

AEROSPACE MATERIAL SPECIFICATION



AMS-S-5000A

Issued MAR 1999
Cancelled MAR 2007

Superseded by AMS 6415 and
AMS 6484

Steel, Chrome-Nickel-Molybdenum (E4340) Bars and Reforging Stock

RATIONALE

AMS-S-5000A was issued to cancel and supersede AMS-S-5000 with current technically equivalent specifications.

CANCELLATION NOTICE

This specification has been declared "CANCELLED" by the Aerospace Materials Division, SAE, as of March 2007 and has been superseded by the applicable AMS specifications listed below. The requirements of the latest issue of the appropriate AMS specification listed below shall be fulfilled whenever reference is made to the cancelled AMS-S-5000. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications, noting that it has been superseded by the applicable AMS.

AMS 6415 Steel, Bars, Forgings, and Tubing 0.80Cr 1.8Ni 0.25Mo (0.38 - 0.43C) (SAE 4340)

AMS 6484 Steel, Bars, Forgings, and Tubing 0.80Cr 1.8Ni 0.25Mo (0.38 - 0.43C) (SAE 4340)
Normalized and Tempered

Either AMS specification is suitable for reforging stock as that product condition is defined "As ordered by the forging manufacturer" in both specifications.

Cancelled specifications are available from SAE.

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NOTICE

This document has been taken directly from U.S. Military Specification MIL-S-5000E and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-S-5000E. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical report.

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1. SCOPE:

1.1 Scope:

This specification covers electric furnace steel bars and reforcing stock of aircraft quality.

1.2 Classification:

1.2.1 Physical condition: Bars shall be furnished in one of the following physical conditions, as specified (see 6.2):

- (A) As forged
- (B) As rolled
- (C) Annealed
- (D) Normalized
- (E) Normalized and tempered
- (F) Hardened and tempered, 130,000 psi minimum yield strength

1.2.2 Surface conditions: Bars shall be furnished in one of the following conditions, as specified (see 6.2):

- (1) Black, as forged or rolled
- (2) Pickled or blast cleaned
- (3) Rough turned
- (4) Cold drawn
- (5) Turned, ground, and polished
- (6) Turned and polished

1.3 Sizes and shapes:

Bars and reforcing stock shall be furnished in the sizes and shapes specified (see 6.2).

2. APPLICABLE DOCUMENTS:

The following publications, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2301 Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-I-6868 Inspection Process, Magnetic Particle
MIL-I-8950 Inspection, Ultrasonic, Wrought Metals, Process for

FED-STD-151 Metals; Test Methods
FED-STD-183 Continuous Identification Marking of Iron and Steel Products

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

2.3 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 29 General Requirements for Hot-rolled and Cold Finished Carbon and Alloy Steel Bars
ASTM A 255 End Quench Test for Hardenability of Steels, Method of
ASTM E 8 Tension Testing of Metallic Materials, Methods of
ASTM E 10 Brinell Hardness of Metallic Materials, Test Method for
ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Test Methods for
ASTM E 112 Estimating Average Grain Size of Metals, Methods for
ASTM E 381 Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms and Forgings

3. REQUIREMENTS:

3.1 Material quality:

The steel shall be produced by electric furnace practice and shall be of aircraft quality conforming to AMS 2301 except that a maximum average frequency (F) rating of 0.34 and a maximum average severity (S) rating of 0.25 shall apply for all sizes and products. In addition, AMS 2301 specimens which contain indications representing non-metallic inclusions over 1.00 inch in length shall be subject to rejection.

- 3.1.1 Ultrasonic inspection: When specified, bars or intermediate mill products and reforcing stock shall be ultrasonically inspected in accordance with MIL-I-8950. The minimum quality level shall be as specified below (see 4.6):

<u>Dimensions (inches)</u>	<u>Ultrasonic Classification</u>
1-1/2 to 9 thickness	A
Larger than 9	B

3.2 Chemical composition:

The chemical composition shall be as specified in Table I.

