AEROSPACE MATERIAL SPECIFICATION

AMS5898™	REV. C

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Superseding AMS5898B

Steel, Corrosion Resistant, Bars, Wire, Forgings and Forging Stock 15.2Cr - 1.0Mo - 0.40N - (0.28 - 0.34C) Consumable Electrode Melted Under Pressure

RATIONALE

AMS5898 is the result of a Five-Year Review and update of the specification. The revision updates the Title to match the Scope, updates composition testing and reporting (see 3.1 and 3.1.1), updates bar condition (see 3.3.1), prohibits bar from plate (see 3.3.1.3 and 4.4.2), revises decarburization test requirements (see 3.4.5), updates heat treatment and quench requirements (see 3.4.6.1 and 3.4.6.2), updates bar quality requirements (see 3.5.2 and 8.5), addresses updates to AMS2300 (see 8.7), and updates the prohibition of exceptions (see 3.7 and 8.6).

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1. SCOPE

1.1 Form

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

1.2 Application

These products have been used typically for anti-friction bearing components requiring resistance to both corrosion and wear with hardness not lower than 58 HRC after hardening and tempering, 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

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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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

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

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 E45 Determining the Inclusion Content of Steel

ASTM E112 Determining the 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 E1077 Estimating the Depth of Decarburization of Steel Specimens

2.3 Definitions

Terms used in AMS are defined in AS7766.

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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 the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.28	0.34
Manganese	0.30	0.60
Silicon	0.30	0.80
Phosphorus	--	0.020
Sulfur	--	0.010
Chromium	14.5	16.0
Molybdenum	0.95	1.10
Nitrogen	0.35	0.44
Nickel	--	0.30

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 AMS2248.

3.2 Melting Practice

Steel shall be multiple melted using consumable electrode practice under pressurized protective gas in the remelt cycle to enable nitrogen to be dissolved in the steel to meet the requirements of Table 1.

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

Annealed, having hardness not higher than 255 HBW, or equivalent (see 8.2).

3.3.1.1 Bars 2.75 inches (69.8 mm) and under in nominal diameter or least distance between parallel sides (thickness), and all hexagons shall be cold finished.

3.3.1.2 Bars, other than hexagons, over 2.75 inches (69.8 mm) in nominal diameter or least distance between parallel sides (thickness) shall be hot or cold finished.

3.3.1.3 Bars shall not be cut from plate.

3.3.2 Wire

Annealed and cold finished having a tensile strength not higher than 130 ksi (896 MPa) or equivalent hardness (see 8.3).

3.3.3 Forgings

As ordered.

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3.3.4 Forging Stock

As ordered by the forging manufacturer.

3.4 Properties

The product shall conform to the following requirements:

3.4.1 Macrostructure

Visual examination of transverse full cross sections from bars, wire, billets, 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 square inches (232 cm^2) 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 of 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	2.0	1.0	1.5	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency, Max	a	1	a	1	a	1	3	1
Total Ratable Fields, Frequency, Max	b	1	b	1	b	1	8	1
a - Combined A+B+C, not more than three fields. b - Combined A+B+C, not more than eight fields.								

3.4.2.1 A ratable field is defined as one that has a type A, B, C, or D inclusion rating of at least No. 1.0 thin or heavy in accordance with ASTM E45.

3.4.3 Microstructure

The product shall be free of carbide network.

3.4.4 Average Grain Size

Shall be ASTM No. 6 or finer, determined in accordance with ASTM E112.

3.4.5 Decarburization and Denitridation

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

3.4.5.2 Allowable decarburization and/or denitridation of bars, wire, and billets ordered for redrawing, forging, or to specified microstructural requirements shall be as agreed upon by the purchaser and the producer.

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3.4.5.3 Decarburization and/or denitridation of bars and wire, to which 3.4.5.1 or 3.4.5.2 is not applicable, shall not be greater than shown in Table 4.

