and tube rounds 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 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 Diameter or Distance<br>Between Parallel Sides<br>Inches | Total 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 Diameter or Distance<br>Between Parallel Sides<br>Millimeters | Total Depth of<br>Decarburization<br>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 of tubing to which 3.3.4.1 or 3.3.4.2 is not applicable shall be not greater than shown in Table 4.

TABLE 4A - Maximum Decarburization, Inch Pound Units

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

TABLE 4B - Maximum Decarburization, SI Units

| Nominal Wall Thickness<br>Millimeters | Total Depth of<br>Decarburization<br>Millimeter<br>ID | Total Depth of<br>Decarburization<br>Millimeter<br>OD |
|---------------------------------------|-------------------------------------------------------|-------------------------------------------------------|
|                                       |                                                       |                                                       |
| Up to 2.75, incl                      | 0.20                                                  | 0.38                                                  |
| Over 2.75 to 5.00, incl               | 0.25                                                  | 0.50                                                  |
| Over 5.00 to 10.00, incl              | 0.30                                                  | 0.62                                                  |
| Over 10.00 to 15.00, incl             | 0.38                                                  | 0.75                                                  |
| Over 15.00 to 25.00, incl             | 0.42                                                  | 0.88                                                  |
| Over 25.00                            | 0.50                                                  | 1.00                                                  |

- 3.3.4.5 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.

- 3.3.4.5.1 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.

3.4.2 Bars and mechanical 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 grain flow.

### 3.5 Tolerances:

Shall be as follows:

3.5.1 Bars: Shall conform to the applicable requirements of AMS 2251.

3.5.2 Mechanical Tubing: Shall conform to the applicable requirements of AMS 2253.

## 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), 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, Mechanical Tubing and Forging Stock: In accordance with AMS 2370.

4.3.2 Forgings: In accordance with AMS 2372.