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AEROSPACE STANDARD

SAE AS81820

Issued 1998-03

Submitted for recognition as an American National Standard

Bearings, Plain, Self-Aligning, Self-Lubricating, Low Speed Oscillation, General Specification For

NOTICE

This document has been taken directly from U.S. Military Specification MIL-B-81820F, Supplement 1, Amendment 2 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-B-81820F, Supplement 1, Amendment 2. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirements relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this technical report.

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1. SCOPE:

1.1 Scope:

This specification covers plain spherical bearings which are self-aligning and self-lubricating by incorporating polytetrafluoroethylene (PTFE) in a liner between the ball and race (outer ring). PTFE is incorporated in a fabric or composite material bonded to the ID of the outer ring, or in a composite material molded into a pre-formed cavity between the inner and outer ring. These bearings are for use in the temperature range -65°F to +325°F (-54°C to +163°C.)

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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 document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

QQ-C-320	-	Chromium Plating (Electrodeposited)
QQ-P-35	-	Passivation Treatment for Corrosion Resistant Steel
QQ-P-416	-	Plating, Cadmium (Electrodeposited)
TT-S-735	-	Standard Test Fluids, Hydrocarbon

MILITARY

MIL-P-116	-	Preservation, Methods of
MIL-P-197	-	Packaging of Antifriction Bearings, Associated Parts and Sub-Assemblies
MIL-H-5606	-	Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance
MIL-T-5624	-	Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP-5/JP-8 ST
MIL-L-7808	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-148
MIL-A-8243	-	Anti-Icing and Deicing-Defrosting Fluids
MIL-B-8942	-	Bearings, Plain, Polytetrafluoroethylene (PTFE) Lined, Self-Aligning
MIL-H-83282	-	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric, NATO Code Number H-537
MIL-B-81820/1	-	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Narrow, Grooved Outer Ring, -65° to 325°F
MIL-B-81820/2	-	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Wide, Chamfered Outer Ring, -65° to 325°F
MIL-B-81820/3	-	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Wide, Grooved Outer Ring, -65° to 325°F
MIL-B-81820/4	-	Bearing, Plain, Self-Aligning, Self-Lubricating, Low Speed, Narrow, Chamfered Outer Ring, -65° to 325°F

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2.1.1 (Continued):

MS14101	-	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Narrow, Grooved Outer Ring, -65° to 325°F
MS14102	-	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Wide, Chamfered Outer Ring, -65° to 325°F
MS14103	-	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Wide, Grooved Outer Ring, -65° to 325°F
MS14104	-	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Narrow, Chamfered Outer Ring, -65° to 325°F

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the DODSSP - Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications:

The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

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)

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

(Copies of the above publication may be obtained from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

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2.2 (Continued):

AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

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

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

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS 2417 - Nickel-Zinc Alloy Plating

(Application for copies should be addressed to SAE, 400 Commonwealth Drive, Warrendale, PA 15096.)

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

2.3 Order of precedence:

In the event of a conflict between the text of this document and the references cited herein (except for associated detail specifications, specification sheets or MS's), the text of this document takes precedence. Nothing in this document however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS:

3.1 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 of award of contract (see 4.3 and 6.3).

3.2 Materials:

The ball, outer ring and liner shall be in accordance with the applicable MS or specification sheets (slash sheets) hereinafter referred to as "applicable drawing."

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3.2.1 Plating: Plating of the ball will be permitted, at the option of the manufacturer, and shall be in accordance with QQ-C-320. Plating of the outer race shall be in accordance with AMS-2417, Type 2 or QQ-P-416 Type II, Class 2 and the applicable drawing.

3.2.2 Passivation: PH13-8 Mo steel balls shall be passivated in accordance with QQ-P-35.

3.2.2.1 440 Steel balls: Passivation of 440C steel balls is optional.

3.3 Design:

Bearing design shall conform to that identified in MIL-B-81820, Supplement 1 documents.

3.4 Construction:

The liner shall be so secured that all relative motion will be between the unbonded surface of the liner and the ball. The bearing shall not have loading slots. Except as otherwise specified, the details of the working parts shall be optional.

3.4.1 Dimensions and tolerances: Dimensions and tolerances shall be specified on the applicable drawing. Dimensions not shown shall be at the option of the manufacturer.

3.4.2 Surface texture: All specified surface textures shall be in accordance with ANSI/ASME B46.1. The sphered surface of the ball shall have a surface texture of R_a 8 maximum. The ball bore, ball 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 sphered surface of the ball shall be honed, polished or similarly finished subsequent to grinding.

3.4.3 Lubrication: Initial grease or oil lubrication by the manufacturer shall not be permitted.

3.4.4 Conformity: For bearings with fabric or fabric composite type liners the conformity of the ball and outer ring shall be measured normally. For bearings with molded liners, the conformity of the ball and outer ring shall be measured both normally and circumferentially (see 6.6).

