MILITARY SPECIFICATION

STEEL BARS, REFORGING STOCK, AND MECHANICAL TUBING, 4340M, HIGH QUALITY

1. SCOPE

1.1 Scope.- This specification covers vacuum melted low alloy steel bars, reforging stock, and mechanical tubing intended for use at tensile strength levels of 270,000 pounds per square inch (psi) and above.

1.2 Classification.- Materials shall be of the following conditions, as specified (see 6.2):

(a) Physical condition

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

(b) Surface condition

(1) Black as forged or rolled
(2) Descaled
(3) Rough turned
(4) Cold drawn
(5) Turned, ground, and polished
(6) As drawn

2. APPLICABLE DOCUMENTS

2. 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:

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 Marking 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 document forms 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.

American Society for Testing and Materials
AMS 2300 Premium Aircraft Quality Steel Cleanliness Magnetic Particle Inspection Procedure

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., Department A1, 485 Lexington Avenue, New York, New York 10017).

3. REQUIREMENTS

3.1 Chemical composition.- The chemical composition shall conform to the compositions of table I, as specified (see 6.2).

Table I. Percent range of chemical composition

Element	4340M	Check analysis tolerance
Carbon	0.38 to 0.43	±0.02
Manganese	.65 to 0.90	± .04
Phosphorous	.012 maximum	+ .005
Sulfur	.012 maximum	+ .005
Silicon	1.45 to 1.80	± .05
Nickel	1.65 to 2.00	± .05
Chromium	0.70 to 0.95	± .05
Molybdenum	.35 to 0.45	± .03
Vanadium	.05 minimum	- .003
Boron		± .0005

3.2 Surface and physical condition.- 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) (see 6.2).

3.2.1 Tubing shall be supplied in a machinable condition, as drawn.

3.2 Response to heat treatment.- All steel products supplied under this specification shall be capable of developing transverse mechanical properties as follows when heat treated in accordance with 4.6.

(a) Transverse ultimate tensile strength (minimum): 270,000 psi

(b) Transverse tensile yield strength (minimum): 220,000 psi

(c) Transverse Reduction of area:

Cross sectional area of bar, billet, or tube represented, square inch	Transverse reduction of area percent minimum	
	Average of lot	Single test value
100 and less	30	25
100 to 144	27	20
Over 144	25	15

3.4 Grain size.- The austenitic grain size shall be predominantly No. 6 or finer, with grains as large as No. 4 permissible.

3.5 Quality.- Materials shall be tested in accordance with magnetic particle procedures of AMS 2300. The size and frequency or indications shall not exceed the limits specified therein.

3.6 Decarburization.-

3.6.1 Surfaces of mill products ordered in the ground, turned, or polished conditions shall be free from decarburization.

3.6.2 The depth of decarburization of as forged, as rolled, cold finished, or descaled bars shall not exceed the table II limits.

TABLE II. Decarburization Limits
(Microscopic method)

Nominal diameter or distance between opposite faces (inches)	Maximum depth of decarburization (inches) 1/
To 0.375, incl.	0.010
0.376 to 0.500, incl.	.012
0.501 to 0.625, incl.	..014
0.626 to 1.000, incl.	.017
1.01 to 1.50, incl.	.020
1.51 to 2.00, incl.	.025
2.01 to 2.50, incl.	.030
2.51 to 3.00, incl.	.035
Over 3.00	.045

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

3.6.3 The decarburization of surfaces of mechanical tubing not ground, turned, or polished shall not exceed the table III limits.

TABLE III. Decarburization limits for tubing

Nominal wall thickness (inches)	Maximum depth of decarburization (inches)	
	Inside	Outside
0.110 and under	.008	.015
Over 0.110 to 0.200 incl.	.010	.020
Over 0.200 to 0.400 incl.	.012	.025
Over 0.400 to 0.600 incl.	.015	.030
Over 0.600 to 1.000 incl.	.017	.035
Over 1.000	.020	.040

3.7 Identification of product.- Each piece shall be identified in accordance with Federal Standard No. 183, and the markings shall include the number of the remelt heat of metal, the composition designator, condition, and designation of this specification.

3.8 Tolerances.- Tolerances shall conform to the applicable limits of Federal Standard No. 48, except when bars are specifically intended for reforging purposes.

