

 <b>AEROSPACE STANDARD</b>	<b>AS81936</b>	<b>REV. A</b>
	Issued	1998-05
	Revised	2006-06
Superseding AS81936		
(R) Bearings, Plain, Self-Aligning (Cu-Be Ball, CRES Race) General Specification For  FSC 3120		

## RATIONALE

This document has been revised to update references to current specifications and standards; to update references to the qualifying activity; to aid users by including reference to requirement paragraphs in Qualification Tests table; to revise Quality Conformance requirements to account for the cancellation of MIL-STD-105; to incorporate packaging requirements adopted by the ACBG; and to clarify figures."

## NOTICE

Under Department of Defense Policies and Procedures, any qualification requirements and associated qualified products lists are mandatory for DoD contracts. Any material relating to Qualified Products Lists (QPLs) has not been adopted by SAE and is not part of this SAE technical document.

### 1. SCOPE

#### 1.1 Scope

This SAE Aerospace Standard (AS) covers airframe plain spherical bearings utilizing a copper-beryllium ball and corrosion resistant steel outer race for use between -65 °F and +350 °F.

### 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.

#### 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AS81936/1 Bearing, Plain, Self-Aligning, Cu-Be Ball CRES Race (With Staking Groove) -65°F to +350°F

AS81936/2 Bearing, Plain, Self-Aligning, Cu-Be Ball, CRES Race, -65°F to +350°F

AMS 2759 Heat Treatment of Steel Parts, General Requirements

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## 2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

ASTM D 3951 Standard Practice for Commercial Packaging

ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials (DoD adopted)

## 2.3 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, [www.asme.org](http://www.asme.org).

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

ASME Y14.24 Types and Applications of Engineering Drawings

ASME Y14.34M Associated Lists

ASME Y14.35M Revision of Engineering Drawings and Associated Documents

ASME Y14.100 Engineering Drawing Practices

## 2.4 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-DTL-197 Bearing, Anti-friction, Associated Parts, and Subassemblies, Packaging of

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

MIL-STD-129 Military Marking for Shipment and Storage

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

MIL-STD-2073 Standard Practice for Military Packaging

## 3. REQUIREMENTS

### 3.1 Qualification

The bearings furnished under this document shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL-AS81936) at the time set for opening of bids (see 4.3 and 6.3).

#### 3.1.1 Product Design Change

Any change in product design or description shall be reported to the qualifying activity and shall require requalification of the product to an extent determined by the activity responsible for qualification.

### 3.1.2 AS Sheets

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

### 3.1.3 Product Manufacture

Except for the assembly operation, the manufacturer is permitted to sub-contract manufacturing operations without violating the requirements of 3.1.1. The assembly operation shall be performed in the plant listed on the Qualified Products List.

## 3.2 Materials

The ball and outer race shall be in accordance with AS81936/1 or AS81936/2.

## 3.3 Design

Bearing design shall conform to that specified on AS81936/1 or AS81936/2.

## 3.4 Construction

Except as otherwise specified, the details of the working parts shall be optional. The bearings shall not have loading slots.

### 3.4.1 Dimensions and Tolerances

Dimensions and tolerances shall be as specified on the applicable AS sheet. Dimensions not shown shall be at the option of the manufacturer.

### 3.4.2 Surface Texture

Surface textures shall have a roughness height rating (RHR) in accordance with ASME B46.1 and not in excess of the values shown on the applicable AS sheet.

### 3.4.3 Lubrication

The bearings shall be thoroughly cleaned and dried in accordance with MIL-DTL-197. The mating spherical surfaces lubricant groove and bore shall be coated with grease conforming to MIL-PRF-81322. The date of lubrication, month and year, shall be marked on each bearing package.

### 3.4.4 Hardness

The hardness shall be as specified on the applicable AS sheet.

### 3.4.5 Conformity

The conformity between the ball and race shall be checked in accordance with 4.6.6. Measurements shall be taken at a minimum of six positions, three uniformly spaced positions on each side of the lubrication groove. Ten percent of the race width on each edge shall be excluded from measurement and in addition, for sizes -12 and greater, 5% of the race width on each side of the lubrication groove shall be excluded. Variation between measured values shall not exceed 0.001 inch. Overforming within 10% of each side face (H/10) is not permitted. Underforming is not controlled.

