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MILITARY SPECIFICATION

BEARINGS, PLAIN, (SELF-ALIGNING, SLEEVE AND THRUST) SELF-LUBRICATING, HIGH SPEED OSCILLATION GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the requirements for sliding spherical, sleeve, and thrust self-lubricating bearings which are for use in the ambient temperature range -65°F to +160°F at high cyclic speeds.

1.2 Classification.

1.2.1 Types. Bearings covered by this specification shall be of the following types:

Type I - Bearings with liners of a fabric or composite or molded polytetrafluoroethylene (PTFE) material.

Class 1 - Self-aligning
Class 2 - Sleeve
Class 3 - Thrust

Type II - Bearings with machined liners of self-lubricating solids mechanically retained in the race.

Class 1 - Self-aligning
Class 2 - Sleeve
Class 3 - Thrust

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Air Engineering Center, Systems Engineering and Standardization Department (Code 5311), Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 3120

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

QQ-P-416	Plating, Cadmium (Electrodeposited)

MILITARY

MIL-P-116	Preservation, Methods of
MIL-B-197	Bearings, Anti-Friction, Associated Parts and Sub-Assemblies, Packaging of
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine Synthetic Base
MIL-A-8243	Anti-Icing and Deicing-Defrosting Fluid
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft
MIL-B-81819/1	Bearing, Plain, Sliding, Spherical, Self-Lubricating, Self-Aligning, High Speed Oscillation

STANDARDS

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage

(Copies of specifications, standards, handbooks, drawings, publications and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules

(Application for copies of the above publication should be addressed to the Uniform Classification Committee, 202 Chicago Union Station, Chicago, IL 60606.)

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI B46.1	Surface Texture (Surface Roughness, Waviness and Lay)

(Copies of the above publication may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING MATERIALS

F-25	Method for Sizing and Counting Airborne Particulate Contamination in Clean Rooms and Other Dust Controlled Areas Designed for Electronic and Similar Applications
F-50	Practice for Continuous Sizing and Counting of Airborne Particles in Dust Controlled Areas Using Instruments Based Upon Light Scattering Principles
C-794	Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants

(Copies of the above publications may be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103, telephone (215) 299-5400.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which 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 specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification. Bearings furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List at the time set for opening of bids (see 4.3.1 and 6.3).

3.2.1 Retention of qualification. To maintain status on a Qualified Products List (QPL), certification shall be submitted at two year intervals to indicate continued compliance with the requirements of this specification (see 6.3).

3.2.2 Requirements for qualification approval. Qualification approval of a production bearing is based on the satisfactory performance of a test bearing to the requirements of this specification. Four test conditions have been established for evaluation of liner systems used in these bearings. The test conditions and the associated test bearing dimensions are specified on MIL-B-81819/1. A test configuration which meets the qualification approval criteria of Table I shall secure qualification approval for all production bearings having that test condition number listed on the specification sheet or drawing.

Prior to initiating the liner system evaluation tests, the manufacturer shall notify the qualifying agency (Naval Air Development Center) of the intention to submit for qualification approval. The letter of notification shall state the proposed date of initiation of the tests, the liner system identification (see 3.6), and the test condition number for which qualification approval is desired. Upon completion of the test program, the test data shall be reported in accordance with 3.2.3. (Note: Data generated during the development phase of the liner system is not acceptable.) The report shall be submitted to the Naval Air Development Center (Code 6061), Warminster, PA 18974-5000, along with the test verification samples required in Table I. The test data shall be analyzed in accordance with the methodology described in 4.8 and shall meet the qualification approval criteria listed in Table I and 3.17.4.5. Additional qualification submittal information is located in 3.17, 4.3 and 6.3.

3.2.3 Requirements for recording performance data. The data recorded for 3.12, 3.13, 3.15 and 3.16 and the performance data for 3.17 shall be summarized in report form. To ensure statistical accuracy of test data, the bearing suppliers (or the testing laboratory) shall certify that the data presented is the performance data for all bearings tested and that no data has been deleted. Any test malfunction resulting in an invalid test shall be noted in the report. A dated drawing completely describing the bearing(s), the dimensions, heat treatment, surface finish and liner system identification shall be included. The manufacturer's liner material identification, whether by trade name or numerical designation, shall be unique to that liner material and its processing.

TABLE I. Constant load dynamic test qualification approval criteria.

Test Condition Number		1	2	3	4
Maximum Allowable Average Wear Rate (WR) (10^{-6} inches/hours)		10.00	6.00	10.00	8.00
Minimum B_{10} Life	Hours	250 hours	400 hours	250 hours	250 hours
	Rated Wear	.005-inch	.005-inch	.005-inch	.005-inch
Verification Test Samples		6	10	10	10

3.3 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.4 and 6.4).

3.4 Product manufacture. Except for the bonding and swaging operations, the manufacturer is permitted to subcontract manufacturing operations without violating the requirements of 3.2.1. The bonding and swaging operations shall be performed in the plant listed on the Qualified Products List. Manufacture of the self-lubricating liner material may also be subcontracted. Any change in (1) the liner manufacturer, (2) the liner manufacturing procedures, or (3) the materials used in manufacture of the liner will require requalification to an extent determined by the qualifying activity.

3.4.1 Product change. Unless written approval is given by the Naval Air Development Center (Code 6061), any change in product design, materials, source of materials used in self-lubricating liner, liner manufacturer, or bonding related operations shall require resubmittal of bearings to qualification inspection and/or first article inspection.

3.5 Materials. Materials shall be as specified on the applicable specification sheet or drawing.

3.5.1 Plating and coating. Unless otherwise specified on the applicable specification sheet or drawing, plating or coating of the mating surface for the liner system shall be an option of the manufacturer. When specified on the applicable specification sheet or drawing, plating of the outer diameter of the outer ring shall be in accordance with QQ-P-416, Type II, Class 2.

3.5.2 Usable liner thickness. The liner used in these bearings shall have a minimum thickness of 0.015-inch.

3.6 Liner system identification. The liner material and any bonding and curing processes shall be established by the manufacturer and maintained by his in-house manufacturing and quality control documents. The manufacturer's liner system identification, whether by trade name or numerical designation, shall identify the liner material and the associated bonding and curing process requirements. In addition to the trade name or numerical designation, the manufacturer shall specify in his test report (see 3.2.3) the classification type and class (see 1.2), and for Type I bearings the minimum and maximum liner thickness in a finished bearing.

3.7 Design. Bearing design shall conform to the dimensional requirements of the applicable specification sheet or drawing. All other design features shall be optional.

3.8 Construction. Bearing construction shall conform to the requirements of the applicable specification sheet or drawing. Details of the parts shall be optional. Spherical bearings shall not have loading slots.

3.9 Dimensions and tolerances. Dimensions and tolerances shall be as specified on the applicable specification sheet or drawing. Dimensions not shown on the applicable specification sheet or drawing or specified herein shall be an option of the manufacturer.

3.10 Surface texture. The specified surface textures shall be in accordance with ANSI B46.1. The mating surface for the liner system shall have a roughness height rating of R_a 5 maximum. This rating also applies to pins and shafts operating in sleeve bearings and to any mating surfaces operating against thrust bearings. These shafts, pins and mating surfaces may be supplied by the bearing user. The inner bore, all faces and outer ring periphery shall have a surface texture of R_a 32 maximum. All other surfaces shall have a texture of R_a 125 maximum. The mating surface for the liner system shall be honed, polished or similarly finished subsequent to grinding.

3.11 Lubrication. The self-lubricating bearings covered by this specification shall operate without subsequent relubrication. Dry film lubrication is acceptable during manufacture if part of the normal manufacturing process. Grease and oil lubrication are not permitted. Relubrication shall not be permitted during qualification testing.

3.12 Conformity (Type I and II, Class 1 bearings only). The spherical surface of the ball shall be in proper contact (conformity) with its mating surface (see 3.12.1 and 3.12.2).

3.12.1 Conformity measurement (Type I, Class 1). For spherical bearings with fabric or fabric composite liners, the conformity of the liner and outer rings shall be measured normally. For bearings with molded liners, the conformity of the liner and the outer rings shall be measured both normally and circumferentially.