TABLE I. Chemical Composition

Element	Analysis (percent)	Check Analysis Tolerance (percent) <u>1/</u>
Carbon	0.38 - 0.43	+ 0.02
Manganese	0.65 - 0.85	± 0.03
Phosphorus	0.025 (max)	+ 0.005, -0.00
Sulfur	0.025 (max)	+ 0.005, -0.00
Silicon	0.15 - 0.35	+ 0.02
Nickel	1.65 - 2.00	± 0.05
Chromium	0.70 - 0.90	± 0.03
Molybdenum	0.20 - 0.30	± 0.02
Copper	0.35 (max)	± 0.03, -0.00

1/ Individual determinations may vary from the specified range to the extent shown in the check analysis column, except that the elements in any heat shall not vary both above and below the specified range. For sizes over 100 square inches in cross-sectional area, the check analysis shall be negotiated.

3.3 Hardenability:

End-quench hardenability values for the steel in all specified conditions shall be Rockwell C-50 minimum at 20/16 inch and Rockwell C-45 minimum at 32/16 inch.

3.4 Grain size:

The austenite grain size shall be predominantly No. 5 or finer with grains as large as No. 3 permissible.

3.5 Macrostructure:

Visual examination of deep-acid-etched reforcing stock in sizes up to and including 36 square inches shall be equal to or better than S-2, R-1 and C-2; sizes over 36 to and including 100 square inches shall be equal to or better than S-2, R-2, and C-2 of ASTM E 381. Product forms other than reforcing stock shall be macroscopic examined at a section thickness not less than 3 inches and shall be equal to or better than S-2, R-1, and C-2 of ASTM E 381.

3.6 Decarburization:

Unless otherwise specified, the depth of decarburization of products in surface condition (2) or (4) shall be not greater than the following limits (see 6.2):

Nominal Diameter or Distance Between Opposite Faces (Inches)	Maximum Depth of Decarburization (Inches) ^{1/}
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 1.00 to 1.50 incl.	0.020
Over 1.50 to 2.00 incl.	0.025
Over 2.00 to 2.50 incl.	0.030
Over 2.50 to 3.00 incl.	0.035

^{1/} The value specified as the maximum depth of decarburization is the sum of the complete plus the partial decarburization.

3.6.1 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the limits specified in 3.6 by more than 0.005 inch and the width is 0.064 inch or less.

3.6.2 Products furnished in surface conditions (3), (5), and (6) shall be free from decarburization.

3.6.3 When intended for reforging purposes, the above decarburization limits shall not apply.

3.7 Surface and physical conditions:

Unless otherwise specified, bars 1-1/2 inches or less in diameter or thickness shall be furnished in condition (C)-(4), and bars over 1-1/2 inches in diameter or thickness shall be furnished in condition (C)-(2).

3.8 Hardness limits:

3.8.1 The hardness for material in physical conditions (C) and (E) shall be not more than Brinell 235 (Rockwell C 22) when furnished in surface conditions (1), (2), or (3).

3.8.2 The hardness for material in physical conditions (C) and (E) shall be not more than Brinell 265 (Rockwell C-27) when furnished in surface condition (4).

3.9 Mechanical properties of condition (F) steel:

Unless otherwise specified, the mechanical properties of products supplied in condition (F) in sizes up to and including 3 inches in the least dimension shall conform to the limits specified in Table II (see 6.2).

TABLE II. Mechanical properties of condition (F) steel ^{1/}

Tensile Strength (min)	Yield Strength at 0.2 percent offset or extension indicated (min) Extension under load		Elongation in 2 inch. (min)	Reduction in area (min)
psi	psi	inches in 2 inches	percent	percent
150,000	130,000	0.0127	14	53

^{1/} When products in condition (F) are ordered with mechanical properties differing from those specified in 3.9 or when products in condition (F) are offered in sizes larger than 3 inches in the least dimension, the mechanical properties shall be as agreed upon the supplier and the purchaser.