3.4.4.1 Fabric liners: The normal conformity between the ball and outer ring shall be checked in accordance with 4.6.8.1. For fabric type liners measurements shall be taken at a minimum of five uniformly spaced positions across the bearing. Variation between measured values shall not exceed 0.003 inch. When overforming of the outer ring is observed per 4.6.8.1, then the measured values in the outer ten percent of the ring width shall not vary from the above measured maximum value by more than 0.005 inch. Underforming is not controlled.

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3.4.4.2 Molded liners: Normal conformity of bearings with molded liners shall be measured in accordance with 4.6.8.1. The precise shape of the cavity containing the liner material is not defined. 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 3B). The allowable values at the H/10 positions for the applicable drawings referenced in 3.3 shall be .011 ±.003 for all sizes. The permitted variation within any one bearing shall not exceed .004 inch. The maximum liner thickness shall occur at the midpoint and 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 ring width shall be checked for overforming and the measured values of "t" in these regions shall be not less than 0.008 inch.

3.4.4.3 Circumferential conformity: In molded liner bearings the circumferential conformity shall be measured in accordance with 4.6.8.2. Variation in measured values of "δ" shall not exceed 0.003 inch.

3.4.5 PTFE liner condition and bond integrity:

3.4.5.1 Visual examination: The visual appearance of the bonded liner shall exhibit a degree of workmanship consistent with proper manufacturing process controls, as checked per 4.6.9.1. The liner shall be uniform in texture and shall contain no embedded 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.

3.4.5.2 Bond integrity and peel strength: When tested in accordance with 4.6.9.2, the liner shall adhere to the metallic substrate 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 areas which cannot be included within a circumscribing circle with a diameter equal to 25 percent of the ring width or 0.25 inch, whichever is smaller.

3.4.5.2.1 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.

3.4.5.2.1.1 Controlled area: The controlled area shall be maintained at a temperature of 75° ±10°F (24°C, 29.44°C maximum, 18.33°C minimum) with a maximum relative humidity of 75%. The enclosed atmosphere of the work area shall be well ventilated and maintained so that the particle count is 2500 maximum 5.0 microns or larger when measured per ASTM F-25 or ASTM F-50. The particle count measurement shall be performed annually as a minimum. There shall be no eating or smoking in the controlled area and no process which produces uncontrolled spray, dust, fumes or particulate matter.

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3.4.5.3 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 4.6.9.2. 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.

3.5 Performance:

3.5.1 Radial static limit load: After the radial load listed on the applicable drawing has been applied as specified in 4.6.1, the total deflection of the bearing and fixture shall be less than 0.010 inch for bearings with a bore of 3/8 inch or less, 0.015 for 7/16 and 1/2 inch, 0.017 for 9/16 and 5/8 inch, 0.020 for 3/4 inch and up. In all instances the permanent set shall be less than 0.0030 inch.

3.5.2 Axial static limit load: After the axial load listed on the applicable drawing has been applied as specified in 4.6.2, the permanent set shall be less than 0.005 inch.

3.5.3 Ultimate load: No fracture of the race or ball, or pushout of the ball shall occur when 1.5 times the radial or axial limit load is applied, as specified in 4.6.1 or 4.6.2.

3.5.4 Oscillation under radial load: When tested in accordance with 4.6.3, the bearing shall not exhibit metal-to-metal contact between the ball and outer ring. The total liner wear of the bearing shall not exceed the values specified in table I and the loaded rotational breakaway torque shall not exceed the value specified in table VII. When inspected in accordance with 4.6.9.2, bond integrity shall be as specified in 3.4.5.

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TABLE I. Maximum allowable wear after oscillation under radial load.

Width	Dash number size	Maximum Allowable Wear After 1000 cycles	Maximum Allowable Wear After 5000 cycles	Maximum Allowable Wear After 25000 cycles
Narrow	-4	.0029	.0033	.0037
Wide	-4	.0031	.0035	.0039
Any	-5 through -16	.0035	.0040	.0045

3.5.5 Self-alignment: The bearing shall be self-aligning and shall permit the angular displacement specified on the applicable drawing.

3.5.6 No-load rotational breakaway torque: When tested in accordance with 4.6.4, no-load rotational breakaway torque shall be within the limits of the values specified on the applicable drawing. The letter “K” after the dash number indicates a bearing supplied with low breakaway torque. See 3.5.10 and 3.5.11 for additional requirements for bearings which are identified as being supplied with low breakaway torque. The absence of the letter “K” indicates standard breakaway torque. Axial or radial play shall not be permitted in standard breakaway torque bearings.

3.5.7 Fluid contamination: When tested in accordance with 4.6.5, the liner wear shall not exceed 0.006 inch, and the bearing shall not exhibit metal-to-metal contact between the ball and the outer ring. No corrosion of the bearing shall result.

