MIL-B-17901B(SH)
17 June 1983
SUPERSEDING
MIL-B-17901A(SHIPS)
3 April 1963
(See 6.5)

MILITARY SPECIFICATION

BEARING COMPONENTS, BONDED SYNTHETIC RUBBER, WATER LUBRICATED

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 stave shaped and cylindrical shaped bearings that have synthetic rubber facings.

1.2 Classification. Bearings shall be of the following classes, as specified (see 6.2.1):

Class I - Stave bearing, metallic backed.
Class II - Cylindrical bearing, with cylindrical shaped metal backing and internally molded rubber stave forms.
Class III - Stave bearing, nonmetallic backed.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

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 55Z3, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

SPECIFICATIONS

FEDERAL

QQ-B-637 - Brass, Naval: Rod, Wire, Shapes, Forgings, and Flat Products With Finished Edges (Bar, Flat Wire, and Strip).
QQ-B-639 - Brass, Naval: Flat Products (Plate, Bar, Sheet, and Strip).
QQ-C-390 - Copper Alloy Castings (Including Cast Bar).

MILITARY

MIL-P-2845 - Packaging of Main Propulsion Shafting, Bearings, Boat and Ship Propellers, and Associated Repair Parts.
MIL-C-15345 - Castings, Nonferrous, Centrifugal.
MIL-P-18324 - Plastic Material, Laminated Phenolic, For Bearings (Water or Grease Lubrication).

STANDARD

FEDERAL

FED-STD-791 - Lubricants, Liquid Fuels, and Related Products; Methods of Testing.

2.1.2 Government drawing. The following Government drawing forms a part of this specification to the extent specified herein.

DRAWING

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
NAVSHIPS 803-1385664 - Bearings Stern Tube and Strut.

(Copies of specifications, standards and drawings required by contractors in connection with specific acquisition functions should be obtained from the contracting 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. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 256 - Impact Resistance of Plastics and Electrical Insulating Materials. (DoD adopted)
D 412 - Rubber Properties in Tension. (DoD adopted)
D 471 - Rubber Property - Effect of Liquids. (DoD adopted)
D 570 - Water Absorption of Plastics. (DoD adopted)
D 638 - Tensile Properties of Plastics. (DoD adopted)
D 790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials. (DoD adopted)
D 1141 - Substitute Ocean Water. (DoD adopted)

D 2240 - Rubber Property - Durometer Hardness. (DoD adopted)
D 3183 - Rubber - Preparation of Pieces for Test from Other Than Standard Vulcanized Sheets. (DoD adopted)

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

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Qualification. The bearings furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

3.2 Bearing material and identification. The contractor shall stamp the following information on the back of each bearing stave: manufacturer identification, cross section size and batch number, also special information such as "1/16 oversize" (for example "RCN010A112 1/16 oversize"). The letters shall be at least 3/8 inch in height and readily visible to the unaided eye. Starting near one end of the stave the above information shall be stamped at 2 foot intervals along the back of the stave. The markings shall not interfere with the installation or performance of the bearing.

3.2.1 Physical requirements for bearing facing material. The facing material shall be a synthetic rubber compound and shall conform to the following physical requirements:

(a) Before aging:
Tensile strength, minimum pounds per square inch (lb/in^2) 1500
Elongation, minimum, percent 150

(b) Hardness - Initial hardness shall be as follows:
Class I - 85 ± 5 points, shore A durometer, instantaneous.
Class II - 70 ± 5 points, shore A durometer, instantaneous.
Class III - 55 - 90 points, shore A durometer, instantaneous (see 3.2.4).

(c) After aging - After being subjected to the oven aging test as specified in 4.7.2.1 the rubber material shall not vary more than 25 percent from the initial tensile strength and elongation.

(d) Surface finish of rubber facing shall be 64 microinches R_A or better.

3.2.2 Metal parts for class I bearings. Metal parts for class I bearings shall be Naval brass in accordance with QQ-B-637 or QQ-B-639.

3.2.3 Metal parts for class II bearings. Metal parts for class II bearings shall be casting or tubing. Casting shall be as specified in table I. Tubing shall be in accordance with the chemical requirements of QQ-B-637 or QQ-B-639.

TABLE I. Castings.

Material	Centrifugal castings	Static castings
Gun metal	MIL-C-15345	QQ-C-390, alloy 903
Naval brass	MIL-C-15345	QQ-C-390
Valve bronze	MIL-C-15345	QQ-C-390

3.2.4 Nonmetallic backing for class III bearing staves. Nonmetallic backing for class III bearing staves shall meet the physical requirements in accordance with table II.

TABLE II. Physical requirements for nonmetallic backing.

(class III bearings only)

Property	Units of measurement	Required test value	Test in accordance with	Remarks
Hardness	Shore D	64 minimum 80 maximum	ASTM D 2240	
Tensile strength	lb/in^2	4500 minimum	ASTM D 638	
Yield	lb/in^2	2800 minimum	ASTM D 638	
Flexural modulus	Secant modulus measured at a maximum 1 percent strain, lb/in^2	65,000 at 73°F	ASTM D 790	Test using method I
Impact resistance	Ft-lb/inch	.8 minimum	ASTM D 256	10 samples tested with method A and a 45 degree notch
Water absorption	Percent of specimen volume	0.2 percent maximum	ASTM D 570	Immersed 24 hours at a water temperature of 23 ± 1°C
Oil absorption	Percent of specimen volume	1 percent maximum	4.7.4.1 and 4.7.4.3	

3.2.5 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall 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. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.3 General requirements. The class, type, size, dimensions and dimensional tolerances shall be as specified in the ordering data (see 6.2.1). (Type is a subdivision of class, that is, flanged, unflanged, option 1, 2 or 3. Size refers to basic dimensions which determine bearing size, that is, shaft sleeve diameter, bearing length.)

3.3.1 Manufacturing of bearings. Unless otherwise specified (see 6.2.1), stern tube and strut bearings shall be manufactured and fabricated in accordance with Drawing 803-1385664.

