

MIL-S-7393C

28 August 1968

Superseding

MIL-S-7393B

20 December 1967

## MILITARY SPECIFICATION

\* STEEL ALLOY CARBURIZING, BARS AND BILLETS, STEEL  
NICKEL-CHROMIUM (3310, 3316 and 9310), AIRCRAFT QUALITY

### 1. SCOPE

\* 1.1 Scope.-- This specification covers air melted nickel-chromium - molybdenum steels intended for use in carburized aircraft parts.

#### 1.2 Classification.--

1.2.1 Composition.-- The steel shall be furnished in three compositions, as specified (see 6.2):

Composition I	(3310)
Composition II	(3316)
Composition III	(9310)

1.2.2 Physical condition.-- Products shall be furnished 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

1.2.3 Surface conditions.-- Products shall be furnished 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 or rolled or cold drawn
- (5) Turned, ground, and polished

### 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.

FSC 9510

**MIL-S-7393C****SPECIFICATIONS****Military**

- \* **MIL-I-6868**                      **Inspection Process, Magnetic Particle**

**STANDARDS****Federal**

- FED. STD. NO. 183**                      **Continuous Identification Marking of Iron and Steel Products**  
**FED. TEST METHOD**                      **Metals; Test Methods**  
**STD. NO. 151**

**Military**

- MIL-STD-163**                      **Steel Mill Products, Preparation for Shipment and Storage**  
**MIL-STD-430**                      **Macrograph Standards for Steel Bars, Billets, and Blooms**

(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 (Aerospace Material Specifications)**

- AMS2301**                      **Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure**  
**AMS2251**                      **Tolerances, Alloy Steel Bars**  
**AMS2640**                      **Magnetic Particle Inspection**

(Copies of SAE publications may be obtained from the Society of Automotive Engineers, Inc., 485 Lexington Avenue, New York, New York 10017.)

**American Society for Testing and Materials**

- ASTM E112**                      **Estimating the Average Grain Size of Metals**

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

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### 3. REQUIREMENTS

- \* 3.1 Materials.- The steel shall be of aircraft quality and satisfactory for the fabrication of parts which may be subject to magnetic particle inspection. The material shall meet the cleanliness requirements of AMS2301.

3.1.1 Sufficient discard shall be taken from each ingot to insure freedom from piping and undue segregation.

3.2 Chemical composition.- Chemical composition shall be as specified in table I.

TABLE I. Chemical composition

Element	Composition I (percent)	Composition II (percent)	Composition III (percent)	Check analysis tolerance <u>1/</u>
Carbon	0.08 - 0.13	0.14 - 0.19	0.07 - 0.13	±0.01
Manganese	0.45 - 0.60	0.45 - 0.60	0.40 - 0.70	± .03
* Sulfur	0.025 (max.)	0.025 (max.)	0.025 (max.)	+ .005
* Phosphorous	0.025 (max.)	0.025 (max.)	0.025 (max.)	+ .005
Silicon	0.20 - 0.35	0.20 - 0.35	0.20 - 0.35	± .02
Nickel	3.25 - 3.75	3.25 - 4.00	3.00 - 3.50	± .07
Chromium	1.25 - 1.75	1.25 - 1.75	1.00 - 1.40	± .05
Molybdenum	----	----	0.08 - 0.15	± .01
* Copper	0.35 (max.)	0.35 (max.)	0.35 (max.)	+ .03
* Iron	Remainder	Remainder	Remainder	

1/ Individual determination 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 Grain size.- The austenitic grain size shall be predominantly No. 5, or finer, with grains as large as No. 3 permissible, in accordance with ASTM E112.

- \* 3.4 Hardness limits for conditions (C), and (E).-

- \* 3.4.1 The hardness for material in physical conditions (C), and E shall be not more than Brinell 229 (Rockwell C-21) when furnished in surface condition (1), (2), or (3).

3.4.2 The hardness for material in physical conditions (C) and (E) shall be not more than Brinell 248 (Rockwell C-24) when furnished in surface condition (4).

3.5 Hardenability.-

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3.5.1 End-quench hardenability values for composition I steel shall be Rockwell C-43 maximum at 1/16 inch and Rockwell C-31 minimum at 6/16 inch.

3.5.2 End-quench hardenability values for composition II steel shall be Rockwell C-47 maximum at 1/16 inch and Rockwell C-35 minimum at 8/16 inch.

3.5.3 End-quench hardenability values for composition III steel shall be Rockwell C-41 maximum at 1/16 inch and Rockwell C-32 minimum at 6/16 inch.

3.6 Macrostructure.- Visual examination of deep acid etched specimens shall comply with MIL-STD-430 at levels S-2, R-1, and C-2.

3.7 Identification marking.- Each bar shall be identified in accordance with Fed. Std. No. 183. The markings shall include the heat number of the metal and the designation of the specification. In lieu of continuous marking, bars under 0.5 inch in diameter may be bundled and each bundle identified by metal tags impression stamped with the legend specified in Fed. Std. No. 183 and securely attached near each end of the bundle.

3.8 Tolerances.-

3.8.1 Diameter or thickness.- The permissible variations in the dimensions of bar or billets shall be as shown in AMS2251, except that when bars are intended for reforging, the requirements of AMS2251 are waived.

3.9 Angles and corners.- The angles and corners of square, rectangular, and hexagonal bars shall be in accordance with best mill practice.

3.10 Workmanship.- Material shall be sound, of uniform quality and condition, free from pipe, and shall not contain laps, cracks, twists, seams, or other defects detrimental to the fabrication or performance of parts.

4. QUALITY ASSURANCE PROVISIONS

\* 4.1 Responsibility for inspection. 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 as specified herein, unless disapproved by the purchaser. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are

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deemed necessary to assure supplies and services conform to prescribed requirements.