3.12.1.1 Normal conformity of fabric or fabric composite spherical bearings. When inspected in accordance with 4.7.8.1, the values of "t measured" shall be within the appropriate range specified in Table II and

within the minimum and maximum values shown on the specification sheet or drawing. Measurements shall be taken at a minimum of five uniformly spaced positions across the width of the bearing. When radial looseness is specified, the process used to generate looseness shall not distort the ball-to-outer ring contour beyond the conformity limits specified in Table II. When overforming of the outer ring is observed during inspection in accordance with 4.7.8.1, two additional measurements shall be taken in the outer ten percent of the outer ring width (one measurement on each side). These additional values shall not vary from the center value by more than 0.001-inch. Underforming is not controlled. These values apply to bearings whose outer ring width (H) to ball diameter (d) ratio is in the range of 0.44 to 0.62. Values for allowable conformity measurements for other H/d ratios shall be specified on the applicable specification sheet or drawing.

TABLE II. Allowable variations.

Ball Diameter (d) (inches)	Allowable Variation of Conformity Measurements (Type I, Class 1 Bearings)
	Swaged Bearings
0 → 2	$t_{min} \leq$ t measured $\leq$ (t min + .0030 inch)
2+ → 3	$t_{min} \leq$ t measured $\leq$ (t min + .0035 inch)
3+ → 4	$t_{min} \leq$ t measured $\leq$ (t min + .0040 inch)
4+ → 10	$t_{min} \leq$ t measured $\leq$ (t min + .0050 inch)
	Non-Swaged Bearings
0 → 10	$t_{min} \leq$ t measured $\leq$ (t min + .0030 inch)

3.12.1.2 Normal conformity of molded liner spherical bearings. Normal conformity of spherical bearings with molded liners shall be measured in accordance with 4.7.8.1. The precise shape of the cavity containing the liner material is not defined. However, the cavity shall not exhibit sharp angular changes in curvature across the width of the bearing. Dimension "t" shall be measured initially at the midpoint and H/10 positions (see figure 4b). The allowable values at the H/10 positions shall be 0.017 ±.002-inch for all sizes. The maximum liner thickness shall occur at the midpoint. The allowable values of "t" at the midpoint shall be equal to, or greater than, the H/10 values but not greater than 0.022-inch. In addition to the three initial measurements, the outer ten percent of the outer ring width shall be checked for overforming and the measured values of "t" in these regions shall not be less than 0.015-inch.

3.12.1.3 Circumferential conformity. In molded liner bearings, the circumferential conformity shall be measured in accordance with 4.7.8.1.1. Variation in the values of "Δ" shall be not greater than 0.003-inch.

3.12.2 Conformity measurement (Type II, Class 1). When inspected in accordance with 4.7.8.2, the variation between measured values shall be not greater than 0.0030-inch. Unless otherwise specified on the applicable specification sheet or drawing, the liner surface shall have a radius of curvature

greater than that of the ball. The liner surface shall be machined and installed so that contact between the liner material and the ball occurs in the sector of the liner between positions 1 and 3 (see figure 5).

3.13 Liner integrity. The material(s) used in the liner shall be free of defects or foreign matter which decrease the serviceability of the bearing.

3.13.1 PTFE liner condition and bond integrity (Type I bearings).

3.13.1.1 Visual examination. The visual appearance of the bonded liner shall exhibit a degree of workmanship consistent with proper manufacturing process controls, as checked per 4.7.9.1.1 The liner shall be uniform in texture and shall contain no imbedded contaminants. The liner set-back shall meet the applicable drawing requirements. There shall be no separation or lifting of the liner at any of the edges. There shall be no unraveling or excessive fraying of the liner at any of the edges. Molded liners shall completely fill the cavity between the ball and outer ring and shall not contain embedded contaminants, cracks or bubbles.

3.13.1.2 Bond integrity and peel strength. When tested in accordance with 4.7.9.1.2, the liner shall be tightly adherent to the metallic substrate over at least 90 percent of the contact area and shall exhibit an average peel strength of 2.0 pounds per inch or greater. The adhesive remaining on the metal substrate shall have no void or unbonded area which cannot be included within a circumscribing circle with a diameter equal to 25 percent of the outer ring width or 0.25-inch, whichever is smaller.

3.13.1.2.1 Processing controls. All fabrication of the PTFE liner involving application or mixing of adhesive, and all liner bonding procedures involving application of adhesive, shall be conducted in a controlled area.

3.13.1.2.2 Controlled area. The controlled area shall be maintained at a temperature of 75° ± 10°F with a maximum relative humidity of 75 percent. The enclosed atmosphere of the work area shall be well ventilated and maintained so that a maximum count of 2500 is allowed for particles 5.0 microns or larger when measured per ASTM F-25 or ASTM F-50. The particle count measurement shall be performed annually (minimum). There shall be no eating or smoking in the controlled area and no process which produces uncontrolled spray, dust, fumes or particulate matter.

3.13.1.3 Liner peelability. Each manufacturer shall establish during qualification testing whether the liner is peelable or non-peelable. If peelable, the manufacturer shall determine the mean and standard deviation peel strength values for the liner based upon a minimum of six peel strength tests conducted in accordance with 4.7.9.1.2. This data shall be recorded in the qualification test report. A liner originally qualified as peelable shall remain peelable in production. A liner originally qualified as non-peelable shall remain non-peelable in production.

3.13.2 Type II bearing liner inspection. The bearing outer ring shall be inspected for fractured liner elements (see 4.7.9.2). There shall be no fractures through the liner elements. Small chips on the edges of an element are acceptable provided they do not exceed 0.050-inch depth, 0.030-inch width, 0.050-inch length, and do not have a cumulative length exceeding 0.200-inch on any side.

3.14 Alignment (Class 1 bearings). Spherical bearings shall be self-aligning. Angular misalignment shall be as specified on the applicable specification sheet or drawing.

3.15 No-load rotational breakaway torque. Bearings designed with no clearance between mating surfaces shall have a no-load breakaway torque specified on the applicable specification sheet or drawing (see 4.7.4).

3.16 Internal clearance. Bearings designed with clearance (internal play) between mating surfaces shall have the allowable clearance specified on the applicable specification sheet or drawing (see 4.7.4.1).

3.17 Performance. The performance requirements of this specification are intended for qualification testing purposes and are applicable only to the test bearings listed in MIL-B-81819/1. The test bearings are intended to provide a means of evaluating and qualifying a liner system to be used in production bearings. The various test conditions and test bearing configurations in MIL-B-81819/1 were chosen to represent typical size and motion regimes associated with main rotor and tail rotor components of helicopters but are not presumed to describe actual operational conditions which production bearings will experience in the aircraft.

The test condition number appropriate to the production bearing shall be specified on the applicable specification sheet or drawing. The bearing manufacturer shall select which test condition number(s) suits the manufacturer's liner system. The bearing manufacturer may seek qualification approval to one or more test condition numbers. The bearing manufacturer shall fabricate test bearings to the dimensions shown in MIL-B-81819/1 for each test condition for which qualification approval is sought. The test bearings shall be produced in accordance with the manufacturer's in-house manufacturing and quality control requirements and with the liner system identified in accordance with 3.6.

The bearing manufacturer shall subject the test bearings to the qualification inspections specified in Table III and report the results in accordance with 3.2.3. The dynamic and static test loads are given in MIL-B-81819/1. These tests are not required for sleeve and thrust bearings using the same liner system if the tests have been successfully completed on the spherical bearings.

3.17.1 Radial static limit load. The radial static limit load test shall be performed at the load specified in MIL-B-81819/1 (see 4.7.1). A load deflection curve shall be prepared and permanent set shall be recorded at the completion of the test. The permanent set shall be not greater than .006-inch.

TABLE III. Qualification inspections.