3.4 Bond life. The adhesive, which bonds the rubber facing to the bearing backing shall maintain the bond for the life of the bearing. Bearing test specimens when subjected to pull tests shall meet the requirements in accordance with 3.4.1 through 3.4.5. Test specimens shall not be subjected to more than one type of aging per specimen.

3.4.1 Adhesion before aging. The adhesion of the rubber facing material to the backing shall be not less than 20 pounds when tested in accordance with 4.7.5.

3.4.2 Adhesion after oven aging. The adhesion of the rubber facing material to the backing shall be not less than 20 pounds when tested after being subjected to warm circulating air for 96 hours in accordance with 4.7.5.1 and tested in accordance with 4.7.5.

3.4.3 Adhesion after oil immersion. The adhesion of the rubber facing material to the backing after oil immersion for 46 hours in accordance with 4.7.5.2 shall be not less than 20 pounds when tested in accordance with 4.7.5.

3.4.4 Adhesion after seawater immersion. The adhesion of the rubber facing material to the backing shall be tested after immersion in seawater for 45 days and shall be not less than 20 pounds when prepared in accordance with 4.7.5.3 and tested in accordance with 4.7.5.

3.4.5 Adhesion after thermal cycling. The adhesion of the rubber facing material to the backing, after thermal cycling for 45 days in accordance with 4.7.5.4 shall be not less than 20 pounds when tested in accordance with 4.7.5.

3.5 Delamination. Rubber material shall show no evidence of separation into distinct layers of laminations when prepared and tested in accordance with 4.7.3.

3.6 Volume change.

3.6.1 Volume change after water immersion. When immersed in water, the volume of the rubber facing specimen shall not increase more than 5 percent when tested in accordance with 4.7.4.1 and 4.7.4.2. No shrinkage shall be permitted.

3.6.2 Volume change after oil immersion. When immersed in oil as specified in 4.7.4.3, the volume of the rubber specimen shall not increase more than 5 percent when tested in accordance with 4.7.4.1. No shrinkage shall be permitted.

3.7 Performance. The rubber material shall pass the performance test for wear, friction and noise characteristics in accordance with 4.7.6.

3.8 Interchangeability. Bearings of the same class, type and size shall be interchangeable both physically and functionally. If the design is symmetric they shall be reversible. (Flanged bearings are not symmetric.)

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 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 assure supplies and services conform to prescribed requirements.

4.1.1 Inspection system. The contractor shall provide and maintain an inspection system in accordance with the data ordering document included in the contract or order (see 6.2.2).

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

(a) Qualification inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 Qualification. Bearings shall pass initial qualification inspection and tests in accordance with 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.7.6 and table III. Selection of sample bearings and the preparation of test specimens shall be in accordance with 4.5.3 and 4.5.4, as applicable.

4.3.1 Visual, dimensional, and hardness inspection. A visual, dimensional and hardness inspection of the bearings selected in accordance with 4.5.3 or 4.5.4, as applicable, shall be performed in accordance with 4.6.1, 4.6.2 and 4.7.1.

4.3.2 Backing of nonmetallic staves. The backing of nonmetallic backed staves shall be subjected to qualification testing. The material shall be as specified in 3.2.4, when tested in accordance with table II. The backing of metallic backed staves need not be qualification tested.

4.3.3 Synthetic rubber facing material. The synthetic rubber facing material shall be subjected to the tensile, elongation, delamination and volume change tests in accordance with table III.

4.3.4 Bearing adhesion test specimens. Bearing adhesion test specimens shall be subjected to the adhesion bond tests in accordance with table III. The force required to strip the rubber facing from the backing at the interface bond shall meet the requirements in accordance with table III.

TABLE III. Summary of qualification test information (class I, II, III bearings).

Tests to determine	Aging details class I, II, III (paragraph)	Aging time	No. specimens per test class I and III	Class II	Requirements paragraph	Unit of measurements	Test paragraph
Tensile and elongation[1/]							
(a) before aging	4.7	N/A	3		3.2.1(a)	Tensile - lb/in^2	4.7.2
(b) after oven aging	4.7.2.1	96 hrs	3		3.2.1(c)	Elongation - percent of original length	4.7.2
Delamination			3		3.5	No separation into layers	4.7.3
Volume change							
(a) after water immersion	4.7.4.2	1 wk	3		3.6.1	Percent increase in volume	4.7.4, 4.7.4.1, 4.7.4.2
(b) after oil immersion	4.7.4.3	46 hrs	3		3.6.2	Percent increase in volume	4.7.4, 4.7.4.1, 4.7.4.3
Adhesion pull force							
(a) before aging	4.7	N/A	3	2	20 pounds or greater (3.4.1)		4.7.5
(b) after oven aging	4.7.5.1	96 hrs	3	2	20 pounds or greater (3.4.2)		4.7.5
(c) after oil immersion	4.7.5.2	46 hrs	3	2	20 pounds or greater (3.4.3)		4.7.5
(d) after seawater immersion	4.7.5.3	45 days	3	2	20 pounds or greater (3.4.4)		4.7.5
(e) after thermal cycling	4.7.5.4	40 days	3	2	20 pounds or greater (3.4.5)		4.7.5

1/ A tensile and an elongation test may be performed on the same specimen.

Rejection Criteria - Bearing and test specimens shall meet the requirements indicated, failure to do so shall be cause to deny qualification.

4.4 Quality conformance inspection. Every bearing lot shall pass a quality conformance inspection in accordance with the following, with samples selected in accordance with 4.5.5 and 4.5.6:

(a) For stave bearings (class I and III) the inspection shall consist of visual inspection (see 4.6.1), a dimensional inspection (see 4.6.2), and a hardness test (see 4.7.1), and an adhesion bond test in accordance with 4.7.5, except accelerated aging of the specimens is not required.

(b) For cyclindrical bearings (class II) the inspection shall consist of a visual inspection (see 4.6.1), a dimensional inspection (see 4.6.2), and a hardness test (see 4.7.1). No adhesion bond test is required.

