SAE-AS7949

ADOPTION NOTICE

SAE-AS7949, "Bearings, Ball, Airframe, Antifriction" was adopted on 23 July 1998, for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3, Highway 547, Lakehurst, NJ 08733-5100. DoD activities may obtain copies of this standard from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. The private sector and other government agencies may purchase copies from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE-AS7949 should be used instead of MIL-B-7949E(1), which was canceled on 23 July 1998.

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AEROSPACE STANDARD

SAE AS7949

Issued 1998-04

Submitted for recognition as an American National Standard

BEARINGS, BALL, AIRFRAME, ANTIFRICTION

NOTICE

This document has been taken directly from U.S. Military Specification MIL-B-7949E, Supplement 1, Amendment 1 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-7949E, Supplement 1, Amendment 1. 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.

Any material relating to qualified product lists has not been adopted by SAE. This material was part of the original military specification and is reprinted here for historic reference only.

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1. SCOPE:

1.1 Scope:

This specification covers antifriction bearings in the -65°F to 350°F temperature range as specified on the applicable military standard.

2. APPLICABLE DOCUMENTS:

2.1 *Issues of documents:*

The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-P-416	Plating, Cadmium (Electrodeposited)

MILITARY

MIL-B-197	Bearings, Anti-Friction, Associated Parts and Sub-Assemblies, Preparation for Delivery of
MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-G-23827	Grease, Aircraft and Instrument, Gear and Actuator Screw
MIL-G-81322	Grease, Aircraft, General Purpose Wide Temperature Range

STANDARDS

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-810	Environmental Test Methods
MIL-STD-831	Test Reports, Preparation of
MS21428	Bearing, Ball, Airframe, Antifriction, Extra Light Duty, Precision
MS27640	Bearing, Ball, Airframe, Antifriction, Heavy Duty
MS27641	Bearing, Ball, Airframe, Antifriction, Intermediate Duty
MS27642	Bearing, Ball, Airframe, Extra Light Duty
MS27643	Bearing, Ball, Airframe, Antifriction, Selfaligning, Double Row, Heavy Duty
MS27644	Bearing, Ball, Airframe, Antifriction, Double Row, Heavy Duty
MS27645	Bearing, Ball, Airframe, Antifriction, Selfaligning, Light and Heavy Duty
MS27646	Bearing, Ball, Airframe, Antifriction, Extra Light Duty
MS27647	Bearing, Ball, Airframe, Antifriction, Extra Wide, Double, Row, Intermediate Duty

2.1 (Continued):

MS27648	Bearing, Ball, Airframe, Antifriction, Externally Selfaligning, Extra Light Duty
MS27649	Bearing, Ball, Airframe, Antifriction, Intermediate Duty
MS21443	Bearing, Ball, Airframe, Antifriction, Pulley Type

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications:

The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American National Standards Institute

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

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway Street, New York, New York 10018.)

3. REQUIREMENTS:

3.1 Qualification:

The bearings furnished under this specification shall be products which are qualified for listing on the applicable qualified product list at the time set for opening of bids.

3.1.1 Product change: Any change in product design, including raceway geometry or dimensions, rolling element dimensions, rolling element quantity, seals, materials or plant location shall be reported to the qualifying activity and will require requalification of the product to an extent determined by the qualifying activity. Any other specific changes which must be brought to the qualifying activity's attention will be identified in the qualification notification letter.

3.1.2 Product manufacture: The bearing manufacturer shall be capable of performing the preponderance of manufacturing operations in-house, but may subcontract these operations at its option. Component inspection shall be performed at the plant listed on the Qualified Products List. If manufacturing operations are performed in more than one plant, the manufacturer's additional plant(s) shall be reported to the qualifying activity and will be listed accordingly on the QPL. The manufacturer is responsible for meeting all requirements of the specification and for the quality of the end product, whether it is manufactured totally in-house or some of the operations are performed by a subcontractor. Inherent in the responsibility for the end product is the responsibility to verify that the subcontractor's processes meet specification requirements. A change in subcontractor need not be reported to the qualifying activity unless specifically identified in the qualification notification letter. (NOTE: Bearings partly or completely manufactured in foreign countries shall be subject to the laws and procurement regulations pertaining to acquisition of foreign made products.

