MIL-S-16598B
30 MARCH 1970
SUPERSEDING
MIL-S-16598A
10 July 1952

MILITARY SPECIFICATION

STEEL BAR (LOW EXPANSION, FREE CUTTING, 36 PERCENT NICKEL)

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope - This specification covers the requirements for a low coefficient of expansion, free cutting, steel bar.

1.2 Classification - Bars shall be of the following finishes, as specified (see 6.2).

Hot finished - Scale not removed
Cleaned - Pickled or blast cleaned
Centerless ground - Round bars only

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:

STANDARDS

Federal

Fed. Test Method Std. No. 151	Metal; Test Methods
FED-STD-183	Continuous Identification Marking of Iron and Steel Products

Military

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

FSC 9510

(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 or proposal shall apply.

American Society For Testing and Materials (ASTM)

A 317 Macroetch Testing and Inspection of Steel Forgings

E 8 Tension Testing of Metallic Materials

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

* 3.1 Material - The steel shall be manufactured by the crucible or the electric-furnace process.

3.1.1 Process - Unless otherwise specified, the steel bars shall be hot rolled or forged.

* 3.2 Chemical composition - The chemical composition shall conform to the composition of Table I.

TABLE I

CHEMICAL COMPOSITION

Carbon (max.)	Manganese (max.)	Silicon (max.)	Nickel	Selenium	Iron
Percent	Percent	Percent	Percent	Percent	Percent
0.15	0.50	0.35	35.0-36.5	0.15-0.25	Remainder 1/

1/ Incidental elements must not be present in such proportions as will modify the low expansivity characterisitcs, reduce the strength or add to the difficulty of machining.

3.3 Mechanical properties - The mechanical properties of the steel shall conform to the requirements of Table II

TABLE II

MECHANICAL PROPERTIES

Tensile strength (min.)	Yield strength (0.2% offset) (min.)	Elongation in 2 inches (min.)	Reduction of area (min.)
psi	psi	percent	percent
75,000	45,000	30	40

3.4 Finish - Hot finished bars shall be furnished as forged or rolled. Bars specified in the cleaned finish shall be free from scale. Centerless ground bars shall be bright and free from pits, scratches, or other injurious defects (see 1.2).

* 3.5 Macrostructure - Visual examination of deep acid etched bars shall show no more than slight pitting and no evidence of change in structure from the surface to the center (see 4.6).

* 3.6 Tolerances - Variations from nominal dimensions shall be within the permissible limits shown in Tables III to VI inclusive.

TABLE III

HOT-FINISHED BARS: ROUNDS AND SQUARES

Diameter or distance across flats	Permissible variations		Out of round 1/ or square
	Plus	Minus	
Inches	Inch	Inch	Inch
5/16 and less	0.005	0.005	0.008
Over 5/16 to 7/16 inclusive	.006	.006	.009
Over 7/16 to 5/8 inclusive	.007	.007	.010
Over 5/8 to 7/8 inclusive	.008	.008	.012
Over 7/8 to 1 inclusive	.009	.009	.013
Over 1 to 1-1/8 inclusive	.010	.010	.015
Over 1-1/8 to 1-1/4 inclusive	.011	.011	.016
Over 1-1/4 to 1-3/8 inclusive	.012	.012	.018
Over 1-3/8 to 1-1/2 inclusive	.014	.014	.021

TABLE III (Continued)

Diameter or distance across flats	Permissible variations		Out of round 1/ or square
	Plus	Minus	
Inches	Inch	Inch	Inch
Over 1-1/2 to 2 inclusive	.016	.016	.023
Over 2 to 2-1/2 inclusive	.031	0	.023
Over 2-1/2 to 3-1/2 inclusive	.047	0	.035
Over 3-1/2 to 4-1/2 inclusive	.063	0	.046
Over 4-1/2 to 5-1/2 inclusive	.078	0	.058
Over 5-1/2 to 6-1/2 inclusive	.125	0	.070
Over 6-1/2 to 8 inclusive	.156	0	.085

1/ Out of round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section. Out of square is the difference in the two dimensions at the same cross section of a square bar, each dimension being the distance between opposite faces, the adjacent sides forming approximately 90-degree angles.

