

AEROSPACE STANDARD

SAE AS7949

REV.
B

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Superseding AS7949A

(R) Bearings, Ball, Airframe, Antifriction,
General Standard for

NOTICE

This document includes cadmium as a plating material. The use of cadmium has been restricted and/or banned for use in many countries due to environmental and health concerns. The user should consult with local officials on applicable health and environmental regulations regarding its use.

1. SCOPE:

This standard covers ball bearings in the -65 to +350 °F temperature range as specified on the applicable drawing standards.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2417	Plating, Zinc-Nickel Alloy
AMS 3652	Polytetrafluoroethylene (PTFE) Film Non-Critical Grade
AMS 3666	Polytetrafluoroethylene (PTFE) Sheet, Glass Cloth Reinforced
AMS 6440	Steel, Bars, Forgings, and Tubing 1.45cr (0.98-1.10c) (SAE 52100) Premium Aircraft-Quality, Consumable Electrode Vacuum Melted
AMS 6444	Steel Bars, Forgings, and Tubing, 1.45cr (0.98 1.10c) for Bearing Applications
AMS-QQ-P-416	Plating, Cadmium (Electro deposited)
AS21428	Bearing, Ball, Airframe, Anti-friction, Extra Light Duty, Precision
AS21443	Bearing, Ball, Airframe, Anti-friction, Pulley Type
AS27640	Bearing, Ball, Airframe, Anti-friction, Heavy Duty
AS27641	Bearing, Ball, Airframe, Anti-friction, Intermediate Duty
AS27642	Bearing, Ball, Airframe, Extra Light Duty
AS27643	Bearing, Ball, Airframe, Anti-friction, Self-aligning, Double Row, Heavy Duty
AS27644	Bearing, Ball, Airframe, Anti-friction, Double Row, Heavy Duty
AS27645	Bearing, Ball, Airframe, Anti-friction, Self-aligning, Light and Heavy Duty
AS27646	Bearing, Ball, Airframe, Anti-friction, Extra Light Duty
AS27647	Bearing, Ball, Airframe, Anti-friction, Extra Wide, Double Row, Intermediate Duty
AS27648	Bearing, Ball, Airframe, Anti-friction, Externally Self-aligning, Extra Light Duty
AS27649	Bearing, Ball, Airframe, Anti-friction, Intermediate Duty

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2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor, West Conshohocken, PA 19428-2959.

ASTM E 1444 Standard Practice for Magnetic Particle Inspection

ASTM F 2215 Standard Specification for Balls, Bearings, Ferrous and Nonferrous for Use in Bearings, Valves, and Bearing Applications

2.3 ASME Publications:

Available from ASME, 22 Law Drive, Box 2900, Fairfield, NJ 07007-2900.

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

ANSI/ABMA STD 4 Gauging/Tolerancing Practices

2.4 ISO Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 12103-1 Arizona Road Dust

2.5 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Electronic copies may be obtained from <http://assist.daps.mil/quicksearch>

MIL-DTL-197 Packaging of Bearings, Antifriction, Associated Parts and Subassemblies

MIL-PRF-23827 Grease, Aircraft and Instrument, Gear and Actuator Screw

MIL-PRF-81322 Grease, Aircraft, General Purpose, Wide Temperature Range

MIL-STD-129 Standard Practice for Military Marking

MIL-STD-130 Identification Marking of U.S. Military Property

MIL-STD-2073-1 DoD Standard Practice for Military Packaging

3. REQUIREMENTS:

3.1 Drawing Standards:

The individual item requirements shall be as specified herein and in accordance with the applicable drawing standards (see 2.1). In the event of any conflict between the requirements of this general standard and the drawing standards, the latter shall govern.

3.2 Qualification:

The bearings furnished under this standard shall be products that are authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL-AS7949) before contract award (see 4.3 and 6.3).

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

3.2.2 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 QPL. If manufacturing operations are performed in more than one plant, the manufacturer's additional plant(s) shall be reported to the qualifying activity. 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.

3.3 Materials:

Material used to manufacture the bearing and its components shall conform to the applicable drawing standard. The lubricant used shall be qualified to the applicable grease specification (see 3.12).

3.4 Bearing Assembly:

The bearing assembly shall be as specified in the applicable drawing standard, but the details of the working parts shall be optional. Only factory-new bearings shall be furnished.