3.2 Materials:

The materials used shall be such that the finished bearings will conform to the requirements specified herein. The manufacturer shall use due care in subjecting metal to suitable check analysis and physical tests to satisfy the purchaser as to the uniformity of the material used.

3.2.1 Rings and balls: Alloy steels used shall conform to the applicable military standard.

3.3 Design and construction:

The bearings shall be in accordance with applicable military standards and shall be designed and constructed as specified. Except as otherwise specified, the details of the working parts shall be optional. Only factory-new bearings shall be furnished.

3.3.1 Rings: Each outer and inner ring shall be of a single-piece construction.

3.3.2 Seals: Seals shall be provided to prevent the entrance of dust and to retain the lubricant and shall be tested and meet the requirements specified in 4.5.7.

NOTE: Bonded pop-in type seals are not permitted on internal self-aligned types.

3.3.2.1 Performance test: The seals shall be capable of withstanding the test requirement as specified in 4.5.7.1 without failure.

3.3.2.2 Seal retention: The seals shall be capable of withstanding the torque requirements as specified in 4.5.7.2 without failure.

3.4 Interchangeability:

All parts having the same manufacturer's part number and MS dash number marked in accordance with 3.13 shall be functionally and dimensionally interchangeable. The item identification and part number requirements of MIL-D-1000 shall govern the manufacturer's part numbers and changes thereto.

3.5 Physical properties:

3.5.1 Radial strength:

3.5.1.1 Limit load: When tested as specified in 4.5.3.1, the limit-load radial strength of the bearing shall be not less than the values specified on the applicable military standard.

3.5.1.2 Fracture strength: When tested as specified in 4.5.3.2, the minimum static fracture radial strength shall be not less than 1-1/2 times the radial limit-load value specified on the applicable military standard.

3.5.1.3 Radial dynamic load rating: When tested as specified in 4.5.3.3, the bearing shall have a radial dynamic load rating of not less than the values specified on the applicable military standard.

3.5.2 Axial strength:

3.5.2.1 Limit load: When tested as specified in 4.5.4.1, the limit-load axial strength of the bearing shall be not less than the values specified on the applicable military standard.

3.5.2.2 Fracture strength: When tested as specified in 4.5.4.2, the minimum static fracture axial strength shall be not less than 1-1/2 times the axial load values specified on the applicable military standard.

3.6 Internal clearance:

Radial or axial clearance shall be measured in accordance with 4.5.5 limits as specified on the applicable military standard.

3.7 Surface roughness:

Surface roughness shall be as specified on the applicable military standard.

3.8 Hardness:

The rings and balls shall be tested in accordance with 4.5.9. The limits shall be in accordance with values on the applicable military standard.

3.9 Plating:

Except when fabricated of corrosion-resistant steel, all external steel surfaces, including metal seals or shields, except the inner ring bore, shall be cadmium plated in accordance with type I, class 2, of QQ-P-416. The plating thickness shall not exceed 0.0005 inch maximum.

3.10 Radial and lateral eccentricity:

The nonself-aligning bearings shall be tested as specified in 4.5.2. Values shall not exceed the limits specified on the applicable military standard.

3.11 Lubrication:

The bearings shall be packed with grease conforming to MIL-G-81322 (-65°F to 350°F) or MIL-G-23827 (-65°F to 250°F), filled 80 percent minimum. The bearings shall be thoroughly cleaned before the lubricant is injected into the bearings. Bearings shall not have been lubricated more than 24 months prior to the date of delivery of the bearings under contract or order. The bore of all bearings and the outside diameter of the outer ring and the inside diameter of the self-aligning ring of the externally self-aligning bearing shall be coated with MIL-G-81322 or MIL-G-23827 grease. The bearing shall be coated with the same grease that is packed in the bearing.

3.12 Stability:

The bearings shall be tested in accordance with 4.5.10 for dimensional stability.