### 3.5 Performance

#### 3.5.1 Radial Static Limit Load

After the radial static load listed on the applicable AS sheet has been applied as specified in 4.6.1, the permanent set shall not exceed 0.0020 inch for sizes -4 through -12 and 0.0030 inch for sizes -13 through -24.

#### 3.5.2 Axial Static Limit Load

After the axial static limit load specified on the applicable AS sheet has been applied as specified in 4.6.2, the permanent set shall not exceed 0.0040 inch.

#### 3.5.3 Ultimate Load

No fracture of the ball or race or push-out of the ball shall occur when 1-1/2 times the radial or axial load specified on the applicable AS sheet is applied, as specified in 4.6.1 and 4.6.2.

#### 3.5.4 Dynamic Tests

##### 3.5.4.1 Mode I Dynamic Test

After completion of the mode I dynamic test, as specified in 4.6.3.1, the maximum wear shall not exceed the values shown in Table 1. The bearing shall not crack, gall or otherwise fail.

TABLE 1 - MAXIMUM ALLOWABLE WEAR

Dash No.	Mode I	Mode II
-6	0.0010	0.0007
-12	0.0020	0.0012
-20	0.0032	0.0020

##### 3.5.4.2 Mode II Dynamic Test

After completion of the mode II dynamic test, as specified in 4.6.3.2, the maximum wear shall not exceed the values shown in Table 1. The bearing shall not crack, gall or otherwise fail.

#### 3.5.5 Self-Alignment

The bearing shall be self-aligning and shall permit the angular displacement specified on the applicable AS sheet.

#### 3.5.6 Internal Play

##### 3.5.6.1 Radial Play

When tested in accordance with 4.6.4.1 the radial play shall not exceed 0.0010 inch.

##### 3.5.6.2 Axial Play

When tested in accordance with 4.6.4.2 the axial play shall not exceed 0.0050 inch.

### 3.6 Interchangeability

All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. The drawing number requirements of ASME Y14.100, ASME Y14.24, ASME Y14.35M, and ASME Y14.34M shall govern documentation of and changes in the manufacturer's part numbers.

### 3.7 Identification of Product

Each bearing shall be permanently and legibly marked with the manufacturer's CAGE code, manufacturer's lot number, and Aerospace Standard part number as a minimum. Where practicable, identification shall appear on the side face of the race; otherwise identification shall appear on the periphery of the bearing outer race. Any additional marking is optional. Metal impression stamping is prohibited.

### 3.8 Workmanship

The bearings shall be free of tool marks, chatter waves, grinding scratches, pits, cracks, burrs, rough or sharp edges or other defects, and shall not catch or bind when manually oscillated or misaligned.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or order, the manufacturer 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 right to perform any of the qualification inspections set forth in this document where such inspections are deemed necessary to ensure products and services conform to prescribed requirements. The procurement activity reserves the right to perform any of the quality conformance inspections set forth in this document where such inspections are deemed necessary to ensure products 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 document shall become a part of the supplier's overall inspection system or quality program. The absence of any inspection requirements in this document or the AS sheets shall not relieve the supplier of the responsibility of ensuring that all products or supplies submitted to the customer 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 examination and testing of the bearings shall be classified as:

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

### 4.3 Qualification Inspection

Qualification inspection shall include all of the tests specified in Table 2.

TABLE 2 - QUALIFICATION TESTS

Examinations and Tests	Requirement Paragraph	Test Paragraph	Samples to be Tested <u>1/</u>
Examination of product	3.2, 3.4.1, 3.4.2, 3.7, 3.8	4.5.1	5
Radial static limit load	3.5.1, 3.5.3	4.6.1	3
Axial static limit load	3.5.2, 3.5.3	4.6.2	3
Mode I dynamic test	3.5.4.1	4.6.3.1	3
Mode II dynamic test	3.5.4.2	4.6.3.2	3 <u>2/</u>
Conformity	3.4.5	4.6.6	3
<u>1/</u> Sizes M81936/1-6, -12 and -20 only.			
<u>2/</u> At manufacturer's option, the Mode II tests may be performed with M81936/1-6R, -12R and -20R Bearings.			