- 3.4.1 Out-of-Roundness: The maximum and minimum bore and outside diameter readings shall be within the out-of-roundness limits specified on the applicable drawing standard. The average bore and outer diameter measurements shall be within the tolerances specified for dimensions "B" and "D" of the applicable drawing standard. Bearings shall be tested in accordance with 4.5.1.1.
- 3.4.2 Seals: Seals shall prevent the entrance of contaminants and retain the lubricant. Seals shall be securely attached to the outer ring. All relative motion shall be between the seal and the inner ring. Removable design seals, which could lead to unintended bearing disassembly, shall not be permitted on internal self-aligned bearings.
 - 3.4.2.1 Seal Test (Grease Retention): The seals shall be capable of withstanding the test requirements as specified in 4.5.2.1 without failure. Grease conforming to MIL-PRF-81322 shall be injected into the bearing. The amount of grease shall be measured by weight and shall be at least 80% of the minimum theoretical volume within the bearing. Not less than 25% of the bearing lubricant by weight shall be retained in the bearing at the end of the test.
 - 3.4.2.2 Dust Test: After completion of the dust test specified in 4.5.2.2, the tested bearings shall meet the following requirements:
 - a. Radial clearance shall not increase more than 50% or 0.0002 in over the pretest value, whichever is greater.
 - b. Starting torque shall not increase more than 100% or 2 in-oz over the pretest value, whichever is greater.
 - 3.4.2.3 Seal Retention: For bearings of internal self-aligning design, the seal retention shall be tested in accordance with 4.5.2.3. The seals shall meet the minimum torque to dislodge the seal as specified on the applicable drawing standard. Any seal that is damaged or dislodged prior to achieving the minimum torque value shall be considered to have failed.

3.5 Interchangeability:

All parts having the same MS part number shall be functionally and dimensionally interchangeable.

3.6 Strength Performance:

3.6.1 Radial Strength:

- 3.6.1.1 Radial Limit Load: The bearings shall meet the radial limit loads specified on the applicable drawing standard when tested in accordance with 4.5.3.1. If the smoothness of operation of the bearings has lessened perceptibly, they shall be considered to have failed.
- 3.6.1.2 Radial Static Ultimate Load: The minimum radial static ultimate strength shall be 1.5 times the radial limit load value specified on the applicable drawing standard when tested in accordance with 4.5.3.2. Bearings shall be capable of being turned by hand and shall not have broken or cracked parts after applying 1.5 times the applicable radial limit load. After the test, all rings and balls shall pass a magnetic particle inspection per ASTM E 1444.
- 3.6.1.3 Radial Dynamic Load: The bearing shall have a radial dynamic load rating of not less than the value specified on the applicable drawing standard when tested in accordance with 4.5.3.3. The bearing shall have an L_{50} life of 10,000 cycles, except for bearings covered by AS21443 which shall have an L_{10} of 3,500 cycles. A bearing shall be considered to have failed when there is any evidence of the following defects: (1) wear of the outer raceway greater than 0.002 in; (2) 0.002 in radial displacement during testing; (3) spalling or cracking detected by magnetic particle inspection per ASTM E 1444; or (4) fracture of any component.

3.6.2 Axial Strength:

- 3.6.2.1 Axial Limit Load: The bearings shall meet the axial limit loads specified on the applicable drawing standard when tested in accordance with 4.5.4.1. If the smoothness of operation of the bearings has lessened perceptibly, they shall be considered to have failed.
- 3.6.2.2 Axial Static Ultimate Load: The axial ultimate strength shall be 1.5 times the axial load value specified on the applicable drawing standard when tested in accordance with 4.5.4.2. Bearings shall be capable of being turned by hand and shall have no cracks or broken parts after applying 1.5 times the applicable axial load. After the test, all rings and balls shall pass a magnetic particle inspection per ASTM E 1444.

3.7 Internal Clearance:

Radial and axial internal clearance shall conform to the applicable drawing standard when measured in accordance with 4.5.5.

