AEROSPACE MATERIAL SPECIFICATION

AMS6482	REV. A

Issued 2012-01
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Superseding AMS6482

Steel Bars, Forgings, and Tubing
1.5Si - 1.25Cr - 3.8Ni - 0.50Mo - 0.30V (0.40C)
Vacuum Remelted
Annealed
(Composition similar to UNS K63835)

RATIONALE

AMS6482A corrects the condition in the title, revises decarburization and reporting.

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 parts requiring high strength and high toughness, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking after heat treatment; ARP1110 recommends practices to minimize such occurrences.

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

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/AMS6482A

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

AMS2750 Pyrometry

AMS2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys

AMS2808 Identification, Forgings

ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion Resistant Steels and Alloys

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 A370 Mechanical Testing of Steel Products

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

ASTM E45 Determining the Inclusion Content of Steel

ASTM E112 Determining Average Grain Size

ASTM E350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E384 Knoop and Vickers Hardness of Materials

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 E350, by spectrochemical, or by other analytical methods approved by purchaser.

Table 1 - Composition

Element	min	max
Carbon	0.33	0.43
Manganese	0.75	1.25
Silicon	1.35	2.25
Phosphorus	--	0.010
Sulfur	--	0.003
Chromium	1.10	2.00
Nickel	3.00	4.10
Molybdenum	0.40	0.90
Vanadium	0.10	0.40
Copper	0.40	0.90

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Melting Practice

Steel shall be multiple melted using vacuum consumable electrode practice in the remelt cycle.

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 and Tubing

Annealed at 1250 °F ± 25 (677 °C ± 15). Pyrometry shall be in accordance with AMS2750.

3.3.1.1 Bars

Hardness shall be not higher than 45 HRC or equivalent tensile strength (See 8.2). Bar shall not be cut from plate.

3.3.1.2 Mechanical Tubing

Tubing shall have hardness not higher than 45 HRC or equivalent (See 8.3).

3.3.2 Forgings

Annealed at 1250 °F ± 25 (677 °C ± 15) to hardness not higher than 45 HRC, or equivalent (See 8.3).

3.3.3 Forging Stock

As ordered by the forging manufacturer.

3.4 Properties

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

3.4.1 Macrostructure

Visual examination of transverse sections from bars, billets, tube rounds, or 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

3.4.2 Micro-Inclusion Rating of Each Heat

No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E45, Method D.

Table 3 - Micro-inclusion rating limits

Type	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency, maximum	a	1	a	1	a	1	3	1
Total Rateable Fields, Frequency, maximum	b	1	b	1	b	1	8	1

a - Combined A+B+C, not more than 3 fields
b - Combined A+B+C, not more than 8 fields

3.4.2.1 A rateable field is defined as one that has a Type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with ASTM E45.

3.4.3 Average Grain Size of Bar, Forgings, and Tubing

Shall be ASTM 6 or finer, determined in accordance with ASTM E112.

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 5.

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 by purchaser and producer.

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 4.

Table 4A - Maximum total depth of decarburization, inch/pound units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inch
Up to 0.375, incl	0.010
Over 0.375 to 0.500, incl	0.012
Over 0.500 to 0.625, incl	0.014
Over 0.625 to 1.000, incl	0.017
Over 1.000 to 1.500, incl	0.020
Over 1.500 to 2.000, incl	0.025
Over 2.000 to 2.500, incl	0.030
Over 2.500 to 3.000, incl	0.035
Over 3.000 to 5.000, incl	0.045

Table 4B - Maximum total depth of decarburization, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 9.52, incl	0.25
Over 9.52 to 12.70, incl	0.30
Over 12.70 to 15.88, incl	0.36
Over 15.88 to 25.40, incl	0.43
Over 25.40 to 38.10, incl	0.51
Over 38.10 to 50.80, incl	0.64
Over 50.80 to 63.50, incl	0.76
Over 63.50 to 76.20, incl	0.89
Over 76.20 to 127.00, incl	1.14

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 5.

Table 5A - Maximum total depth of decarburization, inch/pound units

Nominal Wall Thickness Inches	Total Depth of Decarburization Inches ID	Total Depth of Decarburization Inches 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 5B - Maximum total depth of decarburization, SI units

Nominal Wall Thickness Millimeters	Total Depth of Decarburization Millimeters 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 evaluated by one of the two methods of 3.4.4.5.1 or 3.4.4.5.2.

3.4.4.5.1 Metallographic Method

A cross section taken perpendicular to the surface shall be prepared, etched, and visually examined metallographically at a magnification not to exceed 100X. Optical indications of decarburization (including complete decarburizaion [ferrite] plus partial decarburization) shall not exceed the limits of Tables 4 and 5.

3.4.4.5.2 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microhardness testing in accordance with ASTM E384, at a magnification not exceeding 100X, conducted on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization is defined as the perpendicular distance from the surface to the depth under that surface where there is not 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. Acceptance shall be as listed in Tables 4 and 5.

3.4.4.5.2.1 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 (0.13 mm) and the width is 0.065 inches (1.65 mm) or less.

3.4.4.5.3 In case of dispute, the total depth of decarburization determined using the microhardness traverse method shall govern.

3.4.5 Response to Heat Treatment of Bars, Forgings, and Tubing

Specimens shall conform to the following requirements after being austenitized by heating to 1685 °F ± 25 (918 °C ± 14), holding at heat for 1 hour and 30 minutes ± 5 minutes, and quenching in oil; cooled to -100 °F (-73 °C) or colder, holding at temperature for not less than 1 hour, warming in air to room temperature, and tempered by heating to 500 °F ± 10 (260 °C ± 6) holding at heat for 2 hours ± 0.2, cooling in air to room temperature.

3.4.5.1 Longitudinal Tensile Properties

Shall meet the properties in Table 6.

Table 6 - Minimum longitudinal tensile properties

Property	Value
Tensile Strength	282 ksi (1944 MPa)
Yield Strength at 0.2% Offset	226 ksi (1558 MPa)
Elongation in 4D	9%

3.4.5.2 Longitudinal Impact Toughness

For bars 0.625 inch and larger, the minimum Charpy V-notch impact toughness, when tested at room temperature in accordance with ASTM A370, shall be 11 foot-pounds.

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 Bars and tubing ordered hot rolled or cold drawn, 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.

3.6 Tolerances

Shall conform to all applicable requirements of the following:

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 producer of the product shall supply all samples for producer'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 (3.3), macrostructure (3.4.1), micro-inclusion rating (3.4.2), average grain size (3.4.3), decarburization (3.4.4) and response to heat treatment (3.4.5) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Frequency-severity rating (3.5.1) is a periodic test and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be as follows:

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 producer of bars, forgings, and mechanical tubing shall furnish with each shipment a report showing the producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the results of tests for composition, macrostructure and micro-inclusion rating 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, AMS6482A, 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.

4.4.2 Report the nominal metallurgically worked cross sectional size and the cut size, if different (Also see 3.3.1.1).

4.4.3 The producer of forging stock shall furnish with each shipment a report showing the producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the results of tests for composition, macrostructure, and micro-inclusion rating of each heat and the results of any additional property requirements imposed by 8.6. This report shall include the purchase order number, heat number, AMS6482A, size and quantity.