3.5.8 High temperature: When tested in accordance with 4.6.6, the bearing shall be capable of operating at a temperature of 325°F (163°C). The liner wear shall not exceed 0.006 inch, and the bearing shall not exhibit metal-to-metal contact between the ball and the outer ring.

3.5.9 Sub-zero temperature: When tested in accordance with 4.6.7, the bearing shall be capable of operating at a temperature of -10°F (-29°C). The liner wear shall not exceed 0.0080 inch, and the bearing shall not exhibit metal- to-metal contact between the ball and the outer ring.

3.5.10 Radial play: Bearings which are provided with low breakaway torque shall be measured to determine internal radial play in accordance with 4.4.2.4 and 4.6.10. Radial play shall not be greater than 0.0007 inch for sizes -3K through -12K, nor greater than 0.0010 inch for sizes -14K and -16K. Identification of these parts shall be in accordance with the designation shown on the applicable drawing.

3.5.11 Axial play: Bearings which are provided without preload torque shall be measured to determine axial play in accordance with 4.6.11. Maximum allowable axial play values shall be as identified in table II.

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TABLE II. Maximum axial play.

Width	Dash number size	Maximum axial play
Narrow	-3K thru -12K	.0028
Narrow	-14K thru -16K	.0040
Wide	-3K thru -12K	.0021
Wide	-14K thru -16K	.0030

3.6 Identification of product:

Each bearing shall be permanently and legibly marked with the manufacturer's name or trademark, military part number and the manufacturer's part number. Where practicable, identification shall appear on the side face of the outer ring; otherwise identification shall appear on the periphery of the outer ring. Metal impression stamping is prohibited.

3.7 Workmanship:

The bearing shall be free from defects (i.e., scratches, pits, burrs) 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 (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance: All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept of defective material (see 6.4).

4.1.2 Inspection records: The manufacturer shall maintain records showing quantitative results of all inspections. The record shall be available to the purchaser and shall be signed by an authorized representative of the manufacturer or the testing laboratory, as applicable (see 6.4).

4.2 Classification of inspections:

The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.3).

b. Quality conformance inspection (see 4.4).

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4.3 Qualification inspection:

Qualification inspection shall consist of all the examinations and tests of this specification. In addition, the qualifying activity reserves the right to require other tests not covered in this specification when such tests are deemed necessary to assure the capability of a newly developed bearing material to perform satisfactorily in applications for which this specification is intended. Qualification of a given bearing with a grooved outer ring qualifies the corresponding bearing with a chamfered outer ring. No bearing may be qualified prior to qualification of the MS14101-8 bearing. The bearings in column II of table III will not be qualified prior to qualification of the corresponding bearings in column I. Lined bore spherical bearings will be approved on the basis of similarity to the respective qualified non-lined bore spherical bearings. The liner supplied in the lined bore series bearings must be the same as the liner supplied in the respective non-lined bore spherical bearings which must have been previously approved for listing on the QPL for this specification.

TABLE III. Order of qualifying bearings.

I	II
MS14101-5A	MS14101-3, -4, -6
MS14101-8	MS14101-7, -9
MS14101-12	MS14101-10, -14, -16
MS14103-5	MS14103-3, -4, -6
MS14103-8	MS14103-7, -7A, -9
MS14103-12	MS14103-10, -14, -16

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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 Warfare Center Aircraft Division Warminster, Code 60611, Warminster, PA 18974.

4.3.1.1 Product change: Any change in product design, description, materials or bonding related operations shall require requalification of the product to an extent determined by the qualifying activity.

4.3.1.2 Product manufacture: Except for the bonding and swaging operations, the manufacturer is permitted to subcontract manufacturing operations without violating the requirements of 4.3.1.1. The bonding and swaging operations shall be performed in the plant listed on the QPL. 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 shall require requalification as determined by the qualifying activity.

4.3.1.3 Periodic retest for retention of qualification: In addition to the certification requirement of 4.3.1, each manufacturer shall retest a sample of bearings from recent production at five year intervals beginning in 1988. The tests to be performed shall be as follows:

a. 4.6.3 Oscillation Under Radial Load.
b. 4.6.5 Fluid Contamination, Using MIL-H-83282 Hydraulic Fluid.
c. 4.6.6 High Temperature.
d. 4.6.8 Conformity.
e. 4.6.9 PTFE Liner Condition and Bond Integrity.

The test bearings shall be a single size from normal production. The bearings shall be MS14101-8 or MS14101-12, at the manufacturer's option. Three samples each of tests (a) through (d), and six samples of test (e) are required. The test data shall be assembled in report form, certified by the Chief Engineer or other responsible official of management and forwarded to the qualifying activity in October of the appropriate year (see 6.4).

4.3.2 Sampling instruction: Qualification test samples shall consist of thirty-seven (37) bearings of MS14101-8, eleven (11) each of the sizes in column I of table III and seven (7) each of the sizes in column II of table III upon which qualification is desired. All bearings necessary for tests shall be furnished by the manufacturer and shall be representative of his normal production. Samples shall be identified as required and forwarded to the activity designated in the letter of authorization from the activity responsible for qualification (see 6.3).