Test	Requirement Paragraph	Test Method Paragraph	Samples To Be Tested
Static Tests			
Radial Test	3.17.1, 3.17.3	4.7.1	3
Axial Test	3.17.2, 3.17.3	4.7.2	3
Dynamic Tests			
Water Contaminant Test	3.17.4, 3.17.4.1	4.7.3	3
Fluid Compatibility*	3.17.4, 3.17.4.2	4.7.5	7
Temperature Extremes*	3.17.4, 3.17.4.3	4.7.6	3
Solid Contaminant	3.17.4, 3.17.4.4	4.7.7	3
Cyclic Load	3.17.4, 3.17.4.5	4.7.3.1	12
Conformity	3.12	4.7.8	2
Liner Integrity	3.13	4.7.9	5
No-Load Rotational	3.15	4.7.4	5
Internal Clearance	3.16	4.7.4.1	5

*A bearing liner material/ball surface combination that has been tested in one size need not be retested in additional sizes.

3.17.2 Axial static limit load. The axial static limit load test shall be performed at the load specified in MIL-B-81819/1 (see 4.7.2). A load deflection curve shall be prepared and permanent set shall be recorded at the completion of the test. The permanent set shall be not greater than .006-inch.

3.17.3 Static ultimate load. There shall be no fracture of any component or push-out of the ball when subjected to the radial static test (see 4.7.1) and the axial static test (see 4.7.2). These loads are 1.5 times the radial and axial static limit loads specified in 3.17.1 or 3.17.2. If the static ultimate loads exceed the capability of a candidate liner, the bearing supplier shall establish the static ultimate loads and furnish a load deflection curve for loads up to that radial and axial static ultimate load. The radial and axial static ultimate load and the permanent set shall be recorded upon completion of the test.

3.17.4 Requirements for dynamic test. The samples specified in Table III shall meet the requirements of 3.17.4.1 through 3.17.4.5. Test data shall be analyzed in accordance with the methodology described in 4.8 and shall meet the qualification approval criteria listed in Table I. Data indicating the progress of the test shall be recorded at sufficient intervals to produce an accurate plot of wear and bearing housing temperature versus hours. If fan cooling is utilized to maintain the bearing housing temperature at a lower operating level, then the volume of cooling shall be similarly recorded indicating the cubic feet per minute (CFM) of air cooling the bearing. Before and after testing, the static breakaway torque of the bearing under load shall be measured and recorded. After the test, the bearing liner shall be inspected and the observations recorded.

3.17.4.1 Water contaminant requirement. Sample bearings shall be tested in accordance with 4.7.3. Testing on one bearing shall be continued until one of the following occurs: (1) 0.0200-inch wear; (2) three times the duration requirements of MIL-B-81819/1 have been reached; (3) metal-to-metal contact.

3.17.4.2 Fluid compatibility requirement. Sample bearings shall be tested in accordance with 4.7.5. The bearings shall be compatible with the fluids listed. No corrosion of the bearings shall result. (Superficial tarnish that can be removed with a damp cloth shall not be cause for rejection.) A bearing liner material and ball surface combination that has been tested in one size need not be retested in additional sizes.

3.17.4.3 Temperature extremes requirement. Sample bearings shall be tested in accordance with 4.7.6. A bearing liner material and ball surface combination that has been tested in one size need not be retested in additional sizes.

3.17.4.4 Solid contaminant (dust) requirement. Sample bearings shall be tested in accordance with 4.7.7. Procurement information for test dust is as follows:

NOMENCLATURE	"Air Cleaner Test Dust - Fine"
PART NUMBER:	1543094
ADDRESS:	AC Spark Plug Division P. O. Box 1001 Flint, MI 48501

3.17.4.5 Cyclic load oscillation wear test. Twelve M81819/1-2 bearings shall be tested in accordance with 4.7.3.1 and MIL-B-81819/1. Six bearings shall be tested at 300 CPM, ± 10° oscillation, ± 2300 pounds cyclic load for 600 hours. The other six bearings shall be tested at 300 CPM, ± 10° oscillation, 2300 ± 2300 pounds cyclic load for 600 hours. Synchronization of the load with the ball oscillation shall be such that the maximum load and maximum ball surface speed occur at the same time. For qualification approval purposes, all bearings shall operate for a minimum of 600 hours without metal-to-metal contact. Satisfactory performance of the M81819/1-2 bearings in these cyclic load tests is adequate evidence that sizes -1, -3 and -4 bearings will meet the requirements of the cyclic load tests.

3.18 Test records. During normal production, the bearing manufacturer shall maintain a record showing quantitative results of all inspections and tests for five years. This record shall be available to the procuring activity and shall be signed by an authorized representative of the manufacturer or the testing laboratory. Test samples shall be retained for not less than five years.

3.19 Identification of product. Each bearing shall be permanently and legibly marked with the part number given on the applicable specification sheet or drawing, the bearing manufacturer's name or trademark, and part number of the bearing. Identification shall appear in the location specified on the applicable specification sheet or drawing. Metal impression stamping is prohibited.

3.20 Workmanship.

3.20.1 General requirements. All workmanship shall be such as to result in a first quality bearing which meets the requirements of this specification. The bearing shall be free from defects which may affect its durability and serviceability.

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 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 Responsibility for compliance. All items must 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 assuring that all products or supplies submitted to the government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

1. Qualification inspection (4.3).

2. First article inspection (4.4).

3. Quality conformance inspection (4.5).

4.3 Qualification inspection. Qualification inspection shall consist of the inspections in Table III under one or more of the test conditions of MIL-B-81819/1 (see 3.2, 3.2.2 and 6.3).

4.3.1 Retention of qualification. The continued listing of a product on the Qualified Products List is dependent upon a periodic verification of the manufacturer's continued compliance with the requirements of this specification and with standardization regulations. As part of that verification process, each manufacturer must complete DD Form 1718 during October of each odd numbered year. This form, supplied by the qualifying activity, is to be signed by a responsible official of management and sent to the Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD) (Code 9311), Lakehurst, NJ 08733-5100.

4.4 First article inspection. The first article inspection shall consist of the inspections listed in Table IV. The requirements of Table IV may be satisfied only by actual data from tests on the first lot of bearings produced (see 3.3). Five bearings shall be selected from this lot and subjected to the tests in Table IV in the order in which they are listed. Unless otherwise specified, the first article inspection report format shall be in accordance with Table VIII.

TABLE IV. First article inspections.

Test	Requirement Paragraph	Test Method Paragraph	Samples to be Tested
No-Load Rotational Breakaway Torque	3.15	4.7.4	10
Internal Clearance	3.16	4.7.4.1	10
Conformity	3.12	4.7.8	10
Liner Integrity	3.13	4.7.9	10

4.5 Quality conformance inspections. The quality conformance tests of the bearings shall consist of the examinations and tests of Table V to determine conformance to the requirements of this specification and the applicable specification sheet or drawing. Unless otherwise specified (see 6.2), inspections shall be conducted in accordance with MIL-STD-105, Inspection Level II, Table II-A. Satisfactory results from first article inspection (see Table IV) may be applied toward satisfying the requirements of quality conformance inspections (see Table V, (f), (g), (h)) for the lot from which the samples were obtained. Unless otherwise specified by the procuring activity, the quality conformance inspection report format shall be in accordance with Table IX.

4.5.1 Inspection lot. The inspection lot shall consist of finished bearings having the same part number. The bearings shall be manufactured using the procedures established for the first article inspection. The bearings shall be swaged or formed on the same tool setup, produced as one continuous run, purchase order or portion thereof, and from one or more liner bonding runs which can be identified by means of in-house processing records.

4.5.2 Sampling.

4.5.2.1 Sample for quality conformance inspection (a) through (d), (i) and (j). The sample bearings shall be selected from each inspection lot in accordance with MIL-STD-105, inspection level II.

4.5.2.2 Sample for quality conformance inspection (g) and (h). The sample bearings shall be selected from each inspection lot in accordance with Table VI. The sample bearings shall be selected at random from the lot of finished bearings. A lot that was rejected under Normal Inspection shall be scrapped.

TABLE V. Quality conformance inspection.

