



AEROSPACE STANDARD

AS81819™**REV. B**

Issued 2001-03
Reaffirmed 2017-11
Revised 2024-11

Superseding AS81819A

(R) Bearings, Plain, Self-Aligning, Self-Lubricating,
High Speed Oscillation -65 to +160 °F General Specification For

RATIONALE

This SAE Standard is being revised to add clarification to test procedures. Additionally, the requirement for fluid compatibility testing with anti-icing fluid has been removed due to the primary use of these bearings in helicopter rotor heads (which are not generally exposed to anti-icing fluids).

1. SCOPE

1.1 Scope

This standard covers the requirements for spherical, self-aligning, self-lubricating bearings that are for use in the ambient temperature range of -65 to +160 °F (-54 to +71 °C) at high cyclic speeds. The scope of the standard is to provide a liner system qualification procedure for helicopter sliding bearings defined and controlled by source control drawings. Once a liner system is qualified, the source controlled bearings may be further tested under application conditions.

1.2 Classification

1.2.1 Types

Bearings covered by this standard shall be of the following types:

Type I - Self-aligning bearings with liners of a fabric, composite, or molded polytetrafluoroethylene (PTFE) material.

Type II - Self-aligning bearings with machined liners of self-lubricating solids mechanically retained in the race.

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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Documents

Standard, visit Sharing Hub

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2417	Plating, Zinc-Nickel Alloy
AMS2700	Passivation of Corrosion Resistant Steels
AMS-QQ-P-416	Plating, Cadmium (Electrodeposited)
ARP5448/2	Plain Bearing High Speed Oscillation Test
ARP5448/4	Plain Bearing Bond Integrity - Peelable Woven Fabric PTFE Liners
ARP5448/5	Plain Bearing No-Load Rotational Breakaway Torque Measurement
ARP5448/6	Plain Spherical Bearing Conformity Examination
ARP5448/7	Plain Bearing Wear Measurement
ARP5448/8	Plain Spherical Bearing Radial and Axial Clearance Measurement
AS81819/1	Bearings, Plain, Self-Lubricating, Self-Aligning, High Speed Oscillation -65 to +160 °F

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 A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A967	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
ASTM C794	Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
ASTM D1655	Standard Specification for Aviation Turbine Fuels
ASTM D3951	Standard Practice for Commercial Packaging
ASTM F25	Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas
ASTM F50	Standard Practice for Continuous Sizing and Counting of Airborne Particles in Dust-Controlled Areas and Clean Rooms Using Instruments Capable of Detecting Single Sub-Micrometre and Larger Particles

2.3 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-DTL-197	Packaging of Bearings, Associated Parts and Sub-Assemblies
MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83133	Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)

MIL-HDBK-1599	Bearings, Control System Components and Associated Hardware Used in the Design and Construction of Aerospace Mechanical Systems and Subsystems
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance
MIL-PRF-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537
MIL-STD-129	Military Marking for Shipment and Storage
MIL-STD-2073-1	Standard Practice for Military Packaging

2.4 ANSI Accredited Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ANSI/ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes
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2.5 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)
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3. REQUIREMENTS

3.1 Aerospace Standard (AS) Sheets

The individual item requirements shall be as specified herein and in accordance with the applicable AS sheet (AS81819/1). In the event of any conflict between the requirements of this standard and the applicable AS sheet, the latter shall govern.

3.2 Qualification

Products furnished under this standard shall be products that are authorized by the Qualifying Activity for listing on the applicable Qualified Products Database (listed under the Qualified Products List, QPL-AS81819) at the time of award of contract (see 6.3). See Qualified Products Database (QPD) at <https://assist.dla.mil/>, <https://qpldocs.dla.mil/>, or <https://quicksearch.dla.mil/>.

3.2.1 Retention of Qualification

To maintain status on a Qualified Products List (QPL), certification shall be submitted at 2-year intervals to indicate continued compliance with the requirements of this standard (see 4.3.1). Periodic retention of qualification testing is also required at 5-year intervals (see 4.3.1.3).

3.2.2 Requirements for Qualification Approval

Qualification approval of a self-lubricating liner system is based on the satisfactory performance of test bearings to the requirements of this standard. The test conditions and the associated test bearing dimensions are specified in the applicable AS sheet (AS81819/1). Prior to initiating the liner system evaluation tests, the manufacturer shall notify the Qualifying Activity (Naval Air Systems Command, Code AB24400) of the intention to submit for qualification approval (see 6.3). The letter of notification shall state the proposed date of initiation of the tests, the liner system identification (see 3.6), and that qualification approval is desired. The Qualifying Activity will then provide the manufacturer with a notice containing further instructions and may issue an authorization to begin testing. Upon completion of the test program, the test data shall be reported in accordance with 3.2.3.