\* 4.1.1 Lot.- A lot shall consist of all bars and billets subjected to inspection at one time of the same heat, condition, and size.

4.2 ~~Examination~~ of product.- ~~Examination~~ shall be made to assure compliance with the surface condition, identification, dimensional, and workmanship requirements (see table II).

TABLE II. Sampling for examination of product

Lot size	Sample size	Acceptance number
1 to 15	All	0
16 to 180	15	0
181 to 300	35	0
301 to 500	50	1
Over 500	75	2

\* 4.2.1 Classification of test.- All the tests required for the testing of the product are classified as acceptance tests, for which necessary sampling techniques and methods of testing are specified in this section.

\* 4.3 Magnetic 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.

#### 4.4. Chemical analysis.-

4.4.1 Sampling.- Samples for check chemical analysis shall be selected as described in Federal Test Method Standard No. 151 to represent each heat from which material is submitted for inspection.

4.4.2 Location.- Samples shall be taken parallel to the axis of the bar from a zone midway between the center and the surface, except that material less than 1-1/4 inches thick shall be sampled through the entire cross section.

4.4.3 Waiver.- Samples for check chemical analysis may be waived, with the approval of the procuring activity, provided that all of the material under inspection can be identified as being made from a heat previously analyzed and found to be in conformance with the chemical composition specified in table I.

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4.4.4 Method.- Samples shall be prepared in accordance with Fed. Test Method Std. No. 151 and analyzed by wet chemical, or spectrographic methods. In the event of dispute, analysis shall be by wet chemical methods.

## 4.5. Grain size.-

4.5.1 Sampling.- One sample shall be selected to represent each lot of material.

\* 4.5.2 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 ASTM Method E112.

## 4.6 Hardness of bars in physical conditions (C), (D), and (E).-

4.6.1 Sampling.- At least five bars of each condition 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.

\* 4.6.2 Method.- Hardness testing shall conform to ASTM E10 or ASTM E18.

## 4.7 Hardenability.-

4.7.1 Sampling.- One or more samples for the end-quench hardenability test shall be selected from each heat of steel from which material is presented for acceptance. Specimens for the end-quench hardenability test shall conform to ASTM A255.

4.7.2 Method.- End-quench hardenability tests shall be conducted in accordance with ASTM A255. Specimens shall be austenitized at  $1550^{\circ} \pm 10^{\circ}\text{F}$ .

## \* 4.8 Deep acid etch.-

\* 4.8.1 Sampling.- Samples shall be taken from bars, billets, or blooms representing the top and bottom of each ingot in the heat.

4.8.2 Preparation of specimens.- Specimens for deep acid etching shall be cut from samples taken in 4.8.1 so as to represent the entire cross section and shall be 1/4 inch thick minimum. One of the faces of the specimens shall be finished flat and smooth by a fine machining cut or by grinding to a finish of 63 micro-inch maximum. The finished face of each specimen shall be etched in accordance with ASTM A317.

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\* 4.8.3 Test reports.- The material supplier shall furnish with each shipment a report of the results of the tests for chemical composition, grain size, magnetic particle inspection rating, deep acid etch, and hardenability of each heat in the shipment. This report shall also include:

- (a) Purchase order number
- (b) Heat number
- (c) Material specification number
- (d) Size
- (e) Quantity from heat

4.9 Rejection and retest.- Where failure of a sample or specimen is definitely ascribed to faculty material, the entire lot of material represented shall be rejected. At the discretion of the supplier, retest will be permitted. A retest sample of five specimens shall be tested to replace each failed specimen of the initial sample. If one of the retest specimens fails, the lot represented shall be rejected with no further retesting.

4.9.1 Resubmittal.- Where failure of any lot of material to meet the requirements of this specimen is due to inadequate heat treatment, the material may be reheat treated and resubmitted for test. Only two such reheat treatments will be allowed.

## 5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing.- Materials shall be prepared for shipment in accordance with the methods prescribed by MIL-STD-163. Materials in surface conditions (2) through (5) shall be coated with preservative as prescribed for condition (4).

5.2 Marking of shipments.- Shipping containers shall be marked in accordance with MIL-STD-163.

## 6. NOTES

\* 6.1 Intended use.- These steels are intended for use in the manufacture of carburized parts.

6.2 Ordering data.- Procurement documents should specify:

- (a) Title, number, and date of this specification.
- (b) Composition, physical, and surface conditions (see 2.1).
- (c) Size and shape (exact lengths and length tolerances required if mill lengths are not acceptable).

6.2.1 When bars are intended for reforging purposes, it should be so stated.

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6.3 Marginal indicia.- Asterisks are used in this revision to identify changes (additions, deletions) with respect to the previous issue.

Custodians:

Army - AV  
Navy - AS  
Air Force - 11

Preparing activity:

Air Force - 11

Reviewer activities:

Army - MR, MI  
Air Force - 82, 84

Project 9510-0116

User activity:

Army - WC



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## SPECIFICATION ANALYSIS SHEET

Form Approved  
Budget Bureau No 22-R255

**INSTRUCTIONS** This sheet is to be filled out by personnel either Government or contractor involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT      ☐ SUBCONTRACT

1 HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A GIVE PARAGRAPH NUMBER AND WORDING

B RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2 COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3 IS THE SPECIFICATION RESTRICTIVE?

☐ YES      ☐ NO (If "yes", in what way?)

4 REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers attach to form and place both in an envelope addressed to preparing activity)

SUBMITTED BY (Printed or typed name and activity - Optional)

DATE

DD FORM 1426  
1 JAN 66

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED

AFLC-WPAFB-OCT 67 2M