

**AEROSPACE
MATERIAL
SPECIFICATION**



AMS-S-8690A

Issued DEC 1998
Cancelled SEP 2002

Superseding AMS-S-8690

Steel, Chrome-Nickel-Molybdenum, 8620, Bars
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has been declared "CANCELLED" by the Aerospace Materials Division, SAE, as of September 2002, and has been superseded by the AMS 6274. The requirements of the latest issue of AMS 6274 shall apply when AMS-S-8690 condition (C) 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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1. SCOPE:

1.1 Scope:

This specification covers an aircraft quality, low alloy chrome-nickel-molybdenum steel (8620) in the form of bars.

1.2 Classification:

Bars shall be furnished in one of the following physical and surface conditions as specified (see 6.2);

1.2.1 Physical conditions:

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

1.2.2 Surface conditions:

- (1) Black, as forged or rolled
- (2) Pickled in acid
- (3) Rough turned
- (4) Cold finished
- (5) Sand or shot blasted
- (6) Ground, or 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 ASTM Publications:

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

ASTM A 255	End-Quench for Hardenability of Steel
ASTM A 370	Methods and Definitions for Mechanical Testing of Steel Products
ASTM E 112	Standard Methods for Estimating the Average Grain Size of Metals
ASTM E 350	Standard Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron and Wrought Iron
ASTM E 381	Standard Method for Rating Macroetched steel

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-48	Tolerances for Steel and Iron Wrought Products
FED-STD-151	Metals; Test Methods
FED-STD-183	Continuous Identification Markings of Iron and Steel Products
MIL-STD-163	Steel Mill Products, Preparation for Shipment and Storage

3. REQUIREMENTS:

3.1 Material:

The steel shall be of aircraft quality. The material shall comply with the cleanliness requirements of magnetic particle inspection in accordance with AMS 2301 for qualification of the heat melt or lot of steel as well as bars, the product of the heat melt or lot of the steel.

3.2 Chemical composition:

The chemical composition shall be as specified in Table I.

3.3 Hardenability:

The end-quench hardenability values shall be J48 = 1 max and J32 = 3 min for the steel in all specified conditions using standard specimens in accordance with ASTM A 255.

3.4 Grain size:

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

TABLE I - Chemical Composition

Elements	Percent <u>1/ 2/</u>	Check Analysis Tolerances <u>3/</u>			
		To 100 sq. in.	Over 100 to 200 sq. in.	Over 200 to 400 sq. in.	Over 400 to 800 sq. in.
Carbon	0.18 to 0.23	±0.01	±0.02	±0.03	±0.04
Manganese	0.70 to 1.00	±0.03	±0.04	±0.05	±0.06
Phosphorus	0.025 <u>4/</u>	+0.005 <u>5/</u>	±0.01 <u>5/</u>	±0.01 <u>5/</u>	+0.01 <u>5/</u>
Sulfur	0.025 <u>4/</u>	+0.005 <u>5/</u>	±0.01 <u>5/</u>	±0.01 <u>5/</u>	+0.01 <u>5/</u>
Silicon	0.20 to 0.35	±0.02	±0.02	±0.03	±0.04
Chromium	0.40 to 0.60	±0.03	±0.03	±0.04	±0.05
Nickel	0.40 to 0.70	±0.03	±0.03	±0.03	±0.03
Molybdenum	0.15 to 0.25	±0.02	±0.03	±0.03	±0.04
Copper	0.35	±0.02	±0.03	±0.03	±0.04

1/ All percentages are maximum unless shown as range or otherwise indicated.

2/ Applicable to sizes not exceeding 200 square inches in cross-sectional area, or 18 inches in width, or 10,000 pounds in weight per piece. For oversizes, chemical composition shall be specified by the procuring activity (see 6.2).

3/ Individual determinations may vary from the specified range to the extent shown in the various columns except that elements in any heat shall not vary both above and below the specified range.

4/ The values shall not exceed 0.015 percent maximum when consumable electrode vacuum melted steel is specified (see 6.2).

