

INCH-POUND

MIL-S-21952D(SH)

10 January 1990

SUPERSEDING

MIL-S-21952C(SH)

18 September 1981

(See 6 9)

MILITARY SPECIFICATION

STEEL (HY-80 AND HY-100) BARS, ALLOY

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1 SCOPE

1.1 Scope. This specification covers HY-80 and HY-100 alloy steel bars intended primarily for use in the hulls of combat ships and for other critical structural applications where a notch-tough high-strength material is required

1.2 Classification Steel bars shall be of the following grades, as specified (see 6 2):

Grade HY-80 - 80,000 pounds per square inch (lb/in²) tensile yield strength minimum

Grade HY-100 - 100,000 lb/in² tensile yield strength minimum.

1 2 1 Type Steel (HY-80 and HY-100) bars shall be furnished in the following types, as specified (see 6 2):

Type A - Hot rolled, quenched and tempered.

Type B - Hot rolled, quenched and tempered and cleaned (scale free)

2. APPLICABLE DOCUMENTS

2.1 Government documents

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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2.1.1 Standards. The following standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS

FEDERAL

FED-STD-183 - Continuous Identification Marking of Iron and Steel Products.

MILITARY

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

MIL-STD-271 - Requirements for Nondestructive Testing Methods.

(Unless otherwise indicated, copies of military standards are available from the Naval Publications and Forms Center, (ATTN NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government publication. The following other Government publication forms a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATION

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

Naval Ships Technical Manual S9086-VD-STM-000/CH-631 -
Preservation of Ships in Service (Surface Preservation and Painting)

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 29 - Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold Finished, General Requirements for (DoD adopted)

A 370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products (DoD adopted)

A 673 - Standard Specification for Sampling Procedure for Impact Testing of Structural Steel (DoD adopted)

E 8 - Standard Methods of Tension Testing of Metallic Materials (DoD adopted)

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ASTM (Continued)

- E 23 - Standard Methods for Notched Bar Impact Testing of Metallic Materials. (DoD adopted)
- E 381 - Standard Method of Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings. (DoD adopted)
- E 604 - Standard Test Method for Dynamic Tear Testing of Metallic Materials. (DoD adopted)

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

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services).

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.3.

3.2 Material. Bars shall be made from ingots, billets, or continuous castings, which have been produced by the same process as used for production of the first article bars. As a minimum, the steel shall be fully killed, vacuum degassed, and produced to fine grain practice. The steel may be cast by conventional methods or may be continuous cast. The ratio of reduction in cross sectional area from continuous casting to bar shall be a minimum of 3:1.

3.2.1 Recovered materials Unless otherwise specified (see 6.2), all products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials.

3.2.2 Discard Sufficient discard shall be removed from each ingot to ensure freedom from piping and undue segregation.

3.3 Chemical composition. The chemical composition (heat and product) shall conform to table I. In cases where both heat and product analysis are performed, the product analysis shall be used to determine acceptance or rejection (see 4.6.1).

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TABLE I Chemical composition.^{1/}

Element	Weight percent ^{2/}	
	GRADE (HY-80)	GRADE (HY-100)
Carbon		
Heat (ladle) analysis	0.12-0.18	0.12-0.20
Product analysis	0.10-0.20	0.10-0.22
Manganese		
Heat analysis	0.10-0.40	0.10-0.40
Product analysis	0.10-0.45	0.10-0.45
Phosphorus		
Heat analysis	0 015	0.015
Product analysis	0 015	0.015
Sulfur		
Heat analysis	0 008	0.008
Product analysis	0.008	0.008
Silicon ^{3/}		
Heat analysis	0.15-0 35	0 15-0.35
Product analysis	0.12-0.38	0 12-0.38
Nickel		
Heat analysis	2.50-3.25	2 75-3.50
Product analysis	2.43-3.32	2.67-3.57
Chromium		
Heat analysis	1.35-1.80	1.35-1.80
Product analysis	1.29-1.86	1.29-1.86
Molybdenum		
Heat analysis	0.30-0.60	0.30-0.60
Product analysis	0.27-0.63	0.27-0 63
Residual elements ^{4/} (heat and product analysis)		
Vanadium	0.03	0.03
Titanium	0.02	0.02
Copper	0.25	0.25
Trace elements ^{4/} (heat and product analysis)		
Arsenic	0 025	0.025
Tin	0.030	0.030
Antimony	0.025	0.025