#### 4.3.1 Sampling Instructions

Qualification test samples shall consist of twenty (20) bearings each of M81936/1-6, /1-12 and /1-20. In the event qualification is desired for only a part of the full series of bearings, the manufacturer may request authorization to substitute three other bearing sizes for qualification testing. The three substitute sizes shall be selected by the activity responsible for qualification.

All bearings necessary for test specified herein 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).

#### 4.3.2 Qualification Approval

Qualification approval of the three sizes authorized will secure qualification approval of the remaining sizes for which qualification is desired. Qualification approval of an M81936/1 bearing will secure qualification approval of the M81936/1R, M81936/2 and M81936/2R bearings of the same bore size.

#### 4.3.3 Certified Test Report

The manufacturer shall furnish a certified test report showing that the manufacturer's product satisfactorily conforms to this document. The test report shall include, as a minimum, actual results of the tests specified herein including copies of the load versus deflection curves from the radial and axial static limit load tests. When the report is submitted, it shall be accompanied by a dated drawing which completely describes the manufacturer's product by specifying all dimensions and tolerances, composition of the ball and outer race material, and heat treatment. The manufacturer's part number for each size shall be included on the drawing. A material certification shall be supplied in accordance with the requirements of 4.5.2.

#### 4.3.4 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 document 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 Systems Command, Code 435400A, 48110 Shaw Road Unit 5, Patuxent River, MD 20670-1906.

## 4.4 Quality Conformance Inspections

The quality conformance inspection of the bearings shall consist of the inspections listed in Table 3.

TABLE 3 - QUALITY CONFORMANCE INSPECTIONS

Examination or Test	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
Race 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
Staking Groove:					
Depth (1) "P"		X		3.4.1	4.5.1
Pitch Dia. (1) "E"		X		3.4.1	4.5.1
Root Radius (1)		X		3.4.1	4.5.1
Side Face Angle (1)		X		3.4.1	4.5.1
Outer Race Chamfer (2)	X			3.4.1	4.5.1
Lube Groove:					
Diameter "K"	X			3.4.1	4.5.1
Width "L"	X			3.4.1	4.5.1
Depth "N"	X			3.4.1	4.5.1
Radius "R"	X			3.4.1	4.5.1
(b) Identification of Product		X		3.7	4.5.1
(c) Workmanship		X		3.8	4.5.1
(d) Preparation for Delivery		X			4.5.3
(e) Conformity			Destructive Inspection	3.4.5	4.6.6
(f) Radial Play			100% Inspection	3.5.6.1	4.6.4.1
(g) Axial Play			100% Inspection	3.5.6.2	4.6.4.2
(h) Hardness			100% Inspection	3.4.4	4.6.5
Note: There are no critical characteristics. (1) Inspection applies only to AS81936/1 bearings. (2) Inspection applies only to AS81936/2 bearings.					

#### 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) of Table 3

The sample bearings shall be selected at random from each inspection lot in accordance with Table 4A. If no defect is found in the sample lot, 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) of Table 3

The sample bearings shall be selected at random from each inspection lot in accordance with Table 4B. (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 lot, the lot shall be accepted for these tests. A lot which was rejected under Normal Inspection of Table 4B shall be reinspected under Tightened Inspection of Table 4B. 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 standard.

##### 4.4.2.3 Sample for Quality Conformance Tests (f) Through (h) of Table 3

Inspection shall be 100% of the lot. All defective parts shall be removed from the lot.