TABLE IV

HOT-FINISHED BARS: HEXAGONS AND OCTAGONS

Distance across flats	Permissible variations		Maximum difference 3 measurements (for hexagons only)
	Plus	Minus	
Inches	Inch	Inch	Inch
1/2 and less	0.007	0.007	0.011
Over 1/2 to 1 inclusive	.010	.010	.015
Over 1 to 1-1/2 inclusive	.021	.021	.025
Over 1-1/2 to 2 inclusive	.031	.031	.031
Over 2 to 2-1/2 inclusive	.047	.047	.047
Over 2-1/2 to 3-1/2 inclusive	.063	.063	.063

TABLE V

HOT-FINISHED BARS: FLATS

Ordered width	Permissible variations				
	Width		Thickness		
	Plus	Minus	1/8 inch to 1/2 inch thick inclusive (±)	Over 1/2-inch to 1-inch thick inclusive (±)	Over 1 inch to 2 inches thick inclusive (±)
Inches	Inch	Inch	Inch	Inch	Inch
1 and less	1/64	1/64	0.008	0.010	
Over 1 to 2 inclusive	1/32	1/32	.012	.015	0.031
Over 2 to 4 inclusive	1/16	1/32	.015	.020	.031
Over 4 to 6 inclusive	3/32	1/16	.015	.020	.031
Over 6 to 8 inclusive	1/8	5/32	.016	.025	.031
Over 8 to 10 inclusive	5/32	3/16	.021	.031	.047

TABLE VI

CENTERLESS-GROUND BARS: ROUNDS ONLY

Diameter	Permissible variations	
	Plus	Minus
Inches	Inch	Inch
Less than 1	0.002	0.002
1 to 1-1/2 exclusive	.0025	.0025
1-1/2 to 4 inclusive	.003	.003

3.7 Length - The bars shall be commercially straight and free from twist and damaged ends (see 6.2, 6.2.1).

* 3.7.1 Exact lengths - Bars may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit. A tolerance of plus one eighth inch will be allowed on material so ordered.

3.7.2 Mill lengths - Unless otherwise specified, material shall be furnished in full lengths of 6 to 20 feet. Not more than 10 percent of lengths shorter than 10 feet will be accepted.

* 3.8 Identification of product - Each piece shall be identified in accordance with FED-STD-183, and the markings shall include the number of the heat of metal, the manufacturer's identification, condition, and designation of this specification.

* 3.8.1 Bars of the same size and smaller than 1/2 inch diameter of 3/8 inch width of flat shall be properly marked or tagged at each end and bundled. An extra marking or tag shall be attached to each bundle.

* 3.9 Workmanship - The steel bars furnished under this specification shall be uniform in quality and condition, smooth, free from pipes, laps, cracks, twists, seams, flakes, heat checks, slag hard spots, porosity, slivers, scabs, rolled-in scale, fissures, gas cavities, sponginess, excessive segregation, or any other defects which due to their nature, degree, or extent will be detrimental to the performance of parts fabricated from the metal

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 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 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 4.6 3)

* 4 3 Examinations -

* 4.3.1 Sampling for examination of dimensions, finish, workmanship, packaging, and identification marking - Units of product shall be randomly selected in accordance with Table VII to represent each lot of material of one heat, the same nominal dimensions, and offered for acceptance at one time.

* 4.3.2 Examination of preparation for delivery - Preparation for delivery shall be examined for conformance to Section 5.

4 4 Chemical analysis -

TABLE VII

SAMPLING FOR EXAMINATION OF PRODUCT

Lot size	Sample size	Acceptance no.
1 to 4	1	0
5 to 110	5	0
111 to 500	7	0
501 to 800	10	0
801 to 1200	15	0
Over 1200	25	0

* 4.4.1 Size of lot - For the purpose of sampling for chemical analysis a lot shall consist of all material made from the same heat or melt of steel. If the heat or melt cannot be identified, a lot shall be limited to 500 pounds of bars of each size and configuration.

4.4.2 Sampling - Unless otherwise specified, the sample shall represent material from the topmost portion of an ingot. If unable to identify the melt, a sample shall be taken from each of two bars in the lot and analysed separately. Drillings may be taken from broken test specimens. Drillings shall be fine, clean, and free from oil, dirt, grit, surface scale, or other foreign matter, and shall consist of not less than 2 ounces.

* 4.4.3 Test method - Chemical analysis shall be made in accordance with Method No. 111.2 or 112.2 of Fed. Test Method Std. No. 151 on samples selected as specified in 4.4.2 to determine compliance with 3.2. In the event of disputes, the analysis of Method No. 111.2 shall be the basis for acceptance or rejection.

4.5 Tensile test -

* 4.5.1 Size of lot - For the purpose of sampling for mechanical tests a lot shall consist of all bars of the same size produced from the same heat or melt of steel and offered for delivery at the same time. If the heat or melt cannot be identified, a lot shall be limited to 500 pounds of bars of each size and configuration.

4.5.2 Sampling - Not less than 2 bars nor more than 2 percent of the bars in each lot shall be selected for tension test specimens. From each bar selected a single tension test specimen shall be prepared. Extra length shall be provided on bars from which test specimens are to be taken. Material shall be provided for possible extra tests. The test specimens should be located in that part of the bar nearest the uppermost part of the ingot as cast, unless otherwise specified.

