

# AEROSPACE MATERIAL SPECIFICATION

**SAE AMS6484**

**REV. D**

Issued 1995-06  
Revised 2012-07

Superseding AMS6484C

Steel, Bars, Forgings, and Tubing  
0.80Cr - 1.8Ni - 0.25Mo (0.38 - 0.43C) (SAE 4340)  
Normalized and Tempered

(Composition similar to UNS G43406)

## RATIONALE

AMS6484D 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, mechanical tubing, and forging stock.

#### 1.2 Application

These products have been used typically for parts, 3.5 inch (89 mm) and under in nominal thickness at time of heat treatment, requiring a through-hardening steel capable of developing a minimum hardness of 40 HRC when properly hardened and tempered and also for parts of greater thickness requiring proportionately lower hardness, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking after heat treatment; ARP1110 recommends practices to minimize such conditions.

### 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.

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## 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](http://www.sae.org).

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| AMS2251    | Tolerances, Low-Alloy Steel Bars                                                                                                          |
| AMS2253    | Tolerances, Carbon and Alloy Steel Tubing                                                                                                 |
| AMS2259    | Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels                                                                       |
| AMS2301    | Steel Cleanliness, Aircraft Quality Magnetic Particle Inspection Procedure                                                                |
| AMS2370    | Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock                                     |
| AMS2372    | Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings                                                               |
| AMS2806    | Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys |
| AMS2808    | Identification, Forgings                                                                                                                  |
| AMS-H-6875 | Heat Treatment of Steel Raw Materials                                                                                                     |
| AS1182     | Standard Stock Removal Allowance, Aircraft Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing                          |
| ARP1110    | Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion Resistant Steels and Alloys                                 |

## 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](http://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 | Knoop and Vickers 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     | 0.38 | 0.43  |
| Manganese  | 0.65 | 0.85  |
| Silicon    | 0.15 | 0.35  |
| Phosphorus | --   | 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 AMS2259.

#### 3.2 Condition

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

##### 3.2.1 Bars

Normalized and tempered in accordance with AMS-H-6875 having hardness at mid-radius not higher than 322 HB, or equivalent (See 8.2). Bar shall not be cut from plate. (Also see 4.4.2.)

3.2.1.1 Unless a surface finish is specified, the surface may be furnished hot finished or cold drawn.

##### 3.2.2 Forgings

Normalized and tempered in accordance with AMS-H-6875 having hardness not higher than 322 HB, or equivalent (See 8.2).

##### 3.2.3 Mechanical Tubing

Normalized and tempered having hardness not higher than 322 HB, or equivalent (See 8.2). Tubing 1.0 inch (25 mm) and under in nominal OD shall be cold reduced; larger sizes shall be hot rolled.

##### 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 (solid, not hollow), and forging stock, 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 - C2 |
| Over 100 to 133, incl                 | Over 645 to 858, incl                      | S2 - R2 - C3 |
| Over 133                              | Over 858                                   | Note 1       |

Note 1 Limits for larger sizes shall be agreed upon by purchaser and vendor. The purchaser shall have written approval of the agreement from the cognizant engineering organization.

3.3.1.1 If tubes are produced directly from ingots or large blooms, transverse sections may be taken from the tubes rather than tube rounds. Macroetch standards for such tubes shall be as agreed upon by purchaser and vendor.

### 3.3.2 Average Grain Size of Bars, Forgings and Tubing

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112.

### 3.3.3 Hardenability of Each Heat

Shall be J 12/16 inch (19 mm) = 53 HRC minimum, J 20/16 inch (32 mm) = 50 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at  $1600\text{ }^{\circ}\text{F} \pm 10$  ( $871\text{ }^{\circ}\text{C} \pm 6$ ) and the specimen austenitized at  $1550\text{ }^{\circ}\text{F} \pm 10$  ( $843\text{ }^{\circ}\text{C} \pm 6$ ).

### 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. Decarburization on tubing ID shall not exceed the maximum depth specified in Table 4.

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 TOTAL DEPTH OF 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 TOTAL DEPTH OF 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 15.65, incl                                             | 0.36                                             |
| Over 15.65 to 25.00, incl                                             | 0.43                                             |
| Over 25.00 to 37.50, incl                                             | 0.51                                             |
| Over 37.50 to 50.00, incl                                             | 0.64                                             |
| Over 50.00 to 62.50, incl                                             | 0.76                                             |
| Over 62.50 to 75.00, incl                                             | 0.89                                             |
| Over 75.00 to 100.00, incl                                            | 1.14                                             |

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 TOTAL DEPTH OF DECARBURIZATION, INCH/POUND UNITS

| Nominal Wall Thickness<br>Inches | Total Depth<br>ID<br>Inch | Total Depth<br>OD<br>Inch |
|----------------------------------|---------------------------|---------------------------|
| 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 TOTAL DEPTH OF DECARBURIZATION, SI UNITS

| Nominal Wall Thickness<br>Millimeters | Total Depth<br>ID<br>Millimeter | Total Depth<br>OD<br>Millimeter |
|---------------------------------------|---------------------------------|---------------------------------|
| Up to 2.75, incl                      | 0.20                            | 0.38                            |
| Over 2.75 to 5.00, incl               | 0.25                            | 0.51                            |
| Over 5.00 to 10.00, incl              | 0.30                            | 0.64                            |
| Over 10.00 to 15.00, incl             | 0.35                            | 0.76                            |
| Over 15.00 to 25.00, incl             | 0.40                            | 0.89                            |
| Over 25.00                            | 0.50                            | 1.02                            |

3.3.4.5 Decarburization shall be measured by the metallographic method or by HR30N scale hardness testing method, or by 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 (0.13 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 AMS2301, except specimens containing nonmetallic inclusions over one inch (25 mm) in length shall be subject to rejection.

3.4.2 Bars and mechanical tubing ordered hot rolled or cold drawn, or ground, turned, or polished shall, after removal of the standard stock removal 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 that contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

### 3.5 Tolerances

#### 3.5.1 Bars

In accordance with AMS2251.

#### 3.5.2 Mechanical Tubing

In accordance with AMS2253.

## 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

#### 4.3.1 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.

#### 4.3.2 Forgings

In accordance with AMS2372.