



AEROSPACE MATERIAL SPECIFICATION

AMS5932™

REV. C

Issued 1998-11
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Reaffirmed 2022-11

Superseding AMS5932B

Steel, Corrosion- and Heat-Resistant, Bars, Forgings, and Mechanical Tubing
14.5Cr - 2.3Ni - 12.5Co - 4.0Mo - 0.60V - 0.03Cb(Nb)
Carburizing, Premium Aircraft-Quality, Double Vacuum Melted
(Composition similar to UNS S42640)

RATIONALE

AMS5932C revises title, chemical analysis standards (3.1), introduces a new requirement related to exceptions (3.7), revises reports (4.4) and identification (5.2.1.1), and results from a Five-Year Review and update of this specification.

AMS5932C has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality corrosion and heat-resistant steel in the form of bars, forgings, mechanical tubing, and forging stock.

1.2 Application

These products have been used typically for critical carburized parts such as bearings, cams, shafts, gears, and bolts operating in a corrosive environment under heavy loads and high speeds at elevated temperatures, and subject to very rigid 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.

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.

AMS2241 Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire

AMS2243 Tolerances, Corrosion and Heat-Resistant Steel Tubing

AMS2248 Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys

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For more information on this standard, visit
<https://www.sae.org/standards/content/AMS5932C/>

AMS2300	Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure
AMS2371	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS2374	Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steel and Alloy Forgings
AMS2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys
AMS2808	Identification, Forgings
ARP1917	Clarification of Terms Used in Aerospace Metals Specifications
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 A751	Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
ASTM E45	Determining the Inclusion Content of Steel
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 E384	Microhardness of Materials

3. TECHNICAL REQUIREMENTS

3.1 Composition

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

Table 1 - Composition

Element	Min	Max
Carbon	0.10	0.25
Manganese	--	1.0
Silicon	--	1.0
Phosphorus	--	0.020
Sulfur	--	0.010
Chromium	13.00	16.00
Nickel	1.75	2.75
Cobalt	11.00	14.00
Molybdenum	3.00	5.00
Vanadium	0.40	0.80
Columbium (Niobium)	0.01	0.05
Copper	--	0.35

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Melting Practice

Steel shall be double vacuum melted using vacuum induction melting followed by vacuum arc consumable electrode remelting practice.

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

Cold finished having tensile strength not higher than 201.0 ksi (1386 MPa) or equivalent hardness (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 388 HB, or equivalent (see 8.3). Bars ordered cold finished may have hardness as high as 401 HB, or equivalent (see 8.3).

3.3.2 Forgings

As ordered.

3.3.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 401 HB, or equivalent (see 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 388 HB, or equivalent (see 8.3).

3.3.4 Forging Stock

As ordered by the forging manufacturer.

3.4 Properties

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

3.4.1 Macrostructure

Visual examination of transverse 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 for product 36 in² (232 cm²) and under in nominal cross-sectional area 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

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

Table 3 - Micro-inclusion rating limits

	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	*	1	*	1	*	1	3	1
Total Rateable Fields, Frequency, maximum	**	1	**	1	**	1	8	1

* Combined A+B+C; not more than 3 fields

** Combined A+B+C; not more than 8 fields

3.4.2.1 A rateable field is defined as one which has a type A, B, C, or D inclusion rating of at least No. 1.0 thin or heavy in accordance with ASTM E45 (see 8.6).

3.4.3 Average Grain Size

Shall be ASTM No. 4 or finer, determined in accordance with ASTM E112.

3.4.4 Response to Heat Treatment

Specimens, protected by suitable means or treated in a neutral atmosphere or neutral salt to minimize scaling and prevent either carburization or decarburization, shall have average hardness not lower than 45 HRC after being heated to 2000 to 2050 °F (1093 to 1121 °C) by any convenient means, held to equalize at temperature, oil quenched to 150 °F (66 °C) or lower, air cooled to room temperature, cooled to -110 °F (-79 °C) or lower, held at that temperature for not less than 1 hour, and tempered for 2 hours ± 0.25 hour at 900 to 975 °F (482 to 524 °C).