See footnotes at top of next page

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- 1/ For definition of lot for heat analysis, see 4.4.1 1.
2/ Maximum unless a range is shown.
3/ When vacuum carbon deoxidation is employed, the minimum silicon content may be reduced to 0.08 percent by weight in which case the steel shall be fully killed and shall not be active in the molds during teeming.
4/ Elements not added intentionally.

3.4 Mechanical properties The material shall meet the tensile property requirements specified in table II and the impact property requirements of table III after heat treatments including stress relief.

TABLE II. Tensile properties

	GRADE HY-80	GRADE HY-100
Ultimate tensile strength, lb/in ²	<u>1/</u>	<u>1/</u>
Yield strength, 0.2 percent offset, lb/in ²	80,000 to 99,500	100,000 to 120,000
Elongation in 2 inches minimum, percent ^{2/}		
Longitudinal	20	18
Transverse ^{3/}	18	16
Reduction in area, minimum percent		
Longitudinal	55	50
Transverse ^{3/}	50	45

- 1/ To be recorded for information only
2/ Only applicable to bar thicknesses 7/16 inch and over, and round and hexagon diameters 3/4 inch and over.
3/ Unless otherwise specified (see 6.2), transverse properties are only required for bars greater than or equal to 4 inches in diameter or thickness used for hull penetration applications.

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TABLE III. Impact requirements, Charpy V-notch.^{1/ 4/}

Energy ^{2/} foot-pounds, average of three tests, minimum				
Longitudinal		Transverse ^{3/}		Test (coolant) temperature
Grade HY-80	Grade HY-100	Grade HY-80	Grade HY-100	
50	50	50	50	-120 ± 3°F
70	70	60	60	0 ± 3°F

- ^{1/} As an alternative to Charpy impact testing (transverse and longitudinal directions) of bar with a minimum thickness of 5/8 inch, dynamic tear testing may be substituted at the option of the contractor when approved by the Command or agency concerned (see 6 2). The dynamic tear test specimens shall be of the same orientation to the final direction of bar rolling as the Charpy specimens they are substituting. The minimum dynamic tear energy required for the average of two specimens is 450 foot-pounds (ft-lb) for HY-80 and 500 ft-lb for HY-100 at minus 40 ± 3 degrees Fahrenheit (°F)
- ^{2/} No single Charpy V-notch or dynamic tear test value shall be below the minimum average required by more than 5 ft-lb and 25 ft-lb, respectively
- ^{3/} Unless otherwise specified (see 6.2), transverse properties are only required for bars greater than or equal to 4 inches in diameter or thickness used for hull penetration applications
- ^{4/} For material thicknesses below 5/8 inch and round and hexagon diameters under 5/8 inch, Charpy test subsize specimens shall be as provided in ASTM A 673. Equivalent absorbed energy requirements for subsize specimens shall be as specified (see 6 2).

3 5 Heat treatment The bars shall be quenched and tempered. The contractor shall determine the detailed procedure to produce bars meeting the mechanical property requirements with the exception that the final tempering temperature shall be not less than the temperature specified in table IV. If the bars are stress relieved after final tempering, the stress relief temperature shall be less than the final tempering temperature and shall be not less than the temperature specified in table IV. Bars may be water quenched after tempering. Rapid cooling shall be employed following stress relief (see 6 3 and appendix C)

TABLE IV Minimum tempering and stress relief temperature

Grade	Minimum tempering temperature (°F)	Minimum stress relief temperature (°F)
HY-80	1200	1100
HY-100	1100	1050

3 5 1 Simulated stress relief When a simulated stress relief is specified in the contract or order (see 6.2), samples from the same heat treated lot (see 4 4 2 4) shall be subjected to stress relief thermal cycles and then shall

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be tested for mechanical and impact properties (see 4.6) and shall meet the requirements of 3.4. The fabricator (consignee) shall specify the stress relief thermal cycles (including cooling rates) to the contractor. Stress relief shall be specified only where necessary to meet machining tolerances.