3.9 Hardness limits for as-received material.-

(a) The hardness of material supplied in condition (C) shall be not more than Brinell 265 (Rockwell C-27), except that

tubing ordered in the annealed condition shall have a hardness not greater than Rockwell B-99.

(b) The hardness of material in conditions other than (C) shall be not more than Rockwell C-33.

3.10 Workmanship.- Material shall be sound, of uniform quality and condition, free from pipes, laps, cracks, twists, seams, or other defects detrimental to the performance of parts fabricated from the material.

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 other 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 inspection.- Inspection of the steel is classified as quality conformance inspection (see 4.3 through 4.13).

4.3 Lot.- A lot selected from mill products offered for acceptance shall consist of materials of one configuration, from one heat, and the same nominal dimensions, other than length.

4.3.1 Heat.- A heat shall be the consumable electrode remelted ingots produced from steel air-melted as a single furnace charge or shall be the consumable electrode remelted ingot or ingots produced from not more than five individual melts of similar composition from the same lots of controlled raw materials; each ingot shall be identified as to its position in the heat.

4.4 Examination of product.- Samples selected at random in accordance with table IV shall be examined for compliance with surface condition, identification marking, dimensions, workmanship, and preparation for delivery requirements.

TABLE IV. Sampling for examination of product

Lot size	Sample size	Acceptable Number
1 to 65	4	0
66 to 110	5	0
111 to 300	7	0
301 to 500	10	0
501 to 800	15	0
Over 800	25	0

4.5 Chemical analysis.-

4.5.1 Sampling.- When products are identified as specified in 3.7, and the heats represented have been analyzed by the manufacturer and are in conformance with specified composition limits, the manufacturer's ladle analysis is acceptable.

4.5.1.1 When the manufacturer's chemical analysis is unavailable or compliance with specified limits is not clear, samples for check chemical analysis shall be randomly selected in accordance with table IV.

4.5.2 Method. Samples shall be prepared and tested by wet chemical, spectrographic, or other analytical methods acceptable to the Government. In the event of dispute, analysis shall be by Method 111 or 112 of Federal Test Method Standard No. 151.

4.6 Response to heat treatment.-

4.6.1 Sampling.- Samples shall be selected to represent each heat of steel. Samples shall be selected from the top and bottom of the first and last ingots poured. From the test ingot or test billet, bars shall be forged or rolled to size as follows, heat treated, and tested to determine conformance to 3.3:

Billet size (reforging stock only)	Test billet size
15 inches and over	9-inch sq or 10-inch round or larger
12 to 15 inches	8-inch sq or 9-inch round or larger
10 to 12 inches	6-inch sq or 7-inch round
Under 10 inches	5-inch sq or 6-inch round or larger

In the case of stock which will not be reforged, the section size of the test billets or bars shall be no smaller than the size to be delivered to the customer. Transverse slices shall be cut from the ends of those test billets or bars corresponding to the top and bottom of the original ingot.

4.6.2 Ingot quantity.- From each ingot of a lot not tested in compliance with 4.6.1, test billets or bars representing the top and bottom positions in the ingot shall be forged or rolled, or forged and rolled to not less than 5 inches square or thickness of minimum section, or 6 inches diameter of round. Transverse slices for testing shall be cut from the ends of the billets or bars corresponding to the top and bottom of the original ingot.

4.6.3 Bar quantity.- For individual bars or billets of a lot not previously tested, transverse slices shall be cut from one end of each bar or billet.

4.6.4 Preparation of test specimens.- From the center positions of each sample size or section, duplicate tensile test coupons shall be removed in the transverse direction (short transverse from rectangular sections) relative to the longitudinal axis of the original ingot, for heat treatment and test as specified.

4.6.4.1 Heat treatment.- Prior to machining or grinding to final size, test coupons shall be heat treated as follows:

(a)	Normalize at	1,700° ±25° for 1 hour
(b)	Austenitize at	1,600° ±25° for 1 hour
(c)	Quench in oil at	75° to 140°F
(d)	Double temper at	575° ±20°F for 2 plus 2 hours

4.6.4.2 After heat treatment, test specimens shall be finish machined, or ground to final size to conform to types R1, R2, or R3, Method 211, of Federal Test Method Standard No. 151, and stress relieved for 1 hour at a temperature not exceeding the tempering temperature.