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

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization/Denitridation Inches
Up to 0.50, incl	0.015
Over 0.50 to 1.00, incl	0.020
Over 1.00 to 1.50, incl	0.025
Over 1.50 to 2.00, incl	0.030
Over 2.00 to 2.50, incl	0.035
Over 2.50 to 3.00, incl	0.040
Over 3.00 to 4.00, incl	0.045

Table 4B - Maximum decarburization/denitridation, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization/Denitridation Millimeters
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.51
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 76.20, incl	1.02
Over 76.20 to 101.60, incl	1.14

3.4.5.4 Decarburization and denitridation shall be measured by one of the two methods of 3.4.5.4.1 or 3.4.5.4.2.

3.4.5.4.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be etched and examined metallographically at a magnification not to exceed 200X in accordance with ASTM E1077. The sample shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 4.

3.4.5.4.2 Hardness Traverse (Microindentation) Method

The total depth of decarburization/denitridation shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened in a protective atmosphere to prevent changes in surface carbon content. Samples may be tempered at the option of the producer. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization/denitridation on the adjacent surface. Acceptance shall be as listed in Table 4.

3.4.5.4.3 In case of dispute, the depth of decarburization/denitridation determined using the microhardness traverse method shall govern.

3.4.5.4.4 When determining the depth of decarburization/denitridation, it is permissible to disregard local areas provided the decarburization/denitridation 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.

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3.4.6 Response to Heat Treatment

Specimens protected by suitable means or treated in a neutral atmosphere to minimize scaling and prevent either carburization or decarburization shall have hardness not lower than 58 HRC, or equivalent (see 8.2), after being heated to 1925 °F ± 25 °F (1052 °C ± 14 °C), held at heat for 30 minutes ± 3 minutes, quenched in oil (see 3.4.6.1), and tempered at 350 °F ± 10 °F (177 °C ± 6 °C) for 60 minutes ± 5 minutes.

3.4.6.1 Pyrometry shall be in accordance with AMS2750. The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

3.4.6.2 Sub-zero cooling to -80 °F (-62 °C) or colder, holding at that temperature for 2 hours ± 0.25 hour, and warming in air to room temperature after oil quenching as in 3.4.6 is optional.

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 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

Bars and wires shall conform to all applicable requirements of AMS2241.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.3

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), macrostructures (see 3.4.1), micro-inclusion rating (see 3.4.2), microstructure (see 3.4.3), average grain size (see 3.4.4), decarburization and denitridation (see 3.4.5), response to heat treatment (see 3.4.6), quality (see 3.5), and tolerance (see 3.6) are acceptance tests and shall be performed on each heat or lot, as applicable.

4.2.2 Periodic Tests

Grain flow of die forgings (see 3.5.3) is a periodic test and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

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4.3 Sampling and Testing

Shall be as follows:

4.3.1 Bars, Wire, and Forging Stock

In accordance with AMS2371.

4.3.2 Forgings

In accordance with AMS2374.

4.3.3 Specimens for response to heat treatment (see 3.4.6) from bars, wire, and billets shall be not less than 0.375 inch (9.52 mm) in thickness. Minimum dimensions in other directions shall be either those of the product cross section or 1.125 x 1.125 inches (28.58 x 28.58 mm).

4.4 Reports

4.4.1 The producer of the product shall furnish with each shipment a report showing the producer's name; 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 chemical composition, macrostructure, micro-inclusion rating, and frequency-severity cleanliness rating of each heat, and for microstructure, 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, AMS5898C, size, and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.4.2 Report the nominal metallurgically worked cross-sectional size and the cut size, if different (see 3.3.1.3).

4.4.3 When material produced to this specification has exceptions 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 AMS5898C(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.4.4 The producer of forging stock shall furnish with each shipment a report showing the producer's name, the country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), the results of tests for composition, macrostructure, and micro-inclusion rating of each heat, and the results of any additional property requirements imposed by 8.8. This report shall include the purchase order number, heat number, AMS5898C, size, and quantity.

4.5 Resampling and Retesting

Shall be as follows:

4.5.1 Bars, Wire, and Forging Stock

In accordance with AMS2371.

4.5.2 Forgings

In accordance with AMS2374.

5. PREPARATION FOR DELIVERY

5.1 Sizes

Except when exact lengths or multiples of exact lengths are ordered, straight bars and wire will be acceptable in mill lengths of 6 to 20 feet (1.8 to 6.1 m), but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

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