4.3.3 Certified tests: The manufacturer shall furnish certified test information showing that the manufacturer's product satisfactorily conforms to this specification. The test information shall include as a minimum, actual results of the tests specified herein. When the information is submitted, it shall be accompanied by a dated drawing which completely describes the manufacturer's product by specifying all dimensions and tolerances, construction, materials, heat treat, finishes, part marking, and control specifications. The liner description and bonding process need not be called out except by reference to the manufacturer's internally documented and maintained specifications. The manufacturer's part number for each size shall be included on the drawing (see 6.4).

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4.3.4 Qualification sampling: Qualification sampling shall be in accordance with table IV.

TABLE IV. Qualification test samples.

Examination or Test	Paragraph Number		Samples to be tested
Examination of product	4.5.1		5
Preparation for delivery	4.5.2		5
Radial static limit load	4.6.1		3
Axial static limit load	4.6.2		3
Oscillation under radial load	4.6.3	2/	3
No-load rotational breakaway torque	4.6.4		3
Fluid contamination	4.6.5 (each fluid)	1/	3
High temperature	4.6.6	1/	3
Sub-zero temperature	4.6.7	1/	3
Conformity	4.6.8		1
Bond integrity	4.6.9		1

1/ MS14101-8 size only.
2/ -5, -8 and -12 sizes only.

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4.4 Quality conformance inspections:

The quality conformance inspections shall consist of the inspections listed in Table V.

TABLE V. Quality Conformance Inspections.

	Examination or Test		Critical Characteristics	Major Characteristics	Minor Characteristics	Special Inspection Plan	Requirement Paragraph	Test Paragraph
(a)	Dimensions / MS Ref.							
	Bore	“B”		X			3.4.1	4.5.1
	O.D.	“D”		X			3.4.1	4.5.1
	Outer Ring Width	“H”		X			3.4.1	4.5.1
	Ball Flat Diameter	“M”			X		3.4.1	4.5.1
	Ball Flat Width	“W”		X			3.4.1	4.5.1
	Groove Depth(1)	“P”		X			3.4.1	4.5.1
	Groove Pitch Diam. (1)	“E”		X				
	Groove Root Radius (1)				X		3.4.1	4.5.1
	Groove Side Face Angle (1)				X		3.4.1	4.5.1
	Outer Race Chamfer (2)			X			3.4.1	4.5.1
(b)	Identification of Product				X		3.6	4.5.1
(c)	Workmanship				X		3.7	4.5.1
(d)	Preparation for Delivery				X			4.5.2
(e)	No-Load Rotational Breakaway Torque					100% Inspection	3.5.6	4.6.4
(f)	Conformity					Destructive Inspection	3.4.4	4.6.8
(g)	Liner Condition and Bond Integrity					Destructive Inspection	3.4.5	4.6.9
(h)	Radial Clearance (3)					100% Inspection	3.5.10	4.6.10
(i)	Axial Clearance (3)					100% Inspection	3.5.11	4.6.11

(1) Inspection applies only to MS14101, MS14104, MIL-B-81820/1 and MIL-B-81820/4 parts.
(2) Inspection applies only to MS14102, MS14103, MIL-B-81820/2 and MIL-B-81820/3 parts.
(3) Inspection applies only to bearings which are provided without preload torque (see requirements of paragraphs 3.5.10 and 3.5.11).

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4.4.1 Inspection lot: The inspection lot shall consist of finished bearings, having a single part number, manufactured by the procedures established for the original qualified bearings, swaged on the same tool setup, produced as one continuous run or order or portion thereof, and with one or more liner bonding runs, which can be defined by means of in-house processing records.

4.4.2 Sampling:

4.4.2.1 Sample for quality conformance tests (a) through (d): The sample bearings shall be selected at random from each inspection lot in accordance with Table VI-A. If no defect is found in the sample the lot shall be accepted for these tests. If any defects are found in the sample, the entire lot shall be 100% inspected for each defective characteristic found, and all defective parts shall be removed from the lot.

4.4.2.2 Sample for quality conformance test (e): Inspection shall be 100% of the lot. All defective parts shall be removed from the lot.

4.4.2.3 Sample for quality conformance tests (f) and (g): The sample bearings shall be selected at random from each inspection lot in accordance with Table VI-B. (At the bearing manufacturer's option, the sample bearings for these destructive inspections may be selected at random from the non-repairable defective-parts rejected from the inspection lot during quality conformance tests (a) through (d).) If no defect is found in the sample the lot shall be accepted for these tests. A lot which was rejected under Normal Inspection of Table VI-B shall be reinspected under Tightened Inspection of Table VI-B. If a defect is found in the Tightened Inspection sample, the entire lot shall be rejected and shall not be offered for sale or acceptance under this specification or any other military specification.