3.8 Plating (Except for the AS27649 Bearings):

When tested in accordance with 4.5.6, all external surfaces of the bearing excluding the inner ring bore and chamfer, seal retainers, and seals, shall be cadmium plated per AMS-QQ-P-416, Type I, Class 2 or zinc-nickel plated in accordance with AMS 2417, Type 2. The plating thickness shall be 0.0003 to 0.0006 in. The plating thickness of the bore chamfers shall be a maximum of 0.0006 in. Plating on the ball loading slot is optional.

3.9 Surface Roughness:

The surface roughness shall be measured in accordance with 4.5.7, and shall conform to the values on the applicable drawing standard.

3.10 Hardness:

The rings and balls shall be tested in accordance with 4.5.8. The hardness shall be in accordance with values on the applicable drawing standard.

3.11 Radial and Lateral Eccentricity:

Non-self-aligning bearings shall be tested in accordance with 4.5.9. The eccentricity values shall be in accordance with the limits specified in the applicable drawing standard.

3.12 Lubrication:

The bearings shall be packed with grease qualified to MIL-PRF-81322 for -65 to 350 °F operating range or MIL-PRF-23827 for -65 to 250 °F operating range. The bearings shall be filled with lubricant not less than 80% by volume, and shall be cleaned before the lubricant is injected into the bearings. Bearings shall not have been lubricated more than 36 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 the same grease that is packed in the bearing. Inspection of lubricant shall be in accordance with 4.5.10.

3.13 Dimensional Stability:

Bearings shall exhibit dimensional stability by not changing more than 0.0001 in per inch diameter from the last reading when tested in accordance with 4.5.11.

3.14 Starting Torque:

Starting torque shall be within the allowable values specified in the applicable drawing standard. The amount of torque required to begin rotation of the bearing shall be measured in accordance with 4.5.12.

3.15 Marking:

Each bearing shall be permanently marked with the bearing manufacturer's part number, name or symbol (in accordance with MIL-STD-129 and MIL-STD-130), and lot control number. Each bearing package shall be marked with the complete MS number, manufacturer's name, brand, or trademark, part number, lot number and date of lubrication (month and year).

3.16 Workmanship:

Workmanship shall be in accordance with high grade, aircraft bearing manufacturing practices. Bearings shall be free from defects such as rust, dirt, and broken or cracked parts or other defects, which may adversely affect performance of the bearing.

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 (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase 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 qualifying activity. The qualifying activity reserves the rights to perform any of the inspections set forth in this standard where such inspections are deemed necessary to ensure product and/or services conform to prescribed requirements.

- 4.1.1 Responsibility for Compliance: All items shall meet the requirements of Sections 3 and 5. The inspections set forth in this standard shall become part of the supplier's overall inspection system or quality program. The absence of any inspection requirements in the standard shall not relieve the supplier of the responsibility of ensuring all products or services submitted 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 customer to accept defective material.

4.2 Classification of Inspections:

The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (4.3)
- b. Conformance inspection (4.4)

Each bearing shall be inspected in accordance with ANSI/ABMA STD 4 Gauging/Tolerancing Practices.

4.3 Qualification Inspection:

Initial qualification inspection consists of the tests listed in Table 1, and shall be performed at a laboratory acceptable to the qualifying activity (see 6.3) on sample bearings selected in Table 2. Bearings shall be qualified with MIL-PRF-81322 grease only.

- 4.3.1 Inspection Samples: Unless otherwise specified by the qualifying activity (see 6.3), representative sizes for qualification testing are listed in Table 2. Twenty-eight samples of each size shall be selected and tested according to the inspections listed in Table 1. The bearing samples shall be manufactured with equipment and procedures used in production.
- 4.3.2 Inspection Routine: The qualification tests shall include all of the examinations and tests specified under 4.3. Tests shall be conducted in the order listed in Table 1.
- 4.3.3 Qualification Failure: Any failures during examinations or tests shall be reported to the qualifying activity before testing continues. Based on corrective action, authorization to complete the qualification test may be granted by the qualifying activity. Failure of any test shall be cause for refusal to grant qualification.
- 4.3.4 Retention of Qualification: In order to retain qualification, the results of the retention of qualification tests, listed in Table 3, shall be furnished to the qualifying activity at 60 month intervals. One part number from each AS sheet for which the manufacturer is qualified shall be tested. The qualifying activity shall select the dash number to be tested. To retain qualification, the manufacturer's products shall pass all the retention of qualification tests. Failure to furnish the test information shall result in loss of qualification for that product. The qualifying activity may periodically request samples for in-house verification testing.
- Failure of Retention of Qualification: Any failures during retention of qualification testing should be reported immediately to the qualifying activity. Authorization to continue retention of qualification testing will be based on corrective action acceptance by the qualifying activity.
- 4.3.5 Qualification by Similarity: qualification by similarity to qualified products, or to products being submitted for qualification, is permissible when materials, designs, or manufacturing processes are identical. When materials, designs, or manufacturing process differ, sufficient testing of the affected characteristics will be required to obtain qualification by similarity. Full details of the similarity and differences, along with the proposed tests, shall be submitted to the qualifying activity for approval prior to the commencing of testing.

