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Superseding AMS 6294F

**Steel Bars and Forgings, Carburizing  
1.8Ni - 0.25Mo (0.17 - 0.22C) (SAE 4620)**

(Composition similar to UNS G46200)

**1. SCOPE:**

**1.1 Form:**

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

**1.2 Application:**

These products have been used typically for carburized parts which require high minimum core hardness and allow wide hardness range in sections 0.375 inch (9.5 mm) and under in nominal thickness, but usage is not limited to such applications. The core may or may not be machinable after hardening.

**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 canceled 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.

- 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 2301 Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure
- MAM 2301 Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
- AMS 2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel, Wrought Products and Forging Stock

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## 2.1 (Continued):

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 Heat and Corrosion and Heat 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.

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

## 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 or by spectrographic methods, or by other analytical methods acceptable to purchaser:

TABLE 1 - Composition

Element	min	max
Carbon	0.17	0.22
Manganese	0.45	0.65
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Nickel	1.65	2.00
Molybdenum	0.20	0.30
Chromium	--	0.20
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 unless another condition is authorized by purchaser; 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: Cold finished having tensile strength not higher than 130 ksi (895 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, unless otherwise ordered, having hardness not higher than 229 HB, or equivalent. Bars ordered cold finished may have hardness as high as 241 HB or equivalent (See 8.3).

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 A 370:

3.3.1 Macrostructure: Visual examination of transverse full cross-sections from bars, billets, 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 macrograph ratings 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 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 5 or finer determined in accordance with ASTM E 112 (See 8.4).

3.3.3 Hardenability: Shall be J1/16 inch (1.6 mm) = 48 HRC maximum and J3/16 inch (4.8 mm) = 27 HRC minimum (See 8.5), 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 1700 °F ± 10 (925 °C ± 6).

### 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 or MAM 2301.

3.4.2 Bars and 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 reentrant flow.

### 3.5 Tolerances:

3.5.1 Bars: In accordance with AMS 2251 or MAM 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 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) 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: 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 and Forging Stock: In accordance with AMS 2370.

4.3.2 Forgings: In accordance with AMS 2372.