SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS-S-6709A

Issued DEC 1998
Cancelled SEP 2002

Superseding AMS-S-6709

Steel, Chrome-Molybdenum-Aluminum; Bars, Rods, Billets and Forging Stock (For Nitriding) (Aircraft Quality)

CANCELLATION NOTICE

This specification has been declared “CANCELLED” by the Aerospace Materials Division, SAE, as of September 2002, and has been superseded by the following:

For the annealed condition, use AMS 6470. The requirements of the latest issue of AMS 6470 shall apply when AMS-S-6709 condition (C) is specified.

For the hardened and tempered condition, use AMS 6472. The requirements of the latest issue of AMS 6472 shall apply when AMS-S-6709 condition (F) is specified.

By this action, this document will remain listed in the Index of Aerospace Material Specifications noting that it has been cancelled. Cancelled specifications are available from SAE.

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This document was taken directly from U.S. Military Specification MIL-S-6709A, Amendment 2, Notice 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 was intended to replace MIL-S-6709A, Amendment 2, Notice 2. Any part numbers established by the original specification remain unchanged.

1. SCOPE:

1.1 Scope:

This specification covers steel of aircraft quality for use in the manufacture of nitrided parts (see 6.1).

1.2 Classification:

The steel shall be furnished in the following conditions, as specified (see 6.2):

Physical condition:

(A) As forged
(B) As rolled
(C) Annealed
(D) Normalized
(E) Normalized and tempered
(F) Hardened and tempered

Surface condition:

(1) Black, as forged or as rolled
(2) Pickled or blast cleaned
(3) Rough turned
(4) Cold finished and stress relieved
(5) Turned, ground, 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 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
FED-STD-48	Tolerances for Steel and Iron Wrought Products
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 magnetically inspected in accordance with the procedures of AMS 2301, and shall not exceed the size and frequency rating limits indicated in the paragraph entitled “Disposition” of AMS 2301 (see 4.10).

3.2 Chemical composition:

The material shall conform to the chemical composition and shall be within the check analysis tolerances specified in Table I.

3.3 Hardness limits for conditions (C) and (E) material:

The hardness for materials in physical conditions (C) and (E) shall be not more than Brinell 229 (Rockwell C-21) when furnished in surface conditions (1), (2), (3), or (5), and shall be not more than Brinell 248 (Rockwell C-24) when furnished in surface condition (4).

3.4 Hardenability:

End-quench hardenability values for the steel in all conditions shall be not less than J50 at 8/16 inch and J45 at 12/16 inch.

TABLE I. Chemical composition

Element	Composition [1] (percent)	Check analysis tolerance [2] (percent)
Carbon	0.38 to 0.43	±0.02
Manganese	.50 to 0.70	±0.03
Phosphorus	.025 (max)	+0.005
Sulfur	.025 (max)	+0.005
Silicon	.20 to 0.40	±0.02
Chromium	1.40 to 1.80	±0.05
Aluminum	.95 to 1.35	±0.10
Molybdenum	.30 to 0.40	±0.02

[1] For sizes over 200 square inches in cross sectional area, or 18 inches in width, or 10,000 pounds in weight per piece, the composition shall be negotiated.

[2] 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 tolerances shall be negotiated.

3.5 Macrostructure and Microstructure:

3.5.1 Macrostructure: Segregation and imperfections disclosed by examination of deep-acid-etched 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 square inches to 100 square inches inclusive, shall not exceed S-2, R-2, and C-3.

3.5.2 Microstructure: The material shall reveal no excessive segregation of ferrite nor excessive banding when examined as specified in 4.7.

3.6 Decarburization:

Unless otherwise specified, the depth of decarburization for bars and rods furnished in surface conditions (2) and (4) shall be not greater than the limits specified in Table II.

3.6.1 Bars and rods furnished in surface conditions (3) and (5) shall be free from decarburization.

3.6.2 When bars are intended for reforging purposes, the decarburization limits of table II shall not apply.

3.6.3 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 table II by more than 0.005 inch and the width is 0.065 inch or less.

TABLE II. Decarburization limits

Nominal diameter or distance between opposite faces (inches)	Maximum permissible depth of decarburization (inches)[1]
0.5 and under	0. 030
Over 0.5 to 1.0, incl	. 035
Over 1.0 to 1.5, incl	. 040
Over 1.5 to 2.0, incl	. 050
Over 2.0 to 2.5, incl	. 060
Over 2.5 to 3.0, incl	. 070

[1] The value specified as the maximum depth of decarburization is the sum of the complete plus the partial decarburization.