TABLE 1 - Qualification Inspection

Test	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	26	27	28	Requirement paragraph	Test Paragraph
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	X	X	X	3.1, 3.3 3.15, 3.16	4.5.1
Radial and lateral eccentricity	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	X	X	X	3.11	4.5.9
Out-of-roundness	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	X	X	X	3.4.1	4.5.1.1
Starting torque	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	X	X	X	3.14	4.5.12
Radial limit load	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	X	X	X	3.6.1.1	4.5.3.1
Radial static	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	X	X	X	3.6.1.2	4.5.3.2
Fracture load	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	X	X	X	3.6.2.1	4.5.4.1
Axial limit load	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	X	X	X	3.6.2.2	4.5.4.2
Axial static	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	X	X	X	3.7	4.5.5.1
Fracture load	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	X	X	X	3.7	4.5.5.1
Radial internal Clearance	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	X	X	X	3.7	4.5.5.2
Axial internal Clearance	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	X	X	X	3.6.1.3	4.5.3.3
Radial dynamic Load	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	X	X	X	3.12	4.5.10
Lubrication	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	X	X	X	3.8	4.5.6
Plating	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	X	X	X	3.9	4.5.7
Surface	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	X	X	X	3.10	4.5.8
Roughness	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	X	X	X	3.4.2.1	4.5.2.1
Hardness	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	X	X	X	3.4.2.2	4.5.2.2
Seal Test	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	X	X	X	3.13	4.5.11
Dust Test	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	X	X	X	3.4.2.3	4.5.2.3
Stabilization	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	X	X	X	3.4.2.3	4.5.2.3
Seal Retention	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	X	X	X	3.4.2.3	4.5.2.3

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TABLE 2 - Representative Sizes for Qualification Testing

Testing & Approval of These Sizes	Gain Approval for These Additional Sizes
MS21428-39 -42 -45	-38 and -40 -41 and -43 -44 and -46
MS21443-3A -4B -5B -8 -10	-3B -4A and -4C (no others) (no others) -5A
MS27640-3 -5 -10	-3A and -4 -6 -8
MS27641-4 -8 -16	-3 and -5 -6 and -10 -12 and -20
MS27642-16 -23 -33 -49 -60 -72 -80 -92	-21 -25 -29 and -37 -47 and -52 -56 and -64 -68 -76 and -84 -88 and -96
MS27643-4 -8	-3 and -5 -6 and -10
MS27644-4 -8	-3 and -5 -6 and -10
MS27645-3A -5A -4 -8	-4A -6A -3 and -5 -6 and -10
MS27646-39 -42 -45	-38 and -40 -41 and -43 -44 and -46
MS27647-4 with relube grooves -8 with relube grooves	-4A and -5 with or w/o relube grooves -6 with or w/o relube grooves
MS27648-16 -23 -33 -48	-21 -25 -29 and -37 -47 and -49
MS27649-4 -8 -16	-3 and -5 -6 and -10 -12 and -20

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TABLE 3 - Retention of Qualification Tests

Examination or Test	Sample Number													Requirement Paragraph	Test Paragraph
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Examination of product	X	X	X	X	X	X	X	X	X	X	X	X	X	3.1, 3.3, 3.15, 3.16	4.5.1
Starting torque	X	X	X	X	X	X	X	X	X	X				3.14	4.5.12
Radial and lateral eccentricity	X	X	X	X	X	X	X	X	X	X				3.11	4.5.9
Out-of-roundness	X	X	X	X	X	X	X	X	X	X				3.4.1	4.5.1.1
Radial internal clearance	X	X	X	X	X	X	X	X	X	X				3.7	4.5.5.1
Axial internal clearance	X	X	X	X	X	X	X	X	X	X				3.7	4.5.5.2
Seal retention test	X	X	X											3.4.2.3	4.5.2.3
Plating	X	X	X											3.8	4.5.6
Hardness	X	X	X											3.10	4.5.8
Surface roughness	X	X	X											3.9	4.5.7
Lubrication	X	X	X											3.12	4.5.10
Radial dynamic load				X	X	X	X	X	X	X	X	X	X	3.6.1.3	4.5.3.3