TABLE 4A - SAMPLING PLAN FOR QUALITY CONFORMANCE INSPECTIONS EXCEPT DESTRUCTIVE INSPECTIONS ZERO-BASED ACCEPTANCE PLAN (C=0, I.E., NO REJECTS)

Lot Size	SAMPLE SIZE	
	Acceptance number in all cases is zero. "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	3
51-90	13	6
91-150	13	7
151-280	20	10
281-500	29	11
501-1200	34	15
1201-3200	42	18
3201-10,000	50	22



TABLE 4B - DESTRUCTIVE INSPECTIONS SAMPLING PLAN  
ZERO-BASED ACCEPTANCE PLAN (C=0, I.E., NO REJECTS)

Lot Size	Normal Inspection			Tightened Inspection		
	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
5001-50,000	8	0	1	16	0	1

#### 4.5 Examinations

##### 4.5.1 Examination of Product

The bearings shall be examined to determine conformance to this document for material (3.2), dimensions (3.4.1), surface texture (3.4.2), identification of product (3.7), workmanship (3.8), and requirements not covered by tests.

##### 4.5.2 Material Certification

The manufacturer shall furnish to the qualifying activity a material certification specifying the composition of the material used in the manufacture of the bearings.

##### 4.5.3 Inspection of Packaging

Preservation, packaging, packing, and marking shall be inspected to determine conformance to Section 5.

#### 4.6 Test Methods

Unless otherwise specified, all tests shall be performed at room temperature.

##### 4.6.1 Radial Static Limit Load

The bearings shall be installed in a test fixture as shown on Figure 1, using an 0.000 to 0.001-inch loose fit for the shaft and the housing. The use of differential temperatures for installation will not be allowed. A preload of 4 to 6% of the radial static limit load shall be applied to the bearing for 15 seconds and the measuring device set at zero. The load shall then be increased at a rate not to exceed 2% of the specified load per second until it equals the radial static limit load. The load shall then be reduced at the same rate to the preload value. The permanent set shall be the reading at preload. The ultimate radial load (see 3.5.3) shall be applied at a rate not to exceed 2% 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 on Figure 2. Bearings shall fit on the housing with an 0.000 to 0.001-inch loose fit. The hole in the support fixture for clearance of the ball shall be the nominal diameter of the ball plus 0.020. The bearing shall be preloaded between 4 to 6% of the axial static limit load. After holding for 15 seconds, the measuring device shall be set at zero. The load shall be increased at a rate not to exceed 2% of the specified load per second until it equals the axial static limit load. It shall be held for 1 minute, then reduced at the same rate to the preload value. The permanent set shall be the reading at preload. The ultimate axial load (see 3.5.3) shall be applied at a rate not to exceed 2% of the specified load per second.

