MIL-S-8690B
1 February 1978
Superseding
MIL-S-8690A
6 September 1967

MILITARY SPECIFICATION

STEEL, CHROME-NICKEL-MOLYBDENUM, 8620, BARS AIRCRAFT QUALITY

* This specification is approved for use by all Departments and Agencies of the Department of Defense

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, New Jersey 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 9510

2 APPLICABLE DOCUMENTS

* 2 1 The following documents 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

SPECIFICATIONS

Military

MIL-I-6868	Inspection Process, Magnetic Particle

STANDARDS

Federal

FED STD No 48	Tolerances for Steel and Iron Wrought Products
FED TEST METHOD STD NO 151	Metals, Test Methods
FED STD NO 183	Continuous Identification Markings of Iron and Steel Products

Military

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

(Copies of specifications, standards, drawings and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer)

* 2 2 Other publications - The following documents form a part of this specification to the extent specified herein Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply

Society of Automotive Engineers Publications

AMS 2301 -	Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
AMS 2640 -	Magnetic Particle Inspection

(Application for copies of AMS Standards should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096)

American Society for Testing and Materials

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

(Application for copies of ASTM standards should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103)

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 1/ 2/	Check Analysis Tolerances 3/			
		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 4/	+0 005 5/	+0 01 5/	+0 01 5/	+0 01 5/
Sulfur	0 025 4/	+0.005 5/	+0 01 5/	+0 01 5/	+0 01 5/
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	Macrographs
Up to 36, inclusive	S2-R1-C2
Over 36 to 100, inclusive	S2-R2-C3
Over 100	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 1/ 2/
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 No. 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 No 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 No 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 requirments 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), macro-structure (see 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 Test Method Std No 151 to determine conformance to 3 2 and Table I ASTM E350 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 A255 for conformance to 3 3 For the standard end-quench test specimen, the steel shall be normalized at 1700 ±10°F and the test specimen austenitized at 1500 ± 10°F The hardenability test in accordance with ASTM A225 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 E112 for conformance to 3.4, using the McQuaid-Ehn Test for the austenite grain formation.

* 4 5 6 Macrostructures - Transverse sections shall be made from the samples selected in accordance with 4 3 4 Specimens shall be cut a sufficient distance from the hot-cut surfaces and from the ends of the selected bars The disk specimens shall be prepared and deep-acid etched in accordance with ASTM E381, using a hot 1 1 hydrochloric acid solution at 160 to 180°F, for a sufficient time to develop a deep well-defined macrostructure Specimens shall be examined to determine conformance to 3.5 by comparison with the standard macrographs of ASTM E381

4 5 7 Hardness of bars in physical conditions (C) and (E) - Hardness and tensile strength of the samples, selected in accordance with 4 3 6, shall be determined in accordance with specimens prepared and tested in accordance with ASTM A370, as applicable, for conformance to the requirements of 3 7

* 4 5 8 Decarburization - The depth of the zone of decarburization, below a surface, shall be measured by a microscopic examination of a metallographic specimen, by the Rockwell Superficial 30-N scale or by an equivalent hardness testing method, on hardened but untempered specimens protected during heat treatment to prevent changes in the surface carbon contents Bars, 1 inch or less in diameter or distance between parallel sides, shall be represented by specimens that are the entire cross section. With bars over 1 inch in diameter or distance between sides, the section shall not be less than 1 linear inch of the original surface of the bar For microscopic examination, the specimen shall be polished, etched with 5 percent nital and examined at 100 diameters magnification The decarburization depth shall be measured by a hardness method of making a successive reading of microhardness transverse at intervals of 0.001 inch on a line perpendicular to the surface to such a depth under the surface below which there is no further increase in hardness Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon It shall be permissible when determining decarburization depth, to disregard local areas provided that the decarburization of such areas does not exceed the limits by more than 0 005 inch and the widths 0 065 inch

* 4 6 Mill products - Heats, melts or lots of steel which have been acceptable as a semi-finished bar product shall be considered acceptable for flat bar products Mill products from a heat, melt or lot of steel which has been previously tested and found to comply with cleanliness (see 3.1), chemical composition (see 3 2), hardenability (see 3 3) and macrostructure (see 3 5) requirements specified herein, need not be retested for these attributes by the producer

* 4 7 Rejection and retest - Failure of any specimen to meet the specified requirements, using the above tests, shall cause rejection of the materials represented At the discretion of the procuring activity, retesting by the supplier will be permitted Acceptance shall be based on the results of testing five additional specimens for each original nonconforming or failed specimen Failure of any retest specimens to conform to the specified requirements shall be cause for rejection of the lot of the material represented and no further testing shall be permitted