4.4.2.4 Sample for quality conformance test (h): Each lot of bearings which is provided without preload torque shall be 100% inspected for radial clearance in accordance with 3.5.10 and 4.6.10. All defective parts shall be removed from the lot.

4.4.2.5 Sample for quality conformance tests (i): Each lot of bearings which is provided without preload torque shall be 100% inspected for axial clearance in accordance with 3.5.11 and 4.6.11. All defective parts shall be removed from the lot.

4.4.3 Quality assurance certification: For each inspection lot the manufacturer shall maintain and supply to the purchaser upon demand:

a. Certified copies of all records or quality conformance tests specified in 4.4 and the purchase order.

b. Certification that the bearings were produced without any change in the product design, description, materials or bonding related operations from those supplied for qualification testing per 4.3.1.1 and 4.3.1.2.

These records and certifications shall identify the manufacturer of the bearings, the address of the plant where they were manufactured, the purchaser and the purchase order number (see 6.4).

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TABLE VI-A. Sampling Plan for Quality Conformance Inspections Except Destructive Inspections.
Zero-Based Acceptance Plan (C=0)

	SAMPLE SIZE Acceptance number in all cases is zero. "A" indicates the entire lot must be inspected.		
LOT SIZE	Critical Characteristics	Major Characteristics	Minor Characteristics
1-2	A	A	A
3-8	A	A	3
9-12	A	A	3
13-15	A	13	3
16-25	A	13	3
26-50	A	13	5
51-90	A	13	6
91-150	A	13	7
151-280	A	20	10
281-500	A	29	11
501-1200	A	34	15
1201-1249	A	42	18
1250-3200	1250	42	18
3201-10,000	1250	50	22

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TABLE VI-B. Destructive Inspection Sampling Plan.
Zero-Based Acceptance Plan (C=0)

	Normal Inspection			Tightened Inspection		
Lot Size	Sample Size	Accept	Reject	Sample Size	Accept	Reject
2-50	2	0	1	4	0	1
51-500	3	0	1	6	0	1
501-5000	5	0	1	10	0	1
5001-50000	8	0	1	16	0	1

4.5 Examinations:

4.5.1 Examination of product: The bearings shall be examined to determine conformance to the requirements of this specification and the applicable military document for material, plating, dimensions, finish, identification of product, workmanship and requirements not covered by tests.

4.5.2 Preparation for delivery: Packing and marking shall be inspected to determine conformance to section 5.

4.6 Test methods:

Unless otherwise specified, all tests shall be conducted at room temperature. When performing the tests specified in 4.6.1, 4.6.3, 4.6.5, and 4.6.6 on molded liner bearings, the bearing shall be installed in the test fixture so that the maximum load is applied at the larger injection hole.

4.6.1 Radial static limit load: The bearing shall be installed in a test fixture as shown in figure 1. The use of differential temperatures for installation will not be allowed. A preload of 4 to 6 percent of the radial static load shall be applied to the bearing for 3 minutes, and the measurement device set at zero. The load shall then be increased at the rate of 1 percent of the specified load per second until it equals the radial static limit load. The total deflection shall be the reading at the radial static limit load after 2 minutes. The load shall then be reduced at the same rate to the preload value. The permanent set is the reading at preload. The ultimate radial load (see 3.5.3) shall be applied at the rate of 1 percent of the specified load per second.

4.6.2 Axial static limit load: The test bearing shall be installed in a test fixture as shown in figure 2. The hole in the support fixture for clearance of the ball shall be the nominal diameter of the ball plus double the thickness of the liner. The bearing shall be preloaded between 4 to 6 percent of the axial limit load. After holding for 3 minutes, the measuring device shall be set at zero. The loads shall be increased at the rate of 1 percent of the specified load per second until it equals the axial static limit load. It shall be held for 2 minutes, then reduced at the same rate to the preload value. The permanent set is the reading at preload. The ultimate axial load shall be applied at the rate of 1 percent of the specified load per second (see 3.5.3).

