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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS-S-6050

Issued NOV 1998

Submitted for recognition as an American National Standard

Steel, Chrome-Nickel-Molybdenum (8630) Bars and Reforging Stock (Aircraft Quality)

NOTICE

This document has been taken directly from U.S. Military Specification MIL-S-6050A, Amendment 2 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-6050A, Amendment 2. 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 technical report.

1. SCOPE:

1.1 Scope:

This specification covers steel bars and reforging stock of aircraft quality.

1.2 Classification:

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1.2.1 Physical conditions: Material shall be 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

1.2.2 Surface conditions: Material shall be in one of the following surface 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.

2. APPLICABLE DOCUMENTS:

The following publications, of the issues 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 2251 Tolerances, Alloy Steel Bars
AMS 2301 Aircraft Quality Steel Cleanliness-Magnetic Particle Inspection Procedure
AMS 2640 Magnetic Particle Inspection

2.3 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

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
MIL-STD-430 Macrograph Standards for Steel Bars, Billets, and Blooms

3. REQUIREMENTS:

3.1 Material:

The steel shall be of aircraft quality. The material shall be magnetic particle inspected in accordance with MIL-I-6868 or AMS 2640. The quality requirements of paragraph 3.3 entitled “Inspection” and paragraph 4 entitled “Disposition” of AMS 2301 shall apply.

3.2 Chemical composition:

Chemical composition shall be as specified in table I.

TABLE I. Chemical composition

Element	Analysis (percent)	Check analysis 1/ tolerance (percent)
Carbon	0.28 - 0.33	±0.02
Manganese	.70 - 0.90	±0.03
Phosphorus	.025 (max)	+0.005
Sulfur	.025 (max)	+0.005
Silicon	.20 - 0.35	±0.02
Nickel	.40 - 0.70	±0.03
Chromium	.40 - 0.60	±0.03
Molybdenum	.15 - 0.25	±0.02
Copper	.35 (max)	+0.02

1/ Individual determinations may vary from the specified range to the extent shown in the check analysis column, except that 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-35 minimum at 5/16 inch and Rockwell C-28 minimum and 8/16 inch.

3.4 Grain size:

The austenitic grain size shall be predominately No. 5 or finer, with grains as large as No. 3 permissible.

3.5 Macrostructure:

Segregation and imperfections disclosed by examination of deep-acid-etched reforging bars in sizes up to 36 square inches, inclusive, shall not exceed the limits indicated by plates S-2, R-1, and C-2 of MIL-STD-430. Bars in sizes over 36 inches shall not exceed S-2, R-2, and C-3.

3.6 Decarburization:

Unless otherwise specified (see 6.2.2), the depth of decarburization of products in surface conditions (2) and (4) shall be not greater than the following limits:

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.	.012
Over 0.500 to 0.625, incl.	.014
Over 0.625 to 1.000, incl.	.017
Over 1.00 to 1.50, incl.	.020
Over 1.50 to 2.00, incl.	.025
Over 2.00 to 2.50, incl.	.030
Over 2.50 to 3.00, incl.	.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 0.065 inch or less.

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

3.6.3 When material is intended for reforging purposes, the decarburization limits specified herein are waived.

3.7 Surface and physical condition:

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 for conditions (C), (D), and (E) material:

3.8.1 The hardness for material in physical conditions (C), (D), and (E) shall be not more than Brinell 229 (Rockwell C-21) when furnished in surface conditions (1), (2), or (3).

3.8.2 The hardness for material in physical conditions (C), (D), and (E) shall be not more than Brinell 241 (Rockwell C-23) 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 1-1/2 inches in the least dimension shall be as specified in table II.

TABLE II. Mechanical properties of condition (F) steel

Tensile strength	Yield strength at 0.2 percent offset or extension indicated		Elongation in 2 inches or 4 times diameter	Reduction of area
		Extension under load (inches in 2 inches)		
(min. psi)	(min. psi)		(min. percent)	(min. percent)
125,000	100,000	0.0107	17	55

3.9.1 When products in condition (F) are ordered with mechanical properties differing from those specified in table II or when products in condition (F) are ordered in sizes larger than 1-1/2 inches in the least dimension, the mechanical properties shall be as agreed upon between 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 the number of this specification.

3.11 Tolerance:

Tolerances shall conform to the limits of AMS 2251 applicable to hot rolled alloy steel bars for surface conditions (1), (2), and (3) and to cold finished alloy steel bars for surface conditions (4) and (5).

