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INTERNATIONAL
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-S-6049

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Submitted for recognition as an American National Standard

Steel, Chrome-Nickel-Molybdenum (8740) Bars and Reforging Stock (Aircraft Quality)

NOTICE

This document has been taken directly from U.S. Military Specification MIL-S-6049A, Amendment 1, Notice 1 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-6049A, Amendment 1, Notice 1. 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 document.

1. SCOPE:

1.1 Form:

This specification presents the requirements for chrome-nickel-molybdenum (8740) steel bars and reforging stock of aircraft quality.

1.2 Classification:

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1.2.1 Physical condition: Material shall be 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 condition: Material shall be 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
6. Turned and polished

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 2251 Tolerances - Alloy Steel Bars
AMS 2301 Aircraft Quality Steel Cleanliness - Magnetic Particle Inspection Procedure
AMS 2640 Magnetic Particle Inspection

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

3. REQUIREMENTS:

3.1 Material:

The steel shall be of aircraft quality (See 3.12).

3.2 Chemical composition:

The chemical composition shall be as specified in table I.

TABLE I. Chemical composition

Element	Analysis Percent	Check analysis tolerance 1/ Percent
Carbon	0.38 - 0.43	±0.02
Manganese	0.75 - 1.00	±0.04
Phosphorus	0.025 max.	±0.005
Sulfur	0.025 max.	±0.005
Silicon	0.20 - 0.35	±0.02
Nickel	0.40 - 0.70	±0.03
Chromium	0.40 - 0.60	±0.03
Molybdenum	0.20 - 0.30	±0.02
Copper	0.35 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-49 minimum at 5/16 inch and Rockwell C-35 minimum at 10/16 inch.

3.4 Grain size:

The austenitic 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 bars in sizes up to 36 square inches, inclusive, shall be equal to or better than C-3, S-2, and R-2 of MIL-STD-430. Bars in sizes 37 to 100 square inches, inclusive, shall be equal to or better than C-4, S-2, and R-2.

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, inclusive	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 0.065 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 Physical and surface 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 limit for conditions (C) and (E) material:

3.8.1 The hardness for material in physical conditions (C) 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) 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 1-3/4 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	Reduction of area
		Extension under load (inches in		
(min. psi)	(min. psi)	2 inches)	(min. percent)	(min. percent)
125,000	103,000	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 1-3/4 inches in the least dimension, the mechanical properties shall be as agreed upon between the supplier and the procuring activity.

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 Tolerances:

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), (5), and (6).

3.12 Inspection:

Unless otherwise specified in the contract or purchase order, material shall be inspected as follows.

3.12.1 Magnetic particle inspection: The material shall be inspected in accordance with the procedures of AMS 2301 and shall not exceed the size and frequency rating limits indicated in paragraph 4 entitled “Disposition” of AMS 2301.

3.12.2 Ultrasonic inspection: All bars and reforging stock shall be ultrasonically inspected in accordance with MIL-I-8950. The minimum quality level shall be as specified below:

Dimensions (inches)	Ultrasonic classification
1-1/2 to 9 thickness	A
Larger than 9	B

3.13 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.

3.13.1 Cold drawn bars: Cold drawn bars shall be free from scale or surface imperfections. Drawing shall be accomplished after all heat-treating operations have been completed. 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 in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by 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:

Sufficient spot checks shall be made to assure compliance with the surface condition, identification, dimensional, and workmanship requirements.

4.4 Magnetic particle inspection quality:

The 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: One or more samples 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 of material.

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 1600° ± 10 °F, holding at this temperature for 1 hour and cooling in still air.

4.6.3 Test method: End-quench hardenability tests shall be conducted in accordance with Method 711 of FED-STD-151. Specimens shall be austenitized at 1550° ± 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.

4.8.3 Test method: 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 approximately 71 °C (160 °F). Specimens shall be examined to determine compliance with 3.5.

4.9 Decarburization:

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

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.

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

4.10.1 Sampling: At least five bars of each temper and size shall be tested to ascertain conformance with the permissible hardness values. When less than five bars are ordered, each bar shall be tested.

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

4.11 Mechanical properties of condition (F) steel:

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

4.11.1.1 Tensile test specimens shall conform to the round type specimens of Method 211 of FED-STD-151. For bars up to 1-1/2 inches in diameter or thickness, the axis of the test specimen shall coincide with the central axis of the bar; 1-1/2 inches and over, the axis shall be located midway between the center and the surface of the bar. The axis of tensile test specimens shall be parallel to the direction of rolling or drawing.

4.11.2 Test method: Tensile tests shall be conducted in accordance with Method 211 of FED-STD-151. Yield strength shall be determined by the offset or extension-under-load methods.