MIL-S-21946A (OS)
18 July 1972
SUPERSEDING
See Section 6

MILITARY SPECIFICATION

STEEL, WROUGHT, MANGANESE-NICKEL, AUSTENITIC (LOW MAGNETIC PERMEABILITY)

This specification has been approved by the Naval Ordnance Systems Command, Department of the Navy.

1. SCOPE

1.1 This specification covers annealed austenitic manganese-nickel steel bars, forgings, plates, sheets, strips, and structural shapes for uses in applications wherein low magnetic permeability is the primary characteristic required.

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-STD-48	Tolerance for Steel and Iron Wrought Products
FED-STD-151	Metals; Test Methods

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.

American Society for Testing and Materials (ASTM) Standards

E 8	Tension Testing of Metallic Materials
A 317	Macroetch Testing and Inspection of Steel Forgings
A 342	Standard Method of Test for Permeability of Feebly Magnetic Materials

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

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Material. The material shall be an austenitic manganese-nickel steel meeting the requirements specified herein.

3.2 Manufacture.

3.2.1 Sufficient discard of the ingot end shall be taken to insure freedom from piping, undue segregations, and other injurious defects.

3.2.2 Ingots shall be reduced sufficiently in cross section to assure proper refinement of the structure in the finished product. Bars and forgings shall have been reduced from ingots by hot rolling, pressing, and hammering.

3.2.3 All material shall be subjected to annealing as the last heat treatment. It shall be done under time and temperature conditions adequate to insure optimum nonmagnetic properties.

3.2.4 All material may be ground to remove surface defects provided such grinding does not reduce the thickness or width at any point below the allowable dimensional tolerances. An iron-free abrasive shall be used for such grinding and shall be operated at a speed proper to insure that defective areas are cleanly cut out.

3.3 Chemical composition. The material shall conform to the chemical composition shown in table I.

Table I

CHEMICAL COMPOSITION

Ingredient	Percent
Carbon	0.25 - 0.40
Manganese	10.5 - 12.5
Phosphorous	0.045, max.
Sulfur	0.05 - 0.15
Silicon	0.75, max.
Nickel	7.0 - 8.5
Chromium	1.0, max.
Manganese plus nickel	18.5, min.

3.4 Mechanical properties. The material in the annealed condition shall conform to mechanical properties shown in table II.

Table II

MECHANICAL PROPERTIES

Form	Diameter or thickness	Yield strength (0.2 percent offset) (psi, min.)	Tensile strength (psi, min.)	Elongation in 2 inches (%, min.)
Bars and forgings	All sizes	25,000	80,000	35
Plates, sheets strips, and structural shapes	All sizes	Not applicable	75,000	35

3.5 Finishes.

3.5.1 Bars. Bars shall be annealed and subsequently ground, pickled, or otherwise finished as specified (see 6.2, 6.2.1, and 6.3), so that the surface is free from scale and rust.

3.5.2 Plates and shapes. Plates and shapes shall be annealed and have a pickled finish unless otherwise specified.

3.5.3 Sheets and strips. Sheets and strips shall be annealed and pickled free from scale and rust unless otherwise specified.

3.5.4 Rough forgings. Rough forgings shall be annealed and have sufficient excess stock to permit finishing to required dimensions without excessive waste. Surfaces shall be blasted or pickled free from scale and rust.

3.6 Magnetic permeability. Except for rough forgings, the magnetic permeability of material in the annealed and pickled condition shall not exceed 1.10 in a 200-oersted background field when tested in accordance with 4.5.3. Measurements shall be taken on samples whose surfaces represent the surfaces of the material ready for shipment except for machined edges. Any indications that reflect an increase in permeability resulting from the cold shearing of stock to size shall not be cause for rejection. The magnetic permeability of rough forgings will be considered acceptable if fully machined sections pass the 1.10 permeability requirement.

3.6.1 Optional magnetic permeability requirement. When specified, the magnetic permeability when measured as in 3.6 shall not exceed 1.01.

3.7 Macroscopic etch. When subjected to the macroscopic etch test specified in 4.5.4, bars and forgings shall be demonstrated to be dense and sound and to be free from injurious pipes, fissures, gas cavities, sponginess, abnormal inclusions or segregation, or unusually numerous pinholes.

3.8 Dimensional tolerances. The dimensions of the material offered for delivery shall not vary by amounts greater than those shown in the following paragraphs of FED-STD-48.