Examinations and Tests	Requirement Paragraph	Test Method Paragraph	AQL
(a) Dimensions	3.9	4.6	4.0
(b) Identification of Product	3.19	4.6	1.0
(c) Workmanship	3.20	4.6	1.0
(d) Packaging		4.9	1.0
(e) Internal Clearance	3.16	4.7.4.1	*
(f) No-Load Rotational Breakaway Torque	3.15	4.7.4	*
(g) Conformity	3.12	4.7.8	**
(h) Liner Integrity	3.13	4.7.9	**
(i) Surface Texture	3.10	4.6	1.0
(j) Alignment	3.14	4.6	4.0

* Acceptance number should be zero. See 4.5.2.3.
** Special inspection plan. See 4.5.2.2.

TABLE VI. Destructive inspection sampling plan.

	Normal Inspection		
Lot Size	Sample Size	A	R
5 - 50	4	0	1
51 - 500	6	0	1
501 - 5000	10	1	2
5001 - 50000	16	1	2

A = Acceptance Number
R = Rejection Number

4.5.2.3 Sample for quality conformance inspection (e) and (f). The inspection lot shall be 100 percent inspected. Defective bearings shall be removed from the inspection lot and reworked or scrapped. If rework entails mechanical adjustments that could change the conformity of the bearing, the reworked bearings shall be reinspected as a new inspection lot.

4.5.3 Quality assurance certification. For each inspection lot the manufacturer shall maintain, for not less than five years, and supply to the purchaser upon demand, certified copies of all records of quality conformance inspections. These records and certifications shall identify the manufacturer of the bearings, the address of the manufacturing plant, the procuring activity and the purchase order number (see 6.2.1e).

4.5.4 Resubmitted inspection lots for quality conformance tests (a) through (d), (i) and (j) (see Table V). The paragraph titled "Resubmitted Lots or Batches" of MIL-STD-105 shall apply. A resubmitted inspection lot shall be inspected using tightened inspection. Where the original acceptance number was zero, a sample size represented by the next higher sample size code

letter shall be selected. When an inspection lot is resubmitted, full particulars concerning the cause of previous rejection and the action taken to correct the defects shall be furnished by the contractor to the procuring activity.

4.6 Examination of product. The bearings shall be examined to determine conformance to the requirements of this specification and the applicable specification sheet or drawing for plating, dimensions, finish, identification of product, workmanship and requirements not covered by tests.

4.7 Test methods. Unless otherwise specified, all tests shall be conducted at room temperature.

4.7.1 Radial static test. The bearings shall be installed in a test fixture as shown on figure 1. Differential temperatures for installation are not allowed. A preload of 4 to 6 percent of the radial static limit load shall be applied to the bearing for 3 minutes (see MIL-B-81819/1), and the measuring device set at zero. Increase the load at a rate of 1 percent per second of the specified load until it equals the radial static limit load. Maintain the load for two minutes. Reduce the load at the same rate to the preload value. The permanent set is the reading at preload. The radial static ultimate load shall be applied at the rate of 1 percent per second of the specified load.

4.7.2 Axial static test. The bearing shall be installed in a test fixture as shown on figure 2. The hole diameter in the support fixture shall be the nominal diameter of the ball plus 0.025-inch. A preload of 4 to 6 percent of the axial static limit load shall be applied to the bearing for 3 minutes (see MIL-B-81819/1). Set the measuring device at zero. Increase the load at the rate of 1 percent per second of the specified load until it equals the axial static limit load. Hold for 2 minutes, then reduce at the same rate to the preload value. The permanent set is the reading at preload. The axial static ultimate load shall be applied at the rate of 1 percent per second of the specified load.

4.7.3 Dynamic test. The bearing shall be installed in a steel housing (see figure 3). A standard close tolerance aircraft bolt or pin (125,000 psi minimum) shall be used as a shaft for the bearing. The clearance between the bearing I.D. and the bolt (or pin) shall not be greater than .0015. The bearing shaft shall be placed in double shear with a minimum of bending and permit rotation of the ball with respect to the outer ring. Prior to and upon completion of the test, the breakaway torque and the static coefficient of friction of the bearing under the test load shall be recorded.

The dynamic load shall be applied so that the shank of the bearing housing is in compression as shown in figure 3. (The shank of the bearing housing may be placed in a horizontal position.) The bearing shall be loaded statically for 15 minutes. After this time, the indicating device shall be set to zero and the test started. As the ball of the bearing is oscillated, the bearing shall be contaminated with distilled water applied at the juncture of the upper side of the ball and outer ring. The water shall be applied once per hour in the amount of 15 ml (1/2 fluid ounce) to 45 ml (1-1/2 fluid ounce) to each side of the bearing. Due to the length of the dynamic tests, it is permissible for

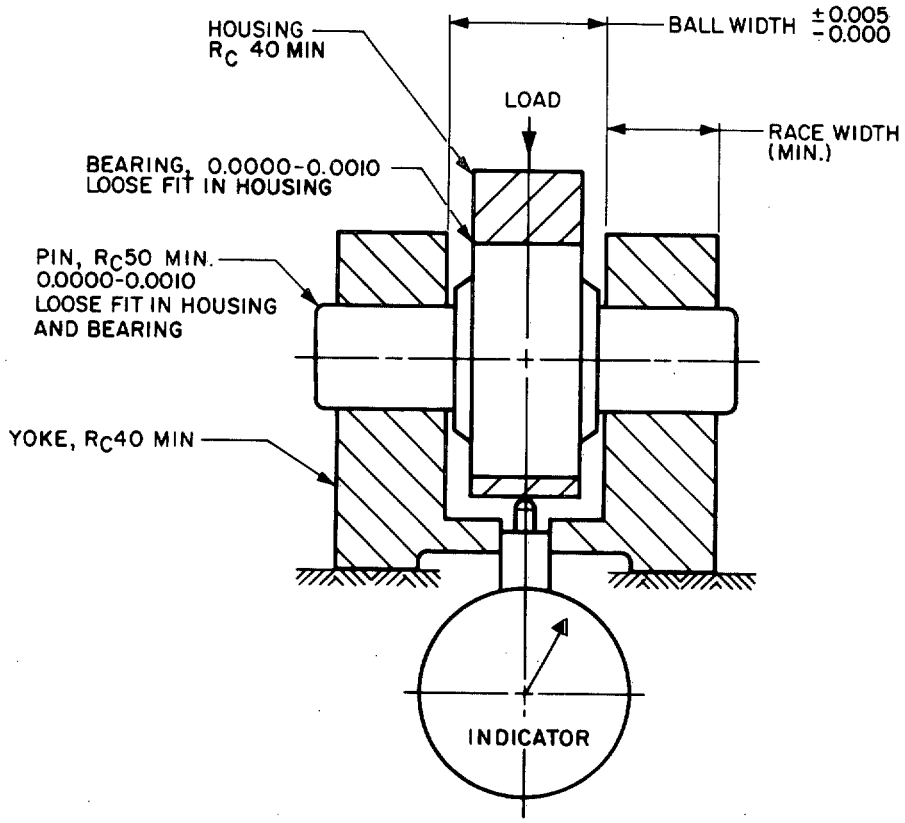


FIGURE 1. Radial static test load test fixture.

