



AEROSPACE STANDARD	AS81820	REV. D
	Issued	1998-03
	Revised	2014-07
Superseding AS81820C		
Bearings, Plain, Self-Aligning, Self-Lubricating, Low Speed Oscillation		

RATIONALE

The reason for updating this document is to clarify the requirements for the subzero testing for Type A bearing qualification, mandate passivation for 440C balls after June 1, 2015, add Liquid Nitrogen testing requirements and to remove chrome plating on the ball OD.

1. SCOPE

This SAE Aerospace Standard (AS) covers plain spherical bearings which are self-aligning and self-lubricating by utilizing polytetrafluoroethylene (PTFE) in a fabric composite or molded material that is bonded to the inner diameter surface of the race and when specified, to the bore diameter surface of the ball. These bearings are for use in the temperature range -65 to +325 °F (-54 to +163 °C).

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.

AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
ARP5448/4	Plain Bearing Bond Integrity - Peelable Woven Fabric PTFE Liners
ARP5448/5	Plain Bearing No-Load Rotational Breakaway Torque Measurement
ARP5448/8	Plain Spherical Bearing Radial and Axial Clearance Measurement
ARP5448/9	Plain Bearing Lined Inside Diameter Plug Gaging

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on this Technical Report, please visit
<http://www.sae.org/technical/standards/AS81820D>**

AS8243	Anti-Icing and Deicing - Defrosting Fluids
AS8942	Bearings, Plain and PTFE Lined, Self-Aligning
AS14101	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Narrow, Grooved Race, -65 to +325 °F
AS14102	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Wide, Chamfered Race, -65 to +325 °F
AS14103	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Wide, Grooved Race, -65 to +325 °F
AS14104	Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Narrow, Chamfered Race, -65 to +325 °F
AS81820/1	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Narrow, Grooved Race, -65 to +325 °F
AS81820/2	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Wide, Chamfered Race, -65 to +325 °F
AS81820/3	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Wide, Grooved Race, -65 to +325 °F
AS81820/4	Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Narrow, Chamfered Race, -65 to +325 °F
AMS1424	Deicing/Anti-Icing Fluid, Aircraft, SAE Type I
AMS2417	Plating, Zinc-Nickel Alloy
AMS2700	Passivation of Corrosion Resistant Steels
AMS5629	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Rings, and Extrusions, 13Cr - 8.0Ni - 2.2Mo - 1.1Al, Vacuum Induction Plus Consumable Electrode Melted, Solution Heat Treated, Precipitation Hardenable
AMS-QQ-P-416	Plating, Cadmium (Electrodeposited)

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM F25	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 F50	Standard Practice for Continuous Sizing and Counting of Airborne Particles in Dust Controlled Areas Using Instruments Based Upon Light Scattering Principles
ASTM C794	Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealant
ASTM A967	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

2.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), 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 DLA Document Services, Bldg 4/D, 700 Robbins Ave, Philadelphia, PA 19111, Tel: 215-697-6396, <http://quicksearch.dla.mil/> or http://www.assistdocs.com/search/search_basic.cfm.

- MIL-STD-129 DoD Standard Practice Military Marking for Shipment and Storage
- MIL-DTL-197 Packaging of Bearings, Anti-Friction, Associated Parts and Sub-Assemblies
- MIL-STD-2073-1 Standard Practice for Military Packaging
- MIL-PRF-5606 Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance
- MIL-DTL-5624 Turbine Fuel, Aviation, Grades JP-5 and JP-5/JP-8 ST
- MIL-PRF-7808 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-148
- MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric, NATO Code Number H-537

3. REQUIREMENTS

3.1 Qualification

Bearings furnished under this standard shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL-AS81820) at the time of award of contract (see 4.3 and 6.3). See Qualified Products Database (QPD) at <http://quicksearch.dla.mil/>, or http://www.assistdocs.com/search/search_basic.cfm.

3.2 Materials

The ball, race and liner shall conform to the applicable AS sheet.