3.13 Identification of product:

The bearings shall be permanently and legibly marked with the manufacturer's name or trademark and part number. The individual bearing package shall be marked with the complete MS part number, the manufacturer's name and part number, and the date of lubrication.

3.14 Workmanship:

The workmanship shall be in accordance with high-grade aircraft bearing manufacturing practice. Bearings shall be free from defects which may affect their durability and serviceability.

3.15 Bearing starting torque:

The amount of torque required to begin rotation of the bearing shall be measured as specified (see 4.5.12). Starting torque shall be within the allowable values specified in Table I.

TABLE I. Maximum allowable torque values.

MS No.	Ref. No.	Torque inch-oz
27640-3A	EP3L	1
-3	EP3	1
-4	EP4	1
-5	EP5	1
-6	EP6	2
-8	EP8	3
-10	EP10	3
27641-3	EP3A	1
-4	EP4A	1.5
-5	EP5A	1.5
-6	EP6A	2
-8	EP8A	2.5
-10	EP10A	3
-12	EP12A	3
-16	EP16A	4
-20	EP20A	5
27642-16	EP16S	5
-21	EP21S	7
-23	EP23S	8
-25	EP25S	9
-29	EP29S	12
-33	EP33S	14
-37	EP37S	17
-47	EP47S	24
-49	EP49S	25
-53	EP53S	28
-55	EP55S	28
-59	EP59S	28
-61	EP61S	*
-69	EP69S	*
-73	EP73S	*
-75	EP75S	*
-80	EP80S	*
-85	EP85S	*
-89	EP89S	*
-93	EP93S	*
-95	EP95S	*

MS No.	Ref. No.	Torque inch-oz
27643-3	DSP3	1
-4	DSP4	1
-5	DSP5	2
-6	DSP6	2
-8	DSP8	2
-10	DSP10	3
27644-3	DPP3	1
-4	DPP4	1
-5	DPP5	1
-6	DPP6	2
-8	DPP8	2
-10	DPP10	3
27645-3A	ESP3L	1
-4A	ESP4L	1
-5A	ESP5A	2
-6A	ESP6A	3
-3	ESP3	1
-4	ESP4	1
-5	ESP5	2
-6	ESP6	3
-8	ESP8	4
-10	ESP10	5
27646-38	MS3800	2
-39	MS3900	2
-40	MS4000	3
-41	MS4100	4
-42	MS4200	4
-43	MS4300	5
-44	MS4400	5
-45	MS4500	6
-46	MS4600	6

*Values to be specified in purchase orders.

MS No.	Ref. No.	Torque inch-oz
27647-4A	DM4C2	1
-4	DM4L	1
-5	DM5	1
-6	DM6	2
-8	DM8	2
27648-16	EP16S	5
-21	EP21S	7
-23	EP23S	8
-25	EP25S	9
-29	EP29S	12
-33	EP33S	14
-37	EP37S	17
-47	EP47S	24
-49	EP49S	25
-53	EP53S	28
27649-3	AM3AK	1
-4	AM4AK	1.5
-5	AM5AK	1.5
-6	AM6AK	2
-8	AM8AK	2.5
-10	AM10AK	3
-12	AM12AK	3
-16	AM16AK	4
-20	AM20AK	5
21428-38	MS3800	2
-39	MS3900	2
-40	MS4000	3
-41	MS4100	4
-42	MS4200	4
-43	MS4300	5
-44	MS4400	5
-45	MS4500	6
-46	MS4600	6

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for 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 Test records: The manufacturer shall maintain a record showing quantitative results of all tests performed to the requirements of this specification. 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.

4.2 Classification of inspections:

The inspection and testing of the bearings shall be classified as follows:

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

4.3 Qualification inspection:

Initial qualification inspection consists of all requirements of this specification. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.

4.3.1 Inspection samples: Unless otherwise specified by the qualifying activity (see 6.3), each bearing size shall be tested. The number of specimens of each size shall be as indicated in Table II. The sample shall be manufactured with equipment and procedures normally used in production.