4.5 Selection of sample bearings and preparation of test specimens.

4.5.1 Definition of a lot. Bearings of the same class having identical dimensions, the same facing and backing material and which are delivered to the contracting activity on the same contract or order shall be considered a lot.

4.5.2 Statistical selection of samples. Whenever a visual and dimensional examination of a lot of bearings is required, the sample shall be obtained by statistical sampling. Bearings shall be selected from each lot in accordance with table IV. The bearings shall be visually (see 4.6.1) and dimensionally (see 4.6.2) inspected to verify compliance with this specification.

TABLE IV. Sampling for visual and dimensional inspection.

(AQL (approx.) = 1.5 percent defective)

Lot size number of bearings	Sample size number to be inspected	Rejection 1/ number (defectives)
15 and under	7	1
16 to 40	10	1
41 to 110	15	1
111 to 300	25	2
301 to 500	35	2
501 to 800	50	3
801 to 1300	75	4
1301 and over	110	5

1/ Any bearing in the sample containing one or more visual or dimensional defects shall be rejected, and if the number of defective bearings in any sample exceeds the rejection number for that sample, the lot represented by that sample shall be rejected.

4.5.3 Selection of sample bearings and preparation of test specimens for qualification testing - stave shaped bearings only (class I and III). The bearings used for qualification shall be size 10 with a length of 36 inches or longer. The selection of sample stave bearings for visual, dimensional and hardness tests and the preparation of test specimens shall follow the sequence as specified below:

(a) Samples for visual, dimensional, and hardness tests. From a production run of 40 or more bearings, select a random sample in accordance with 4.5.2. The visual, dimensional and hardness tests shall be performed on these selected staves in the as-manufactured condition (prior to cutting stave specimens) in accordance with 4.6.1, 4.6.2 and 4.7.1, respectively. If the number of defective bearings in the sample equals or exceeds the rejection number specified in table IV the entire production run shall be rejected and no further qualification tests shall be run on the bearings. The manufacturer shall determine the cause of the defects by a check of materials and processes, and only after the manufacturer has improved the materials and processes, shall a new run for qualification be produced.

(b) Samples and specimens for tensile strength and elongation tests. The rubber specimens for tensile and elongation testing shall be obtained from the facing material of three sample staves. Select three sample staves from those selected in 4.5.3(a) and cut into 6-inch lengths, marking each piece taken from the first stave with the number 1, each piece taken from the second stave with the number 2 and each piece taken from the third stave with the number 3. Select one 6-inch stave section from each stave and identify on the rubber for use in the before aging test. Select a second set, one from each stave, and identify them on the rubber for use in the after aging test. The rubber for the tension and elongation test shall be sliced from the surface of each of these staves by means of a fine toothed band saw (16 teeth per inch) and buffed to a thickness of not less than 0.060 inch or more than 0.120 inch in accordance with ASTM D 412. The remaining 6-inch pieces shall be used in subsequent tests.

(c) Samples and specimens for delamination tests. The rubber specimens for delamination testing shall be obtained from the 6-inch stave lengths cut as in (b) above. Select three stave pieces, one from each stave, and remove the rubber from the backing at the interface bond. Cut specimens 3 inches by 1 inch by the thickness of the rubber facing from the three separate staves pieces.

(d) Samples and specimens volume change tests. The rubber specimens for the volume change testing shall be obtained from the 6-inch stave lengths cut as in (b) above. Select one 6-inch stave section from each of the three staves and identify on the rubber for use in the water immersion test. Select a second set of three from each of the staves and identify on the rubber for use in the oil immersion test. Cut one specimen, 2 inches by 1 inch with a thickness not to exceed 1/16 inch, from the surface of each of the six samples above. These samples are now ready for aging by oil and water immersion.

(e) Samples and specimens for adhesion bond tests. Select three sample staves from those selected in (a) above from which adhesion test specimens may be cut. The rubber facing of these three staves shall be buffed to a uniform thickness of 1/4 inch (see ASTM D 3183 for buffing procedures). Cut each stave into 6-inch lengths marking each piece taken from the first stave with the number 4, each piece taken from the second stave with the number 5, and each piece from the third stave with number 6. The three test specimens required for each type test shall be from different staves. The test specimens for adhesion pull testing shall have the rubber facing divided into strips by means of saw cuts parallel to the sides of the staves. The cuts shall go completely through the rubber and to a depth of approximately 1/16 inch into the backing. A cut shall be made 1/2 inch from each stave edge. Also two longitudinal cuts equally spaced about the centerline a distance of 1/2 inch apart measured along the bond interface shall be made. The rubber between the center and edge strips should be removed from the backing at the bond. This leaves a 1/2-inch center strip and two 1/2-inch wide edge strips. Tests will be performed on these three strips. For adhesion testing, these three strips will be considered as one test specimen. (See figure 1 for a cross section view of a test specimen.) The test specimens are now ready for the type of aging required by the particular tests (see 4.7.5).

4.5.4 Selection of sample bearings and preparation of test specimens for qualification testing - cylindrical shaped bearings (class II only). The cylindrical bearings used for qualification tests shall have an inside diameter (i.d.) of 6 inches or greater and shall be 18 inches or greater in length and be of the split type. The selection of sample cylindrical bearings for visual, dimensional and hardness inspection and the preparation of test specimens shall follow the sequence as specified below:

(a) Samples for visual, dimensional and hardness tests. From a production run of 8 to 15 bearings, select a random sample in accordance with 4.5.2. The visual, dimensional and hardness tests shall be performed on all these selected bearings in the as-manufactured condition (prior to cutting into specimens) in accordance with 4.6.1, 4.6.2 and 4.7.1, respectively. If the number of defective bearings in the sample equals or exceeds the rejection number specified in table IV, the entire production run shall be rejected and no further qualification tests shall be conducted on the bearings. The manufacturer shall determine the cause of the defects by a check of materials and processes and only after the manufacturer has improved the materials and processes shall a new run for qualification be produced. After successful completion of visual, dimensional and hardness inspection a single bearing shall be selected, from the sample bearings, to be used for supplying all required tests specimens. The bearing shall be cut into circumferential segments as shown

on figure 2. Each segment shall be cut into 6-inch lengths. Longitudinal cuts shall be made along the length of the cylindrical bearings which cut completely through the rubber and backing separating the bearing into a number of longitudinal segments. The plane of the saw shall pass through the axial center line of the bearing and through the center of molded grooves that exist between the simulated stave shapes that run the length of the bearings (see figure 3). A total of 25 test specimens shall be required for all the tests.