3.7 Mechanical properties of condition (F) steel:

The mechanical properties of material supplied in condition (F) shall be as specified in table III for rounds and squares 3 inches and under in diameter or cross section. For sizes over 3 inches, the mechanical properties shall be as negotiated.

TABLE III. Mechanical properties of condition (F) steel

Tensile strength, minimum (psi)	Yield strength at 0.2 percent offset or at extension indicated		Elongation in 2 inches, minimum (percent)	Reduction of area, minimum (percent)
	Minimum (psi)	Extension under load (inches in 2 inches)		
112, 000	90, 000	0. 0101	16	50

3.8 Dimensions and tolerances:

3.8.1 Width and thickness: Unless otherwise specified, the permissible variation in dimensions of bars and rods shall be as specified in FED-STD-48 (see 6.2).

3.8.2 Exact lengths: Bars and rods of all sizes may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit, with tolerances as specified in paragraph 1d4 entitled “Stainless and Heat Resisting Steels” of FED-STD-48.

3.8.3 Mill lengths: When exact or multiple lengths are not ordered, bars and rods will be acceptable in mill lengths of 6 to 20 feet, but not more than 10 percent of any order shall be furnished in lengths shorter than 10 feet.

3.9 Identification marking:

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

3.9.1 Billets and forgings: Billets and forgings shall be individually marked with markings specified in 3.8, or shall have attached metal tags impression stamped with the information.

3.10 Workmanship:

The bars, rods, billets, and forgings shall be straight, of uniform quality and condition, free from pipes, laps, cracks, twists, seams, damaged ends, or other harmful defects, and shall have a finish of the best quality. Surface imperfections such as handling marks, light seams, straightening marks, light die or roll marks, shallow pits and scale pattern, will not be considered as harmful defects, provided the imperfections are removable within the tolerances specified for the diameter or across flats. The removal of surface imperfections is not required.

3.10.1 Cold finishing: Cold finishing shall be accomplished subsequent to heat treating operations. The surfaces of cold finished bars shall be free from scale.

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 Classification of tests:

All the examinations and tests of steel are classified as quality conformance tests.

4.2.1 Inspection Lot: An inspection lot shall consist of mill forms of one heat, shape, condition, and size presented for acceptance at one time.

4.3 Examinations:

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

4.3.2 Examination of preservation, packaging, packing, and marking: Preparation for delivery shall be examined for conformance to section 5.

4.4 Chemical analysis:

4.4.1 Sampling: One or more samples shall be selected and prepared in accordance with Method 111 or 112 of FED-STD-151 to represent each heat of steel. Samples shall be taken in a zone midway between the center and surface, except that material less than 1 1/4 inch thick shall be sampled through the entire cross section.

4.4.2 Samples for check chemical analysis may be waived at the discretion of the procuring activity, provided that all material under inspection can be identified as being made from a heat previously analyzed and found to conform to the chemical composition specified herein.

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

4.5 Hardness:

4.5.1 Sampling: Five samples, or 5 percent of the lot, whichever is greater, shall be selected at random from each lot of material. When a lot consists of less than five, each bar or rod shall be tested.

4.5.2 Method of test: Hardness testing shall conform to Method 242 or 243 of FED-STD-151 to insure compliance with 3.3.

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 of FED-STD-151. Specimens shall be normalized from 1,800° ± 10 °F. prior to machining the test specimen.

4.6.3 Method of test: End-quench-hardenability tests shall be conducted in accordance with Method 711 of FED-STD-151 to insure compliance with 3.4. Specimens shall be austenitized at 1,700° ± 10 °F.

4.7 Macrostructure and microstructure:

4.7.1 Sampling: Two or more samples shall be selected at random from each lot of material (see 4.2.1).

4.7.2 Preparation of specimens:

4.7.2.1 Macrostructure specimens: Samples shall be machined or ground, or both, as required, in such manner that the specimen test surface shall represent an entire cross section of the bar, rod, billet, or forging. The specimen shall be ground to appropriate fineness, etched with an aqueous solution containing 50 percent hydrochloric acid by volume and maintained at a temperature of approximately 71 °C (160 °F) to reveal the grain structure and the presence of defects.

4.7.2.2 Microstructure specimens: Samples shall be selected in such a manner to represent the entire cross sectional area of the bar, billet, or forging. Samples shall be austenitized at 1,700 °F, oil quenched, and tempered at 1,000 °F. Samples size 3/8 by 3/4 inch or more shall be suitably polished and etched for examination of the microstructure.