3.10 Identification of product:

Each bar shall be identified in accordance with FED-STD-183. The markings shall include the heat number of the metal and number of this specification.

3.11 Tolerances:

Tolerances shall conform to the limits of ASTM A 29.

3.12 Workmanship:

Material shall be sound, of uniform quality and condition, free from pipes, and shall not contain laps, cracks, twists, seams, or other defects detrimental to the fabrication or performance of parts. Steel melting practice shall produce metal complying with all requirements of this specification.

3.12.1 Cold drawn bars: Cold drawn bars shall be free from scale. Drawing shall be accomplished after all heat-treating operations have been completed; however, stress relieving should be accomplished after drawing.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the contractor may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests:

All the tests required for the testing of the product are classified as acceptance tests, for which necessary sampling techniques and methods of testing are specified in this section.

4.2.1 Inspection conditions: Unless otherwise specified, all inspections shall be preformed in accordance with the test conditions specified in the applicable test method document or applicable paragraph(s) in the specification.

4.2.2 Inspection Lot: An inspection lot shall include all mill forms of one heat, condition and size presented for acceptance at one time, and when heat treated, from the same process and the same batch.

4.3 Examination of product:

Samples selected at random in accordance with Table III shall be examined for compliance with surface condition, identification, dimensional, marking, workmanship, and preparation for delivery requirements.

TABLE III. Sampling for examination of product

Lot Size	Sample Size	Acceptance number
1 to 65	4	0
66 to 110	5	0
111 to 300	7	0
301 to 500	10	0
501 to 800	15	0
Over 800	25	0

4.4 Chemical analysis:

- 4.4.1 Sampling: Samples for check chemical analysis shall be selected to represent each heat of steel in accordance with requirements of method 111.2 of FED-STD-151.
- 4.4.2 Specimens: Samples for check chemical analysis shall be taken parallel to the axis of the billet selected, at a point midway between the center and surface, except that material less than 1 1/4 inches thick shall be sampled through the entire cross-section. The sample shall consist of not less than 2 ounces of material.
- 4.4.3 Test method: Samples shall be prepared in accordance with Method 111.2 of FED-STD-151, and shall be tested by wet chemical, spectrographic, or other analytical methods. In the event of dispute, analysis shall be by wet chemical methods.

4.5 Steel cleanliness inspection:

The material shall be magnetic particle inspected in accordance with MIL-I-6868 to comply with the steel cleanliness requirements of AMS 2301.

4.6 Ultrasonic inspection:

Inspection shall be in accordance with MIL-I-8950. Surface roughness shall not exceed 125 roughness height rating (RHR) at 5 megahertz (mhz) and 250 RHR at 2.25 mhz and lower frequencies. The surface roughness of the reference standards shall not vary more than plus or minus 25 RHR from the surface roughness of material being tested.

4.7 Hardenability:

- 4.7.1 Sampling: One or more samples for end-quench hardenability test shall be selected from each heat of steel from which material is presented for acceptance.
- 4.7.2 Preparation of specimens: Specimens for the end-quench hardenability test shall conform to ASTM A 255. The steel shall be normalized prior to machining the test specimen by heating $1,600^{\circ} \pm 10^{\circ}\text{F}$ holding at this temperature for 1 hour and cooling in still air.
- 4.7.3 Test method: End-quench hardenability test shall be conducted in accordance with ASTM A 255. Specimens shall be austenitized at $1,550^{\circ} \pm 10^{\circ}\text{F}$. Tests shall establish compliance with 3.3.

4.8 Grain size:

- 4.8.1 Sampling: One or more samples shall be selected to represent each heat of steel from which material is submitted for acceptance.
- 4.8.2 Test method: Specimens shall be sectioned and polished to appropriate fineness by metallographic methods and suitably etched to reveal the grain structure. The austenite grain size shall be determined in accordance with ASTM E 112.