(b) Test specimens for tensile, elongation and hardness tests. Select six segments as prepared in 4.5.4(a) and buff facings flat. Measure the hardness of the segments at this time in accordance with 4.7.1. The rubber for tension and elongation tests shall be sliced from the surface of each of these segments by means of a fine tooth band saw (16 teeth per inch) and buffed to a thickness of not less than 0.060 inch or more than 0.120 inch in accordance with ASTM D 412.

(c) Test specimens for delamination tests. Select three segments as prepared in 4.5.4(a). The rubber for delamination testing shall be obtained by removing the rubber facing from the backing at the interface bond. From each of the pieces cut a test specimen 3 inches by 1 inch by the thickness of the rubber.

(d) Specimens for volume change test. The rubber specimens for the volume change test shall be obtained from the facing material of six bearing segments. Buff the rubber of each segment to a flat surface. Cut one specimen 2 inches by 1 inch with a thickness not to exceed 1/16 inch from the surface of the segments. These specimens are now ready for aging (see 4.7.4.2 and 4.7.4.3).

(e) Specimens for adhesion bond testing. Select 15 segments and buff facings to 1/4-inch thickness (see ASTM D 3183 for buffing procedure). The test specimens for adhesion pull testing shall have two longitudinal cuts, in the facing, equally spaced about the center line 1/2 inch apart. The cuts shall go completely through the rubber to a depth of approximately 1/16 inch into the backing. The rubber on each side of the center strip shall be removed from the backing at the bond. This leaves one 1/2 inch center strip per test specimen. The test specimens are now ready for the type of aging required by the particular tests specified in 4.7.5.

4.5.5 Selection of samples and preparation of test specimens for quality conformance inspection - stave bearings only (class I and III). Selection of samples and preparation of test specimens for quality conformance inspection (class I and III) shall be as follows:

(a) Sample stave bearings shall be statistically selected from each lot in accordance with table IV. A visual, dimensional and hardness inspection shall be performed on each bearing of the statistical sample (in the as-manufactured condition) in accordance with 4.6.1, 4.6.2 and 4.7.1, respectively. This portion of the quality conformance inspection shall be successfully

passed before proceeding with the preparation of test specimens for adhesion bond testing. If the number of defective bearings in any sample equals or exceeds the rejection number specified in table IV, the entire lot shall be rejected and no further testing shall be performed on any bearing of that lot, therefore no bearing of the lot shall be offered for sale to the Navy. The manufacturer shall determine the cause of the defects by a check of his materials and processes and only after he has improved his materials or processes shall he produce a new lot for visual examination and tests.

(b) If the statistical sample passes the above inspection, select three staves from the sample. Buff the rubber facing of the sample staves to a thickness of 1/4 inch. Cut a 6-inch long piece from the end of each stave to use in making the test specimens.

(c) The rubber facing of the above 6-inch stave pieces shall be divided into strips by means of longitudinal cuts which go completely through the rubber and to a depth of 1/16 inch into the backing. A cut shall be made 1/2 inch from each stave edge and two longitudinal cuts equally spaced about the center line a distance of 1/2 inch apart. This leaves a 1/2-inch wide center strip and two 1/2-inch edge strips. The rubber between the center and edge strips shall be removed from the backing at the interface bond. The three specimens, (each with three 1/2-inch wide strips) are ready for testing. No accelerated aging of the specimens is required.

4.5.6 Selection of samples for quality conformance inspection - cylindrical bearings only (class II). Sample cylindrical bearings shall be selected from each lot in accordance with table IV. The quality conformance inspection shall be performed on these bearings in the as-manufactured condition, no test specimens are required. Conformance inspection of cylindrical bearing (class II) does not require adhesion pull testing (due to superior bonding record). Therefore, there is no need to cut any of the bearings into test specimens. A visual, dimensional and hardness inspection shall be performed on each bearing of the statistical sample in accordance with 4.6.1, 4.6.2 and 4.7.1, respectively. This completes the quality conformance requirements for class II bearings. The total number of defects shall not exceed the number specified in table IV. In cases of rejection the manufacturer shall isolate the cause of the defects and produce another lot for inspection in which the cause of the previous defects is eliminated.

4.5.7 Sampling for performance test. When required by NAVSEA or the agency concerned, a bearing assembly or test specimen, or both shall be selected and subjected to the test specified in 4.7.6.

4.6 Examination.

4.6.1 Visual inspection. Sample bearings shall be visually inspected in a strong light for separation at the interface between the surface rubber face and the backing material. Slide the edge of a 0.005-inch feeler gage against the entire length of the bond line to uncover bond separation not readily visible. If separation exists, determine the length and depth of the unbonding

by inserting the 0.005-inch thick feeler gage. A total cumulative length of unbonding greater than 1 inch or any unbonding of any length allowing the feeler gage to be inserted to a depth of depressions 1/4 inch or more shall be cause for rejecting the sample. Roughness, holes, cuts, gouges, molding imperfections or tears in the bearing facing material which would indicate a bearing of poor workmanship or quality shall also be cause for rejection of the sample. The Government inspector shall be the final arbitrator on site in questions of suitability.

4.6.2 Dimensional inspection. Sample bearings shall be dimensionally inspected for conformance with the requirements as specified in 3.2.1(d). As a minimum, the following dimensions should be measured and recorded for each sample:

(a) For class I and III - the stave width, thickness, length, side angle and bearing face surface finish.
(b) For class II - the bore, outside diameter (o.d.), flange dimensions, length and bearing face surface finish.