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.

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

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier 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 Quality conformance inspection:

All the examinations and tests of steel are classified as quality conformance inspection, for which necessary sampling techniques and methods of testing are specified in this section.

4.2.1 Inspection lot: An inspection lot shall consist of 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 in accordance with table III shall be examined for compliance with surface condition, identification, dimensional, and preparation for delivery requirements.

TABLE III. Sampling for examination of product

Lot size	Sample size		Acceptance number
	Direct (mill) procurement	Warehouse procurement	
1 to 15	All	All	0
16 to 180	15	All or 30, whichever is less	0
181 to 300	35	55	0
301 to 500	50	100	1
Over 500	75	150	2

4.4 Magnetic particle inspection quality:

Specimens shall be selected and rated in accordance with the procedures of AMS 2301. Inspection shall be in accordance with MIL-I-6868 or AMS 2640.

4.5 Chemical analysis:

4.5.1 Sampling: At least one sample shall be selected to represent each heat of steel in accordance with FED-STD-151. The sample shall consist of not less than 2 ounces.

4.5.1.1 Location: Samples for check chemical analysis shall be taken parallel to the axis of the bar 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.

4.5.2 Analysis: Chemical analysis shall be by wet chemical or spectrochemical analysis in accordance with Method 111 or 112, respectively, of FED-STD-151, or other analytical methods. In the event of dispute, analysis shall be by wet chemical methods.

4.6 Hardenability:

4.6.1 Sampling: One or more samples shall be selected from each heat of steel from which material is presented for acceptance. Cast, forged, or rolled samples are acceptable.

4.6.2 Preparation of specimens: Specimens for the end-quench-hardenability test shall conform to Method 711, FED-STD-151. The steel shall be normalized prior to machining the test specimen by heating to 1650° ± 25 °F, holding at this temperature for 1 hour and cooling in still air.

4.6.3 Test method: End-quench-hardenability tests shall be performed in accordance with Method 711 of FED-STD-151 to ensure compliance with 3.3. Specimens shall be austenitized at 1600° ± 10 °F.

4.7 Grain size:

4.7.1 Sampling: One or more samples shall be selected to represent each heat of steel from which material is submitted for acceptance.

4.7.2 Test method: Specimens shall be sectioned and polished to appropriate fineness by metallographic methods and suitably etched to reveal the grain structure. The austenitic grain size shall be determined in accordance with procedure B, C, or D, Method 311 of FED-STD-151.

4.8 Macrostructure:

4.8.1 Sampling: Two or more samples shall be selected to represent each heat of steel from which material is submitted for acceptance.

4.8.2 Preparation of specimens: Deep-acid etch specimens shall be cut from the ends of the bars selected as samples and shall represent the entire cross section of the bar. The specimen shall measure 1/2 inch or more in the direction of the axis of the bar. One of the faces of the specimen representing the cross section shall be finished flat and smooth by a fine machine cut or by grinding. The finished face of the specimen shall be etched in an aqueous solution containing 50 percent hydrochloric acid by volume and maintained at a temperature of approximately 71 °C (160 °F).

4.8.3 Test method: Specimens shall be examined by a metallographist to determine compliance with 3.5 and 3.12.

4.9 Decarburization:

4.9.1 Sampling: If the inspector has reason to suspect that the decarburization limits specified herein may have been exceeded, samples shall be selected for determination of the depth of decarburization.

4.9.2 Test method: Depth of the zone of decarburization below a surface shall be determined by examination of a metallographic specimen or specimens representing the entire cross section of bars 1 inch or less in diameter or width. With bars over 1 inch in diameter, the section shall exhibit not less than 1 linear inch of the original surface of the bar. This specimen shall be polished, etched with 5 percent nital, and examined at 100 diameters magnification.

4.9.2.1 Measuring depth of decarburization: Decarburization depth may be measured by making a microhardness transverse at intervals of 0.001 inch on a line perpendicular to the surface in question and noting the depth at which successive hardness readings do not increase continuously.

4.10 Hardness of bars in physical conditions (C), (D), and (E):

4.10.1 Sampling: At least 5 bars of each temper and size shall be tested to ascertain conformance to the permissible hardness values. When a lot consists of less than 5 bars, each bar shall be tested.

4.10.2 Test method: Hardness testing shall conform to Method 242 or 243 of FED-STD-151 to ensure compliance with 3.8.

4.11 Mechanical properties of condition (F) steel:

4.11.1 One or more samples shall be selected from the lot.