3.4.5 Decarburization

3.4.5.1 Bars and tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

- 3.4.5.2 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.
- 3.4.5.3 Decarburization of bars to which 3.4.5.1 or 3.4.5.2 is not applicable shall be not greater than shown in Table 4.

Table 4**Table 4A - Maximum decarburization, inch/pound units**

Nominal Diameter or Least Distance Between Parallel Sides Inches	Total Depth of Decarburization Inch
Up to 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.030
Over 1.000 to 2.000, incl	0.040
Over 2.000 to 3.000, incl	0.050
Over 3.000 to 4.000, incl	0.065
Over 4.000 to 5.000, incl	0.095

Table 4B - Maximum decarburization, SI units

Nominal Diameter or Least Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.76
Over 25.40 to 50.80, incl	1.02
Over 50.80 to 76.20, incl	1.27
Over 76.20 to 101.60, incl	1.65
Over 101.60 to 127.00, incl	2.41

- 3.4.5.4 Decarburization of tubing to which 3.4.5.1 or 3.4.5.2 is not applicable shall be not greater than shown in Table 5.

Table 5**Table 5A - Maximum decarburization, inch/pound units**

Nominal Outside Diameter Inches	Total Depth of Decarburization Inch
Up to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035
Over 2.000 to 3.000, incl	0.045
Over 3.000 to 4.000, incl	0.055
Over 4.000 to 5.000, incl	0.080

Table 5B - Maximum decarburization, SI units

Nominal Outside Diameter Millimeters	Total Depth of Decarburization Millimeters
Up to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.89
Over 50.80 to 76.20, incl	1.14
Over 76.20 to 101.60, incl	1.40
Over 101.60 to 127.00, incl	2.03

3.4.5.5 Decarburization shall be measured by the metallographic method, by HR 30N scale hardness testing method, or by a traverse method using microhardness testing in accordance with ASTM E384. 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 decarburization on any adjacent surface. In case of dispute, the depth of decarburization determined using the microhardness transverse method shall govern.

3.4.5.5.1 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 (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

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 and tubing ordered hot rolled or cold drawn or ground, turned, or polished shall, after removal of the standard machining 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 which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.6 Tolerances

Shall be as follows:

3.6.1 Bars

In accordance with AMS2241.

3.6.2 Mechanical Tubing

In accordance with AMS2243.

3.7 Exceptions

Any exceptions shall be authorized by purchaser and reported as in 4.4.1.

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 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 (3.3), macrostructure (3.4.1), micro-inclusion rating (3.4.2), average grain size (3.4.3), response to heat treatment (3.4.4), decarburization (3.4.5), and tolerances (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 (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 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 AMS2371.

4.3.2 Forgings

In accordance with AMS2374.

4.3.3 Samples for response to heat treatment (3.4.4) shall be as follows:

4.3.3.1 Specimens from bars shall be full cross-sections of the bar, ground on both faces normal to the axis so that length is 0.500 inch \pm 0.010 inch (12.70 mm \pm 0.25 mm).

4.3.3.2 Specimens from mechanical tubing shall be full cross-sections of the tubing, shall have wall thickness not over 0.625 inch (15.88 mm) with wall thicknesses over 0.625 inch (15.88 mm) being turned to 0.625 inch \pm 0.010 inch (15.88 mm \pm 0.25 mm), and shall be ground on both faces so that length is 0.500 inch \pm 0.010 inch (12.70 mm \pm 0.25 mm).

4.4 Reports

The producer of the product shall furnish with each shipment a report showing the producer's name and the 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, micro-inclusion rating, and response to heat treatment of each heat and for 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, AMS5932C, size, and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.4.1 When material produced to this specification has exceptions authorized by purchaser (see 3.7) taken to the technical requirements listed in Section 3 (see 5.2.1.1), the report shall contain a statement "This material is certified as AMS5932C(EXC) because of the following exceptions." and the specific exceptions shall be listed.