4.7 Tests. Unless otherwise indicated in the test, tests shall be conducted on test specimens after a conditioning period of 4 hours minimum at a room temperature of 68-75 degrees Fahrenheit (°F). Sample preparation may be undertaken without regard to this time interval.

4.7.1 Hardness test of rubber facing and nonmetallic backing. The hardness of the bearing face or backing shall be measured in accordance with ASTM D 2240. Type A durometer shall be used for the bearing face. Type D durometer shall be used for the backing of class III bearings.

4.7.2 Tension and elongation tests. Tension and elongation tests shall be conducted on straight type test specimens of rubber facing material in accordance with method A of ASTM D 412. Tests shall be conducted on both aged and unaged specimens (as applicable, for class I, II or III test specimens).

4.7.2.1 After oven aging for tension and elongation tests. Test specimens of the rubber facing shall be subjected to circulating air at a temperature of 158 $\pm$ 2°F for 96 hours. Tension and elongation tests shall be performed on the straight type specimens in accordance with method A of ASTM D 412 not less than 20 hours or more than 48 hours after removal from the 158°F environment.

4.7.3 Delamination test of rubber facing. The rubber facing material shall be tested for evidence of delamination. Specimens cut in accordance with 4.5.3(c) and 4.5.4(c) shall be immersed in methyl ethyl ketone at a temperature of 73 $\pm$ 3°F for 22 $\pm$ 1/4 hours. After immersion, the specimens shall be examined visually in a strong light for evidence of separation into layers by attempting to separate the layers by hand.

4.7.4 Volume change test for rubber facing. The volume change of the rubber facing shall be measured after immersing of a test specimen in water and after immersing another test specimen in oil.

4.7.4.1 Procedure for determining volume change. The volume of each test specimen shall be measured by the water displacement method, in which the specimen is accurately weighed to the nearest milligram (mg) in air (W_1) and in distilled water (W_2) at room temperature. When weighing in water, care shall be taken that the specimen is free from adhering air bubbles, and, if necessary, it may first be wetted by dipping into 95 percent ethyl alcohol and then thoroughly rinsed with distilled water. After weighing, the specimen shall be blotted dry with filter paper, completely immersed in 100 milliliters (mL) of oil, and conditioned for 46 $\pm$ 1/4 hours, at room temperature (77 to 87°F). At the termination of the immersion period, the specimen shall be removed from the oil dipped in 95 percent ethyl alcohol, bottled lightly with filter paper, and placed in a tared weighing bottle and weighed (W_3). The specimen shall then be removed from the bottle and weighed in distilled water (W_4) in immediate consecutive procedure to determine the displacement after test. The final weighing shall be completed within 3 minutes after removal from the oil.

Calculation. The increase in volume shall be calculated as follows:

$$\text{Percentage increase in volume} = \frac{(W_3-W_4)-(W_1-W_2)}{(W_1-W_2)} \times 100$$

4.7.4.2 Aging by water immersion. Specimens scheduled for volume change testing shall be immersed for a period of 1 week in distilled water maintained at a temperature of 73 $\pm$ 3°F. Except temperature, immersion time, and the immersion liquid (distilled water) the procedure for determining volume change shall be as specified in 4.7.4.1.

4.7.4.3 Aging by oil immersion. Aging of the rubber facing for volume change testing after oil immersion shall be as specified in 4.7.4.3.1.

4.7.4.3.1 Specimens for volume change tests shall be conditioned for 46 $\pm$ 1/4 hours, at room temperature (77 to 87°F) in a petroleum base oil with the following properties as specified in FED-STD-791: (ASTM oil no. 3 as specified in ASTM D 471 meets the requirement of this test fluid.)

(a) Viscosity, Saybolt Universal: 155 $\pm$ 5 seconds (measured at 100°F).
(b) Aniline point: 157 $\pm$ 1°F.
(c) Flash point: 330 $\pm$ 5°F.

4.7.5 Adhesion tests. The bond strength between the rubber face and the backing material shall be determined by measuring the force required to pull the test strips from the backing at right angles to the interface surface. The testing machine shall be power driven with a devise for continuously recording graphically, the force in pounds required to strip the rubber from the backing. The recorder shall be accurate within plus or minus 2 percent of the actual pull force. The moving grip of the machine shall travel at the rate of 2 inches per minute. The fixture which holds the test specimen shall be capable of being moved, either manually or automatically, so that pull force is always at 90 degrees to the backing. If the rubber interface is curved, the specimen shall be free to rotate parallel to the long axis of the specimen to insure that the

pull is at right angles to the curvature. Test specimens shall be in accordance with 4.5.3(e), 4.5.4(e), or 4.5.5(c), as applicable. Before the load is applied the rubber shall be stripped from the backing at one end for a distance of approximately 1 inch using a sharp knife. This tab is then placed in the grip and a steady load is applied at the rate of 2 inches per minute until separation is complete. The autographic recorder shall be used to show graphically the adhesion values over the full length of the test specimen. The average pull force required to separate the bond shall be recorded. If the rubber face material begins to tear instead of separating at the bond interface, a sharp knife shall be used to encourage separation at the bond line by cutting back to the bond interface. If the strip persists in tearing instead of separating from the backing, the average load at which tearing occurs shall be reported with notation to that type of failure. If the tear strength of the strip is less than the specified minimum adhesive strength, the sample shall be considered to have failed the specification requirements.

4.7.5.1 Oven aging. Test specimens for adhesion testing shall be subjected to circulating air at a temperature of 158 ± 2°F for 96 hours. Following oven aging, specimens shall be subjected to adhesion bond tests.

4.7.5.2 Oil immersion aging. Test specimens for adhesion testing shall be immersed in a petroleum base oil for a period of 46 ± 1/4 hours at room temperature of 68 to 75°F (ASTM oil no. 3 meets these requirements):

(a) Viscosity: 155 ± 5 Saybolt Universal seconds at 100°F.
(b) Aniline point: 157 ± 1°F.
(c) Flash point: 330 ± 5°F.