3.2.1 Plating

When specified, plating of the race shall be Zinc-Nickel plating in accordance with AMS2417 Type 2 Grade A or B and the applicable drawing or Cadmium plating per AMS-QQ-P-416 Type II, Class 2 and the applicable drawing.

When AMS2417 is specified, only Type 2 Grade B shall be permitted on bearings manufactured after June 1, 2015.

3.2.2 Passivation

3.2.2.1 PH13-8 Balls

PH13-8 steel balls shall be passivated in accordance with AMS2700, Method 1 (Nitric Acid) or Method 2 (Citric Acid), or ASTM A967 Citric 1, Citric 2, and Citric 3 are acceptable. A permissible method for determining passivity is the Copper Sulfate test defined in ASTM A967 or AMS2700.

3.2.2.2 440C Steel Balls

The passivation of 440C steel balls is mandatory on all parts manufactured after June 1, 2015. The balls shall be passivated in accordance with AMS2700, Method 1 (Nitric Acid) or Method 2 (Citric Acid), or ASTM A967 - Citric 1, Citric 2, and Citric 3 are acceptable. The preferred method for determining passivity on 440C balls is the Copper Sulfate test defined in ASTM A967 or AMS2700.

3.3 Design

Bearing design shall conform to the applicable AS sheet (AS81820/1, AS81820/2, AS81820/3, AS81820/4, AS14101, AS14102, AS14103, and AS14104).

3.4 Construction

The liner shall be secured such that all relative motion will be between the liner wear surface and the ball, or in the case of lined bore bearings between the liner wear surface and the shaft. The bearing shall not have loading slots.

3.4.1 Dimensions and Tolerances

Dimensions and tolerances shall be specified on the applicable AS sheet. Dimensions not shown shall be at the option of the manufacturer. Lined bores shall be inspected per ARP5448/9.

3.4.2 Surface Texture

All specified surface textures shall be in accordance with the applicable AS sheet and ASME B46.1 (see 4.5.1).

3.4.3 Lubrication

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

3.4.4 Conformity

For bearings with composite type liners, the conformity of the ball and race shall be measured normally. For bearings with molded liners, the conformity of the ball and race shall be measured both normally and circumferentially (see 4.6.8).

3.4.4.1 Fabric Liners

The normal conformity between the ball and race shall be checked in accordance with 4.6.8.1. For fabric composite 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 race is observed per 4.6.8.1, then the measured values in the outer 10% of the race width shall not vary from the above measured maximum value by more than 0.005 inch. Underforming is not controlled.

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 0.011 inch \pm 0.003 inch for all sizes. The permitted variation within any one bearing shall not exceed 0.004 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 10% of the race 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 (see Figure 4).

3.4.5 PTFE Liner Condition

3.4.5.1 Visual Examination

The liner shall be uniform in texture and shall contain no embedded contaminants. The liner setback shall meet the applicable drawing requirements. Any liner seam gap shall be as qualified. There shall be no separation or lifting of the liner at any of the edges. Unraveling and fraying is not permitted outside the set back area. Molded liners shall completely fill the cavity between the ball and race 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% 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% of the race 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 °F \pm 10 °F (18.3 to 29.4 °C) 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/cubic foot maximum for particles 5.0 microns or larger when measured per ASTM F25 or ASTM F50. 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.

3.4.5.3 Liner Peelability

Each manufacturer shall establish during qualification testing whether the liner is peelable or non-peelable. A peelable liner is one that is capable of being stripped or sloughed off in one continuous piece without breakage of the fabric fiber. 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 AS sheet has been applied as specified in 4.6.1, the total deflection of the bearing and fixture shall be in accordance with the values shown in Table 1. In all instances the permanent set shall be less than 0.003 inch, and less than 0.006 inch for lined bore bearings.