NOTE: Data generated during the development phase of the liner system is not acceptable.

The test data shall be analyzed in accordance with the methodology described in 4.8 and shall meet the qualification test criteria listed in Table 1 of AS81819/1 and 3.17.4.5. Additional qualification submittal information is located in 3.17, 4.3, and 6.3. The report and verification test samples shall be submitted to the Air Vehicle Engineering Department, Attn: Mechanical Systems Branch Code AB24400, Naval Air Warfare Center Aircraft Division, 48110 Shaw Road, Bldg 2187 Rm 1B60, Patuxent River, MD 20670-1907.

3.2.3 Requirements for Recording Performance Data

The data recorded for 3.12, 3.13, 3.15, and 3.16 and the performance data for 3.17 shall be summarized in report form. To ensure statistical accuracy of test data, the bearing suppliers (or the testing laboratory) shall certify that the data presented is the performance data for all bearings tested and that no data has been deleted. Any test malfunction resulting in an invalid test shall be noted in the report. A dated drawing completely describing the bearing(s), the dimensions, heat treatment, surface finish, platings or coatings, and liner system identification shall be included. The manufacturer's liner material identification, whether by trade name or numerical designation, shall be unique to that liner material and its processing.

Table 1 - Constant load dynamic test qualification approval criteria

AS81819/1 Dash No.		-2
Maximum Allowable Average Wear Rate (WR) (10 ⁻⁶ inches/hours)		6.0
Minimum B-10 Life	Hours	400 hours
	Rated Wear	0.005 inch

3.3 First Article

When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.4 and 6.4).

3.4 Product Manufacture

Except for the bonding and swaging operations, the manufacturer is permitted to subcontract manufacturing operations without violating the requirements of 3.4.1. The bonding and swaging operations shall be performed in the plant listed on the Qualified Products List (QPL-AS81819). 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 will require requalification to an extent determined by the Qualifying Activity. The manufacturer is responsible for meeting all requirements of the standard 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 standard requirements.

3.4.1 Product Change

Any change in product design, description, materials, processing procedures, or plant location shall be reported to the Qualifying Activity and may require requalification of the product to an extent determined by the Qualifying Activity. Any other specific changes, which must be brought to the Qualifying Activity's attention, shall be identified in the qualification notification letter.

3.5 Materials

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

3.5.1 Plating and Coating

Unless otherwise specified in the applicable AS sheet, plating or coating of the ball surface interfacing with the liner system shall be an option of the manufacturer. The ball surface material that interfaces with the liner is part of the liner system and would require requalification if changed. If plating or coating is used, it must be identified in the manufacturer's test report and drawings. Plating of the race shall be cadmium plating per AMS-QQ-P-416 Type II, Grade A or B Class 2 and the applicable AS sheet, or zinc-nickel plating per AMS2417, Type 2, Grade B and the applicable AS sheet. To prevent over-curing of the liner adhesive, the pre- and post-process bake requirements of AMS2417 plating specification are not required. Hydrogen embrittlement testing is not required. Dimensions in the applicable AS sheet apply.

Hexavalent chromate treatment (AMS-QQ-P-416 Type II, Grade A) shall not be permitted on bearings manufactured after June 1, 2028.

3.5.2 Usable Liner Thickness

The liner used in these bearings shall have a minimum usable thickness of 0.015 inch.

3.5.3 Passivation

Passivation is at the option of the manufacturer. Passivation, if used, should be in accordance with AMS2700, Method 1, Type 2 (Nitric Acid) or Method 2 (Citric Acid) or ASTM A967, Citric 1, Citric 2, and Citric 3 after all metal removal operations. The preferred method for determining passivity on 440C steel balls is the Copper Sulfate test defined in ASTM A967 or AMS2700.

3.6 Liner System Identification

The liner material and any bonding and curing processes shall be established by the manufacturer and maintained by their in-house manufacturing and quality control documents. The manufacturer's liner system identification, whether by trade name or numerical designation, shall identify the liner material and the associated bonding and curing process requirements. In addition to the trade name or numerical designation, the manufacturer shall specify in their test report (see 3.2.3) the classification type and for Type I bearings the maximum liner thickness in a finished bearing.