3.5.2 Heat treatment equipment and controls. Continuous or automatic heat treating equipment may be employed, provided it produces heat-treated material meeting the requirements of this specification. For the particular loading and size range of the pieces being heat treated, the temperature recording equipment shall be maintained and calibrated on a regular basis. The temperature of the furnace charge shall be recorded during the heating, holding, and when applicable, the cooling cycles of the heat treatment. After the charge reaches the selected temperature control setting, furnaces shall maintain the temperature at any point in the furnace charge to within plus or minus 25°F of the desired temperature.

3.6 Surface quality. The bars shall be free of pipe, cracks, and flakes. Within the limits of good manufacturing and inspection practices, the bars shall be free of injurious seams, laps, segregation, or other imperfections which, due to their nature, degree, or extent, will interfere with the use of the material in machining or fabrication of parts. Surface imperfections may be removed by grinding, provided the thickness is not reduced below the minimum thickness permitted and the ground area is well flared into the surrounding metal.

3.7 Dimensions and tolerances. Bars shall conform to the dimensions and tolerances specified in ASTM A 29.

3.8 Identification marking. Bars shall be identified with this specification number, grade HY-80 or grade HY-100, whichever is applicable, lot number, class and contractor's name or trademark, as follows:

Type A bars

- (a) Bars having the following cross-sections shall have the lot number and the designation grade HY-80 or grade HY-100 whichever is applicable, indent stamped on one end.

Sizes - Round, hexagons, and square - 2-1/2 inches and over.

Flats over 2 inches wide and 2 inches thick

This specification number, the grade and the contractor's name or symbol shall be securely affixed to each end of each lift or bundle of bar, or to each bar when shipped loose.

- (b) Bars having cross-sections less than the bars specified above shall have the identification markings placed on waterproof tags. At least one tag shall also be securely attached to each end of each lift or bundle, or to each bar when shipped loose.

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Type B bars Type B bars of the following sizes shall be continuously marked with the lot number, grade HY-80 or grade HY-100 whichever is applicable, and the contractor's name or trade mark in accordance with FED-STD-183

Sizes - Rounds 3/4 inch diameter and over.
Hexagons 7/8 inch across flats and over.

Smaller bars shall be marked as specified for type A bars, 3.8(b), above.

3.9 Descaling and cleaning Scale may be removed from type B bars by abrasive blast, acid pickling, grinding, or machining. Bars shall meet the specified dimensions and tolerances after cleaning. Acid pickling shall be accomplished in accordance with the following:

- (a) Rust preventives, oils, greases, oil paints, and other foreign matter shall be removed prior to immersion in pickling bath. When alkaline solutions are used for this purpose, the bars shall be thoroughly rinsed with water prior to pickling. The final rinse shall be hot water between 160 and 200°F.
- (b) The pickling bath shall consist of the following initial solution
 - Sulfuric acid - 5 to 10 percent by volume. The sulfuric acid concentration shall be maintained at 5 to 10 percent by volume
 - Sodium chloride - 1-1/2 percent by weight (13 pounds per 100 gallons of solution) Sodium chloride should be added as required to maintain this concentration.
 - Inhibitor - as recommended by the contractor.