Dimension	Paragraph
Bars, hot-rolled	
Diameter or distance across flats (round or square)	1a1
Distance across flats (hexagon)	1a2
Distance across flats (flat)	1d3
Straightness (machine straightened)	1d5
Bars, general	
Length (hot or cold cut)	1d4
Plates	
Thickness and weight	4d1
Width and length	4d2
Camber	4a9
Flatness	4d5
Sheets	
Weight	11a1
Thickness	11a3
Width	11a4-11a5
Length	11a6
Resquared	11a10
Camber	11a12
Flatness	11a13
Strips (for widths not covered by the strip tables, use values specified above for sheet)	
Thickness	14a1
Crown	14a2
Width	14a3
Length	14a4
Camber	14a5

3.9 Identification marking.

3.9.1 Bars and shapes.

3.9.1.1 Bars, 3/4 inch or larger in diameter or across parallel faces, and shapes of equivalent cross-sectional area shall be die or rubber stamped or marked in a nonwater-soluble ink on or near one end with the following information:

Specification number
Manufacturer's name, trademark, and symbol
Heat number.

3.9.1.2 Bars, less than 3/4 inch in diameter or across parallel faces, and shapes of equivalent cross-sectional area shall be bundled and tagged at each end by firmly attached oil-proof or metal tags with the information specified in 3.9.1.1.

3.9.2 Forgings. Forgings shipped loose and, whenever possible, each forging shipped in bundles shall carry the identification marks specified in 3.9.1.1. Small forgings shipped in bundles of such size where individual marking is not practical, shall be identified as specified in 3.9.1.2.

3.9.3 Plates, sheets, and flat strips. Plates, sheets, and flat strips shall carry the identification marks specified in 3.9.1.1 on one side, near one end.

3.9.4 Coiled strips. When strips are shipped in coils and the size permits, the loose end of the coils shall carry the identification marks specified in 3.9.1.1. On coils too narrow for marking, identification shall be provided as specified in 3.9.1.2.

3.10 Workmanship. The material shall be sound, of uniform quality and condition, free from flakes or heat checks, and shall contain no welds or any other defects such as nonmetallic inclusions, segregations, seams, laps, twists, cracks, slivers, scabs, and rolled-in scale.

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 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 this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Lot.

4.2.1 Plates, sheets, strips, shapes, bars, and forgings. For purposes of sampling, a lot shall consist of all plates, bars, forgings, sheets, strips, or shapes of the same size rolled from the same melt and heat-treated at the same time. In case the melt or heat cannot be identified, a lot shall consist of not more than 50 pieces of the same size and condition.

4.2.2 All material. For the purpose of dimensional and visual surface inspection, a lot shall consist of all material of the same size and shape presented for inspection at one time.

4.3 Sampling procedure.

4.3.1 For chemical analysis. One sample shall be selected from each heat for chemical analysis. If the material cannot be identified by heat, two samples shall be selected from each lot. Drillings shall be taken from finished bars, forgings, shapes, plates, sheets, flat strips, and coils representing the topmost central portion of the ingot, as cast, wherever practical and shall consist of not less than 60 grams, free from oil, dirt, grit, or other foreign matter. In the selection of the two samples for chemical analysis, each shall be taken from separate pieces of material. The samples shall be forwarded for analysis to a laboratory designated by the procuring activity.

4.3.2 For mechanical tests.

4.3.2.1 Bars. For the purpose of mechanical tests, one tension-test specimen shall be selected from each lot of bars (rolled or forged) for the test specified in 4.5.2.

4.3.2.2 Forgings. No tensile tests are required.

4.3.2.3 Plates, sheets, strips, and shapes. One longitudinal tension-test specimen and one transverse tension-test specimen shall be taken from different pieces in each lot, except that, in the case of shapes and strips, if it is not practicable to take a transverse test piece, two longitudinal test pieces may be taken. In lieu of one longitudinal and one transverse tension test, two transverse tension tests, one each from two different pieces, will be permitted on plates and sheets.

4.3.3 For magnetic permeability tests. Two specimens from each lot, taken from different pieces wherever possible, shall be selected for magnetic permeability tests.

4.3.4 For macroscopic etch test (bars and forgings). For the purpose of macroscopic examination, the bar or forging which was nearest the uppermost part of each of three representative ingots as cast shall be selected from each lot where practicable. Where not practicable, a sample shall be selected at random from each 2,000 pounds in a lot. In

special cases where more than the usual number of macroscopic etch tests are required, the number of such tests shall be as specified in the contract or order.