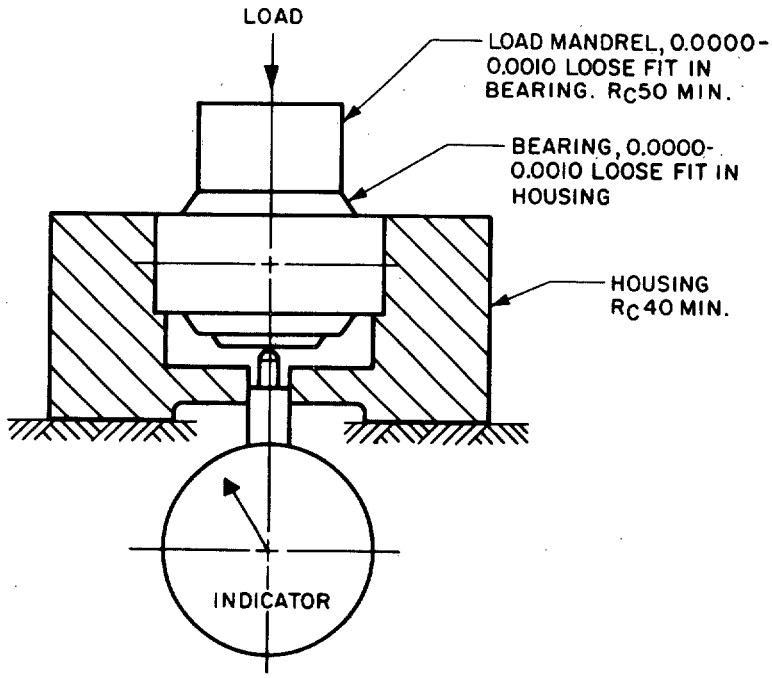
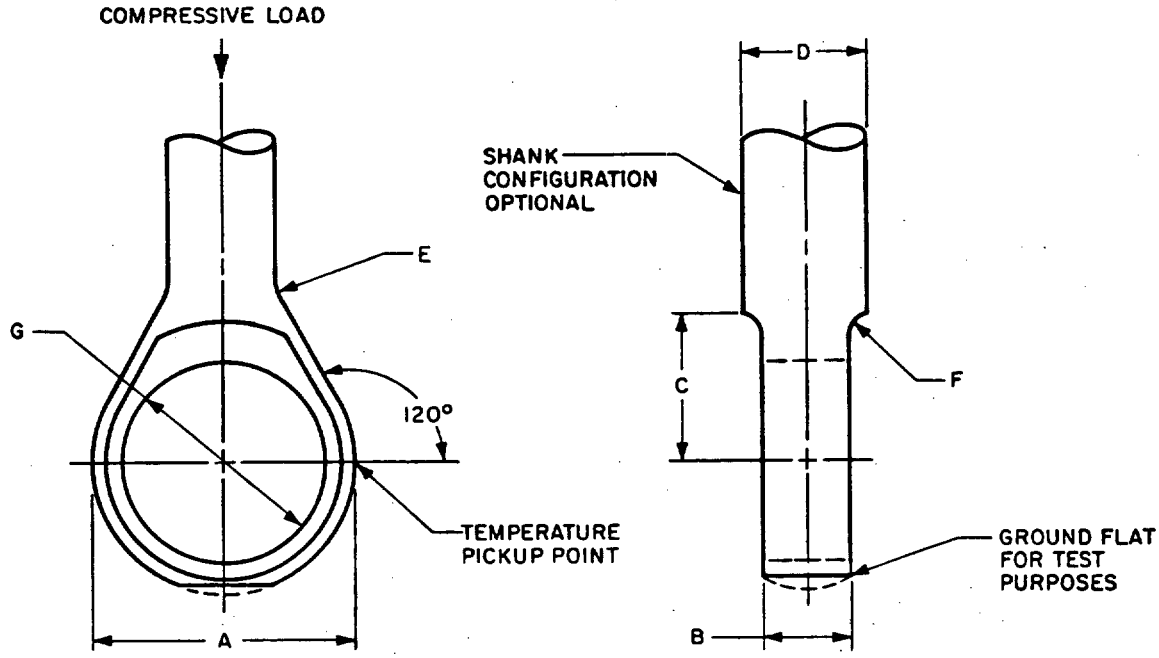


FIGURE 2. Axial static test load test fixture.



Test Conditions	A (Dia) ±.010	B ±.005	C ±.010	D (Dia) ±.010	E (Radius) Min	F (Radius) Min	G (Dia)	Test Bearing O.D.
#1	4.000	1.375	2.250	2.000	2.250	.375	3.2490 3.2480	3.2500 3.2490
#2	2.150	.797	1.125	1.000	1.125	.125	1.7495 1.7490	1.7500 1.7495
#3	1.468	.500	.875	.625	.750	.093	1.1870 1.1865	1.1875 1.1870
#4	1.000	.312	.625	.375	.500	.062	.8123 .8118	.8125 .8120

Material: Steel (CRES Recommended)
Heat Treatment: Optional

FIGURE 3. Bearing housing configurations for dynamic tests.

the test machine to be allowed to run unattended overnight and up to three successive days provided that the water contamination is applied at least six but not more than ten times per calendar day of attended testing for a minimum of thirty and a maximum of sixty times per calendar week.

The wear shall be recorded at time intervals close enough to produce a graph showing wear in thousandths of an inch versus life in hours. There shall be a minimum of one reading per normal work day. The bearing housing temperature shall be measured as shown in figure 3 at intervals close enough to produce a graph of temperature versus hours.

The usable liner thickness shall be established from the recorded data. The usable liner thickness is defined as the smallest of the following three quantities: (1) the minimum allowable liner thickness (see 3.6); (2) the value determined from the graph of wear versus hours where a sudden increase in wear rate is exhibited which results in rapid loss of bearing serviceability; (3) metal-to-metal contact.

4.7.3.1 Cyclic load oscillation wear test. Install M81819/1-2 bearings in the same manner as in 4.7.3 and test according to the requirements shown under "Cyclic Load Oscillation Wear Test Conditions" of MIL-B-81819/1. The load application rate and ball oscillation shall approximate a sinusoidal curve. Water shall be applied as specified in 4.7.3. Wear readings shall be taken once per normal work day with a bearing under a load of 200 pounds. At the completion of the specified test time, the bearing shall be removed and sectioned through the maximum load zone and the amount of liner material remaining shall be measured so that the amount of wear can be calculated.

4.7.4 No-load rotational breakaway torque test. The no-load rotational breakaway torque shall be determined by holding the outer ring/sleeve member of the bearing fixed while rotating the ball/sleeve about the bearing axis. The outer ring/sleeve shall be held in such a manner as to minimize bearing distortion and resultant effect on the bearing preload torque. The use of excessive ball clamping forces to drive the ball/sleeve must also be avoided. The ball/sleeve shall be disaligned in two mutually perpendicular planes and rotated through two to three revolutions immediately prior to testing. This operation is mandatory and may require some simple fixturing. The test shall then be conducted by gradually applying torque to the ball/sleeve; the minimum torque required to start the ball/sleeve moving shall be recorded. The no-load rotational breakaway torque shall be as specified on the applicable military standard.

4.7.4.1 Internal clearance. The radial and axial clearance shall be measured in accordance with 4.7.4.1.1 or 4.7.4.1.2 as applicable. The gage loads shall be as follows:

Inner Member Diameter (inches)	Gage Load (pounds)
0 to 1	10
1+ to 2	20
2+ to 3	30
3+ to 4	40
Over 4	50

4.7.4.1.1 Radial clearance in spherical and sleeve bearings. Radial clearance shall be measured with the load applied to one member (inner or outer) perpendicular to the bore axis alternately in opposite directions. The other member shall be rigidly clamped. Radial clearance shall be the full dial movement less shaft clearance.

4.7.4.1.2 Axial clearance in spherical bearings. Axial clearance shall be measured with the gage load applied to the inner member parallel to the bore axis alternately in opposite directions. The outer member shall be rigidly clamped. The axial clearance is equal to the full dial movement.

4.7.5 Fluid compatibility. Five bearings (one for each fluid) shall be immersed for 24 hours in each of the following fluids at 160° ± 5°F, except for (b) which shall be at 110° ± 5°F. At the beginning of the fluid immersion, the ball shall be misaligned 90° and manually manipulated to cause complete contamination of the liner.

a. MIL-H-83282 hydraulic fluid.

b. MIL-T-5624 turbine fuel, Grades JP-4 or JP-5.

c. MIL-L-7808 lubricating oil.

d. MIL-H-5606 hydraulic oil.

e. MIL-A-8243 anti-icing fluid.

Within one-half hour after removal from the fluid, the bearing shall be tested in accordance with 4.7.3 except that no water contamination will be applied and the test shall be run for 200 hours. Upon completion of the dynamic test, two additional bearings shall be immersed in the fluid which resulted in the greatest wear and the fluid compatibility test repeated. Upon completion of these tests, the bearings shall be examined to determine conformance to 3.13.