4.3.2 Inspection routine: The qualification tests shall include all of the examinations and tests specified under 4.5. Tests shall be conducted in the order specified in Table II.

4.3.3 Test reports: The manufacturer's test report shall be prepared in accordance with MIL-STD-831 and the qualifying activity authorization letter (see 6.2). The report shall include a dated drawing which shall describe in detail the manufacturer's product by specifying all dimensions and tolerances, materials selected, lubricant, plating, and heat treatment. Any information the manufacturer deems proprietary must be so indicated.

4.3.4 Qualification failure: Failure of any requirement of this specification shall be cause for refusal to grant qualification.

4.3.5 Retention of qualification: To retain qualification, a summary of the inspection for reliability provisions tests results (see 4.4.3) shall be furnished to the qualifying activity (see 6.2) at two year intervals and shall cover the results of inspection for reliability provisions tests performed during that period. The summary shall also include the number and type of any part failures and shall be forwarded via the Government inspector to the activity responsible for qualification (see 6.2). Failure to furnish the summary shall result in loss of qualification for that product. The qualifying activity shall establish the initial starting date and reserve the right to require samples to be submitted with the test data.

4.4 Quality conformance tests:

The quality conformance tests shall consist of sampling tests specified in 4.4.3 on each lot of bearings.

4.4.1 Lot: A lot shall consist of bearings of one type and size offered for delivery at one time.

TABLE II. Qualification inspection samples.

Examination or Test	Sample Number																									Test paragraph
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Examination of product	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4.5.1
Preservation, packaging, packing and marking	X	X	X	X	X	X																				4.6
Radial and lateral eccentricity	X	X	X	X	X	X	X	X	X	X																4.5.2
Out of roundness	X	X	X	X	X	X	X	X	X	X																4.5.2.1
Starting torque (before)											X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4.5.12
Radial limit load											X	X	X													4.5.3.1
Radial static fracture load											X	X	X													4.5.3.2
Axial limit load														X	X	X										4.5.4.1
Axial static fracture load														X	X	X										4.5.4.2
Radial play	X	X	X	X	X	X	X	X	X	X																4.5.5.1
Axial play	X	X	X	X	X	X	X	X	X	X																4.5.5.2
Radial dynamic load																	X	X	X	X	X	X	X	X	X	4.5.3.3
Starting torque (after)											X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4.6.12
Plating	X	X																								4.5.6
Seals			X	X	X																					4.5.7
Hardness	X																									4.5.9
Surface roughness	X	X	X																							4.5.8
Stabilization						X	X	X																		4.5.10
Lubrication	X	X	X																							4.5.11

4.4.2 Sample for quality conformance inspection: A random sample of bearings shall be selected in accordance with MIL-STD-105, Inspection Level II, AQL 1.0, except torque shall be inspected in accordance with MIL-STD-105, Inspection Level I, AQL 0.40.

4.4.3 Inspection for reliability provisions: Samples, as specified in 4.4.2 shall be examined for the following:

a. Dimensions (4.5.1)
b. Identification of product (4.5.1)
c. Examination of product (4.5.1)
d. Workmanship (4.5.1)
e. Radial or axial play (4.5.5.1 or 4.5.5.2)
f. Bearing starting torque (4.5.12)

In addition, laboratory verification of all other tests shall be performed on random samples from periodic lots as specified by the procuring activity (see 6.2) to determine continued performance with the requirements of this specification.

4.5 Test methods:

4.5.1 Examination of product: Each bearing shall be carefully examined to determine conformance with all requirements of this specification as to dimensions, lubrication, identification, and workmanship. In addition, all bearings shall be inspected by manual rotation and may be rejected if there is frequent and regular catching or binding as might be caused in interference of balls with loading slots or filling notches. Due regard shall be given to the fact that bearings without retainers or separators are likely not to have absolute freedom of rotation because of adjacent balls rubbing each other.