4.4 Conformance Inspection:

Conformance inspection shall consist of sampling tests specified in 4.4.2 on each lot of bearings.

4.4.1 Lot Control (Manufacturing Lot):

- 4.4.1.1 Inspection Lot: The inspection lot shall consist of finished bearings having a single part number manufactured by the procedures established for the originally qualified bearings and produced as one continuous batch which receives final inspection at the same location. The Inspection Lot shall be identified by a unique number (Manufacturer's Lot Control Number) to be included on the bearing, in the package marking and on the associated certification that accompanies the shipping paperwork. The manufacturer's lot control number shall be traceable to the finished bearing assembly and the quality conformance inspection or acceptance tests. The samples taken for acceptance testing shall be randomly selected to ensure that they are representative of the production run/lot.

The manufacturer shall have a quality control/assurance system in effect that ensures traceability of the rings and balls or rollers (main components) that make up the final bearing assembly and documentation that provides objective evidence that the components meet the drawing standard requirements. Individual component lots shall keep their integrity through all the manufacturing, storage and process operations. The final bearing assembly that makes up an individual production run may have more than one component lot number as long as the traceability is maintained.

- 4.4.2 Conformance Tests: Samples shall be examined for conformance to the tests listed in Table 4. The sample bearings shall be selected at random from each inspection lot in accordance with Table 5. 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.

4.5 Test Methods:

- 4.5.1 Examination of Product: The bearing sample shall be examined to determine compliance with respect to dimensions, lubrication, and identification (see 3.1, 3.3, 3.15, 3.16).
- 4.5.1.1 Out-of-Roundness: On each bearing designated for out-of-roundness inspection, the bore and outside diameters shall be checked for the full 360° using a two-point diameter gage. Maximum, minimum, and average diameters shall be determined (see 3.4.1).

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TABLE 4 - Conformance Tests

Examination or Test	Major Characteristic	Minor Characteristic	Requirement Paragraph	Test Paragraph
Dimensions				
Bore "B"	X		3.4	4.5.1
O.D. "D"	X		3.4	4.5.1
Inner Ring Width "W"	X		3.4	4.5.1
Outer Ring Width "H"		X	3.4	4.5.1
Inner Ring Chamfer "E"		X	3.4	4.5.1
Outer Ring Chamfer "C"		X	3.4	4.5.1
Workmanship		X	3.16	4.5.1
Marking		X	3.15	4.4.1.1
Hardness		X	3.10	4.5.8
Surface Roughness		X	3.9	4.5.7
Lubrication		X	3.12	4.5.10
Radial Internal Clearance	X		3.7	4.5.5.1
Axial Internal Clearance	X		3.7	4.5.5.2
Plating		X	3.8	4.5.6
Starting Torque	X		3.14	4.5.12

TABLE 5 - Sampling Plan for Quality Conformance Tests

Lot Size	Sample Size "A" indicates the entire lot must be inspected	
	Major Characteristics	Minor Characteristics
1-2	A	A
3-8	A	3
9-12	A	3
13-15	13	3
16-25	13	3
26-50	13	5
51-90	13	6
91-150	13	7
151-280	20	10
281-500	29	11
501-1200	34	15
1201-1249	42	18
1250-3200	42	18
3201-10,000	50	22

4.5.2 Seal Performance Tests:

- 4.5.2.1 Seal Test (Grease Retention): Three bearings of each MS size shall be maintained at a minimum of 250 °F +10 °F/ -0 °F for 100 hours while being rotated in a test chamber at 3 rpm $\pm$ 1 rpm with no applied load (successful testing of parts at temperatures above 260° F shall not be cause for rejection). The bearings shall be mounted on a horizontal shaft with the bodies held stationary. Prior to testing the bearings shall be wiped free of grease and weighed. After testing they shall again be wiped free of grease and weighed. Then all bearing components shall be weighed again after being thoroughly washed to remove all grease. The percent grease fill prior to testing and the percent of the grease retained shall be calculated as follows:

$$\% \text{ grease retained} = 100(W_{pt} - W_d)/(W - W_d) \quad (\text{Eq.1})$$

where:

W = Weight of the greased bearing with grease wiped off external surfaces

W_d = Dry weight of the bearing components after cleaning

W_{pt} = Weight of bearing after testing with grease wiped off external surfaces

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- 4.5.2.2 Dust Test (Except AS21428 and AS27646): Three bearings of each representative size shall be subjected to the dust test. The bearings shall be tested at $77^{\circ}\text{F} \pm 15^{\circ}\text{F}$ in the closed test chamber described in 4.5.2.2.2. Duration of test shall be 48 hours for rigid bearings and 24 hours for internal self-aligning bearings. The bearings shall be mounted on a horizontal shaft and shall be rotated at $3\text{ rpm} \pm 1\text{ rpm}$ with no applied bearing load and with the outer rings held stationary. Pre-test measurements of starting torque and radial clearance shall be recorded. Post-test measurements for starting torque shall be made in the "as tested" condition. Before post-test measurements of radial clearance, seal retainers shall be removed and the bearings cleaned thoroughly and re-lubricated with MIL-PRF-81322 grease. Bearings shall be reassembled before radial clearance is measured (see 3.4.2.2).
- 4.5.2.2.1 Test Media (Dust): The test media shall be Arizona Road Dust in accordance with ISO 12103-1 supplied to SAE coarse grade (see 6.4). The coarse mixture shall be:

TABLE 6

Particle Size	Percent (%)
$0 \geq < 5\text{ }\mu\text{m}$	12
$5 \geq < 10\text{ }\mu\text{m}$	12
$10 \geq < 20\text{ }\mu\text{m}$	14
$20 \geq < 40\text{ }\mu\text{m}$	23
$40 \geq < 80\text{ }\mu\text{m}$	30
$80 \geq < 200\text{ }\mu\text{m}$	9
	100%

- 4.5.2.2.2 Test Chamber: The test chamber shall be cubic, 2 ft per side, and shall provide viewing ports for test observation. A minimum layer of 1 inch test media (see 4.5.2.2.1) shall be maintained on the chamber floor. Test chamber actuation shall provide continuous movement of dust, creating a uniform cloud that shall render the test specimens invisible through the view ports. Test specimens shall have a minimum spacing of 3 inches from each other and from the chamber walls. The mounting shaft centerline shall be 8 to 16 inches above the chamber bottom.
- 4.5.2.3 Seal Retention Test: The seal retention test shall be performed on three bearings of each representative size of self-aligning bearings. Figure 1 shows the test fixture to be employed in the test. The test shall be conducted at four outer ring positions (0° , 45° , 90° , and 135°) by inserting a bolt through the bore of the bearing and applying the minimum torque to dislodge the seal as specified in the applicable drawing standard. The torque shall be applied alternately in both directions as shown in Figure 1 so that each seal is tested in two locations before turning the bearing 45° for the next check. The outer race shall then be rotated 45° with respect to the torque arm and the test repeated until all outer ring positions have been tested (see 3.4.2.2).

NOTE: The bolt head diameter shall be less than the shoulder diameter, inner ring (dimension $\varnothing A$ in the drawing standards) of the bearing tested.