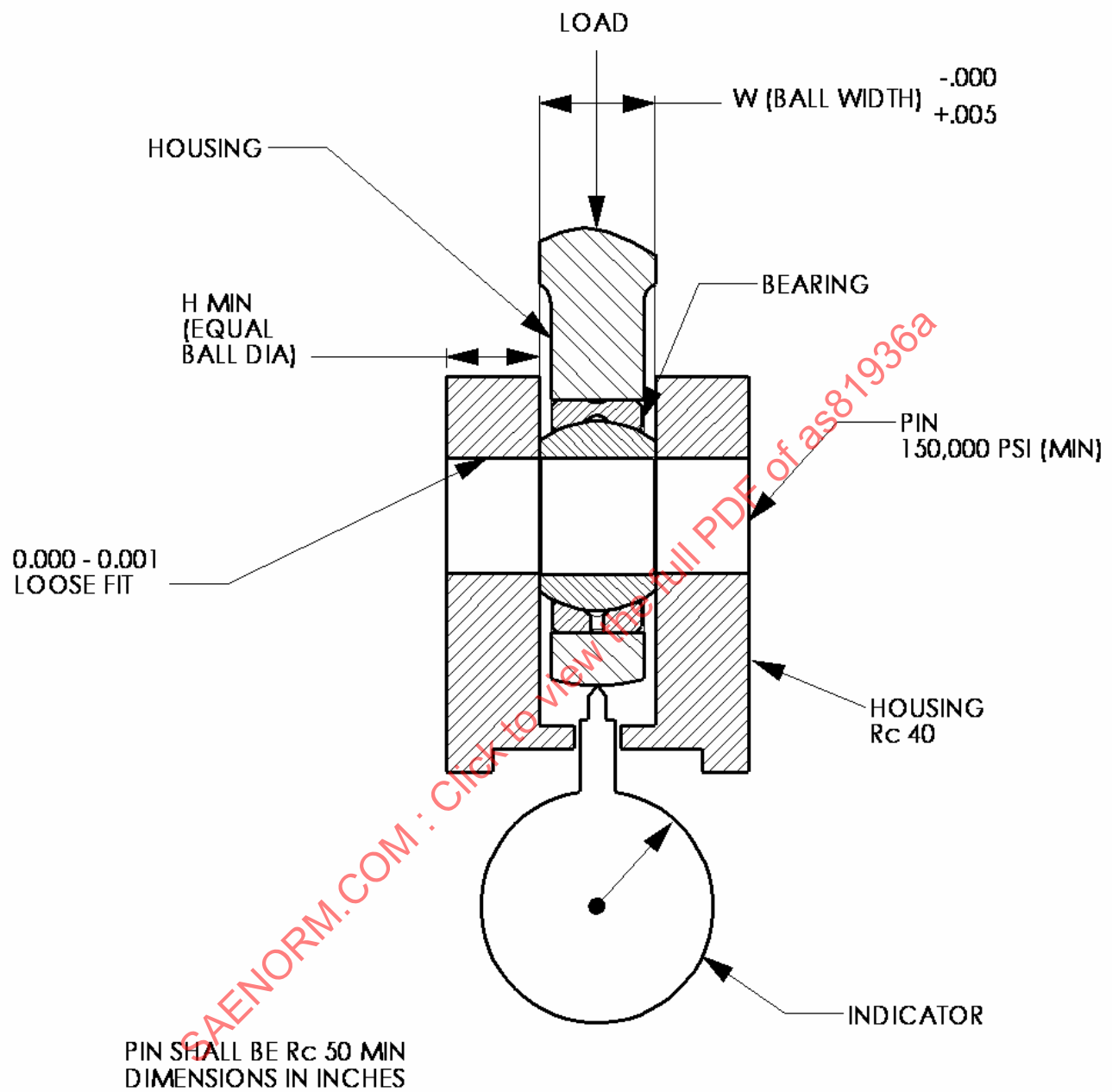


FIGURE 1 - RADIAL TEST FIXTURE

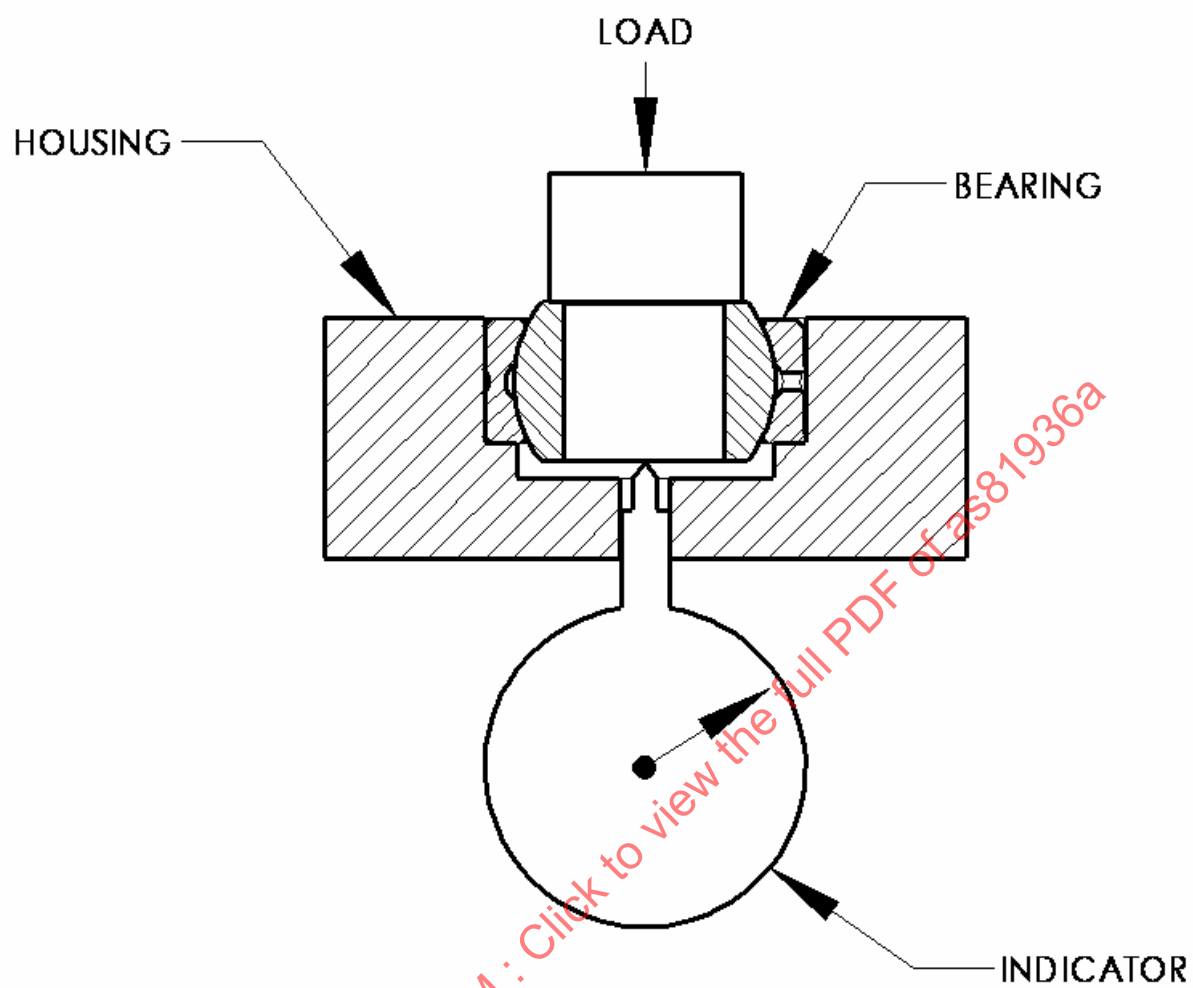


FIGURE 2 - AXIAL TEST FIXTURE

#### 4.6.3 Dynamic Tests

##### 4.6.3.1 Mode I Dynamic Test

The bearing shall be installed in a test fixture so that the ball is free to rotate on the outer race and the bore. The peak radial load (Mode I) specified in AS81936/1 shall be applied and reversed during each cycle while the bearing is oscillated through  $\pm 10^\circ$  for 65,000 cycles. The load versus oscillation plot is shown in Figure 3. The bearing shall be relubricated with MIL-PRF-81322 grease every 2430 cycles. A dial indicator or electronic pickup device shall be so mounted as to facilitate measurement of radial wear along the axis of load application. Wear shall be measured in the test fixture with full test load applied. Test bearing must be allowed to cool to ambient temp prior to final wear measurement.

##### 4.6.3.2 Mode II Dynamic Test

The bearing shall be installed in a test fixture so that the ball is free to rotate on the outer race only. The peak radial load (Mode II) specified in AS81936/1 shall be applied and reversed during each cycle while the bearing is oscillated through  $\pm 10^\circ$  for 20,000 cycles. The load versus oscillation plot is shown in Figure 3. The bearing shall be relubricated with MIL-PRF-81322 grease every 750 cycles. A dial indicator or electronic pickup device shall be so mounted as to facilitate measurement of radial wear along the axis of load application. Wear shall be measured in the test fixture with full test load applied. Test bearing must be allowed to cool to ambient temperature prior to final wear measurement.

#### 4.6.4 Internal Play

##### 4.6.4.1 Radial Play

Radial play shall be measured with a 5-1/2-pound measuring load applied to one member (inner or outer) perpendicular to the bore axis successively in opposite directions. The other member shall be rigidly clamped. Radial play shall be the full dial movement less shaft clearance.

##### 4.6.4.2 Axial Play

Axial play shall be measured with a 5-1/2-pound measuring load applied to the inner member parallel to the bore axis successively in opposite directions. The outer member shall be rigidly clamped. The axial play is equal to the full dial movement.

#### 4.6.5 Hardness

Hardness tests shall be performed as specified in ASTM E 18.