4.5.2 Radial and lateral eccentricity: Where specified in the applicable military standard ten bearings shall be checked. Each bearing shall be mounted on a vertical axis. The radial eccentricity of the bearing inner race shall be measured by rotating the inner race, while preventing rotation of the outer race and measuring variations on a dial indicator placed radially against the outer race. For lateral eccentricity, the dial indicator shall be placed axially as shown on figure 1. The outer race radial and lateral eccentricity shall be determined by holding the inner race in a fixed position and rotating the outer race.

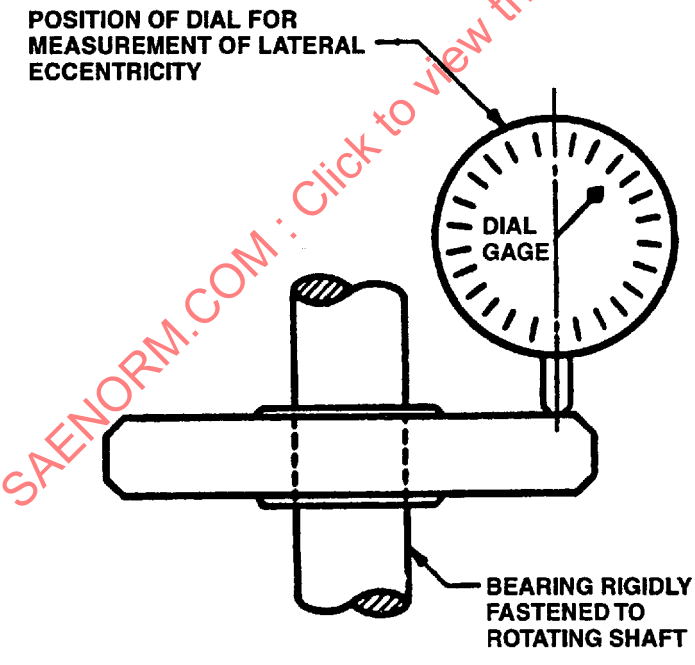

Figure 1. Test setup.

4.5.2.1 Out-of-roundness: The out-of-roundness shall be within the out-of-roundness tolerances specified for dimensions B and D on the applicable military standard. Ten military standard bearings shall be tested.

4.5.3 Radial strength: The starting torque shall be measured before and after these tests (see 3.15).

4.5.3.1 Limit load: Three bearings shall be tested in a rigid support as shown on figure 2. Each bearing shall be rotated by hand to determine smoothness of operation before testing. The pertinent radial limit load specified on the applicable military standard shall be applied for 1 minute. The load shall then be removed and the bearing shall be inspected for evidence of failure. In inspection by manual rotation after the radial load test, the bearing shall be subjected to a 5-1/2 pound radial load. If the smoothness of operation of the bearing has been lessened perceptibly, it shall be considered to have failed.

4.5.3.2 Radial static fracture loads: The minimum static fracture radial load of 1-1/2 times the pertinent rated limit load specified on the applicable military standard shall be applied to the bearings for 1 minute. After removal from the load, the bearings shall be examined. Bearings not capable of being turned by hand or having parts broken or cracked shall be considered to have failed. Three military standard bearings shall be tested.

4.5.3.3 Radial dynamic load: Ten bearings shall be mounted on a test fixture having suitable support bearings and drive linkages to cause oscillation of the inner ring. The load specified as 'radial load rating for average life of 10,000 cycles' specified on the applicable military standard shall be applied and maintained within ±1 percent. The bearings shall be oscillated through an arc of 90 degrees and back to the starting position for 15,000 cycles. The bearings shall be removed and examined for excessive roughness and looseness. Any bearing that does not operate smoothly because of ball or raceway defects shall be considered to have failed. Any bearing that does not operate smoothly because of ball or raceway defects shall be considered to have failed. Five bearings shall be disassembled and inspected for ball and raceway defects. No more than 5 bearings shall have failed this test.

4.5.4 Axial strength:

4.5.4.1 Limit load: Three bearings shall be individually subjected to the pertinent axial limit load specified on the applicable military standard, applied for 1 minute as indicated on figure 3. The load shall then be removed and the bearings shall be inspected for evidence of failure. The bearings shall then be turned over and the test repeated. In inspection by manual rotation after the axial load test, the bearings shall be subjected to 5-1/2 pound axial load. If the smoothness of operation of the bearings has been lessened perceptibly, they shall be considered to have failed.