When the iron content in the pickling solution exceeds 5 percent of the total weight of the entire bath, the pickling solution shall be discarded and another pickling solution in accordance with 3.9 shall be used instead. Methods for calculating the iron and acid concentrations shall be in accordance with NAVSEA S9086-VD-STM-000/CH-631

- (c) Pickling bath temperature shall be in the range of 150 to 200°F
- (d) Pickling time shall be limited to 2 hours with normal rinsing time. If necessary, up to 4 hours pickling time shall be permitted provided additional rinsing time is employed
- (e) Rinsing shall be carried out in fresh water maintained at a minimum temperature of 170°F. Minimum rinsing time shall be 2 minutes for bars pickled up to 2 hours. Bars pickled over 2 but less than 4 hours shall be rinsed for 20 minutes.
- (f) Acid concentration of the rinse water shall not exceed 2 grams per gallon
- (g) After pickling, the bars shall be allowed to age a minimum of 24 hours before fabricating or welding

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3.10 Macrostructure. The quality and cleanliness of bars shall be equal to or better than the following macrographs of ASTM E 381. Unacceptable conditions of ASTM E 381 also apply.

<u>Cross-sectional area</u>	<u>Macrograph numbers</u>
36 square inches and less	C2, S2, R2
Over 36 square inches	C3, S3, R3

3.11 Repair by welding. Weld repair is not allowed unless specifically approved on a case basis by the Command or agency concerned.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor 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 ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material (see 6.3 and appendix A).

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows.

- (a) First article inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of testing the samples specified in 4.3.1 in accordance with the procedures of 4.5 and 4.6 (see 6.3 and appendix B).

4.3.1 First article samples. First article samples shall be taken from bars rolled from castings that represent the largest size to be used at the rolling facility and from one lot (see 4.4.1). As a minimum, the thickest or largest diameter bars, whichever are greater, to be produced at the mill shall be tested.

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4.4 Quality conformance inspection. Quality conformance inspection shall consist of the examination of 4.5 and the tests of 4.6.

4.4.1 Lot.

4.4.1.1 Lot for chemical composition. Lots for chemical composition shall be defined as follows: ingot cast, each heat; continuous cast, each ladle; vacuum arc remelt (VAR) or electroslag remelt (ESR), each remelted ingot; argon oxygen decarburization (AOD), each vessel charge. Unless multiple ladle continuous casting was qualified by first article testing, continuous casting shall cease after one ladle of steel is completely cast.

4.4.1.2 Lot for macroetch tests. Each heat of steel shall constitute a lot.

4.4.1.3 Lot for mechanical tests. All bars of the same nominal size of the same lot for chemical composition, and heat treated in the same furnace charges or continuously tempered under the same conditions of time and temperature shall constitute a lot.

4.4.1.4 Lot for dimensional and surface examination. A lot shall consist of all bars of the same type and size offered for inspection at one time.

4.4.2 Sampling

4.4.2.1 Sampling for chemical or spectrographic analysis. Samples for chemical analysis shall be taken from the top bar of each of two ingots or continuous castings in each lot. Solid samples may be taken for spectrographic analysis from the same locations as above

4.4.2.2 Macroetch test Samples for macroetch test shall be taken from each lot in accordance with method A or B below.

Method A - Where the product of the heat is identified by original position in the ingot, samples shall be taken from the top of the first and bottom of the last useable bar produced from the first, middle, and last useable ingots.

Method B - Where the product of the heat is not identified with respect to position in ingot or continuous cast, the inspection lot shall consist of all bars of the same nominal size and heat. From each lot, samples for macroetch test shall be taken from one end of bars selected at random in accordance with table V.

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TABLE V. Sampling for macroetch tests.

Number of bars in lot	Number of bars selected for macroetch test
3 to 8	3
9 to 15	4
16 to 25	5
26 to 40	7
41 to 65	10
66 to 110	15

4.4.2.2.1 Where less than one half of a heat is applied, macroetch tests may be taken from the first and last ingot applied, in lieu of the first, middle, and last useable ingot.

4.4.2.3 Sampling for mechanical tests. Longitudinal tension and Charpy V-notch test specimens shall be machined as follows:

- (a) For bars up to 2 inches in diameter or thickness, centerline of tests shall correspond with centerline of bar.
- (b) For bars over 2 inches in diameter or thickness, centerline of test specimens shall correspond to 1/4 diameter or thickness of bar

When specified (see 6 2), transverse tension and impact specimens shall be machined from bars as shown on figure 1.