TABLE 1 - TOTAL ALLOWABLE DEFLECTION FOR RADIAL STATIC LIMIT LOAD

	-3 thru -6 Sizes	-7 and -8 Sizes	-9 and -10 Sizes	-12 thru -16 Sizes
Plain Spherical Bearings	<0.010 inch	<0.015 inch	<0.017 inch	<0.020 inch
Lined bore Spherical Bearings	<0.020 inch	<0.030 inch	<0.034 inch	<0.040 inch

3.5.2 Axial Static Limit Load

After the axial load listed on the applicable AS sheet 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 race. The measurement method of 4.6.3 indicates total liner wear. The total liner wear of the bearing shall not exceed the values specified in Table 2, and the loaded rotational breakaway torque shall not exceed the value specified in Table 7. When inspected in accordance with 4.6.9.2, bond integrity shall be as specified in 3.4.5.

TABLE 2 - MAXIMUM ALLOWABLE WEAR AFTER OSCILLATION UNDER RADIAL LOAD

Maximum Allowable Wear After 1000 Cycles	Maximum Allowable Wear After 5000 Cycles	Maximum Allowable Wear After 25 000 Cycles or 100 000 Cycles for Type A Bearings
0.0035 inch	0.0040 inch	0.0045 inch

3.5.5 Self-Alignment

The bearing shall be self-aligning as specified on the applicable AS sheet.

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 AS sheet. 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. Neither axial play nor radial play shall be permitted in standard breakaway torque bearings. Radial and axial play are permitted for "K" designated bearings (Reference 3.5.10 and 3.5.11), within the limits specified on the applicable AS sheet, to achieve the reduced torque values.

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 race. 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 race.

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 -65 °F (-54 °C). The liner wear shall not exceed 0.008 inch, and the bearing shall not exhibit metal-to-metal contact between the ball and the race.

3.5.10 Radial Play

"K" designated bearings shall be measured to determine internal radial play in accordance with 4.6.10. Radial play and identification of these parts shall be as shown on the applicable AS sheet.

3.5.11 Axial Play

"K" designated bearings shall be measured to determine axial play in accordance with 4.6.11. Axial play and identification of these parts shall be as shown on the applicable AS sheet.

3.6 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 race. Any additional marking is optional. Metal impression stamping is prohibited.

3.7 Workmanship

All workmanship shall be such as to result in a first quality bearing which meets the requirements of this standard. The bearing shall be free from defects (i.e. scratches, pits, burrs) which may affect its durability and serviceability.

3.8 Interchangeability

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

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 purchase 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 inspections set forth in 4.3 of this standard where such inspections are deemed necessary to ensure product and/or services conform to prescribed requirements. The procurement activity reserves the right to perform any of the inspections set forth in 4.4 of 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 requirements of Sections 3, 4, and 5. The inspection set forth in this standard shall become a 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 that all products or services submitted to the qualifying activity 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.

4.1.2 Inspection Records

The manufacturer shall maintain records showing quantitative results of all inspections for seven years, or as contractually obligated. 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 requirements specified herein are classified as follows:

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

4.3 Qualification Inspection

Qualification inspection shall consist of all the examinations and tests of this standard. In addition, the qualifying activity reserves the right to require other tests not covered in this standard when such tests are deemed necessary to assure the capability of a newly developed bearing material to perform satisfactorily in applications for which this standard is intended. Qualification of a given bearing with a grooved race qualifies the corresponding bearing with a chamfered race. No bearing may be qualified prior to qualification of the MS14101-8 or MS14101A-8 (Type A) bearing. Corresponding bearings in column II of Tables 3A and 3B will be qualified on the basis of similarity. Qualification of lined bore spherical bearings will be by similarity, however a peel test will be required. 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 3A - ORDER OF QUALIFYING BEARINGS

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

TABLE 3B - ORDER OF QUALIFYING BEARINGS FOR TYPE A BEARINGS

I	II
MS14101A-5A	MS14101A-3, -4, -5, -5A, -6
MS14101A-8	MS14101A-7, -8, -9
MS14101A-12	MS14101A-10, -12, -14, -16
MS14103A-5	MS14103A-3, -4, -5, -6
MS14103A-8	MS14103A-7, -7A, -8, -9
MS14103A-12	MS14103A-10, -12, -14, -16

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 standard and with standardization regulations. As part of that verification process, each manufacturer must complete DD Form 1718 every two years. 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.