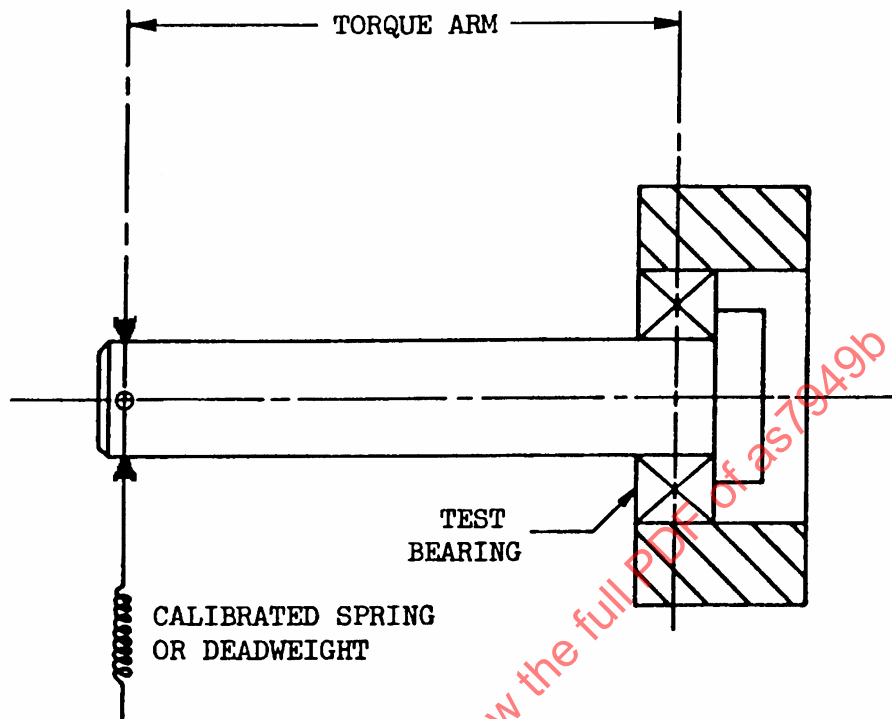


FIGURE 1 - Test Fixture Used to Determine Torque Required to Dislodge Seal in Bearing

4.5.3 Radial Strength Test:

- 4.5.3.1 Radial Limit Load Test: Three bearings of each representative size shall be tested in a rigid support as shown in Figure 2. While a 5-1/2 lb radial load is applied, each bearing shall be manually rotated to determine the smoothness of operation before the test. The radial limit load specified on the applicable drawing standard shall then be applied for 1 min. After removing the load, each bearing shall be inspected for evidence of failure by manual rotation of the bearings while a 5-1/2 lb radial load is applied (see 3.6.1.1).

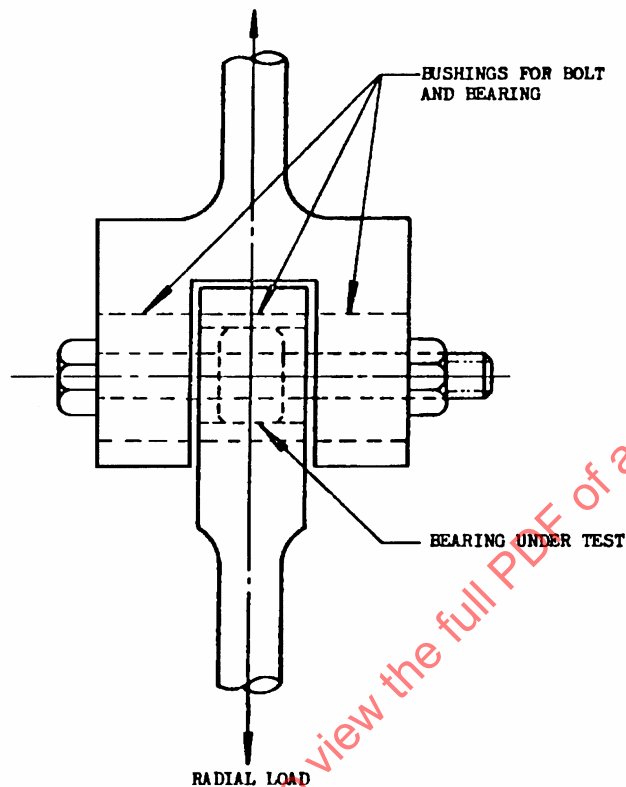


FIGURE 2 - Radial Load

- 4.5.3.2 Radial Static Ultimate Load Test: Three bearings of each representative size shall be tested in a rigid support as shown in Figure 2. The minimum radial static ultimate load of 1.5 times the applicable rated limit load specified on the applicable drawing standard shall be applied to the bearings for 1 min. After removal from the load, the bearings shall be examined (see 3.6.1.2).
- 4.5.3.3 Radial Dynamic Load Test: Ten bearings of each representative size submitted shall be subjected to a radial dynamic load not less than that specified in the applicable drawing standard. The bearing shall be mounted on a test fixture having support bearings and drive linkages to provide oscillation of the inner ring. The bearing shall be oscillated through an arc of 90° and back to the starting position for 10,000 cycles, or until failure. The bearings shall be disassembled and the raceways inspected. The outer raceway may need to be cut for inspection (see 3.6.1.3).