4.4.2 3.1 Tension test specimens. Samples for tension test shall be taken from each heat in a lot, on the basis of one sample for each 5 tons (10,000 pounds) or fraction thereof. Each sample shall be taken from a different bar and not less than 2 samples shall be selected from any lot. Test specimens shall be located in accordance with ASTM A 370.

4.4.2.3.2 Charpy V-notch test specimen. Samples for Charpy V-notch tests shall be selected from each heat in a lot on the basis of one sample for each 5 tons or fraction thereof. Each sample shall be taken from a different bar and shall be of a size sufficient to allow preparation of at least three Charpy V-notch test specimens.

4.4.2.3.3 Dynamic tear test specimen For dynamic tear testing, one specimen per each 5 tons or fraction thereof is required.

4.4.2 3.4 Marking of test specimens. The test specimens shall be marked to ensure positive identification of the lot being tested.

4.4.2.4 Sampling for mechanical properties following simulated stress relief. When specified (see 6.2), sample material (see 4.4.2) shall be subjected to simulated stress relief operations after quenching and tempering, but prior to

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testing for conformance to the mechanical property requirements in 3.4. The sample material shall not be removed from the parent material prior to quenching and tempering. The total time at temperature and cooling rate for the simulated stress relief operations shall be as specified (see 6.2).

4.5 Examination.

4.5.1 Dimensional examination Bars from each lot, selected at random, shall be measured for conformance to the requirements of 3.7.

4.5.2 Nondestructive testing. The requirements of MIL-STD-271 shall apply for the qualification of personnel, equipment, procedures, and reporting of test results for inspections performed in accordance with this procedure except as modified herein.

4.5.2.1 Visual examination. Each length of bar shall be visually examined for surface condition and finish in accordance with 3.6 and 3.8. Any bar not meeting these requirements shall be rejected. Packaging shall conform to the requirements of section 5, deficiencies shall be corrected prior to shipment.

4.5.2.2 Ultrasonic examination Each length of bar shall be examined in accordance with MIL-STD-271. Any bar that produces a signal equal to or greater than the calibration hole shall be rejected.

4.6 Test procedures

4.6.1 Product chemical analysis Samples selected in accordance with 4.4.2.1 shall be analyzed in accordance with a standard ASTM method or a method that will assure accurate results for conformance to 3.3 as applicable. The methods shall be correlated with National Bureau of Standards reference materials, when available, to insure the validity of the method that is used as a control in chemical analysis or for calibration in instrumental methods of analysis. If any analysis fails to conform to 3.3, the lot represented by that analysis shall be rejected. When both a heat and product analysis are determined, the product analysis shall be used to determine acceptance or rejection.

4.6.2 Tensile tests Tensile testing shall be in accordance with ASTM E 8. The largest round standard tensile specimens of ASTM E 8 which can be obtained from the test material shall be prepared and tested.

4.6.3 Charpy impact test. The test specimens selected in accordance with 4.4.2.3.2 shall be tested with coolant temperature of $\text{minus } 120 \pm 3^{\circ}\text{F}$ and $0 \pm 3^{\circ}\text{F}$, in accordance with ASTM E 23. Precautions shall be taken to assure that the specimen has reached the temperature of the coolant, and the tongs used in handling the specimen shall be cooled with the specimen. For first article inspection, transition curves (transverse, when possible, and longitudinal to the direction of rolling) shall be taken with data points at each temperature of $\text{minus } 120^{\circ}\text{F}$, $\text{minus } 90^{\circ}\text{F}$, $\text{minus } 40^{\circ}\text{F}$, 0°F and room temperature. A minimum of five specimens for each point are required.

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4.6.4 Dynamic tear impact test. The test specimens selected in accordance with 4.4.2.3 shall be tested with a coolant temperature of minus $40 \pm 3^{\circ}\text{F}$, in accordance with ASTM E 604.

4.6.5 Macrostructure. Samples selected in accordance with 4.4.2.2 shall be prepared and examined in accordance with ASTM E 381. Approximately half the samples shall be cut to reveal a transverse surface. The remainder of the samples shall be cut to reveal a longitudinal surface.