5/ Over maximum only.

3.5 Macrostructure:

Visual examination of transverse sections, deep-acid-etched for sufficient time to develop a well-defined macrostructure, shall show no injurious imperfections such as pipes, cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure shall be equal or better than the following macrographs of ASTM E 381:

Section Size - Square Inches

Up to 36, inclusive
Over 36 to 100, inclusive
Over 100

Macrographs

S2-R1-C2
S2-R2-C3
As specified by the procuring activity (see 6.2).

3.6 Physical and surface conditions:

Unless otherwise specified, bars over 1/2 inch in diameter or distance between parallel sides shall be furnished in conditions (C), (2), (3), (4) or (5) (see 6.2). Unless otherwise specified, bars 1/2 inch or less in diameter or distance between parallel sides shall be furnished in condition (C) (5).

3.7 Hardness limits for conditions (C) and (E) materials:

Hardness for bars over 1/2 inch in diameter or distance between parallel sides shall not be higher than 229 HB or equivalent hardness when hot finished in surface conditions (1), (2), (3) or (5). When specified to a cold finish (4), the bars may have a hardness as high as 248 HB or equivalent hardness. Cold finished bars, 1/2 inch or less in diameter or distance between parallel sides, shall have a tensile strength not greater than 130 KSI or equivalent hardness.

3.8 Decarburization:

Bars specified to surface conditions (3) and (6) shall be free from decarburization on the turned, ground, or polished surfaces. Unless otherwise specified, the depth of decarburization of products in surface conditions (2), (4), or (5) shall not be greater than the limits shown in Table II. When intended for redrawing or reforging purposes, the decarburization limits specified in Table II shall not apply.

TABLE II - Decarburization Limits

Nominal Diameter or Distance Between Opposite faces - Inches	Depth of decarburization - Inch - Maximum <u>1/</u> <u>2/</u>
Up to 0.375, inclusive	0.010
Over 0.375 to 0.500	0.012
Over 0.500 to 0.625	0.014
Over 0.625 to 1.000	0.017
Over 1.000 to 1.500	0.020
Over 1.500 to 2.000	0.025
Over 2.000 to 2.500	0.030
Over 2.500 to 3.000	0.035
Over 3.000 to 4.000	0.045

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

2/ Limits for depth of decarburization over 4.000 inches in nominal diameter or distance between parallel side shall be specified in the contract, purchase order or applicable drawing (see 6.2).

3.9 Tolerances:

Tolerances shall conform to the limits of FED-STD-48 applicable to hot rolled or cold rolled, alloy steel bars.

3.9.1 Exact lengths: Bars of all sizes may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit, with tolerances in accordance with FED-STD-48 or as specified in the contract or purchase order (see 6.2).

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

3.10 Identification:

Each bar shall be identified in accordance with FED-STD-183. The marking shall include the number of this specification, the heat numbers of the metal and the manufacturer's identification.

3.11 Workmanship:

Material shall be sound, of uniform quality and condition, clean and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts. Bars specified turned, ground or polished shall be free from seams, laps, tears, cracks, and twists. Products specified to surface conditions other than turned, ground or polished shall, after removal of standard machining allowances, be free from seams, laps, tears, cracks, scale and other surface defects and imperfections. Cold finishing of bars shall be accomplished after heat treating operations have been completed, however stress relieving may be accomplished after cold finishing.

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 supplied 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 Procuring Activity. The Procuring Activity 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 requirement.

4.2 Lot:

A lot shall consist of all material identifiable to a single heat, or melt or shall consist of the milled formed bars of one composition, shape, condition and nominal dimension from a single heat or melt, heat treated as a batch or sequentially heat treated in a continuous furnace. The lot shall be submitted for inspection at one time.

4.3 Sampling:

4.3.1 For product examination: For compliance with surface conditions, dimensions, identification, workmanship and preparation for delivery requirements, samples of the product shall be drawn at random from the lot as indicated in Table III.