3.7 Design

Bearing design shall conform to the applicable AS sheet (AS81819/1). All other design features shall be shown on the manufacturer's drawings and shall be sent to the Qualifying Activity. Drawings shall show in detail the manufacturer's product by specifying all dimensions, tolerances, materials, liners, plating, heat treatment, and passivations. Any information the manufacturer deems proprietary must be so indicated. Bearings shall not have loading slots.

3.8 Construction

Bearing construction shall conform to the applicable AS sheet. The liner shall be secured such that all relative motion will be between the liner wear surface and the ball.

3.9 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.

3.10 Surface Texture

The surface texture shall be in accordance with the applicable AS sheet and ASME B46.1. Bearings shall be free of any surface defects that may be detrimental to satisfactory installation, performance, or bearing life as defined in this standard. Unless otherwise specified, liner surfaces are exempt from surface texture measurements.

3.11 Lubrication

The self-lubricating bearings covered by this standard shall operate without subsequent relubrication. Dry film lubrication is acceptable during manufacture if part of the normal manufacturing process. Grease or oil lubrication by the manufacturer shall not be permitted.

3.12 Conformity

The spherical surface of the ball shall be in proper contact (conformity) with its mating surface (see 3.12.1 or 3.12.2).

3.12.1 Conformity Measurement (Type I Bearings)

For spherical bearings with fabric or fabric composite liners, the conformity of the ball and lined race shall be measured normally. For bearings with molded liners, the conformity of the ball and lined race shall be measured both normally and circumferentially.

3.12.1.1 Normal Conformity of Fabric or Fabric Composite Spherical Bearings (Type I Bearings)

When inspected in accordance with 4.7.8.1, the values of “t measured” shall be within the appropriate range specified in Table 2. Measurements shall be taken at a minimum of five uniformly spaced positions across the width of the bearing. When radial clearance is specified, the process used to generate clearance shall not distort the ball-to-race contour beyond the conformity limits specified in Table 2. When over-forming of the race is observed during inspection in accordance with 4.7.8.1, two additional measurements shall be taken in the outer 10% of the race width (one measurement on each side). These additional values shall not vary from the center value (dimension “C”) by more than 0.001 inch. Over-forming is allowed in the outer 10% of the race as long as the minimum liner thickness is greater than or equal to 0.015 inch. Under-forming is not controlled. These values apply to bearings whose race width (H) to ball diameter (d) ratio is in the range of 0.44 to 0.62.

Table 2 - Allowable variations

Ball Diameter (d) (Inches)	Allowable Variation of Conformity Measurements (Type I Bearings)
	Swaged Bearings
0 → 2	$t_{min} \leq t \text{ measured} \leq (t_{min} + 0.0030 \text{ inch})$
2+ → 3	$t_{min} \leq t \text{ measured} \leq (t_{min} + 0.0035 \text{ inch})$
3+ → 4	$t_{min} \leq t \text{ measured} \leq (t_{min} + 0.0040 \text{ inch})$
4+ → 10	$t_{min} \leq t \text{ measured} \leq (t_{min} + 0.0050 \text{ inch})$
	Non-Swaged Bearings
0 → 10	$t_{min} \leq t \text{ measured} \leq (t_{min} + 0.0030 \text{ inch})$

3.12.1.2 Normal Conformity of Molded Liner Spherical Bearings (Type I Bearings)

Normal conformity of spherical bearings with molded liners shall be measured in accordance with 4.7.8.1. The precise shape of the cavity containing the liner material is not defined. However, the cavity shall not exhibit sharp angular changes in curvature across the width of the bearing. Dimension “t measured” shall be measured initially at the center (dimension “C”) and H/10 positions (see Figure 4B). The values at the H/10 positions shall be 0.015 inch minimum for all sizes. The maximum liner thickness shall occur at the center (dimension “C”). The allowable values of “t” at the center 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 over-forming in accordance with 3.12.1.1.

3.12.1.3 Circumferential Conformity of Molded Liner Spherical Bearings (Type I Bearings)

In molded liner bearings, the circumferential conformity shall be measured in accordance with 4.7.8.1.1. Variation in the values of “δ” (measured liner thickness) shall not be greater than 0.003 inch (see Figure 5).

3.12.2 Conformity Measurement (Type II Bearings)

When inspected in accordance with 4.7.8.2, the variation between measured values shall be not greater than 0.003 inch. Unless otherwise specified in the applicable AS sheet, the liner surface shall have a radius of curvature greater than that of the ball. The liner surface shall be machined and installed so that contact between the liner material and the ball occurs in the sector of the liner between positions 1 and 3 (see Figure 6).