4.7 Rejection. Individual bars not meeting the requirements of this specification shall be cause for rejection. If a bar representative of a lot fails to meet the chemical, macroetch, or mechanical property requirements of this specification, the lot shall be subject to rejection. When a rejected lot consists of more than one piece, each remaining piece in the lot may be retested for the nonconforming characteristic, and each piece that conforms to requirements may be offered for acceptance. Retests shall be in accordance with 4.8. The contractor is required to keep rejected lots identified and separate from acceptable lots until the rejected lots are withdrawn by the contractor or demonstrated as meeting specification requirements.

4.8 Retests.

4.8.1 Reheat treatment. The contractor shall be permitted to reheat treat a lot which fails to meet tensile or impact requirements of this specification. All required tests originally performed on the failed bars except chemical analysis and macroetch shall be repeated when the material is reinspected.

4.8.2 Tensile retest. If any specimen fails to meet the mechanical requirements, the lot may be reheat treated and retested in accordance with 4.6.2. If the results on an original tensile specimen are within $1,000 \text{ lb/in}^2$ of the required yield strength, or within 2 percent of the required elongation or within 2 percent of the required reduction in area, a retest on a duplicate specimen (selected from the same approximate location) will be permitted. If the percentage of elongation or reduction in area of any tensile specimen is less than that specified in table II, and any part of the fracture is outside the gauge length, or within the gauge length and less than 25 percent of the gauge length from either datum point, another specimen from essentially the same location may be selected in its place.

4.8.3 Charpy impact retest. In the event a Charpy specimen does not meet individual value requirements, a retest of three specimens shall be permitted on the same lot. If the retest specimens do not meet requirements (average and individual value) the lot represented by the specimens shall be rejected. At the option of the contractor, each bar in the rejected lot may be impact tested in accordance with 4.6.3, and each bar that fails to meet the requirements of table III shall be rejected.

4.8.4 Dynamic tear retest. If dynamic tear specimens do not meet the requirements of table III, a retest of two additional specimens from that lot may be performed. If both retest specimens do not meet table III requirements, the

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lot represented by the specimens shall be rejected. At the option of the contractor, each bar in the rejected lot may be impact tested in accordance with 4.6.4, and each bar that fails to meet the requirements of table III shall be rejected.

4.8.5 Retests (defective material). If the results of the mechanical tests do not conform to the specified requirements because a flaw is found in the specimen during testing, a retest may be allowed if the defect is not caused by defective machining, cracks, or flakes.

4.8.6 Macroetch tests. Where macroetch tests are not as specified in 4.4.2.2, appropriate discard shall be made until sound metal is obtained. In such instances the product from the tops and bottoms of the ingots in the lot shall be subjected to macroscopic etch test and appropriate discard made until sound metal is reached. Where the material is not identified with respect to original position in the ingot, and one or more macroetch tests do not conform to 4.4.2.2, all bars in the lot shall be subjected to macroetch test on each end.

4.9 Inspection of packaging. Samples packs, and the inspection of the preservation, packing and marking for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition)

5.1 Preservation and packing Bars shall be preserved and packed level A, or commercial, as specified (see 6.2) When level A is specified, type B bars shall be preserved with type A preservative in accordance with MIL-STD-163.

5.2 Marking. In addition to any special marking required (see 6.2), marking shall be in accordance with MIL-STD-163

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory)

6.1 Intended use. Grade HY-80 and grade HY-100 alloy steel bars are intended primarily for use in the hulls of combatant ships and for other critical structural applications where a notch tough weldable high strength material is required. The use of these steels in fabricated structures or equipment entails much more than materials specification and caution is advised in the areas of welding, fabrication, and nondestructive testing.