4.3.1.1 Product Change

Any change in product design, description, materials or bonding related operations shall be reported to the qualifying activity and 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 four year intervals beginning in 2008. 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-PRF-83282 Hydraulic Fluid
- c. 4.6.6 High Temperature
- d. 4.6.8 Conformity
- e. 4.6.9 PTFE Liner Condition

The test bearings shall be a single size from normal production. The bearings shall be MS14101-8 or MS14101-12 (or MS14101A-8 or MS14101A-12 for Type A bearings), at the manufacturer's option. Three samples each of tests (a) through (d), and seven 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 6.3).

4.3.2 Sampling Instruction

When the qualifying activity is conducting the actual qualification tests, qualification test samples shall consist of 37 bearings of MS14101-8, or MS14101A-8 for Type A bearings, 11 each of the sizes in column I of Table 3A or 3B and 6 each of the sizes in column II of Table 3A or 3B upon which qualification is desired. All bearings necessary for tests shall be furnished by the manufacturer and shall be representative of normal production. Samples shall be permanently marked with the test bearing number 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 standard. 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). Samples shall be permanently marked with the test bearing number. Supplier shall retain actual test samples for a period of one year minimum, with the timeline starting after issuance of formal QPL or Letter of Qualification from the Qualifying entity. The supplier shall make available the actual test samples to the Qualifying entity if formally requested within the retaining period.

4.3.4 Qualification Sampling

Qualification sampling shall be in accordance with Table 4.

TABLE 4 - QUALIFICATION TEST SAMPLES

Examination and Tests	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 <u>1/</u>	4.6.3	3
No-load rotational breakaway torque	4.6.4	3
Fluid contamination <u>2/</u>	4.6.5	3 (each fluid)
High temperature <u>2/</u>	4.6.6	3
Sub-zero temperature <u>2/</u>	4.6.7	3
Conformity	4.6.8	1
Liner condition, bond integrity and peel strength <u>3/</u>	4.6.9	6

1/ -5, -8 and -12 sizes only

2/ MS14101-8 or MS14101A-8 size only

3/ 3 of the 6 parts must undergo LN₂ exposure per 4.6.12; peel strength applies to peelable liners only

4.4 Quality Conformance Inspections

The quality conformance inspections shall consist of the inspections listed in Table 5.

TABLE 5 - 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
Groove Depth(1) "P"		X		3.4.1	4.5.1
Groove Pitch Diam. (1) "E"		X		3.4.1	4.5.1
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) PTFE Liner Condition			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
(j) Examination of Product					
Materials		X		3.2	4.5.1
Design		X		3.3	4.5.1
Construction		X		3.4	4.5.1
Lubrication		X		3.4.3	4.5.1

Note: There are no critical characteristics.

(1) Inspection applies only to AS14101, AS14103, AS81820/1, and AS81820/3 parts.

(2) Inspection applies only to AS14102, AS14104, AS81820/2, and AS81820/4 parts.

(3) Inspection applies only to bearings which are provided without preload torque (see requirements of 3.5.10 and 3.5.11).

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 5

The sample bearings shall be selected at random from each inspection lot in accordance with Table 6A. 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 5

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) of Table 5

The sample bearings shall be selected at random from each inspection lot in accordance with Table 6B. (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 6B shall be reinspected under Tightened Inspection of Table 6B. 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.

4.4.2.4 Sample for Quality Conformance Test (h) of Table 5

Each lot of bearings which is provided without preload torque shall be 100% inspected for radial clearance in accordance with 4.6.10. All defective parts shall be removed from the lot.

4.4.2.5 Sample for Quality Conformance Tests (i) of Table 5

Each lot of bearings which is provided without preload torque shall be 100% inspected for axial clearance in accordance with 4.6.11. All defective parts shall be removed from the lot.

