SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS6497

Issued 2009-09

Steel Bars, Forgings, and Tubing, Nitriding
1.4Cr – 1.2Mo – 0.3V (0.29 – 0.36C)
Premium Aircraft-Quality for Bearing Applications
Electroslag Remelted or Consumable Electrode Vacuum Remelted

(Composition similar to UNS K23280)

RATIONALE

AMS6497 is a new specification to cover premium aircraft-quality UNS K23280.

1. SCOPE

1.1 Form

This specification covers a nitriding grade of 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 nitrided parts such as bearings, operating under heavy loads and high speeds at moderate temperatures, and subject to very rigid inspection standards, and requiring highest surface hardness, high core toughness, and less distortion than parts made from steel requiring quenching to case harden, 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.

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)
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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS6497

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
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

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 A 604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
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 Microindentation 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	0.29	0.36
Manganese	0.70	1.20
Silicon	--	0.30
Phosphorus	--	0.015
Sulfur	--	0.005
Chromium	1.10	1.60
Nickel	0.50	1.00
Molybdenum	0.90	1.40
Vanadium	0.20	0.40
Aluminum	0.10	0.30

3.1.1 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) or vacuum arc consumable electrode practice (VAR) 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 A 370:

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

Cold finished having tensile strength not higher than 138 ksi (950 MPa) or hardness not higher than 285 HB 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

Hot finished and annealed, unless otherwise ordered, having hardness not higher than 285 HB or equivalent (See 8.2). Bars ordered cold finished may have hardness as high as 310 HB or equivalent (See 8.2).

3.3.2 Forgings

As ordered.

3.3.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 285 HB, or equivalent (See 8.2). Tubing ordered hot finished and annealed or tempered shall have hardness not higher than 285 HB or equivalent (See 8.2).

3.3.4 Forging Stock

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 A 370:

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 A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections for product 36 square inches (232 cm^2) and under in nominal cross-sectional area shall be no worse than the macrographs of ASTM A 604 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

3.4.2 Average Grain Size

Shall be ASTM No. 6 or finer determined in accordance with ASTM E 112.

3.4.3 Response to Heat Treatment

Specimens from product shall have the properties shown in Table 4 after being austenitized by heating to 1720 °F ± 25 (938 °C ±14), holding at heat for a time commensurate with section thickness, heating equipment, and procedure used, oil quenched below 90 °F (32 °C) followed by tempering for 2 hours minimum at no lower than 1110 °F (599 °C).

TABLE 4 – LONGITUDINAL MECHANICAL PROPERTIES

PROPERTY	VALUE
Tensile Strength, min	181 ksi (1250 MPa)
Yield Strength 0.2%, min	155 ksi (1070 MPa)
Elongation in 4D, min	11%
Charpy V–notch, min	18 ft-lb (25 J)
Hardness	375 to 450 HB, or equivalent (See 8.2)

3.4.4 Decarburization

3.4.4.1 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 6.

3.4.4.2 Allowable decarburization of bars, billets, and tube rounds ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon purchaser and vendor.

3.4.4.3 Decarburization of bars to which 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table 5.

TABLE 5A - MAXIMUM DECARBURIZATION, BARS, INCH/POUND UNITS

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inch
Up to 0.500, incl	0.030
Over 0.500 to 1.000, incl	0.035
Over 1.000 to 1.500, incl	0.040
Over 1.500 to 2.000, incl	0.050
Over 2.000 to 2.500, incl	0.060
Over 2.500 to 3.000, incl	0.070
Over 3.000	0.080

TABLE 5B - MAXIMUM DECARBURIZATION, BARS, SI UNITS

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.76
Over 12.70 to 25.40, incl	0.89
Over 25.40 to 38.10, incl	1.02
Over 38.10 to 50.80, incl	1.27
Over 50.80 to 63.50, incl	1.52
Over 63.50 to 76.20, incl	1.78
Over 76.20	2.04

3.4.4.4 Decarburization of tubing to which 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table 6.

TABLE 6A - MAXIMUM DECARBURIZATION, TUBING, INCH/POUND UNITS

Nominal Wall Thickness Inches	Total Depth of Decarburization Inch ID	Total Depth of Decarburization Inch OD
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 6B - MAXIMUM DECARBURIZATION, TUBING, SI UNITS

Nominal Wall Thickness Millimeters	Total Depth of Decarburization Millimeter ID	Total Depth of Decarburization Millimeters OD
Up to 2.77, incl	0.20	0.38
Over 2.77 to 5.16, incl	0.25	0.51
Over 5.16 to 10.16, incl	0.30	0.64
Over 10.16 to 15.24, incl	0.38	0.76
Over 15.24 to 25.40, incl	0.43	0.89
Over 25.40	0.51	1.02

3.4.4.5 Decarburization shall be measured by the metallographic method, by the HR30N scale hardness testing method, or by a 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.

3.4.4.5.1 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 (0.12 mm) and the width is 0.065 inch (1.65 mm) or less.

3.5 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.

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

3.5.2 Product 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 ground, turned, or polished surface.

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 Bars

In accordance with AMS2251.

3.6.2 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

4.2.1.1 Composition (3.1), condition (3.3), macrostructure (3.4.1), average grain size (3.4.2), response to heat treatment (3.4.3), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.2 When specified, decarburization (3.4.4).

4.2.2 Periodic Tests

Frequency-severity cleanliness rating (3.5.1) and grain flow of die forgings (3.5.3) are periodic tests 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

The vendor of the product shall furnish with each shipment a report showing the results of tests for composition and macrostructure of each heat, and for condition, average grain size, and response to heat treatment 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, AMS6497, melt practice, 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.

4.5 Resampling and Retesting

4.5.1 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.