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6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification.
- (b) Type and grade required (see 1.2 and 1.2.1).
- (c) Sizes and quantity of bars required.
- (d) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (e) When first article inspection is required (see 3.1).
- (f) Whether virgin raw materials are required (see 3.2.1).
- (g) Whether transverse mechanical properties are required (see footnote 3 of table II, footnote 3 of table III, and 4.4.2.3).
- (h) Whether dynamic tear test impact criteria are to be the sole requirements for bars (see footnote 1 of table III).
- (i) Absorbed energy requirements of subsized specimens (see footnote 4 of table III).
- (j) When a simulated stress relief sample is required. If required, the number of thermal cycles, the heating and cooling rates, and time at temperature shall be specified (see 3.5.1 and 4.4.2.4).
- (k) Level of preservation or packing required (see 5.1).
- (l) Special marking required (see 5.2).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
3.5 and appendix C	DI-MISC-80653	Test reports	----
4.1.1 and appendix A	DI-MISC-80678	Certificate data/report	----
4.3	DI-T-4901	First article inspection procedure	----
4.3 and appendix B	DI-T-4902	First article inspection report	----

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

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6.4 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the items should be a preproduction sample, a first article sample, a first production item, a sample selected from the first ___ production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.3. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.4.1 Government inspection. The ingot or continuous casting technique, the rolling of the bar, the laying-out of the test specimens, and the testing should be witnessed by the American Bureau of Shipping (ABS) or Defense Contract Administration Services Management Area (DCASMA) representatives

6.5 Inspection after delivery. Post delivery inspection of bar to determine conformity to this specification and for acceptance thereof is the responsibility of the consignee.

6.6 Field identification. Hardness testing may be used as a supplementary aid for field identification purposes. The Brinell hardness values should be between 212/248 for grade HY-80 and 241/285 for grade HY-100 for bars over 3 inches in diameter. On sizes 3 inches and under in diameter thickness, the Brinell ranges should be slightly higher. This paragraph is for information purposes and is not intended as a specification requirement.

6.7 Contractor. References to the contractor in this specification are meant to apply to a specific steel manufacturer's mill facility.

6.8 Subject term (key word) listing.

- Charpy V-notch
- Dynamic tear testing
- Heat treatment
- Impact test
- Stress relief temperature
- Tempering
- Tensile properties

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6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 9510-N043)