4.4.2.6 Sample for Quality Conformance Tests (j) of Table 5

Each lot of bearings shall be 100% inspected for Examination of Product in accordance with 3.2, 3.3, 3.4, 3.4.3, and 4.5.1. 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 customer 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 be kept for seven years, or as contractually obligated, and identify the manufacturer of the bearings, the address of the plant where they were manufactured, the customer and the purchase order number (see 6.4).

TABLE 6A - SAMPLING PLAN FOR QUALITY CONFORMANCE INSPECTIONS EXCEPT
DESTRUCTIVE INSPECTIONS
ZERO-BASED ACCEPTANCE PLAN (C=0, I.E., NO REJECTS)

Lot Size	SAMPLE SIZE	
	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
501-1249	34	15
1250-3200	42	18
3201-10 000	50	22

TABLE 6B - DESTRUCTIVE INSPECTION SAMPLING PLAN
ZERO-BASED ACCEPTANCE PLAN (C=0, I.E., NO REJECTS)

Lot Size	SAMPLE SIZE	
	Normal Inspection	Tightened Inspection
2-50	2	4
51-500	3	6
501-5000	5	10
5000-50 000	8	16

4.5 Examinations

4.5.1 Examination of Product

The bearings shall be examined to determine conformance to the requirements of this standard and the applicable AS sheet for material, plating, dimensions, finish, identification of product, workmanship and requirements not covered by tests (see 3.2, 3.3, 3.4, 3.4.1, 3.4.2, 3.4.3).

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 65 to 85 °F (18 to 29 °C). 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% of the radial static load shall be applied to the bearing for 3 to 4 minutes, and the measurement device set at zero. The load shall then be increased at the approximate rate of 1% of the specified load per second, but not taking less than 90 seconds, until it equals the radial static limit load. The total deflection shall be the reading at the radial static limit load after 2 to 3 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 shall be applied at the rate of 1% of the specified load per second (see 3.5.3).

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% of the axial limit load. After holding for 3 to 4 minutes, the measuring device shall be set at zero. The loads shall be increased at the rate of 1% of the specified load per second, but not taking less than 90 seconds, until it equals the axial static limit load. It shall be held for 2 to 3 minutes, and 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% of the specified load per second (see 3.5.3).

4.6.3 Oscillation Under Radial Load

Prior to installation in the test housing, each bearing is to be exposed to LN₂ per 4.6.12. The bearing shall then be installed in a steel housing, using a slip fit, with a hardened shaft (HRC 50 minimum) in the bore using a 0.0005 to 0.0015 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 race 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 race. The oscillating load specified on the applicable drawing shall be applied and held statically for 15 to 20 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 a minimum of ± 25 degrees from the zero position (a minimum of 50 degrees included angle or 100 degrees total travel per cycle), at a minimum of 10 cycles per minute (cpm) for a minimum of 25 000 cycles (or 100 000 cycles for Type A liner system). One cycle shall consist of rotation from zero degrees to at least +25 degrees, return through zero to at least -25 degrees and return to 0 degrees. 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 versus life in cycles (see 3.5.4). Upon completion of the test, the loaded rotational breakaway torque shall be measured and shall be as specified in Table 7. 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 race of the bearing fixed while rotating the ball about the race bore axis (reference ARP5448/5). The race 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 100% reinspected. Individual bearings which are rejected due to low torque values may not be reworked and shall not be accepted (see 3.5.6).