4.7.6 Temperature extremes. Three bearings shall be subjected to the test of 4.7.3. Before testing, the bearing and housing shall be placed in an air circulating oven at a temperature at or above +160°F followed by a cold soak at or below -65°F. The bearing and housing shall be held at each temperature for four hours. After soaking at each temperature extreme, the no-load breakaway torque shall be measured and recorded within two minutes of removal from the oven or cold box. Upon completion of the dynamic test, one bearing shall be examined to determine conformance to 3.17.4.3.

4.7.7 Solid contaminant (dust). Three bearings shall be tested in accordance with 4.7.3 except that the test bearings shall be contaminated with a powdery earth or a matter in bits fine enough to be easily suspended in (i.e., Arizona road dust, Red China clay or silica flour) without water contamination. The dust shall be applied once per hour in the amount of one-half gram (minimum) to each side of the bearing. Due to the length of the dynamic tests, it is permissible for the test machine to be allowed to run unattended overnight up to three successive days provided that the dust contamination is applied at least six but not more than ten times per calendar day of attended testing for not less than thirty and not more than sixty times per calendar week.

4.7.8 Conformity test. This test applies only to spherical bearings. Test samples shall be selected in accordance with 4.5.2.2.

4.7.8.1 Normal conformity of Type I, Class 1 bearings. Encapsulate the bearing in plastic material, as used in metallurgical mounts, to prevent motion of the ball with respect to the outer ring. Section the bearing on a diameter and normal to the outer ring side face to produce a surface as in figure 4(a) or 4(b). Grind and polish the face to obtain a true view of the edges of the curved portions of the ball and outer ring. By use of an optical comparator or other suitably accurate technique, measure dimension "t" radially from the ball to the outer ring. The measurements need not be taken closer to the outer ring face than ten percent of "H" (.025-inch minimum) except when overforming of the outer ring has occurred. The normal conformity must meet the applicable requirements of 3.12.1.1 or 3.12.1.2. Conformity in the ten percent of "H" regions (see H/10 in figures 4(a) and (b)) is not controlled by this specification except when overforming of the outer ring has occurred. Overforming of the outer ring is defined as the condition when a side portion of the outer ring is in closer proximity to the ball surface than the center of the outer ring. When overforming is observed, then two additional measurements (one in each H/10 region) shall be taken to determine if the amount of overforming meets the requirements of 3.12.1.1 or 3.12.1.2, as applicable.

Bearings manufactured with radial looseness shall have an appropriate thickness of shim stock inserted between the ball and outer ring to force the ball radially against the outer ring at the point diametrically opposite the shim. The bearing shall then be encapsulated in plastic mounting material, sectioned along the diameter through the ball/ring contact point and inspected as above.

4.7.8.1.1 Circumferential conformity. Bearings with molded liners shall be encapsulated in plastic material as used in metallurgical mounts to prevent motion of the ball with respect to the ring. Section the bearing along the diameter described by the centerline of the outer ring width so as to produce a surface as shown in figure 4(c). Grind and polish the surface to obtain a true view of the exposed liner cross section. By use of an optical comparator or other suitably accurate technique, measure dimension "△" radially from the center of the bore at a minimum of eight uniformly spaced positions. The circumferential conformity shall meet the requirements of 3.12.1.3.

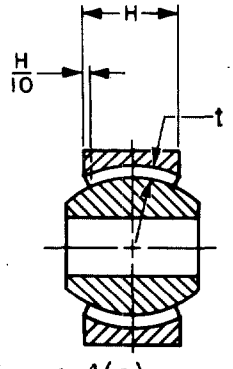


Figure 4(a)
Normal Conformity Bearing
Fabric or Composite Liner

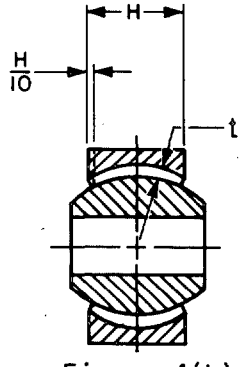


Figure 4(b)
Normal Conformity
Molded Liner

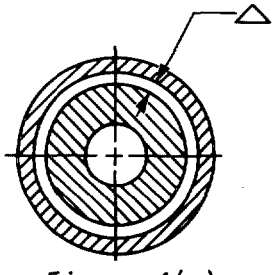


Figure 4(c)
Circumferential
Conformity
Molded Liner

FIGURE 4. Bearing conformity Type I, Class 1.

4.7.8.2 Conformity measurement (Type II bearings, Class 1). Encapsulate the bearing in plastic material so as to prevent motion of the ball with respect to the outer ring. Section the bearing on a diameter and normal to the ring side face so as to produce a dimensionally true surface as in figure 5. Grind the polish face to obtain sharp true edges on the curved portions of the ball and outer ring. By use of an optical comparator or other suitably accurate technique, measure radially the distance from the ball to the liner surface at the positions shown in figure 5. The conformity must meet the requirements of 3.12.2.

Bearings manufactured with radial looseness shall have an appropriate thickness of shim stock inserted between the ball and outer ring to force the ball radially against the outer ring at the point diametrically opposite the shim. The bearing shall then be encapsulated in plastic mounting material, sectioned along the diameter through the ball/ring contact point, and inspected as above.

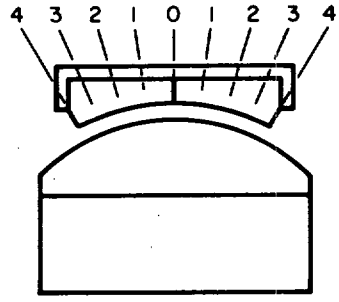


FIGURE 5. Bearing section for conformity test - Type II, Class 1.

4.7.9 Liner material integrity. Test samples shall be selected in accordance with 4.5.2.2. For spherical bearings, the unused half-bearing from the test in 4.7.8.1 or 4.7.8.2 may be broken out of the mount and used to determine material integrity in accordance with 4.7.9.1 or 4.7.9.2, as applicable. At the manufacturer's option, the tests may be performed on a part which has not been encapsulated. In the case where a disagreement exists between the manufacturer and the procuring activity, an unencapsulated bearing shall be used for final resolution.

4.7.9.1 Type I bearings. Prepare the sample(s) for the evaluation of 4.7.9.1.1 and 4.7.9.1.2 by exposing the liner surface to make it accessible for inspection. When cutting spherical or sleeve bearings, care should be taken to avoid damage or contamination of the liner material.

4.7.9.1.1 Liner condition - Type I bearings. Visually examine the exposed liner surface for conformance to the liner condition requirements of 3.13.1 and the applicable specification sheet or drawing.

4.7.9.1.2 Bond integrity and peel strength (Type I bearings). Peel the liner away from the metal substrate and evaluate the peel strength and adhesive bond appearance per 3.13.1.2. A blade or scribe may be used to initiate the peel. To determine peel strength, the liner shall be attached to a calibrated spring scale or tension testing machine of the type described in

ASTM C-794 and the liner peeled back from the substrate at 140° ± 40° angle to the bond surface at a speed of 0.5 to 1.0-inch per minute (see figure 6). The average peel strength value shall be recorded and included in the test report. Where possible, the peel shall be conducted on the entire width of the bonded liner. When the peel is conducted on the entire width of the outer ring, the width for calculating peel strength in pounds per inch shall be the machined width minus 0.050-inch to account for chamfers and edge effects. At the manufacturer's option, or when peeling of the full outer ring width is impractical, the liner may be cut through to the metal substrate to form a peel sample with a minimum width of 0.500-inch. This peel sample may be cut either parallel to or perpendicular to the outer ring side face. This sample shall be peeled as previously described. The peel strength test shall be waived for 0.688-inch outer diameter and smaller bearings, but the liner shall be peeled by hand to permit visual examination of the bond line for voids. Following liner peel, the adhesive bond appearance shall be evaluated to determine the location and size of any voids or unbonded areas as specified in 3.13.1.2. A void is an area where the metal substrate is smooth and shiny with no visible adhesive. An unbonded area is where the adhesive remaining on the metal substrate is smooth and shiny indicating a lack of bonding pressure. In the event the liner cannot be removed without employing chipping, scraping, or abrasive techniques, the liners shall be considered to be properly bonded and free of voids, and shall be classed as nonpeelable.