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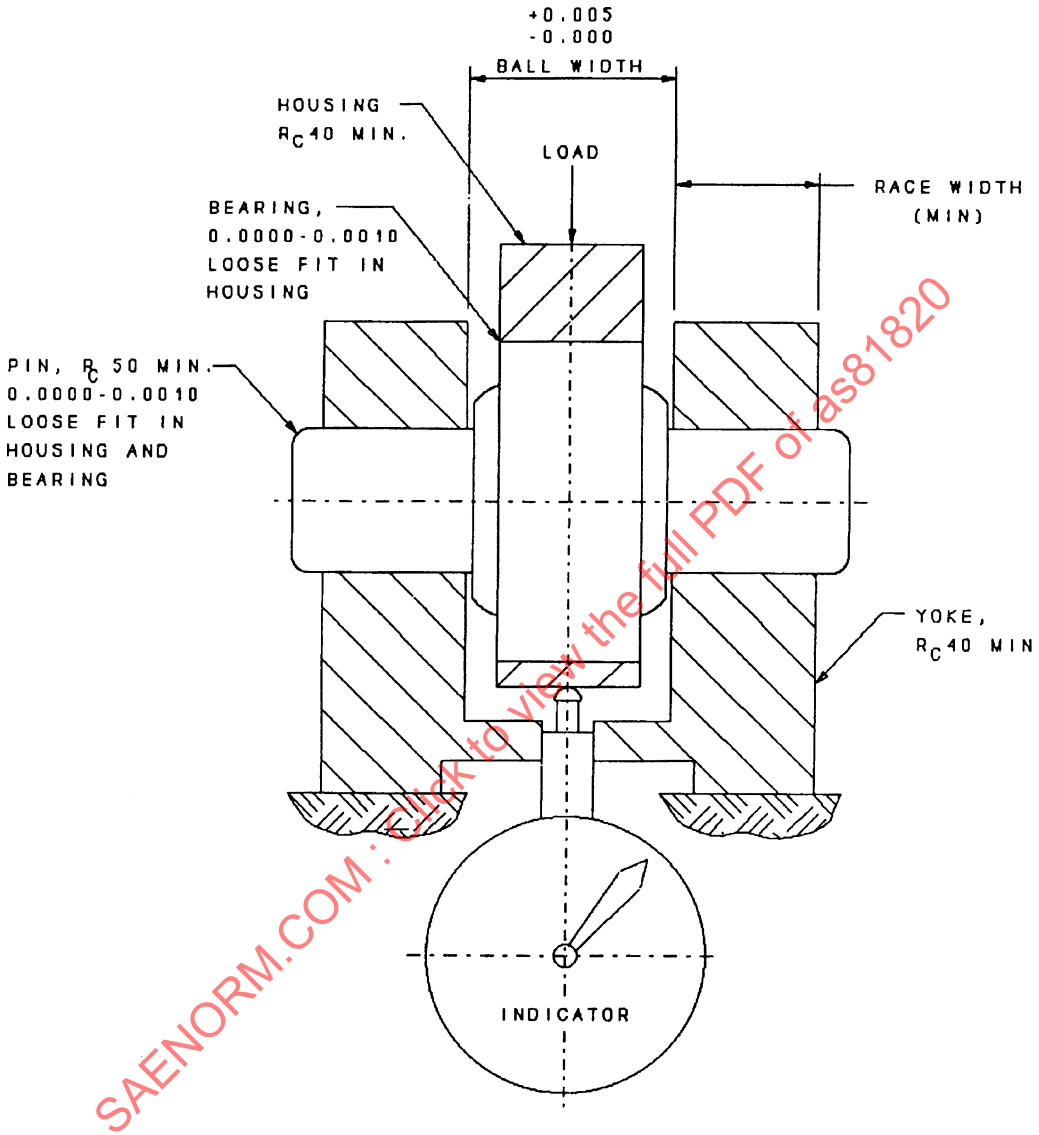

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FIGURE 1. Radial static limit load test fixture.

