AEROSPACE MATERIAL SPECIFICATION

AMS6493™	REV. C

Issued 2009-09
Revised 2024-12

Superseding AMS6493B

Steel Bars, Forgings, Tubing, and Forging Stock
1.0Cr - 3.25Ni - 0.40Mo (0.17 - 0.22C)
Electroslag Remelted or Consumable Electrode Vacuum Remelted
Premium Aircraft Quality
(Composition similar to UNS K41910)

RATIONALE

AMS6493C is the result of a Five-Year Review and update of the specification. The revision clarifies composition reporting (see 3.1.1), revises macrostructure requirements (see 3.4.1 and 8.7), clarifies grain size requirements (see 3.4.2), adds ordering information for forging stock (see 4.4.3 and 8.7), adds guidance on ordering bar stock (see 8.5), and updates the exceptions prohibition (see 4.4.4 and 8.7).

1. SCOPE

1.1 Form

This specification covers a premium 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 carburized parts requiring high minimum core hardness with a narrow range, reduced distortion, and subject to stringent magnetic particle inspection standards, but usage is not limited to such applications.

1.3 Classification

Steel covered by this specification is classified by melting practice as follows:

Type 1 Electroslag remelted (ESR)

Type 2 Consumable electrode vacuum remelted (VAR)

1.3.1 Unless a specific type is ordered, either type may be supplied.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6493C/

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 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

AMS2253 Tolerances, Carbon and Alloy Steel Tubing

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

AMS2300 Steel Cleanliness, Premium 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

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 A370 Mechanical Testing of Steel Products

ASTM A604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets

ASTM A751 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

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

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

Table 1 - Composition

Element	Min	Max
Carbon	0.17	0.22
Manganese	0.30	0.60
Silicon	--	0.40
Phosphorus	--	0.020
Sulfur	--	0.015
Chromium	0.80	1.20
Nickel	3.00	3.50
Molybdenum	0.30	0.60

3.1.1 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. 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.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Melting Practice

Steel shall be multiple melted using either electroslag remelt practice (ESR) Type 1 or vacuum arc consumable electrode practice (VAR) Type 2 in the remelt cycle (see 1.3).

3.3 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.3.1 Bars

3.3.1.1 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 138 ksi (950 MPa) or hardness not higher than 285 HBW, or equivalent (see 8.2).

3.3.1.2 Bars over 0.500 inch (12.70 mm) in nominal diameter or least distance between parallel sides shall be hot finished and annealed, unless otherwise ordered, having hardness not higher than 285 HBW, or equivalent (see 8.2). Bars ordered cold finished may have hardness as high as 310 HBW, or equivalent (see 8.2).

3.3.1.3 Bars shall not be cut from plate.

3.3.2 Forgings

Forgings shall be supplied as ordered.

3.3.3 Mechanical Tubing

Mechanical tubing shall be cold finished, unless otherwise ordered, having hardness not higher than 285 HBW, or equivalent (see 8.2). Tubing ordered hot finished and annealed or tempered shall have hardness not higher than 285 HBW, or equivalent (see 8.2).

3.3.4 Forging Stock

Forging stock shall be supplied as ordered by the forging manufacturer.

3.4 Properties

The product shall conform to the following requirements; hardness, tensile, and impact testing shall be performed in accordance with ASTM A370:

3.4.1 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 A604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM A604 shown in Table 2.

Table 2 - Macrostructure limits

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	B
4	Ring Pattern	B

3.4.1.1 Macrostructure examination is not required for bored/hollow forgings (including ring forgings) and mechanical tubing that are produced directly from ingots or blooms unless specified by the purchaser, in which case the purchaser shall specify standards to be used (see 8.7).

3.4.1.2 If mechanical tubing is produced directly from ingots or large blooms, transverse sections may be taken from the tubing. Macroetch standards for such tubes shall be as agreed upon by the purchaser and producer (see 8.7).

3.4.2 Average Grain Size

Average austenitic grain size shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.4.3 Response to Heat Treatment

3.4.3.1 Bars, Forgings, and Mechanical Tubing

Specimens from product shall have the properties shown in Table 3 after being austenitized by heating to 1515 °F ± 25 °F (824 °C ± 14 °C), holding at heat for a time commensurate with section thickness, heating equipment, and procedure used, and oil quenched to below 90 °F (32 °C) followed by tempering for 2 hours minimum at 285 °F ± 10 °F (141 °C ± 6 °C).

Table 3 - Minimum longitudinal mechanical properties

Property	Value
Tensile Strength	196 ksi (1350 MPa)
Yield Strength 0.2%	152 ksi (1050 MPa)
Elongation in 4D	11%
Charpy V-Notch	44 ft-lb (60 J)

3.4.3.1.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (±0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 in/in (0.05 and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min).

3.4.3.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.4.3.1, specimens taken from the heat-treated coupon shall conform to the requirements of 3.4.3.1. If specimens taken from the stock after heat treatment as in 3.4.3.1 conform to the requirements of 3.4.3.1, tests shall be accepted as equivalent to tests of a forged coupon.

3.5 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.

3.5.1 Steel shall be premium aircraft-quality conforming to AMS2300.

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

3.5.3 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.

3.6 Tolerances

3.6.1 Bar tolerances shall be in accordance with AMS2251.

3.6.2 Mechanical tubing tolerances shall be in accordance with AMS2253.

3.7 Exceptions

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 3.3), macrostructure (see 3.4.1), average grain size (see 3.4.2), response to heat treatment (see 3.4.3.1), and tolerances (see 3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Frequency-severity cleanliness rating (see 3.5.1), grain flow of die forgings (see 3.5.3), and response to heat treatment of forging stock (see 3.4.3.2) are periodic tests 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, Mechanical Tubing, and Forging Stock

Sampling and testing shall be in accordance with AMS2370.