4.7.9.2 Type II bearings. Prepare the sample(s) by exposing the liner elements so as to make them accessible for inspection. When cutting spherical or sleeve bearings, care should be taken to prevent cracking and chipping of the liner elements during the cutting or removal operation. Inspect the liner elements for conformance to 3.13.2 and the applicable specification sheet or drawing.

4.8 Test data analysis methodology. The following procedure is provided to establish a uniform methodology for analyzing test data generated during testing. The procedure utilizes a Weibull analysis of the test data. It is to be noted that in order for the method to be statistically valid, data from different test condition numbers cannot be mixed.

1. Assemble the test data on chart 1 and list the life (in hours) at the Rated Wear in ranking order from the lowest to highest using linear interpolation if necessary. The life of test bearings which exhibit wear less than the Rated Wear must be extrapolated in accordance with 4.8.1. The data shall include water, dust and temperature extremes tests.

2. Calculate the record the natural logarithm of hours to Rated Wear for each test. These become the X_1, X_2, ...X_n values.

3. Using Table VII, record the Y_1, Y_2,.....Y_n values from the column which corresponds to the number of data points being analyzed.

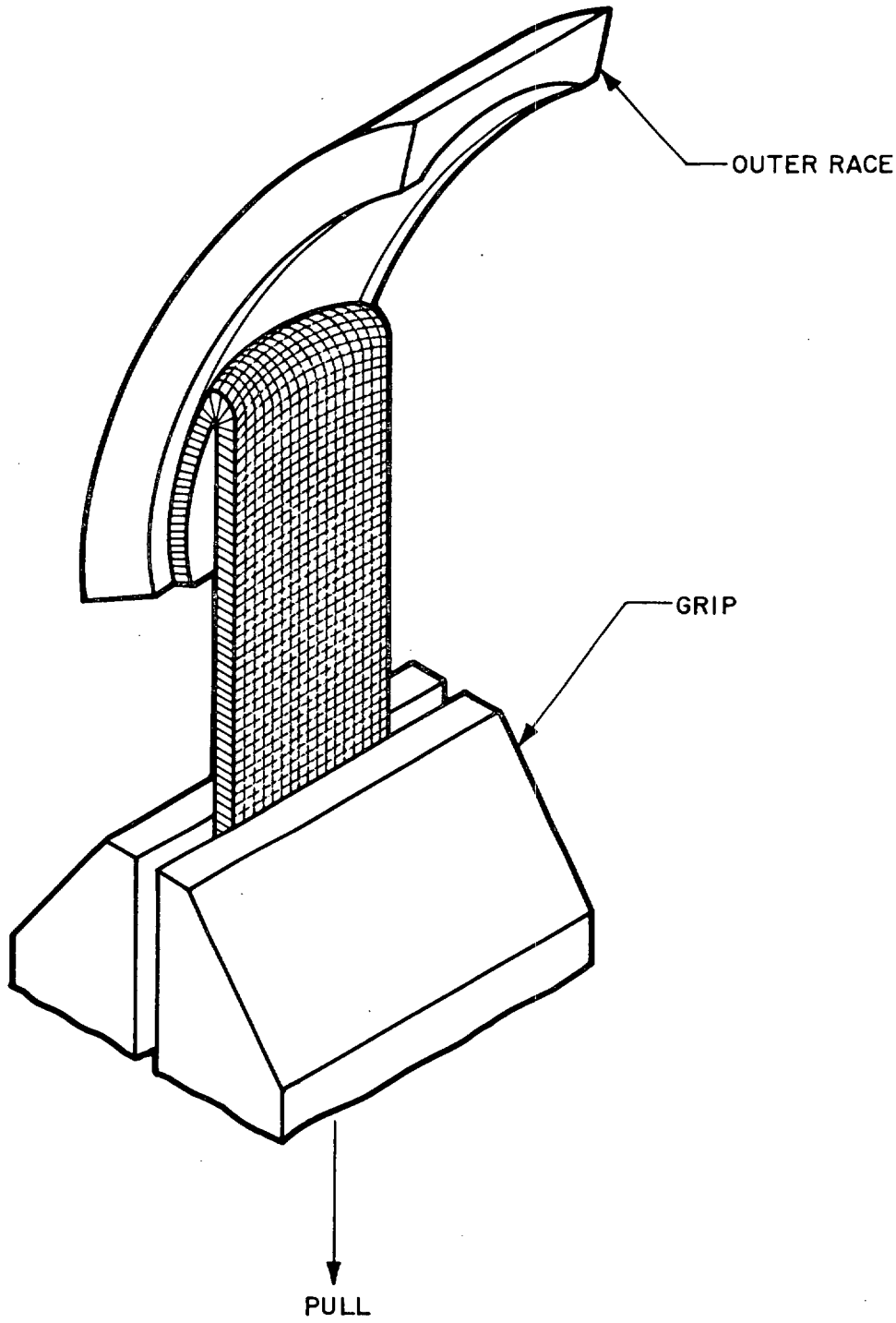


FIGURE 6. Example of peel test fixture.

4. Perform linear regression of the test data using equations (1) and (2).

Equation (1)
$$\beta = \frac{\Sigma x_i y_i - \frac{\Sigma x_i \Sigma y_i}{N}}{\Sigma (x_i)^2 - \frac{(\Sigma x_i)^2}{N}}$$

Equation (2)
$$a = \frac{\Sigma y_i - \beta \Sigma x_i}{N}$$

The values β and a are the slope and Y-intercept of the latest squares linear regression line described by the equation $Y = \beta X + a$. The equations above are provided so that linear regression analysis of a set of data may be performed; however, these calculations may be performed more quickly and easily on programmable calculators, and some models have linear regression analysis preprogrammed into the machine.

5. Calculate the "Characteristic life" (θ) value using equation (3).

Equation (3) $\theta = e^{-\frac{a}{\beta}}$

6. Calculate B_{10} and B_{50} life values using equations (4) and (5).

Equation (4) $B_{10} = \theta \left[(.1054)^{1/\beta} \right]$

Equation (5) $B_{50} = \theta \left[(.6931)^{1/\beta} \right]$

7. Calculate the average wear rate ($\overline{WR}$) using equation (6) and the data from the water and dust tests (and temperature extremes test when available).

Equation (6) $\overline{WR} = \frac{\Sigma W_j}{\Sigma \text{ test hours}}$

4.8.1 Extrapolation of test data from tests suspended before bearing failure. Wear testing of bearings under conditions specified herein frequently results in data showing low wear. Bearings which exhibit wear which is less than Rated Wear criteria must have the data extrapolated in order to determine "Hours to Rated Wear" value. The method for extrapolating such data is shown below.

1. Calculate the wear rates for the water test, dust test and temperature extremes test.

Equation (7) $WR_{water} = \frac{\Sigma W_j \text{ water}}{\Sigma \text{water test hours}}$

Equation (8) $WR_{dust} = \frac{\Sigma W_j \text{ dust}}{\Sigma \text{dust test hours}}$

Equation (9) $WR_{T.E.} = \frac{\Sigma W_j \text{ T.E.}}{\Sigma \text{temperature extremes}}$

2. Using Equation (10) and the appropriate wear rate value determined above, calculate the "Hours to Rated Wear" for each test which did not exhibit wear equal to the Rated Wear criteria.

Equation (10) $\text{Hours to Rated Wear} = \frac{(\text{Rated Wear} - W_i)}{WR} + (\text{test hours completed})$

CHART I. Test data.

Rank	1	2	3	4	5	6	7	8	9	10
Hours to Rated Wear										
X_i										
Y_i										
Test Lab ID No.										

Rank	11	12	13	14	15	16	17	18	19	20
Hours to Rated Wear										
X_i										
Y_i										
Test Lab ID No.										

*NOTE: Since the temperature extremes test is required for only one test condition number, that test data shall be included only when it is available for the test condition being analyzed. Data from different test condition numbers shall not be mixed.

TABLE VII. Values of Y_i or Weibull analysis.