4.6.5 Test method.- Specimens shall be tested in accordance with Method 211 of Federal Test Method Standard No. 151.

4.6.6 Rejection and retests (tensile tests).- When one or more specimens from a transverse slice fail to meet the tensile test requirements, the billet from which the slice was taken may be retested after additional cropping. If this second test fails, the billet shall be rejected, and no further retest permitted.

4.6.6.1 Retests are not permitted after failure of a specimen representing a single bar or tube.

4.7 Austenitic 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 Federal Test Method Standard No. 151.

4.8 Quality

4.8.1 Sampling.- Samples shall be selected as specified in 4.6.1, 4.6.2, or 4.6.3.

4.8.1. Test method.- Samples shall be inspected in accordance with the procedures of mined in accordance with AMS 2300.

4.9 Decarburization

4.9.1 Sampling.- One sample shall be selected to represent each size and configuration of product of the same processing condition and delivered at one time.

4.9.2 Test method.- Decarburization may be determined by either the microscopic method or by Rockwell superficial 30N scale hardness measurements on hardened but untempered specimens protected during hardening treatment to prevent changes in surface carbon content.

When the microscopic method is used, the specimen shall represent the entire cross section of bars 1 inch or less in diameter or thickness. With larger section sizes, the specimen shall include approximately one linear inch of the original surface. The specimen shall be polished, etched, and examined at not less than 100X magnification.

When determined by harndess methods, the specimen surface shall be taper ground to a depth not less than 0.030 inch and a Rockwell 15N or 30N hardness traverse made from the undistrubed surface along the ground surface. The depth of decarburization is defined as the perpendicular distance from the surface to the nondecarburized zone below which there is no increase in hardness.

4.10 Test method for hardness.- Hardness testing shall be in accordance with Method 242 or 243 of Federal Test Method Standard No. 151.

4.11 Certified heats.- Materials from heats of steel which have been tested and found to comply with the specified requirements shall be considered acceptable without further testing for chemical composition, grain size, and response to heat treatment.

4.11.1 Each shipment from such heats shall be accompanied by test reports, in duplicate, showing test results in compliance with chemical transverse tensile, hardenability, and grain size requirements.

4.12 Rejection and retest.- Failure of a specimen to meet applicable test requirements shall be cause for rejection of the materials represented. At the discretion of the contractor/supplier, retest will be permitted. A retest sample of five specimens from samples selected in accordance with table V shall be tested to replace each failed specimen of the original sample. If one of the retest specimen fail, the material represented shall be rejected with no further retesting permitted.

TABLE V. Detailed Plan

Property in question (Failure of specimen from original sample	Plan code	Detailed Plan
		PLAN A
Chemical analysis	A	One sample from each five product items form the same heat.
Grain size	A	
		PLAN B
Response to heat treatment	B	One sample from a slice adjacent to that which previously failed, plus one from each of four billets from the same heat.
Quality (inclusion count)	B	
		PLAN C
Decarburization	C	One from each of five items of the respective size, configuration, and processing condition, from the same heat.
Hardness	C	
Impact tests	C	
Visual inspection	C	

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing (see 6.2).-

5.1.1 Level A.- The material shall be properly separated by conditions, configuration and size when prepared for delivery. Materials shall be preserved and packaged in accordance with MIL-STD-163.

5.1.2 Level C.- Materials shall be prepared for delivery in accordance with commercial practice.

5.2 Marking os shipments.- Marking and labeling shall be in accordance with MIL-STD-163.

6. NOTES

6.1 Intended use.- The steel products are intended for use in the manufacture of highly stressed aircraft parts not greater than 3 inches in thickness, requiring high hardenability and heat treated to very high strength levels. The material is weldable; however, special precautions are essential to weld soundness.

6.2 Ordering data.- Procurement documents should specify:

(a) Title, number, and date of this specification.
(b) Condition designation (see 1.2, 3.1, and 3.2).
(c) Size and shape.

(d) Exact lengths and length tolerances, if mill lengths are not acceptable.
(e) Levels of preservation, packaging, and packing (see 5.1).

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

6.2.2 When decarburization limits closer than those specified in 3.6 are desired, these limits should be specified in the contract or purchase order and agreed upon between purchaser and vendor.

Custodian:
Air Force -11

Preparing Activity:
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