Following oil immersion aging, specimens shall be subjected to adhesion bond tests.

4.7.5.3 Seawater immersion aging. Test specimens for adhesion testing shall be immersed in substitute seawater for 45 days at room temperature of 68 to 75°F. The substitute seawater shall be in accordance with ASTM D 1141 (without heavy metals). Following seawater immersion aging, specimens shall be subjected to adhesion bond tests.

4.7.5.4 Thermal cycle aging. Test specimens for adhesion testing shall be thermally cycled by placing in a refrigerator at 32 to 35°F for a period of 8 ± 1/2 hours, removed and allowed to naturally return to a room temperature of 68 to 75°F for 16 ± 1/2 hours. This cycle shall be repeated until 30 cycles have been completed. Five cycles shall be completed per week with specimens being maintained at room temperature over the weekends. Following thermal cycle aging, specimens shall be subjected to adhesion bond tests.

4.7.6 Performance tests. A bearing assembly or test specimen, or both, shall be subjected to performance tests for wear rate and static and dynamic friction coefficients, as described herein to determine acceptability of bearing materials and design. For class I and III bearings, both wear rate and friction coefficient tests shall be performed. For class II, only wear rate tests shall be conducted. Test specimens and bearing components shall represent (a) the material composition to be qualified by that particular manufacturer, (b) the dimensions and design specified in Drawing 803-1385664, and (c) the surface finish as specified in 3.2.1(d). Samples for these tests shall be representative of the product to be furnished to the Government under this specification.

4.7.6.1 Wear test. Three test specimens, prepared in accordance with 4.7.6.1.1 shall be tested at David W. Taylor Naval Ship Research and Development Center (DTNSRDC) Annapolis, MD. Each test specimen shall be identified by permanent markings on the back face of the test piece. A journal, made in accordance with figure 4, shall be used to measure wear (on the three specimens) of the subject bearing material and journal. The thickness in the wearing direction shall be measured to the nearest 0.001 inch for each specimen before testing. The diameter of the journal shall also be measured to the nearest 0.001 inch. Each specimen shall be positioned so it contacts the journal in the center (widthwise). Loads and journal speeds specified in MIL-P-18324 shall apply. The abrasive and lubricant specified in MIL-P-18324, shall be evenly distributed across the specimen width. The lubricant shall be maintained at 75 $\pm$ 5°F. The length of the test for each specimen is 10 hours. The journal diameter shall be measured in the area of heaviest wear to the nearest 0.001 inch following each specimen test. The minimum thickness of each specimen shall be measured to the nearest 0.001 inch. The wear shall be calculated by subtracting the final from the initial measurement.

4.7.6.1.1 Preparation of wear test specimens. Wear test specimens shall be cut from actual bearings and prepared as follows:

(a) Class I and III - Wear samples shall be cut from the no. 1 size stave bearings furnished for the friction tests. Three specimens, each being 1 inch by 1 inch by the thickness of the stave (normally 0.679-0.685 inch), shall be cut from the central portion of a randomly selected stave. The flat bearing surface shall be used to evaluate the wear characteristics and shall be representative of the bearings normally furnished to the Government.

(b) Class II - Three specimens, each being 1 inch by 1 inch shall be cut from the central portion of a fully molded bearing providing at least 1/4-inch thickness of rubber bearing surface to establish wear behavior. The rubber surface shall be machined flat and be representative of bearings normally furnished to the Government.

4.7.6.1.2 Wear test requirements. The average specimen wear shall be computed from the three samples tested. The total journal wear shall be determined by subtracting the final minimum journal diameter from the original diameter. The average bearing specimen wear shall not exceed 0.100 inch. The total journal wear shall not exceed 0.030 inch. If in any test the wear exceeds the thickness of the bearing surface, the product shall be failed and no further tests shall be conducted on that material.

4.7.6.2 Friction tests. Tests shall be performed at DTNSRDC, Annapolis, MD. For speeds below 40 revolutions per minute (r/min), a 10:1 ratio right angle gearbox may be utilized to increase the torque available to rotate shaft under reduced speeds. Compensation for the tare torque of the support bearings and seal shall be made. A journal with a 6-3/4 inch o.d. made of 70-30 copper-nickel shall be used for the friction test. The surface finish of the journal shall be less than 32 microinches R_A. The bearing shall be immersed in clean tap water at 75 $\pm$ 5°F prior to friction test and during all subsequent static and dynamic tests. Initial start up runs shall be performed at 60 r/min on

Record the number of strokes required

the stave assembly by increasing the radial bearing unit loading in 10 lb/in^2 increments until test loads of 40 lb/in^2 based upon projected area (length x diameter) is reached. The rate of load application depends upon the frictional behavior of the bearing and the limitations of the drive system. Load shall be applied at a rate such that the torque will not exceed 500 inch pounds (in-lb). If the 40 lb/in^2 test load cannot be reached in an 8-hour period to prepare for break in, due to high friction and torque loads exceeding 500 in-lb, the subject bearing shall be considered failed and no further tests are required. Once the 60 r/min, 40 lb/in^2 load condition has been reached, continuous operation will be performed under those conditions for 25 hours. Torque shall be periodically recorded during the 25-hour break in. Following break in, the speed of the journal shall be increased to 400 r/min from 60 r/min while under load of 40 lb/in^2. Torque levels shall be recorded upon reaching 400 r/min and after 15 minutes operation under that condition. Speed shall be changed to 250 r/min and data taken immediately and after 15 minutes. This procedure shall be followed for the following speeds - 100, 60, 40, 30, 20, 10 and 5 r/min. Tare torque corrections shall be applied to account for friction in the machine seals and bearings. Friction coefficients for the dynamic conditions of 400, 250, 100, 60, 40, 30, 20, 10 and 5 r/min shall be calculated based upon the formula:

$$T_{bearing} = fRP$$

where;

$T_{bearing}$ - corrected bearing torque in in-lb.

P - normal applied bearing radial load in pounds.