4.5.4.2 Axial static fracture load: The minimum static fracture axial load of 1-1/2 times the pertinent rated limit load specified on the applicable military standard shall be applied to the bearings for 1 minute, as indicated on figure 3. The bearings shall then be turned over and the test repeated. Bearings not capable of being turned by hand after the test, or having parts broken or cracked shall be considered to have failed. Three military standard bearings shall be tested.

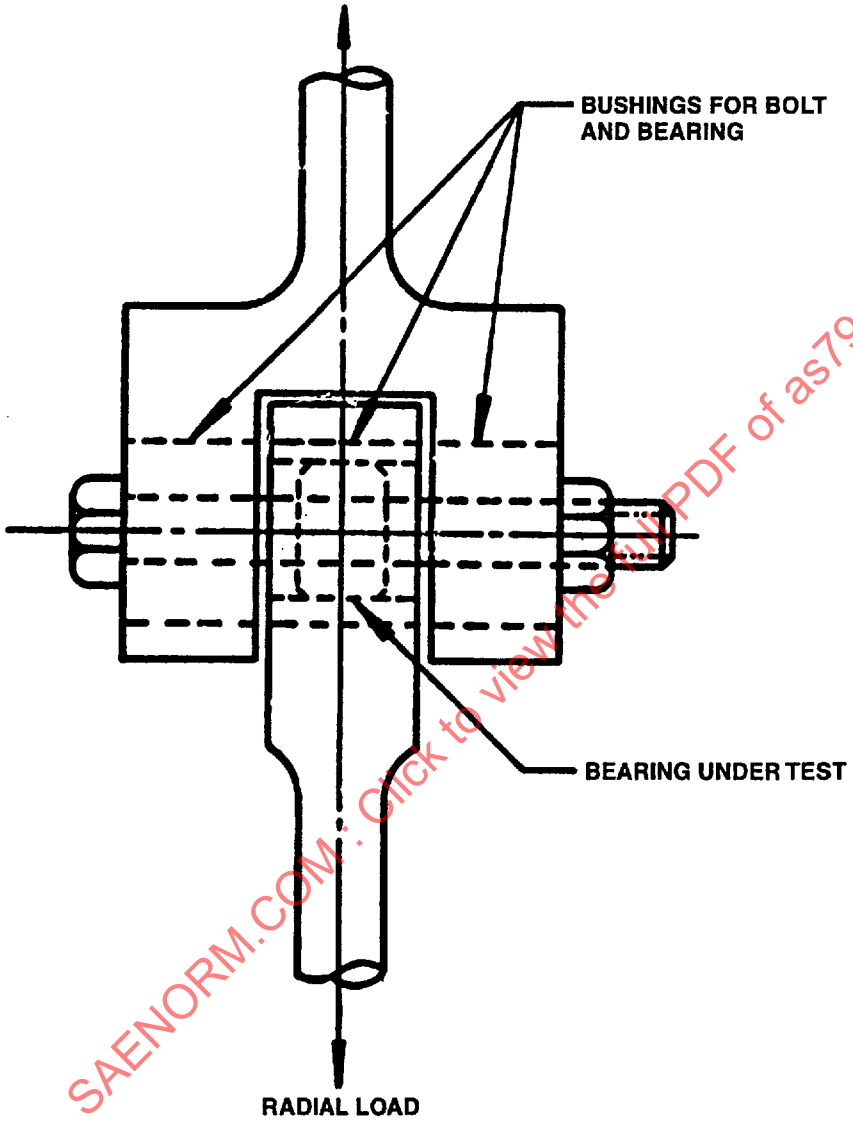

Figure 2. Radial load.

