AEROSPACE MATERIAL SPECIFICATION

AMS6292™	REV. L

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Superseding AMS6292K

Steel Bars and Forgings and Forging Stock, Carburizing, Aircraft Quality, 1.8Ni - 0.25Mo - (0.15 - 0.20C), (SAE 4617) (Composition similar to UNS G46170)

RATIONALE

AMS6292L is the result of a Five-Year review and update of the specification. The revision updates the Title to include form and quality, adds composition reporting information (see 3.1.2), provides guidance on exceptions (see 8.8), updates macrostructure requirements (see 3.3.1.1 and 8.9), updates hardenability (see 3.3.3), incorporates changes in AMS2301 test frequency (see 4.2.1, 4.4.3, and 4.4.5), adds the optional testing of forging stock (see 4.4.3 and 8.9), and adds guidance for ordering bar (see 8.7).

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 that require intermediate minimum core hardness and allow wide hardness range in sections 0.25 inch (6 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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6292L/

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2251 Tolerances, Low-Alloy Steel Bars

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

AS1182 Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel, Bars and Mechanical Tubing

AS7766 Terms Used in Aerospace Metals Specifications

J404 Chemical Compositions of SAE Alloy Steels

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.

ASTM A255 Determining Hardenability of Steel

ASTM A370 Mechanical Testing of Steel Products

ASTM A751 Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

ASTM E112 Determining Average Grain Size

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E381 Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.15	0.20
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 Aluminum, vanadium, and columbium (niobium) are optional grain refining elements and need not be determined or reported unless used to satisfy the average grain size requirements of 3.3.

3.1.2 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.5. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.3 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

The product shall be supplied in the following condition unless another condition is authorized by the purchaser; hardness and tensile strength shall be determined in accordance with ASTM A370:

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 shall be cold finished having tensile strength not higher than 125 ksi (860 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 shall be hot finished, unless otherwise ordered, having hardness not higher than 229 HBW, or equivalent (see 8.3). Bars ordered cold finished may have hardness as high as 241 HBW, or equivalent (see 8.3).

3.2.1.3 Bar shall not be cut from plate (see 4.4.2).

3.2.2 Forgings

Forgings shall be as ordered.

3.2.3 Forging Stock

Forging stock shall be 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 Macrostructure

Visual examination of transverse full cross sections from bars, billets, and forging stock, etched in hot hydrochloric acid in accordance with ASTM E381, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E381 shown in Table 2.

Table 2 - Macrostructure limits

Cross-Sectional Area Square Inches	Cross-Sectional Area Square Centimeters	Macrographs
Up to 36, incl	Up to 230, incl	S2 - R1 - C2
Over 36 to 133, incl	Over 230 to 858, incl	S2 - R2 - C3
Over 133	Over 858	Note 1
Note 1: Limits for larger sizes shall be agreed upon by the purchaser and producer.		

3.3.1.1 Macrostructure examination is not required for bored/hollow forgings (including ring forgings) that are produced directly from ingots or large blooms (see 8.10).

3.3.2 Average Grain Size of Bars and Forgings

Average grain size shall be determined by either 3.3.2.1 or 3.3.2.2.

3.3.2.1 The average grain size shall be ASTM No. 5 or finer determined in accordance with ASTM E112.

3.3.2.2 The product of a heat shall be considered to have an ASTM No. 5 or finer austenitic grain size if one or more of the following are determined by heat analysis (see 8.8):

- A total aluminum content of 0.020 to 0.050%
- An acid soluble aluminum content of 0.015 to 0.050%
- A vanadium content of 0.02 to 0.08%
- A columbium (niobium) content of 0.02 to 0.05%

3.3.3 Hardenability of Each Heat

Hardenability shall be J 1/16 inch (1.6 mm) = 46 HRC maximum and J 2/16 inch (3.1 mm) = 30 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A255, except that the steel shall be normalized at 1700 °F ± 10 °F (925 °C ± 6 °C) and the test specimen austenitized at 1700 °F ± 10 °F (925 °C ± 6 °C). Cast specimens do not need to be normalized.

3.4 Quality

The product as received by the 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.

3.4.2 Bars shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

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 flow.

3.5 Tolerances

Bars shall conform to AMS2251.

3.6 Any exceptions shall be authorized by the purchaser and reported as in 4.4.4.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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 (see 3.1), condition (see 3.2), macrostructure (see 3.3.1), average grain size (see 3.3.2), hardenability (see 3.3.3), frequency-severity cleanliness rating (see 3.4.1), and tolerances (see 3.5) are acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (see 3.3.2.2) are not present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on each lot. If process qualification in accordance with AMS2301 has been met, the frequency-severity cleanliness rating shall be conducted on a periodic basis as defined in AMS2301.

4.2.2 Periodic Tests

If grain refining elements (see 3.3.2.2) are present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on a periodic basis and shall be performed at a frequency selected by the producer (not to exceed 1 year) unless frequency of testing is specified by the purchaser. Grain flow of die forgings (see 3.4.3) is a periodic test and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

4.3.1 Bars and Forging Stock

Bars and forging stock shall be in accordance with AMS2370.

4.3.2 Forgings

Forgings shall be in accordance with AMS2372.

4.4 Reports

4.4.1 The producer of bars and forgings shall furnish with each shipment a report showing the producer's identity; the country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations); the results of tests for composition, macrostructure, and hardenability; frequency-severity cleanliness rating of each heat (see 4.4.5), and of condition and, if measured, average grain size of each lot; and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS6292L, product form and size or part number, and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included. If the grain size requirement of 3.3.1.2 is met by the aluminum, vanadium, and/or columbium (niobium) content, the aluminum, vanadium, and/or columbium (niobium) content shall be reported and a statement that the chemistry satisfies the grain size requirement shall be included.

4.4.2 Report the nominal metallurgically worked cross-sectional size and the cut size, if different (see 3.2.1.3).

4.4.3 The producer of forging stock shall furnish with each shipment a report showing the producer's identity; the country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations); the results of tests for composition, macrostructure, and hardenability; the results of any additional property requirements imposed by the purchase order (see 8.10); and frequency-severity cleanliness rating of each heat (see 4.4.5). This report shall include the purchase order number, heat number, AMS6292L, size, and quantity.