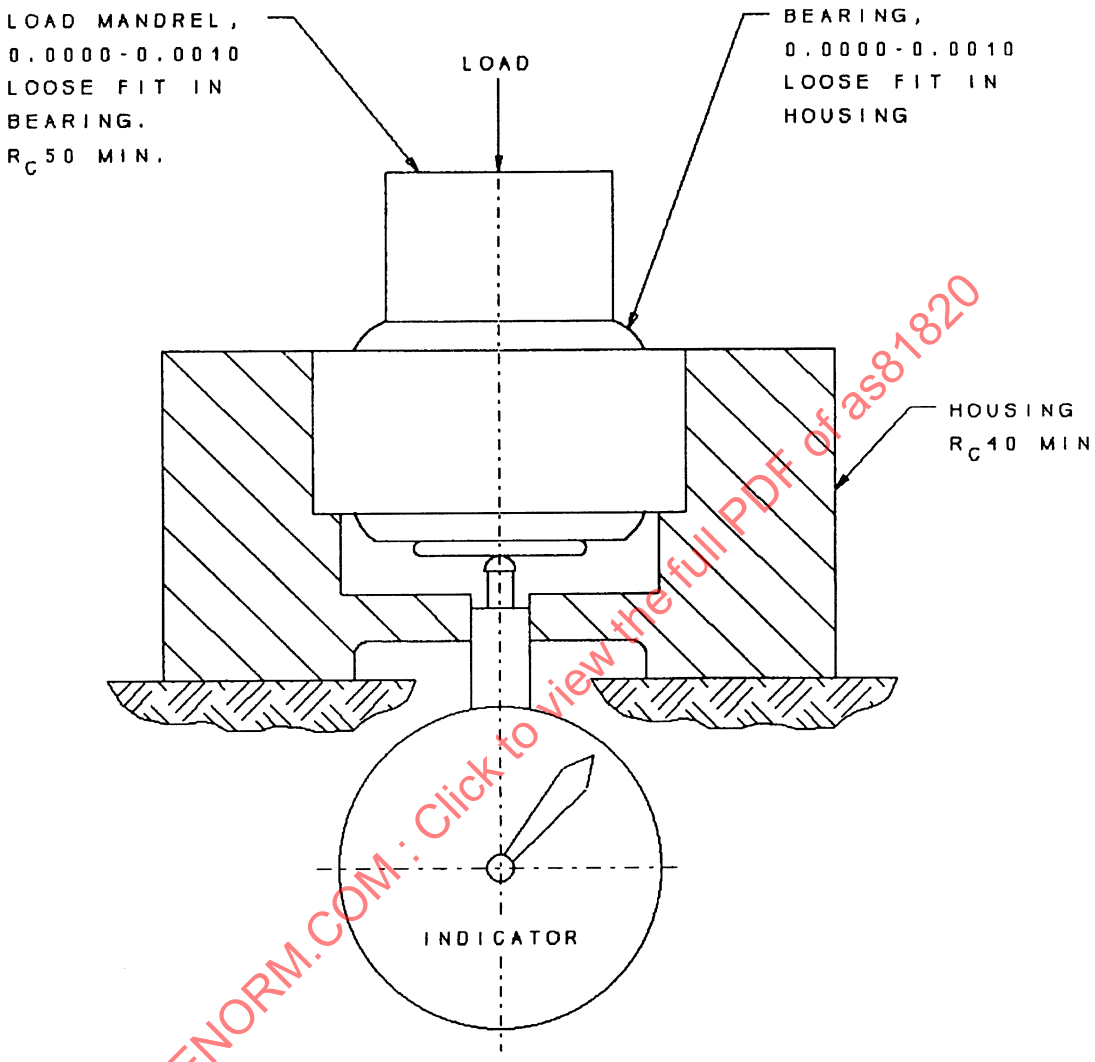

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FIGURE 2. Axial static limit load test fixture.

4.6.3 Oscillation under radial load: The bearing shall be installed in a steel housing, using a slip fit, with a hardened shaft (R_c 50 minimum) in the bore using a .0005 to .0015 inch clearance fit. The bearing shall be so gripped as to place the shaft in double shear with minimum bending, and to permit rotation of the ball with respect to the outer ring and torque read-out while the bearing is under radial load. A dial indicator or electronic pickup device shall be mounted to permit measurement of any radial movement of the ball with respect to the outer ring. The oscillating load specified on the applicable drawing shall be applied and held statically for 15 minutes. At the end of this time, the indicating device shall be set to zero and the oscillating test started. The test shall be run in such a manner that the ball is oscillated at ±25 degrees from the zero position (50 degrees included angle), at 10 cycles per minute (cpm) minimum for 25,000 cycles. A cycle shall consist of rotation from zero to +25 degrees and return thru zero to -25 degrees and return to zero (100 degrees total). The wear shall be measured with the indicating device either continuously or at sufficient intervals as to produce a plot of wear in thousandths of an inch vs. life in cycles. Upon completion of the test, the loaded rotational breakaway torque shall be measured and shall be as specified in table VII. After testing, one bearing shall be subjected to the bond integrity test of 4.6.9.2.

4.6.4 No-load rotational breakaway torque: The no-load rotational breakaway torque shall be determined by holding the outer ring of the bearing fixed while rotating the ball about the bearing axis. The outer ring shall be held in such a manner as to minimize bearing distortion and the resultant effect on bearing preload torque. The use of excessive ball clamping forces to drive the ball shall be avoided. The ball shall be misaligned in two mutually perpendicular planes and rotated through two to three revolutions immediately prior to testing. This operation is mandatory and may require some fixture adjustment. The test shall then be conducted by gradually applying torque to the ball; the minimum torque required to start the ball moving shall be recorded. The no-load rotational breakaway torque shall be as specified on the applicable drawing. Individual bearings which are rejected due to high preload torque values may be reworked by the bearing manufacturer and then reinspected 100%. Individual bearings which are rejected due to low torque values may not be reworked and shall not be accepted.

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TABLE VII. Maximum allowable after test torque.

Dash Number size	Wide (in-lb)	Narrow (in-lb)
3	65	21
4	65	45
5	90	80
6	150	110
7	230	150
8	325	210
9	455	295
10	540	425
12	820	755
14	1150	1045
16	2670	1750

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4.6.5 Fluid contamination: Eighteen bearings (3 for each fluid) shall be immersed for 24 hours in each of the following fluids at 160 ±5°F (71 ±3°C), except for (b) which shall be at 110 ±5°F (43 ±3°C):

a. Phosphate Ester Hydraulic Fluid
b. TT-S-735, Type VII Standard Test Fluid or 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
f. MIL-H-83282 Hydraulic Fluid

Within 1/2 hour after removal from the test fluid the bearing shall be tested in accordance with 4.6.3. The test load shall be 75% of the load specified on the applicable drawing. After testing, six of the tested bearings (one from each fluid) shall be subjected to the bond integrity test of 4.6.9.2. Superficial tarnish which can be removed with a damp cloth shall not be cause for rejection.