4.5.4 Axial Strength Test:

- 4.5.4.1 Axial Limit Load Test: Three bearings of each representative size shall be tested in a rigid support as shown in Figure 3. While a 5-1/2 lb axial load is applied, each bearing shall be manually rotated to determine smoothness of operation before the test. The axial limit load listed on the applicable drawing standard shall be applied for 1 min. After removing the load, each bearing shall be inspected for evidence of failure by manual rotation of the bearings while a 5-1/2 lb axial load is applied (see 3.6.2.1).

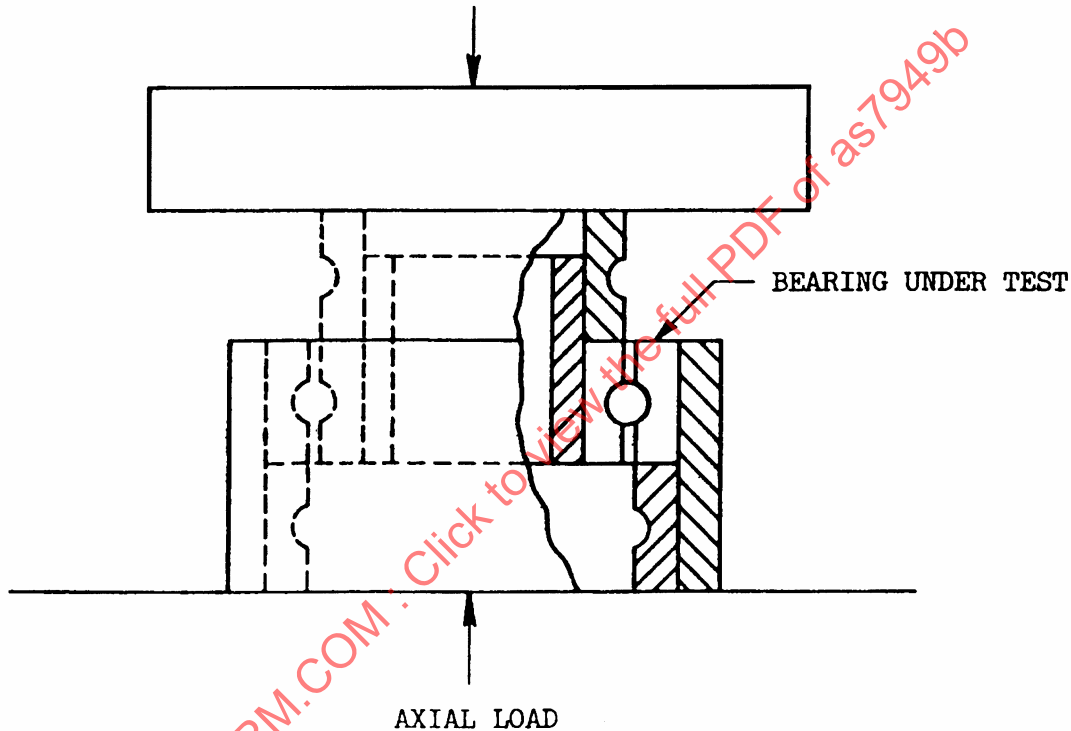


FIGURE 3 - Axial Load

- 4.5.4.2 Axial Static Ultimate Load Test: Three bearings of each representative size shall be tested in a rigid support as shown in Figure 3. The minimum axial static ultimate load of 1.5 times the rated limit load specified on the applicable drawing standard shall be applied to the bearings for 1 min, as indicated in Figure 3. After removal from the test fixture, the bearing shall then be examined (see 3.6.2.2).

4.5.5 Internal Clearance:

- 4.5.5.1 Radial Internal Clearance: The bearings shall be tested at room temperature ($77^{\circ}\text{F} \pm 5^{\circ}\text{F}$) for radial internal clearance. The radial internal clearance shall be measured by means such as a dial indicator or equivalent, while subjecting the bearing to a 5.5 lb radial load applied alternately in opposite directions, see Figure 4 and 3.7.