	Sample size									
	1	2	3	4	5	6	7	8	9	10
Y_1	-.3665	-1.059	-1.465	-1.753	-1.976	-2.158	-2.312	-2.446	-2.564	-2.669
Y_2		.2053	-.3665	-.7166	-.9731	-1.176	-1.344	-1.488	-1.614	-1.725
Y_3			.4564	-.05037	-.3665	-.6018	-.7901	-.9478	-1.083	-1.203
Y_4				.6087	.1451	-.1471	-.3665	-.5438	-.6930	-.8219
Y_5					.7153	.2823	.008371	-.1984	-.3665	-.5087
Y_6						.7950	.3865	.1270	-.0697	-.2303
Y_7							.8952	.4694	.2215	.03311
Y_8								.9118	.5374	.2996
Y_9									.9564	.5949
Y_{10}										.9944

	Sample size (continued)									
	11	12	13	14	15	16	17	18	19	20
Y_1	-2.764	-2.852	-2.932	-3.006	-3.074	-3.139	-3.199	-3.256	-3.312	-3.361
Y_2	-1.825	-1.917	-1.200	-2.076	-2.149	-2.215	-2.277	-2.336	-2.392	-2.445
Y_3	-1.309	-1.405	-1.493	-1.573	-1.648	-1.717	-1.781	-1.843	-1.899	-1.953
Y_4	-.9361	-1.038	-1.130	-1.215	-1.293	-1.365	-1.432	-1.495	-1.554	-1.610
Y_5	-.6324	-.7418	-.8400	-.9289	-1.011	-1.086	-1.156	-1.222	-1.283	-1.341
Y_6	-.3665	-.4854	-.5908	-.6855	-.7721	-.8511	-.9244	-.9926	-1.056	-1.116
Y_7	-.1208	-.2518	-.3665	-.4683	-.5605	-.6442	-.7213	-.7925	-.8590	-.9214
Y_8	.1185	-.02995	-.1567	-.2678	-.3665	-.4558	-.5373	-.6125	-.6822	-.7468
Y_9	.3656	.1906	.04699	-.07597	-.1834	-.2796	-.3665	-.4460	-.5193	-.5873
Y_{10}	.6442	.4224	.2526	.1133	-.00576	-.1106	-.2042	-.2889	-.3665	-.4380
Y_{11}	1.028	.6878	.4719	.3071	.1715	.05543	-.04656	-.1377	-.2206	-.2965
Y_{12}		1.058	.7560	.5158	.3554	.2232	.1100	.01027	-.07869	-.1597
Y_{13}			1.085	.7602	.5553	.3987	.2695	.1588	.06142	-.02588
Y_{14}				1.109	.7913	.5908	.4375	.3114	.2031	.1078
Y_{15}					1.130	.8194	.6229	.4731	.3495	.2433
Y_{16}						1.151	.8450	.6527	.5057	.3845
Y_{17}							1.169	.8687	.6797	.5354
Y_{18}								1.186	.8909	.7048
Y_{19}									1.203	.9914
Y_{20}										1.217

The above values were calculated using the equation $Y = \text{in in } (\frac{1}{1-MR})$ where MR = median rank.

Median rank values were taken from L. G. Johnson, "The Statistical Treatment of Fatigue Experiments," Elsevier Publishing Company, New York, 1964.

4.9 Inspection of packaging. The sampling and inspection of the packing and container marking shall be in accordance with Section 5.

5. PACKAGING

5.1 Preservation. Packaging shall be in accordance with MIL-B-197, Level A or Level C as specified in 6.2.1. For Army purposes, Level A shall be used. These bearings will not tolerate cleaning solvent, grease or oil. Prior to packaging, bearings shall be cleaned in one of the following ways:

a. Clean, dry compressed air per MIL-P-116.

b. Wiping with soft, clean cloth per MIL-P-116.

c. Manufacturer's established cleaning procedures for this bearing.

5.1.1 Level A. Packaging shall be in accordance with Level A of MIL-B-197. The manufacturer's lot control numbers shall be marked on each package.

5.1.2 Level C. Packaging shall be in accordance with the manufacturer's commercial practice. The manufacturer's lot control number shall be marked on each package.

5.2 Packing. Packing shall be in accordance with MIL-B-197, Levels A, B or C as specified (see 6.2).

5.2.1 Level A. Bearings packaged as specified in 5.1.1 shall be packed for overseas shipment and storage in accordance with MIL-B-197.

5.2.2 Level B. Bearings packaged as specified in 5.1.1 shall be packed for domestic shipment and storage in accordance with MIL-B-197.

5.2.3 Level C. Bearings packaged as specified in 5.1.2 shall be packed in a manner to ensure carrier acceptance and safe delivery at destination. The containers shall be in accordance with the Uniform Freight Classification Rules or regulation of other carriers, as applicable to the mode of transportation.

5.3 Marking. Interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129. The nomenclature shall include: BEARINGS, PLAIN, SELF-LUBRICATING, HIGH SPEED OSCILLATION.

6. NOTES

6.1 Intended use. The bearings are intended for use in critical helicopter applications where they are subjected to low loads and high frequency oscillation.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. Applicable specification sheet or drawing.

c. Part number (see applicable specification sheet or drawing).

d. Applicable levels of preservation and packing (see 5.1 and 5.2).

e. Quality assurance certification (see 4.5.3).

f. Waiver of first article inspection (see 3.3).

6.2.1.1 When a production contract is in force, the bearings will be procured via a source control drawing (manufacturer's detail drawing that invokes MIL-B-81819).

Upon completion of the production contract, the bearings will be procured to the requirements of MIL-B-81819 and the applicable specification sheet or drawing.

6.3 Qualification. 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 81819 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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command (Attention: Naval Air Engineering Center, Systems Engineering and Standardization Department, Code 5311, Lakehurst, NJ 08733-5100); however, information pertaining to qualification of products may be obtained from the Naval Air Development Center, Code 6061, Warminster, PA 18974-5000.

6.4 First article. When a first article inspection is required, the items should be a first production item consisting of a sample selected from the first production lot. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval for 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.

6.5 Subject term (keyword) listing.

Bearing
High speed oscillation

6.6 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes (additions, modifications, corrections, deletions) from previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Navy - AS
Air Force - 11
Army - AV

Review:
DLA- IS
Air Force - 99

Preparing activity:
Navy - AS
(Project No. 3120-0668)

TABLE VIII. First article inspection report.

MIL-B-81819 Bearing Inspection Report

Manufacturer's Name _____
Address _____
Manufacturer's P/N _____
Lot Number and Date of Mfr. _____
Contract or Purchase Order No. _____

FIRST ARTICLE INSPECTIONS

Sample No.	Measured Values ①	Conformity Measurements ②					Liner Integrity ②
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

① Check applicable test: ☐ No-load Rotational Breakaway Torque
☐ Internal Clearance

② Conformity and Liner Integrity: A = Accept; R = Reject

Inspector's Name _____ Inspector's Signature _____ Date _____

TABLE IX. Quality conformance inspection report.

MIL-B-81819 Bearing Inspection Report

Manufacturer's Name _____
Address _____
Manufacturer's P/N _____
Military Specification Sheet Part No. _____
Lot Number and Date of Manufacture _____ Lot Size _____ Pieces
Contract or Purchase Order No. _____

QUALITY CONFORMANCE INSPECTIONS

Sample	Dimensions		①	①	①	①	②	③
	Attributes Checked	No. Defects Found	Identification of Product	Workmanship	Packaging	Surface Texture	Alignment	Measured Values
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

① A = Accept; R = Reject
② Record measured value
③ Check Applicable Test ☐ No-load torque ☐ Internal clearance

Sample No.	Conformity Measurements ④						Liner Integrity ④
1							
2							
3							
4							
5							
6							

④ Conformity and Liner Integrity: A = Accept; R = Reject

Inspector's Name _____ Inspector's Signature _____ Date _____

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-B-81819B	Bearings, Plain, Self-Aligning, Sleeve & Thrust Self-Lubricating, High Speed Oscillation, General Specification for

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

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)*

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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.

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DEPARTMENT OF THE NAVY
Commanding Officer
Naval Air Engineering Center
Systems Engineering and Standardization Department
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Lakehurst, NJ 08733-5100

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