4.4 Inspection.

4.4.1 Dimensional and visual surface inspection. All material shall be subject to dimensional and visual surface inspection to determine conformance to the requirements of this specification. Lots containing defective material shall be subject to rejection.

4.4.2 Reinspection. Lots rejected because of dimensional or visual surface defects may be resubmitted for inspection in accordance with 4.4.1 after the supplier has reworked and reinspected them to remove nonconforming material.

4.5 Tests.

4.5.1 Chemical analysis. Each of the samples selected as indicated in 4.2.1 shall be separately analyzed in accordance with method 111 of FED-STD-151. If any sample fails to conform to 3.3, the entire lot shall be rejected.

4.5.2 Tension test. Each of the tensile specimens selected in accordance with 4.3.2 shall be pulled in tension to determine conformance to the requirements of 3.4. For plates, sheets, strips, shapes, and rectangular bars, specimens shall be machined to the form and dimensions of standard rectangular tension-test specimens described in ASTM E 8 or shall be tested in full section. For round bars, standard 0.500-inch tension-test specimens of ASTM E 8 shall be used except in cases where the sizes submitted necessitate the use of small size specimens, then such specimens discribed in the document shall be used. When such specimens are used, the elongation shall be taken in a length 5 times the diameter of the specimen. If any specimen fails to conform to 3.5, the entire lot shall be rejected.

4.5.2.1 Yield strength determination. Yield strength shall be determined by the 0.2 percent offset method as described in ASTM E 8. No lot will be accepted if the yield strength of any one specimen is below the minimum yield strength shown in table II.

4.5.3 Magnetic permeability test. The magnetic permeability test shall be performed in accordance with ASTM A 342. The test shall be conducted at a laboratory designated by the procuring activity. The sample size shall be in accordance with the method utilized in ASTM A 342 except that the sample shall retain as much unmachined surface as is consistent with limitations of the test apparatus. Failure of any specimen to conform to 3.6 shall be cause for rejection of the lot represented.

4.5.4 Macroscopic etch test. For macroscopic examination, the specimen shall be the full cross section of the bar or forging as selected in accordance with 4.3.4. The specimen shall be prepared and tested in accordance with ASTM A 342. If any specimen fails to conform to 3.7, the lot represented shall be rejected.

4.5.5 Rejection. If any specimen fails to conform to the specification, the entire lot shall be rejected, subject to the retest provisions of FED-STD-151.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be level A or C, as specified in the contract or purchase order.

5.1.1 Level A. The material shall be properly separated by heat, condition or temper, finish, and size and prepared for delivery in accordance with MIL-STD-163.

5.1.2 Level C. Packaging shall be in accordance with the supplier's commercial practice.

5.2 Packing. Packing shall be level A or C, as specified in the contract or purchase order.

5.2.1 Level A. The material, packaged in accordance with 5.1.1, shall be packed in accordance with MIL-STD-163.

5.2.2 Level C. The material, packaged in accordance with 5.1.2, shall be prepared for shipment in accordance with commercial practice to insure carrier acceptance and safe delivery at destination at the lowest rate and shall meet, as a minimum, the requirements of carrier rules and regulations applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required by the contract or order, shipments shall be marked in accordance with MIL-STD-163.

6. NOTES

6.1 Intended use. Material furnished under this specification is intended primarily for applications requiring low magnetic permeability and where corrosion resistance is not a major factor.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification
(b) Finish required (flat products) (see 3.5, 6.2.1, and 6.3)
(c) Levels of packaging and packing required (see 5.1 and 5.2).

6.2.1 Procurement documents should specifically waive the requirements for pickling if subsequent operations will remove the original surface, if pickling by the using agency is contemplated, or if, for other reasons, pickling is deemed unnecessary.

6.3 The requirement that all material be pickled results in the application of an additional cost ("standard extra") added to the basic cost of the material.

6.4 Material for reforging may be furnished hot -rolled, forged, or as specified by the forging manufacturer provided that the chemical composition of the material is in accordance with table I.

6.5 Supersession data. This specification includes the requirements of MIL-S-21946 (NOrd) dated 6 March 1959 and NAVORD OS 7999 dated 15 August 1957. When drawings, etc., refer to these superseded documents, this specification applies.

Custodian:
Navy - OS

Preparing activity:
Navy - OS
(Project No. 9520-N003)

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 MIL-S-21946A (OS), Steel, Wrought, Manganese-Nickel, Austenitic (Low Magnetic Permeability)

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 1 JAN 66 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.