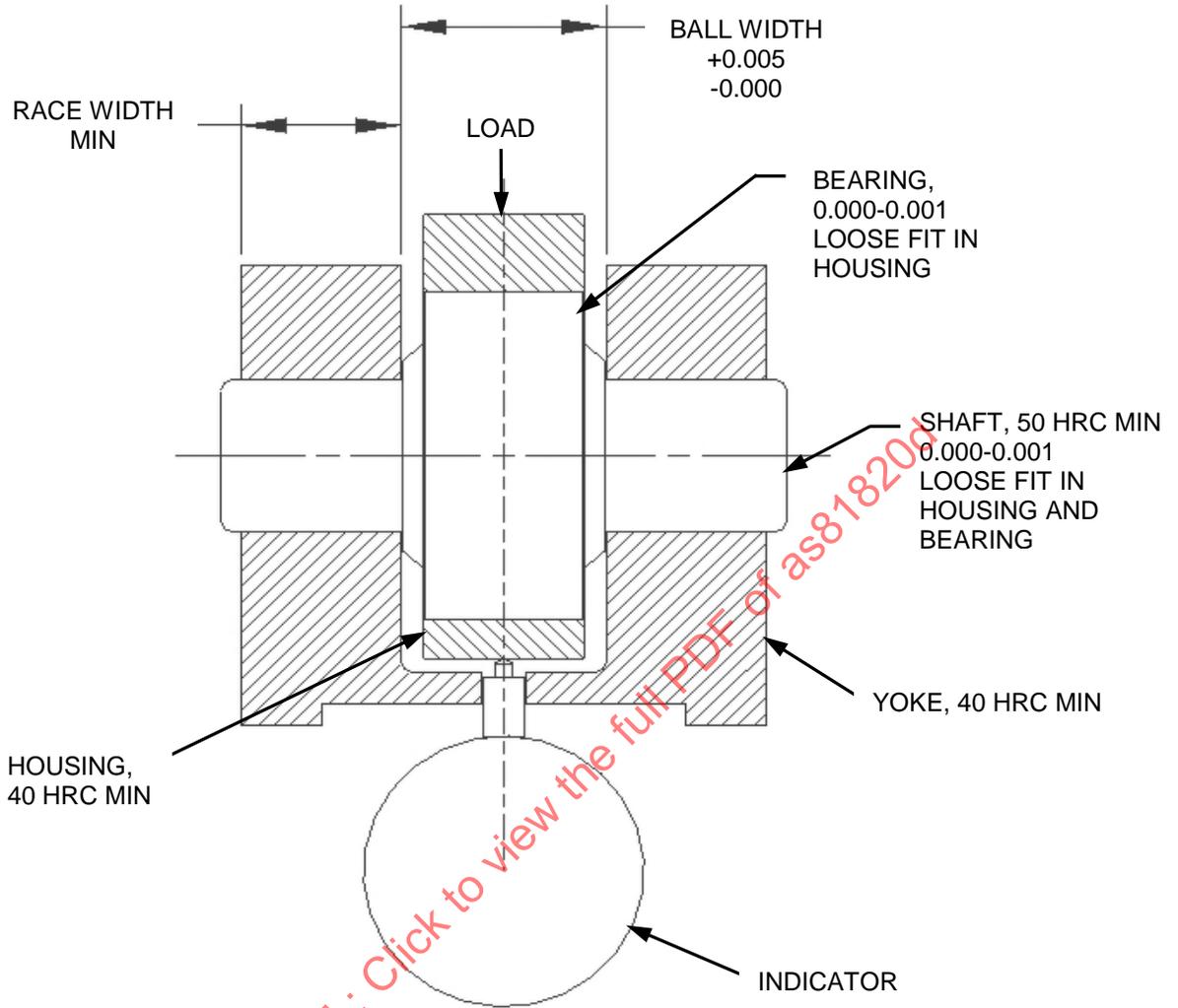


FIGURE 1 - RADIAL STATIC LIMIT LOAD TEST FIXTURE

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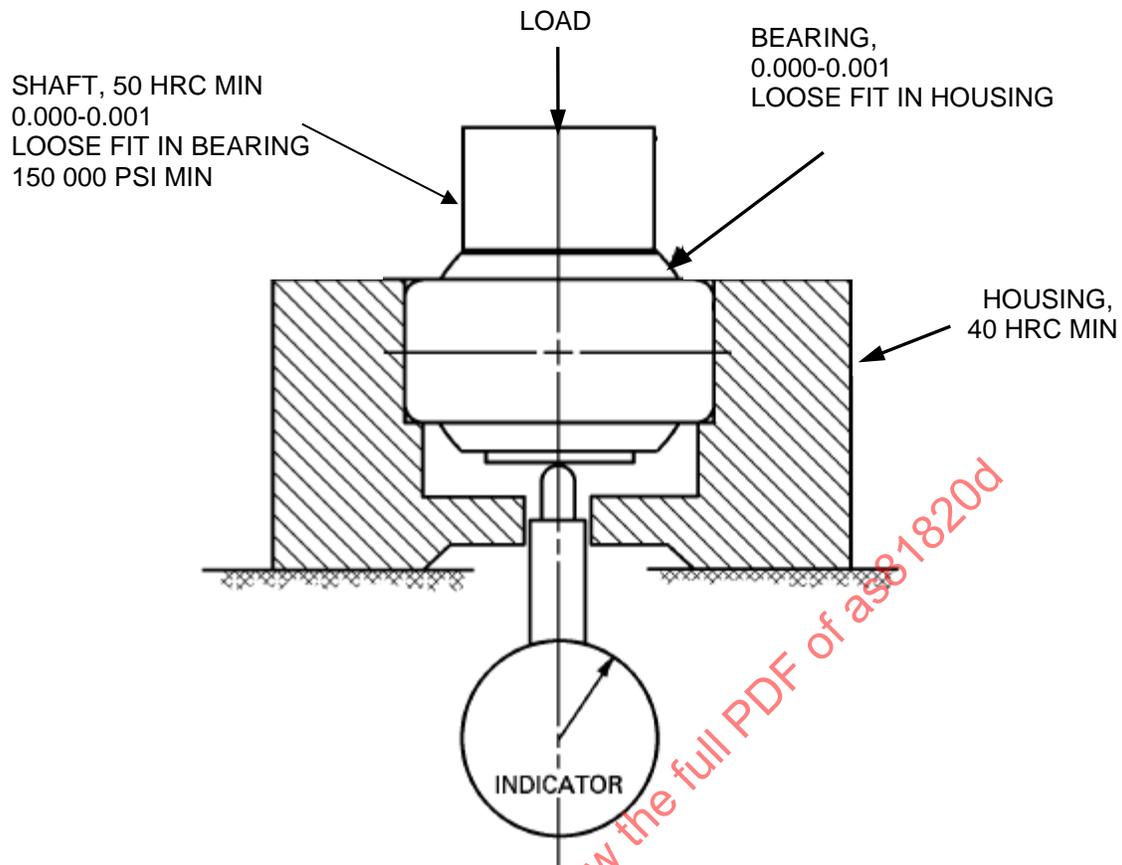


FIGURE 2 - AXIAL STATIC LIMIT LOAD TEST FIXTURE

TABLE 7 - MAXIMUM ALLOWABLE LOADED ROTATIONAL BREAKAWAY TORQUE AFTER TEST

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

4.6.5 Fluid Contamination

Eighteen bearings conforming to MS14101-8, or MS14101A-8 for Type A bearings, (3 for each fluid) shall be immersed for 24 hours in each of the following fluids at 160 °F \pm 5 °F (71 °C \pm 3 °C), except for (b) which shall be at 110 °F \pm 5 °F (43 °C \pm 3 °C):

- a. Phosphate Ester Hydraulic Oil per AS1241, Type IV or Type V.
- b. MIL-DTL-5624 Turbine Fuel Grades JP-5 or JP-8
- c. MIL-PRF-7808 Lubricating Oil
- d. MIL-PRF-5606 Hydraulic Oil
- e. AS8243 Anti-Icing Fluid for all parts qualified by the manufacturer prior to January 1, 2015. AMS1424 Anti-Icing Fluid for all parts qualified by the manufacturer after June 1, 2014.
- f. MIL-PRF-83282 Hydraulic Fluid

Prior to immersing the bearings in the fluids, each bearing is to be exposed to LN₂ per 4.6.12.