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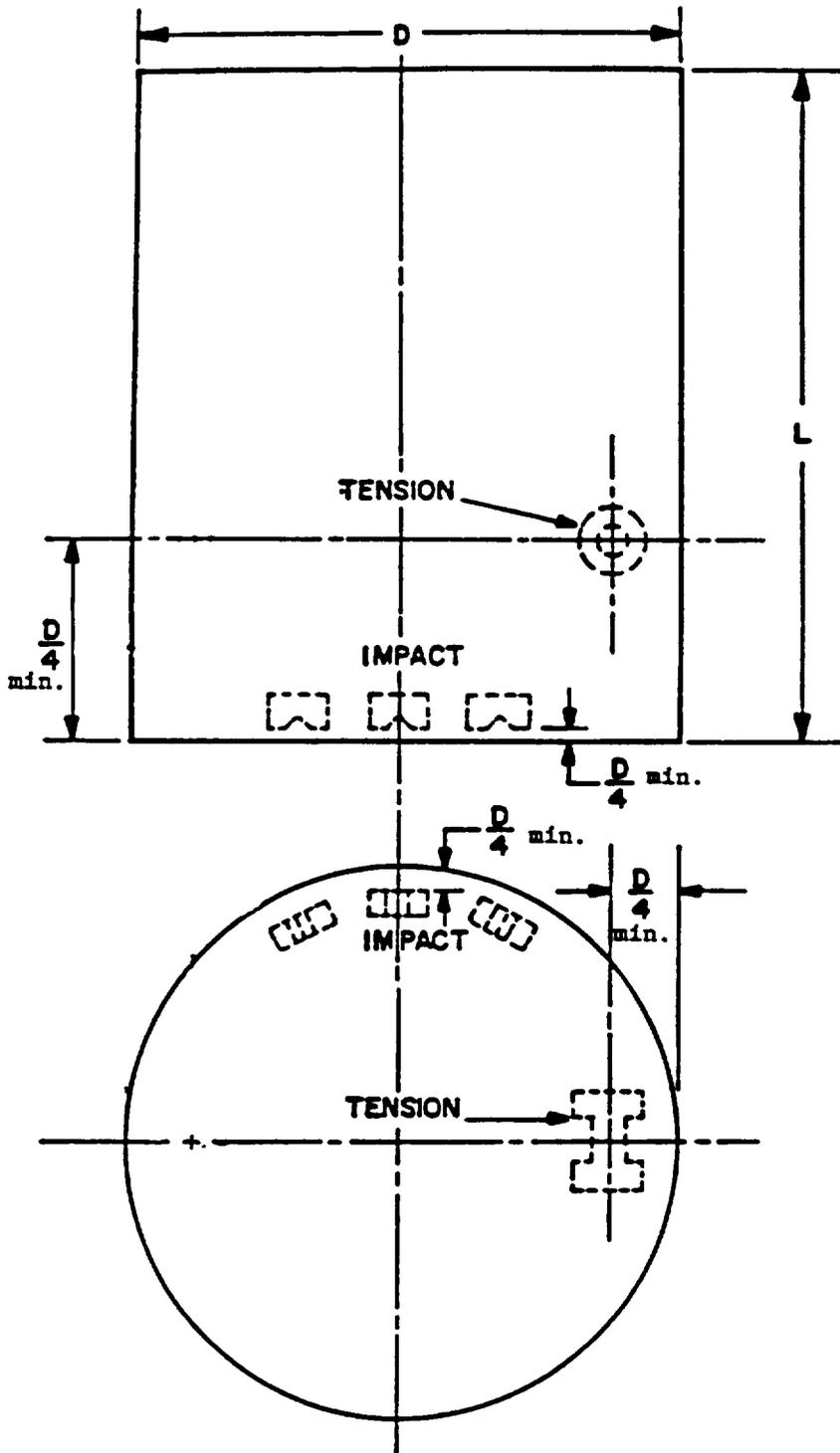


FIGURE 1 Schematic diagram of transverse test specimen location.

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APPENDIX A

CERTIFICATION DATA/REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope This appendix covers the technical content requirements that should be included on certification data/reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80678 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. REPORTS

30.1 Certification data/reports. When required by the contract or order, certification data/reports shall contain the following information:

- (a) Heat treatment information (see 3.5)
- (b) Cooling rate and maximum and minimum time at temperature used on sample material (see 4.4.2.4)
- (c) Specification covering method of chemical analysis (see 4.6.1)
- (d) Destructive and nondestructive test results.
- (e) Visual test results, including date of inspection, procedure number, and inspector's signature and level of qualification.
- (f) Ultrasonic test results, including date of examination, procedure number and technique, inspector's signature and level of qualification, ultrasonic instrument (including model and serial numbers), and transducer (including type, size and frequency).

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APPENDIX B

REPORTS TECHNICAL CONTENT REQUIREMENTS

10 SCOPE

10.1 Scope. This appendix covers the technical requirements that should be included in test reports when required by the contract or order. This appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST REPORTS

30.1 First article test reports When required by the contract or order, first article test reports shall contain the following information:

- (a) Standard specification data from standard production stock (chemistry, macroetch, mechanical properties, visual, dimensional, and ultrasonic inspection results).
- (b) Complete heat treatment record.
- (c) Production line operations such as melt practice, processing history, and heat treatment details
- (d) Charpy V-notch transition curves (transverse when possible, and longitudinal to the direction of rolling) with data points at each required temperature.

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APPENDIX C

TEST REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10 1 Scope. This appendix covers the technical requirements that should be included on test reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80653 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST REPORTS

30 1 Test report contents. When test reports are required by the contract or order, the contractor shall maintain a complete record of the final heat treatment given each bar, including stress relief. The final heat treatment record shall include the time and temperature for the final tempering cycle and stress relief cycle (if any) and the cooling method used.

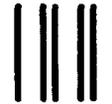
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