TABLE III - Sampling for Product Examination

Number of items in inspection lot	Number of items in sample (randomly selected)	Acceptable number (maximum number of sample items non conforming to any test)
15 or less	All	0
16 to 180	15	0
181 to 300	35	0
301 to 500	50	1
501 and over	75	2

4.3.2 For magnetic particle inspection quality: The sampling shall be selected and rated in accordance with AMS 2301 for either heat qualification of a steel lot or for qualification of the finished product.

4.3.3 For chemical composition:

4.3.3.1 Ingot sampling: At least one sample shall be taken from each group of ingots poured simultaneously from the same source of molten metal by the producer for chemical analysis in accordance with 4.5.3. Ingots not conforming to the requirements of this specification shall be rejected. Complete ingot analysis records shall be available to the procuring activity at the producers plant.

4.3.3.2 Finished product sampling: When compliance with 4.3.3.1 cannot be established, a random sample from two or more bars shall be selected from each lot for chemical analysis in accordance with 4.5.3. Samples shall be taken parallel to the axis of the bars selected at a point midway between the center and the surface except that material less than 1 1/4 inches thick shall be sampled throughout the entire cross-section.

4.3.4 For hardenability, macroexamination and decarburization: A minimum of four samples, consisting of a section randomly selected representing the top and bottom of the first and last ingot in the heat shall be taken for each test to determine hardenability (see 4.5.4), macrostructure (4.5.6) and decarburization (see 4.5.8). Forged or rolled samples shall be acceptable for the determination of hardenability.

4.3.5 For grain size: One or more samples shall be selected to represent each heat of steel or inspection lot for determination of grain size in accordance with 4.5.5.

- 4.3.6 For hardness of bars in conditions (C) and (E): At least five samples shall be randomly selected from each lot of bars of each temper and size for the permissible hardness values in accordance with 4.5.7. If a lot consists of 5 bars or less, then each bar shall be tested.
- 4.4 Quality conformance examination:
- 4.4.1 Product examination: Samples selected in accordance with 4.3.1 shall be visually examined for conformance with the requirements of 3.6 for physical and surface conditions, of 3.10 for identification and of 3.11 for workmanship.
- 4.4.2 Containers: Each of the filled containers selected in accordance with 4.3.1 shall be examined for construction defects, unsatisfactory marking, closure and weight to determine conformance to the requirements of Section 5.
- 4.5 Quality conformance tests:
- 4.5.1 Dimensional measurements: The samples selected in accordance with 4.3.1 shall be measured for cross sectional area, diameter, width, thickness, length to determine conformance to 3.9 and 3.9.1 and counted for conformance to 3.9.2, if applicable.
- 4.5.2 Cleanliness: The samples selected in accordance with 4.3.2 shall be magnetic particle inspected by a circular, wet, continuous method in accordance with MIL-I-6868 or AMS 2640 to determine conformance to 3.1.
- 4.5.3 Chemical composition: The sample selected from the ingot in accordance with 4.3.3.1 or the sample bars selected in accordance with 4.3.3.2 shall be tested in accordance with Method 111 or Method 112 of FED-STD-151 to determine conformance to 3.2 and Table I. ASTM E 350 or other approved standard analytical methods may be used for composition determination.
- 4.5.4 Hardenability: The hardenability of the samples, selected in accordance with 4.3.4 shall be determined in accordance with ASTM A 255 for conformance to 3.3. For the standard end-quench test specimen, the steel shall be normalized at $1700 \pm 10^\circ\text{F}$ and the test specimen austenitized at $1500 \pm 10^\circ\text{F}$. The hardenability test in accordance with ASTM A 225 shall not be required on a product which will not yield a suitable specimen. However, the steel from which the product is made shall conform to the requirements of 3.3.
- 4.5.5 Grain size: The grain size of the sample, selected in accordance with 4.3, shall be determined in accordance with ASTM E 112 for conformance to 3.4, using the McQuaid-Ehn Test for the austenite grain formation.