R - journal radius in inches.

f - friction coefficient

Following dynamic friction tests, static friction values shall be determined by applying 40 lb/in^2 load to the journal at rest. Torque shall be applied manually to the input shaft of the right angle gearbox. Torque shall be recorded on a strip chart recorder during torque build-up and breakaway. Load shall be applied for a length of time of 3 hours before torque is applied to rotate the shaft. The test shall be duplicated three times and the average of those three values of torque determined. The corresponding friction coefficient shall be calculated using the formula above.

4.7.6.2.1 Friction test specimens. No. 1 size bearing staves in accordance with Drawing 803-1385664 shall be cut into 15 pieces of 5-3/4 inches long and furnished for friction and wear tests. Samples shall be measured to check for conformance to the Drawing 803-1385664. Twelve staves shall be installed in a bearing housing conforming to Drawing 803-1385664 for a 6-3/4 inch o.d. bearing sleeve. The i.d. of the bearing assembly shall be measured to the nearest 0.001 inch.

4.7.6.2.2 Friction test requirements. The dynamic friction coefficients after 15 minutes operation, under the various speed conditions shall be as specified below:

(a) Dynamic friction coefficients.

Speed	Maximum acceptable friction coefficient
400	0.02
250	0.02
100	0.02
60	0.02
40	0.03
30	0.04
20	0.09
10	0.16
5	0.25

(b) Static friction coefficient. The average static friction coefficient shall not exceed 0.8.

If any of the friction coefficients of the static or dynamic conditions exceed the above limits, the bearing shall be considered to have failed the performance test requirements.

4.8 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The preparation for delivery requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.4.)

5.1 Preservation, packaging, packing, and marking. Bearings shall be preserved-packaged level A or C, packed level A, B, or C as specified (see 6.2.1) and marked in accordance with MIL-P-2845.

6. NOTES

6.1 Intended use. The bearings herein specified are intended for use in supporting the rotating propulsion shafts for surface ships and submarines.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Class required (see 1.2).

(c) Type, size, dimensions, tolerances, and special requirements required for machining or standard drawings as applicable (see 3.3).
(d) If stern tube and strut bearings are to be manufactured other than as specified in Drawing 803-1385664 (see 3.3.1).
(e) Levels of preservation, packaging, packing, and marking required (see 5.1).
(f) Certification requirement wherein the contractor states that the materials and processes, used in the production of the shipment bearings, have not changed since the most recent qualification.

6.2.2 Data requirements. When this specification is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DAR 7-104.9(n)(2) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraph.

Paragraph no.	Data requirement title	Applicable DID no.	Option
4.1.1	Inspection system program plan	DI-R-4803	----

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DoD 5000.19L., Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of this specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been suplied previously (for example, test reports).

6.3 With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List QPL-17901 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or puchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 55Z3,

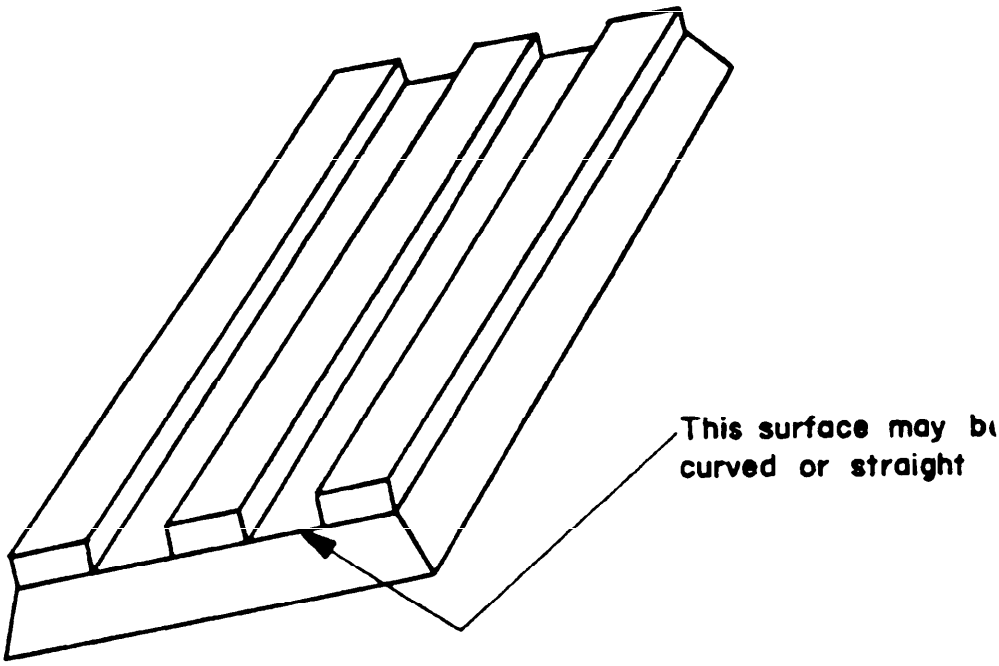
Department of the Navy, Washington, DC 20362 and information pertaining to qualification of products may be obtained from the activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.4 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

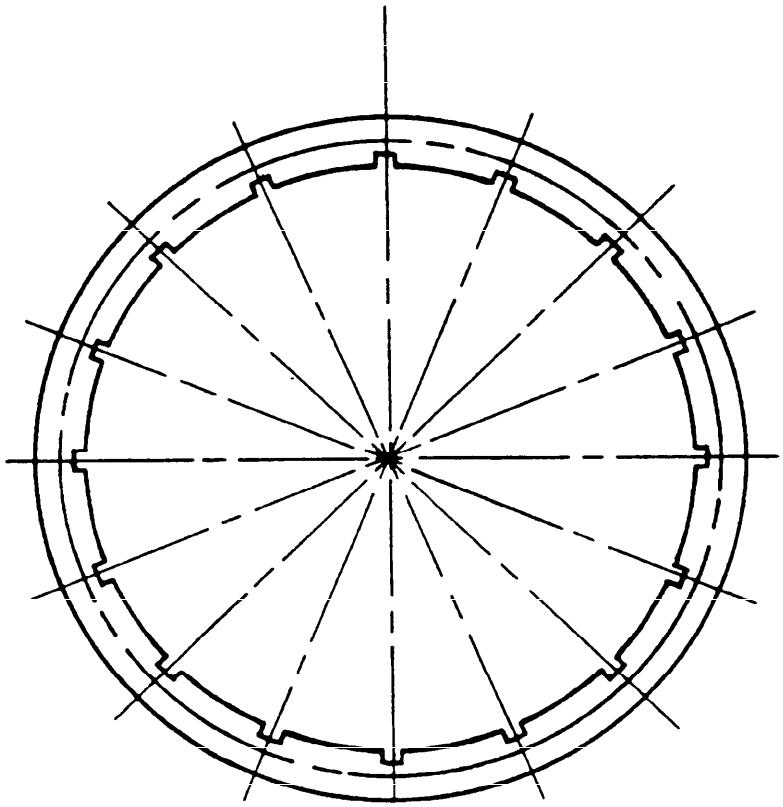
6.5 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 3130-N602)