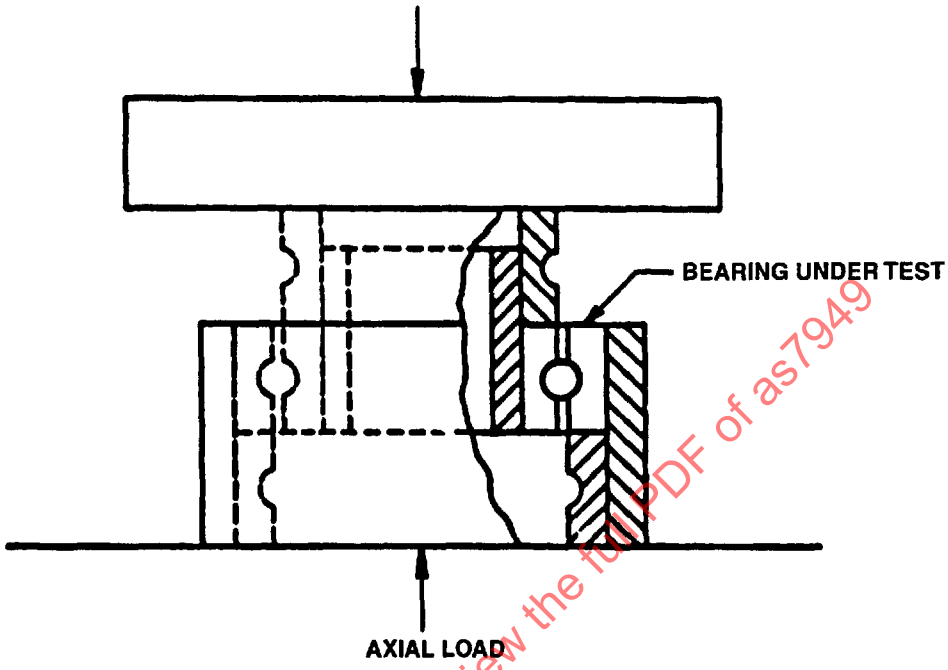

Figure 3. Axial load.

4.5.5 Internal play:

4.5.5.1 Radial: Ten bearings shall be tested at normal room temperature for radial play. The radial play shall be measured by means of a dial indicator with the bearings subjected to a 5-1/2 pound radial load applied alternately in opposite directions.

4.5.5.2 Axial: Ten bearings shall be tested at normal room temperature for axial play. The axial displacement shall be measured by means of a dial indicator with the bearings subjected to a 5-1/2 pound axial load applied alternately in opposite directions.

4.5.6 Plating: Tests to determine the thickness of plating shall be made on two military standard bearings to determine conformance to QQ-P-416.

4.5.7 Seal qualification:

4.5.7.1 Performance test: At least 1 bearing of each MS size shall be held at -65°F for 100 hours, then at 300°F for 100 hours while being operated in the test chamber at 3 revolutions per minute (RPM). The bearings shall be subjected to the sand and dust test, procedure I, of MIL-STD-810. Seal deterioration or ingress of dust that is detrimental to the bearing performance shall be considered seal failure. At least 50 percent of the lubricant by weight shall be retained in the bearing at the end of this test. Bearings shall be qualified with MIL-G-81322 grease only.

4.5.7.2 Seal retention: The seal retention test shall be performed in both directions on three bearings of each MS size shown in Table III. The test shall be conducted by inserting a bolt through the bore of the bearing and applying a torque as shown in Table III in the direction which would tend to cause the seal to be dislodged. The inner race shall then be rotated 90 degrees with respect to the other ring and the above test repeated. Figure 4 shows the test fixture to be employed in the test. Any seals that become loose, damaged or dislodged shall be considered failures and the complete lot rejected.

NOTE: Bolt head diameter must be less than diameter A specified for the applicable MS bearing.

TABLE III. Test torque for seal misalignment.

MS No. 27645	Min Torque to dislodge Seal In/Lbs	MS No. 27643	Min Torque to dislodge Seal In/Lbs
-3A	4	-3	8
-4A	6	-4	12
-5A	10	-5	28
-6A	8	-6	45
-3	6	-8	60
-4	5	-10	78
-5	16		
-6	18		
-8	20		
-10	25		