5 PREPARATION FOR DELIVERY

* 5 1 Preservation - Bars specified as cold drawn, cold rolled, turned, ground or polished shall be coated with a suitable non-staining corrosion preventive oil, conforming to Type A preservative as detailed in MIL-STD-163

* 5 2 Packaging and packing - The bars shall be properly separated by size and condition when prepared for delivery Packaging and packing shall be Level A or Level C as specified (see 6 2)

* 5 2 1 Level A - Bars shall be packaged and packed in accordance with MIL-STD-163 for either cold-finished or hot-rolled alloy steel bars, as applicable

* 5.2.2 Level C - Bars shall be packaged and packed in accordance with the usual commercial practices The exterior type shipping container shall be such that will insure safe transportation of the product, at the lowest rate to the point of delivery, and shall meet as a minimum, the requirements of the rules and regulations applicable to the mode of transportation selected

* 5 3 Marking - In addition to any special markings required by the contract or order (see 6.2), markings shall be in accordance with MIL-STD-163

6 NOTES

* 6 1 Intended use - Steel covered by this specification is intended for use in the manufacture of aircraft parts and components It is suitable for reforging and for carburizing The prime application of this material is for critical carburized parts and components which require a high core hardness even in thin sections. The core may or may not be machinable after hardening

* 6 2 Ordering data - Procurement documents should specify the following:

(a) Title, number and date of this specification

(b) Physical and surface conditions (see 1 2, 1.2 1, 1 2.2 and 3 6)

(c) Size and shape

(d) Chemical composition, if applicable, for oversizes and for consumable electrode vacuum melted material (see 3 2 and Table I)

(e) Decarburization depth, if other than specified (see 3.8 and Table II)

(f) Exact lengths or length units, and length tolerances if mill stock is not acceptable (see 3 9, 3.9 1 and 3 9 2).

(g) Applicable level of packaging and packing (see 5 2, 5.2 1 and 5 2 2).

(h) Special markings (see 5 3).

* 6 2 1 When bars are intended for redrawing or reforging purposes it shall be so stated (see 3 8)

* 6.2 2 Changes from previous issue - The margins of this specification are marked with an asterisk "*" to indicate changes (additions, modifications, corrections, deletions) from the previous issue This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations Bidders and contractors are cautioned to evaluate the requirements of their document based on the entire content irrespective of the marginal notations and relationship to the last previous issue

Custodians
Army-MR
Air Force-11

Preparing Activity
Navy-AS
(Project No. 9510-0227)

Review Activities
Army-MI, AV, , AT, GL, AR
Air Force-99

User Activities
Navy-OS

☆U S GOVERNMENT PRINTING OFFICE 1978 — 703-122/1145

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS This form is provided to solicit beneficial comments which may improve this document and enhance its use DoD contractors, government activities, manufacturers, vendors, or other prospective users of the document are invited to submit comments to the government Fold on lines on reverse side, staple in corner, and send to preparing activity Attach any pertinent data which may be of use in improving this document If there are additional papers, attach to form and place both in an envelope addressed to preparing activity A response will be provided to the submitter, when name and address is provided, within 30 days indicating that the 1426 was received and when any appropriate action on it will be completed

NOTE This form shall not be used to submit requests for waivers, deviations or clarification of specification requirements on current contracts Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements

DOCUMENT IDENTIFIER *(Number)* AND TITLE MIL-S-8690B Steel, Chrome-NIckel-Molybdenum 8620 Bars, Aircraft Quality

NAME OF ORGANIZATION AND ADDRESS OF SUBMITTER

☐ VENDOR ☐ USER ☐ MANUFACTURER

1 ☐ HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? ☐ IS ANY PART OF IT TOO RIGID RESTRICTIVE LOOSE OR AMBIGUOUS? PLEASE EXPLAIN BELOW

A GIVE PARAGRAPH NUMBER AND WORDING

B RECOMMENDED WORDING CHANGE

C REASON FOR RECOMMENDED CHANGE(S)

2 REMARKS

SUBMITTED BY *(Printed or typed name and address — Optional)*

TELEPHONE NO

DATE

DD FORM 1426 1 OCT 76 EDITION OF 1 JAN 72 WILL BE USED UNTIL EXHAUSTED

FOLD

DEPARTMENT OF THE NAVY
Naval Air Engineering Center
Lakehurst, NJ 08733

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
Navy Department
DOD-316

U.S. MAIL

Engineering Specifications and Standards Department (Code 93)
Naval Air Engineering Center
Lakehurst, NJ 08733

FOLD