SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS6539

Issued 2013-02

Steel Bars, Forgings, and Tubing
1.7Cr – 3.8Ni – 0.3Mo (0.32 – 0.38 C)
Aircraft-Quality

(Composition similar to UNS K54532)

RATIONALE

AMS6539 is a new specification to cover aircraft-quality UNS K54532.

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 carburized parts requiring high minimum core hardness with a narrow range, reduced distortion and subject to magnetic particle inspection standards, 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.

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**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS6539

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.

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

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

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 A 255 Determining Hardenability of Steel

ASTM A 370 Mechanical Testing of Steel Products

ASTM E 381 Macroetch Testing Steel Bars, Billets, Blooms and Forgings

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 384 Knoop and Vickers Hardness of Materials

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the following 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	0.32	0.40
Manganese	0.30	0.60
Silicon	0.15	0.40
Phosphorus	--	0.025
Sulfur	--	0.015
Chromium	1.60	2.00
Nickel	3.60	4.10
Molybdenum	0.25	0.60
Copper	--	0.20

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 and tensile strength shall be determined in accordance with ASTM A 370:

3.2.1 Bars

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

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 142 ksi (980 MPa) or hardness not higher than 295 HB or equivalent (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 and annealed, unless otherwise ordered, having hardness not higher than 295 HB or equivalent (See 8.2). Bars ordered cold finished may have hardness as high as 310 HB or equivalent (See 8.2).

3.2.2 Forgings

As ordered.

3.2.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 295 HB, or equivalent (See 8.2). Tubing ordered hot finished and annealed or tempered shall have hardness not higher than 295 HB or equivalent (See 8.2).

3.2.4 Forging Stock

As ordered by the forging manufacturer.

3.3 Properties

The product shall conform to the following requirements; hardness, tensile, and impact 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 Square Inches	Cross-Sectional Area Square Centimeters	Macrographs
Up to 36, incl	Up to 232, incl	S2 - R1 - C2
Over 36 to 133, incl	Over 232 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 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 Response to Heat Treatment of Bars, Forgings, Tubing and Forging Stock

Specimens extracted from the product shall have the properties shown in Table 3 for both tempering temperatures after being austenitized by heating to 1607 °F ± 25 (875 °C ± 14), holding at heat for a time commensurate with section thickness, heating equipment, and procedure used. Specimens to be tempered at 392 °F (210 °C) shall be air quenched to below 90 °F (32 °C), cooled to -100 °F (-73 °C) or colder, holding at that temperature for not less than two hours and warmed in air to room temperature. Specimens to be tempered at 1040 °F (560 °C) shall be air quenched to below 90 °F (32 °C). All specimens shall be tempered for 2 hours minimum.

TABLE 3 – MINIMUM LONGITUDINAL MECHANICAL PROPERTIES

Tempering temperature	PROPERTY	Value
392 °F ± 10 (210 °C ± 6)	Tensile Strength	254 ksi (1750 MPa)
	Yield Strength 0.2%	203 ksi (1400 MPa)
	Elongation in 4D	8%
	Charpy V–notch	14 ft-lb (19 J)
1040 °F ± 10 (560 °C ± 6)	Tensile Strength	178 ksi (1230 MPa)
	Yield Strength 0.2%	152 ksi (1050 MPa)
	Elongation in 4D	12%
	Charpy V–notch	26 ft-lb (35 J)

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.

3.4.2 Bars and mechanical tubing ordered hot finished or cold finished 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 machined, 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), response to heat treatment for both tempering temperatures (3.3.3), 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.

4.4 Reports

4.4.1 The vendor of the bars, forgings and tubing shall furnish with each shipment a report showing the results of tests for composition macrostructure, response to heat treatment and frequency-severity cleanliness rating of each heat, and for condition, 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, AMS6539 product form and size (and/or part number, if applicable) and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.