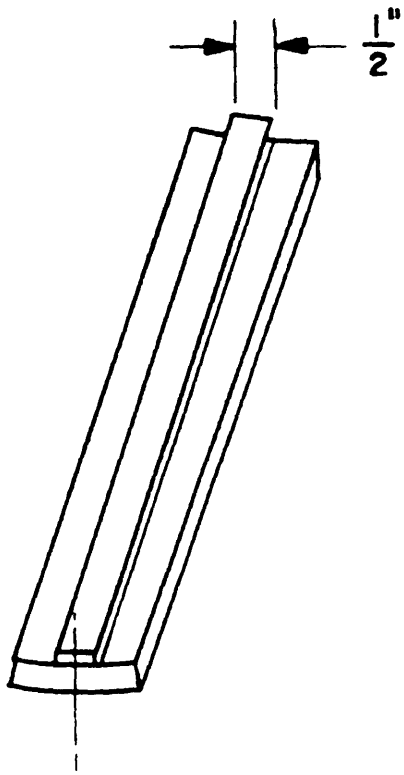
SH 12151

FIGURE 1. Test specimen for adhesion testing class I and class III stave bearing.



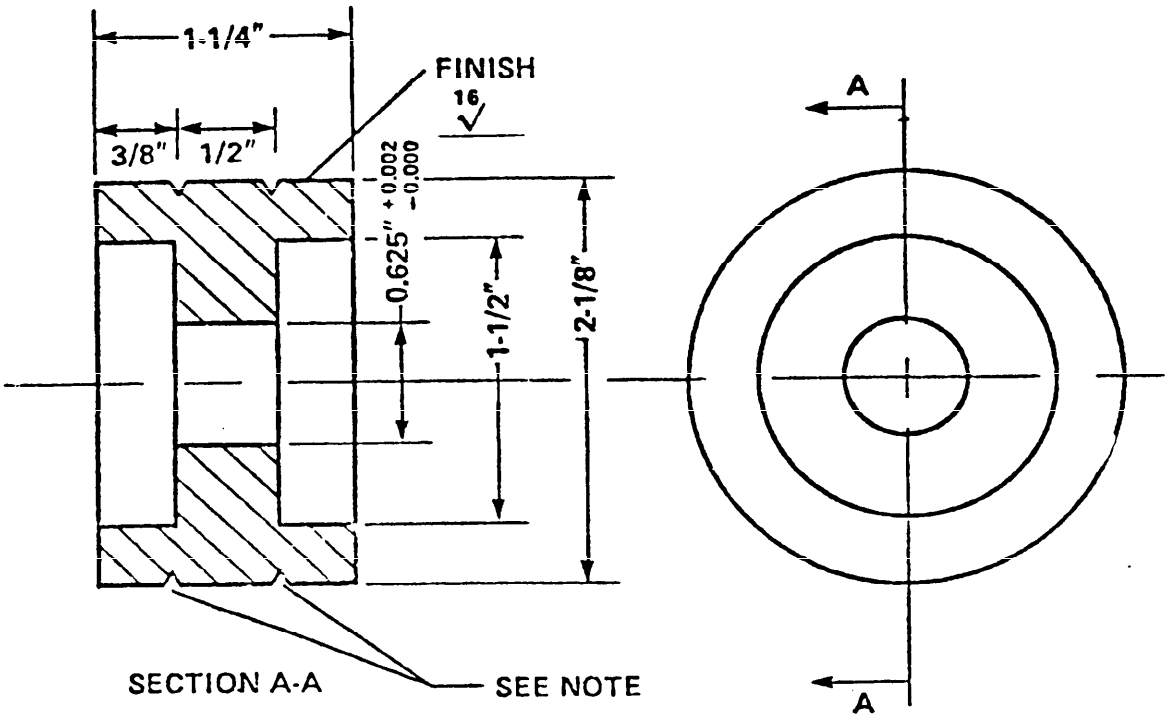
SH 12152

FIGURE 2. End view of class II cylindrical bearing showing location of saw cuts.



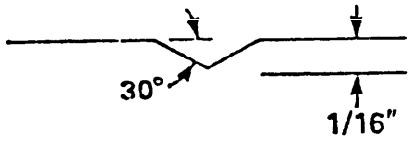
SH 12153

FIGURE 3. Test specimen for adhesion testing class II cylindrical bearing.



MATERIAL—70-30 Cu-Ni

NOTE: TWO CIRCUMFERENTIAL GROOVES 1/16" DEEP
30° ∠ AS SHOWN



SH 12324

FIGURE 4. Journal for measuring wear.

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE NAVY

COMMANDER
NAVAL SEA SYSTEMS COMMAND (SEA 55Z3)
DEPARTMENT OF THE NAVY
WASHINGTON, DC 20362

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 12503 WASHINGTON D C

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE NAVY

COMMANDER
NAVAL SEA SYSTEMS COMMAND (SEA 55Z3)
DEPARTMENT OF THE NAVY
WASHINGTON, DC 20362

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-B-17901B(SH)	

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____
b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.