Within 1/2 hour after removal from the test fluid, the bearing shall be tested in accordance with 4.6.3 (see 3.5.7). 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 conforming to MS14101-8, or MS14101A-8 for Type A bearings, shall be subjected to the test of 4.6.3 except that the bearing shall be heated, after the first 1000 cycles, in such a way that the ball/liner interface is maintained at a temperature of 325 to 335 °F (163 to 169 °C) for the remaining 24 000 cycles (99 000 cycles for Type A bearings) (see 3.5.8). 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 conforming to MS14101-8, or MS14101A-8 for Type A bearings, shall be subjected to the test of 4.6.3 except that the bearings shall be cooled after the first 1000 test cycles (see 3.5.9). 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 friction heating. Upon completion of the first 1000 cycles, oscillation shall be stopped and the test bearing shall be cooled such that the ball/liner interface temperature is maintained at or below -65 °F (-54 °C). The bearing shall be allowed to cold soak at this temperature for 1/2 hour minimum after which time oscillation shall be continued such that the ball/liner interface temperature is maintained at or below -65 °F (-54 °C) for the remaining 24 000 cycles (99 000 cycles for Type A bearings). In the event that the normal wear measurement techniques are inaccurate at low temperature, alternative wear measurement methods (reference ARP5448/8) may be used during the test 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 race. Section the bearing on a diameter and normal to the race side face to produce a surface as in Figure 3A or 3B. 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 race. By use of an optical comparator or other accurate technique, measure dimension "t" radially from the ball to the race (see Figure 3). The measurements need not be taken closer to the race face than 10% of "H" (0.025 minimum) except when overforming of the race has occurred. The normal conformity must meet the applicable requirements of 3.4.4.1. Conformity in the 10% of "H" region (see H/10 in Figure 3A and 3B) is not controlled by this specification except when overforming of the race has occurred. Overforming of the race is defined as the condition when the side portions of the race are in closer proximity to the ball surface than the middle portion of the race. 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.

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 race. Section the bearing along the diameter described by the centerline of the race 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.

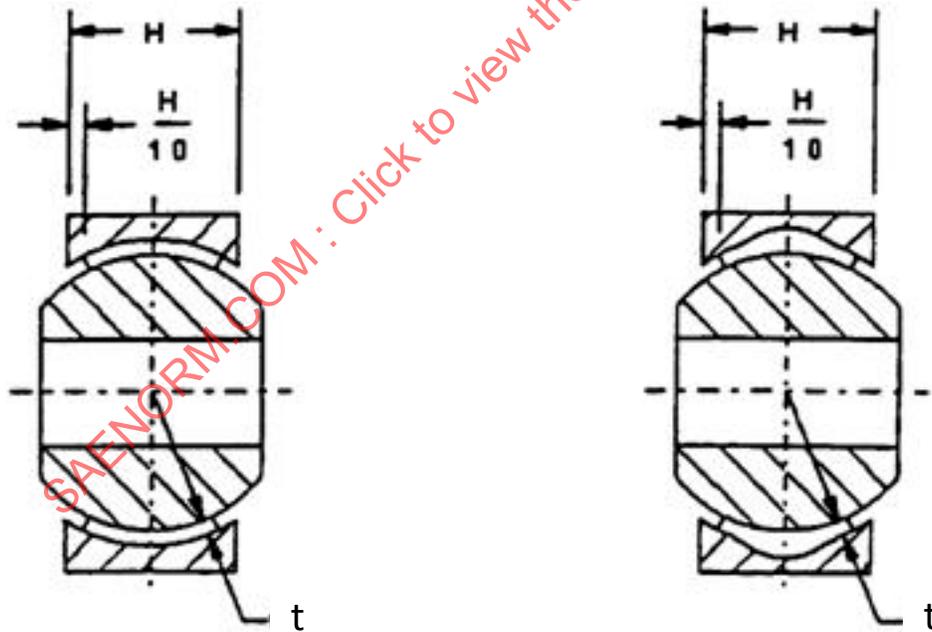


FIGURE 3A - FABRIC OR
NON-MOLDED LINERS

FIGURE 3B - MOLDED
LINERS

FIGURE 3 - NORMAL CONFORMITY