* 4.5.3 Test method - The tensile test shall be performed in accordance with ASTM Method E 8 on samples selected as specified in 4.5.2 to determine compliance with 3.3. Wherever practicable, bars shall be tested in full size, the cross section of the specimen being the full cross section of the material. If full size specimens are not practicable, the Standard 0.500 in. (12.5 mm) Round Tension Test specimen with 2 in. (50 mm) Gage Length or the Standard Sheet - Type, 1/2 in. Wide Rectangular Tension Test Specimen shall be machined and tested as indicated in ASTM Method E 8. The Standard Round Tension Test Specimen shall be machined from any point at mid-radius of the bar.

4.6 Macroetch test -

* 4.6.1 Size of lot - For the purpose of sampling for macroetch examination, a lot shall consist of all bars of the same size produced from the same ingot of steel. In case it is impracticable to identify the material by ingots, a lot shall be limited to 500 pounds of bars of each size and configuration.

* 4.6.2 Sampling - Unless otherwise specified, a specimen for the macroetch test shall be taken from the uppermost end of the top bar in each ingot as cast. If unable to identify the ingot, specimens shall be taken from each of two bars in the lot.

* 4.6.3 Test method - The macroetch test shall be performed in accordance with ASTM Method A 317 on samples selected as specified in 4.6.2. Specimens for the macroetch test shall consist of pieces approximately one-half inch thick cut from the end of the bar. The faces representing the cross-section of the bar shall be finished smooth and flat by a fine machine cut or by grinding. The etching solution shall be a 1 to 1 solution of concentrated hydrochloric acid and water. The specimens shall be immersed in the solution at 160 ±3° F for 15 to 20 minutes. After etching, the specimens shall be washed in running water or steam and scrubbed to remove any cloaking deposits. The specimens shall then be examined for compliance with 3.5.

* 4.7 Rejection and resubmission - If any sample or specimen fails to conform to the requirements of this specification, the lot represented shall be rejected. At the discretion of the contractor/supplier, retest will be permitted. A retest sample of five specimens, one each from five bars in the lot, shall be tested to replace each failed specimen of the original sample. If one of the retest specimens fails, the lot shall be rejected and no further retesting permitted.

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 composition, conditions and size when prepared for delivery. The steel bars shall be preserved, packaged, and packed in accordance with MIL-STD-163.

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

* 5.2 Markings for shipment - Marking and labeling shall be in accordance with MIL-STD-163. The heat number shall be included in the identification.

6. NOTES

6.1 Intended use - The material covered by this specification is intended for use in the manufacture of machined parts in which it is necessary to have little change in size with temperature change. The low expansivity characteristics of this material are applicable over a limited range of temperatures. The most useful range is up to the inflection temperature which is at approximately 390° F. The mean coefficient of expansion between 32° F and the inflection temperature is approximately 1.4×10^{-6} per ° F. If a lower coefficient of expansion is necessary in the above temperature range, bars should be ordered cold drawn, annealed and quenched, or in special cases quenched and stabilized.

* 6.2 Ordering data - Procurement documenst should specify the following:

(a) Title, number, and date of this specification.

* (b) Finish (see 1.2 and 3.4).

(c) Diameter of bars required.

(d) Length of bars and whether "EXACT" or mill lengths are desired (see 3.7).

* (e) Levels of preservation, packaging, and packing (see 5.1).

6.2.1 Length - When bars are ordered in multiples of definite length, allowance should be made for possible waste in cutting.

6.2.2 Finish - In determining the surface finish to be specified, consideration should be given to whether contemplated operations will remove the surface finish, whether pickling by the using agency is contemplated, or if, for other reasons, pickling is deemed unnecessary; and whether the bars are to be machined on "automatic" machines.

* 6.3 Supersession data - This specification supersedes Military Specification MIL-S-16598A dated 10 July 1952 and its amendments. The material furnished under this specification is completely interchangeable with and substitutable for the material procured under the previous issue, MIL-S-16598A dated 10 July 1952.

6.4 The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. 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 this document based on the entire content irrespective of the marginal notations and relationshp to the last previous issue.

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NOTICE - Review/user information is current as of date of this document. For future coordination of changes to this document, draft circulation should be based on the information in the current Federal Supply Classification Listing of DOD Standardization Documents.

SPECIFICATION ANALYSIS SHEET

Form Approved
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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 *(as indicated on reverse hereof)*

SPECIFICATION

MIL-S-16598B STEEL BAR (LOW EXPANSION, FREE CUTTING, 36 PERCENT NICKEL)

ORGANIZATION *(Of submitter)* | CITY AND STATE

CONTRACT NO | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT

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 *(Printed or typed name and activity)* | DATE

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