4.6.6 High temperature: Three bearings shall be subjected to the test of 4.6.3 except that the bearing shall be heated such that the ball/liner interface is maintained at a temperature of 325°F (163°C) minimum. The test load shall be 100% of the load specified on the applicable drawing. After testing, one bearing shall be subjected to the bond integrity test of 4.6.9.2.

4.6.7 Sub-zero temperature: Three bearings shall be subjected to the test of 4.6.3 except that the bearings shall be cooled during the test. The test load shall be 75% of the load specified on the applicable drawing. The oscillation rate is optional except that the minimum shall be 5 cpm. Intermittent operation of the test machine is allowable if necessary to counteract the effects of frictional heating. The first 1000 test cycles shall be conducted at room temperature followed by 24,000 cycles at the specified low temperature below. Upon completion of the first 1000 cycles, oscillation shall be stopped and the test bearing cooled such that the ball/liner interface temperature is maintained at or below -10°F (-23°C) for the sub-zero temperature portion of the test. The bearing shall be allowed to cold soak at this temperature for one-half hour minimum after which time oscillation shall be continued until the remaining 24,000 cycles have been completed. In the event that the normal wear measurement techniques are inaccurate at low temperature, then alternative wear methods may be used provided the method is fully described in the qualification test report. After testing, one bearing shall be subjected to the bond integrity test of 4.6.9.2.

4.6.8 Conformity:

4.6.8.1 Normal conformity: 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 3(a) or 3(b). Bearings which have been subjected to wear testing shall be sectioned so that the entire wear area is exposed when the ball is removed in 4.6.9.2. 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 accurate technique, measure dimension "t" radially from the ball to the outer ring (see figure 3). The measurements need not be taken closer to the outer ring face than ten percent of "H" (.025 minimum) except when overforming of the outer ring has occurred. The normal conformity must meet the applicable requirements of 3.4.4.1. Conformity in the ten percent of "H" region (see H/10 in figure 3(a) and 3(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 the side portions of the outer ring are in closer proximity to the ball surface than the middle portion of the outer ring. When overforming is observed, two additional measurements (one in each H/10 region) shall be taken to determine if the amount of overforming meets the requirements of 3.4.4.1 or 3.4.4.2 as applicable.

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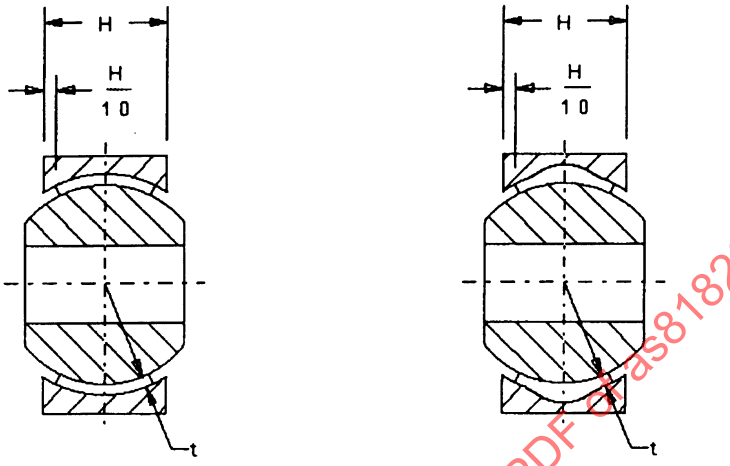

NORMAL CONFORMITY
TYPE I BEARING
FIGURE 3(a)

NORMAL CONFORMITY
TYPE II BEARING
FIGURE 3(b)

FIGURE 3. Normal conformity.

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4.6.8.2 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 outer ring. Section the bearing along the diameter described by the centerline of the outer ring width to produce a surface as shown in figure 4. Grind and polish the surface to obtain a true view of the exposed liner cross section. By use of an optical comparator or other accurate technique, measure dimension "δ" radially from the center of the bore at a minimum of eight uniformly spaced positions (see figure 4). The circumferential conformity shall meet the requirements of 3.4.4.3.

4.6.9 PTFE liner condition and bond integrity: The sectioned half bearing not used in 4.6.8 shall be broken out of the mount and used to determine liner condition and bond integrity. At the manufacturer's option, the bond integrity test may be performed on a part which has not been encapsulated. In the case where a disagreement exists between a manufacturer and a user on bond integrity, an unencapsulated bearing shall be used for final resolution.

4.6.9.1 Visual examination: Visually examine the exposed liner surface for conformance to the applicable requirements of 3.4.5.1, 3.7 and the applicable drawing.