AEROSPACE MATERIAL SPECIFICATION

AMS5899™	REV. D

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Superseding AMS5899C

Steel, Corrosion-Resistant, Bars, Wire, Forgings and Forging Stock 17Cr - 0.52Mo (0.95 - 1.20C) (440C) Powder Metallurgy Product, Hot Isostatically Pressed (Composition similar to UNS S44004)

RATIONALE

AMS5899C is the result of a Five-Year Review and update of the specification. The revision updates the Title to match the Scope, revises composition test methods and reporting (see 3.1 and 3.1.1), adds pyrometry controls (see 3.3.1), revises decarburization test methods (see 3.3.3.4), addresses bar quality (see 3.4.1 and 8.7), updates size restrictions on bar (see 4.4.5), addresses forging stock properties (see 4.4.7 and 8.8), and allows prior revisions (see 8.6).

1. SCOPE

1.1 Form

This specification covers a corrosion-resistant steel, consolidated by hot isostatic pressing (HIP) product from prealloyed powder, in the form of bars, wire, forgings, and forging stock.

1.2 Application

These products have been used typically for parts requiring a minimum hardness of 58 HRC and resistance to wear, corrosion, and oxidation, 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

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5899D/

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 A751 Chemical Analysis of Steel Products

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 E381 Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

ASTM E1077 Estimating the Depth of Decarburization of Steel Specimens

2.3 Definitions

Terms in AMS are defined in AS7766.

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	0.95	1.20
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	16.00	18.00
Molybdenum	0.40	0.65
Nickel	--	0.75
Copper	--	0.50

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 Condition

The product shall be produced from billet created by consolidating pre-alloyed atomized powder using HIP. The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.2.1 Bars

Bars shall have hardness not higher than 270 HBW, or equivalent (see 8.2).

3.2.1.1 Hexagons regardless of size and bars 2.750 inches (69.85 mm) and under in nominal diameter or least distance between parallel sides shall be cold finished.

3.2.1.2 Bars, other than hexagons, over 2.750 inches (69.85 mm) in nominal diameter or least distance between parallel sides shall be hot finished and annealed.

3.2.1.3 Bars shall not be cut from plate (see 4.4.5).

3.2.2 Wire

Wire shall be cold finished having tensile strength not higher than 130 ksi (896 MPa) or equivalent hardness (see 8.3).

3.2.3 Forgings

Forgings shall be as ordered.

3.2.4 Forging Stock

Forging stock shall be as ordered by the forging manufacturer.

3.3 Properties

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

3.3.1 Response to Heat Treatment

Specimens from product 0.375 inch (9.52 mm) and under in nominal thickness and specimens not less than 0.375 inch (9.52 mm) thick in any dimension cut from larger product shall have hardness not lower than 58 HRC, or equivalent (see 8.2), after being heated to 1875 °F ± 10 °F (1024 °C ± 6 °C), held at heat for 30 minutes ± 3 minutes, and cooled at a rate equivalent to cooling in still air. Pyrometry shall be in accordance with AMS2750.

3.3.2 Macrostructure

Visual examination of transverse full cross sections from bars, billets, and forging stock, etched in hot hydrochloric acid in accordance with ASTM E381, shall show no imperfections such as pipe, cracks, or segregation.

3.3.3 Decarburization

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

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

3.3.3.3 Decarburization of bars and wire to which 3.3.3.1 or 3.3.3.2 is not applicable shall be not greater than shown in Table 2.

Table 2A - Maximum decarburization, inch/pound units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inches
Up to 0.500, incl	0.010
Over 0.500 to 1.000, incl	0.015
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 4.000, incl	0.045

Table 2B - Maximum decarburization, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.25
Over 12.70 to 25.40, incl	0.38
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 101.60, incl	1.14

3.3.3.4 Decarburization shall be evaluated by one of the two methods of 3.3.3.4.1 or 3.3.3.4.2.

3.3.3.4.1 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 2.

3.3.3.4.2 Hardness Traverse (Microindentation) Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened and protected during heat treatment 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 on the adjacent surface. Acceptance shall be as listed in Table 2.

3.3.3.4.3 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.

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

3.4 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.

3.4.1 Bars 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.

3.4.2 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.

3.5 Tolerances

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

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.6.

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), response to heat treatment (see 3.3.1), macrostructure (see 3.3.2), and tolerances (see 3.5) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Decarburization (see 3.3.3) and grain flow of die forgings (see 3.4.2) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Shall be as follows:

4.3.1 Bars, wire, and forging stock shall be sampled in accordance with AMS2371.

4.3.2 Forgings shall be sampled in accordance with AMS2374.

4.4 Reports

The producer of the product shall furnish with each shipment a report showing the producer’s name, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), and the following results of tests and relevent information:

4.4.1 For Each Heat

Composition
Macrostructure