3.13 Liner Integrity

The material(s) used in the liner shall be free of defects or foreign matter that decrease the serviceability of the bearing.

3.13.1 PTFE Liner Condition and Bond Integrity (Type I Bearings)

3.13.1.1 Visual Examination

The visual appearance of the bonded liner shall exhibit a degree of workmanship consistent with proper manufacturing process controls, as checked per 4.7.9.1.1. The liner shall be uniform in texture and shall contain no embedded contaminants. The liner setback shall meet the applicable AS sheet requirements. There shall be no separation or lifting of the liner at any of the edges. Unraveling and fraying is not permitted outside the setback area. Molded liners shall completely fill the cavity between the ball and race and shall not contain embedded contaminants, cracks, or bubbles.

3.13.1.2 Bond Integrity and Peel Strength

When tested in accordance with 4.7.9.1.2, the liner shall be tightly adherent to the metallic substrate over at least 90% of the contact area and shall exhibit an average peel strength of 2.0 lb-in or greater. The adhesive remaining on the metal substrate shall have no void or unbonded area that cannot be included within a circumscribing circle with a diameter equal to 25% of the race width or 0.250 inch, whichever is smaller.

3.13.1.2.1 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.

3.13.1.2.2 Controlled Area

The controlled area shall be maintained at a temperature of 75 °F ± 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 ft³ maximum for particles 5.0 µm 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 that produces uncontrolled spray, dust, fumes, or particulate matter.

3.13.1.3 Liner Peelability

Each manufacturer shall establish during qualification testing whether the liner is peelable or non-peelable. If peelable, the manufacturer shall determine the mean and standard deviation peel strength values for the liner based upon a minimum of six peel strength tests conducted in accordance with 4.7.9.1.2. Prior to peel testing, three of the six parts must undergo LN₂ exposure per 4.7.10. Liners are to remain bonded after the LN₂ exposure test. 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.

3.13.2 PTFE Liner Condition (Type II Bearings)

The bearing race shall be inspected for fractured liner elements (see 4.7.9.2). There shall be no fractures through the liner element. Small chips on the edges of an element are acceptable provided they do not exceed 0.050-inch depth, 0.030-inch width, 0.050-inch length, and do not have a cumulative length exceeding 0.200 inch on any side.

3.14 Self-Alignment

Bearings shall be self-aligning. Angular misalignment shall be as specified in the applicable AS sheet.

3.15 No-Load Rotational Breakaway Torque

Bearings designed with no clearance between mating surfaces shall have a no-load breakaway torque specified in the applicable AS sheet (see 4.7.4).

3.16 Internal Clearance

Bearings designed with clearance (internal play) between mating surfaces shall have the allowable clearance specified in the applicable AS sheet (see 4.7.4.1).

3.17 Performance

The performance requirements of this standard are intended for qualification testing purposes and are applicable only to the associated test bearings listed in the applicable AS sheet. The test bearings are intended to provide a means of evaluating and qualifying a liner system to be used in production bearings. The various test conditions in the applicable AS sheet were chosen to represent typical size and motion regimes associated with main rotor components of helicopters but are not presumed to describe actual operational conditions that production bearings will experience in the aircraft.

The bearing manufacturer shall fabricate test bearings to the dimensions shown in the applicable AS sheet for which qualification approval is sought. The test bearings shall be produced in accordance with the manufacturer's in-house manufacturing and quality control requirements and with the liner system identified in accordance with 3.6. The bearing manufacturer shall subject the test bearings to the qualification inspections specified in Table 3 and report the results in accordance with 3.2.3. The dynamic and static test loads are given in the applicable AS sheet.

3.17.1 Radial Static Limit Load

The radial static limit load test shall be performed at the load specified in the applicable AS sheet as specified in 4.7.1. A load deflection curve shall be prepared and permanent set shall be recorded at the completion of the test. The permanent set shall be not greater than 0.006 inch.

3.17.2 Axial Static Limit Load

The axial static limit load test shall be performed at the load specified in the applicable AS sheet as specified in 4.7.2. A load deflection curve shall be prepared and permanent set shall be recorded at the completion of the test. The permanent set shall be not greater than 0.006 inch.

3.17.3 Static Ultimate Load

There shall be no fracture of any component or push-out of the ball when subjected to 1.5 times the radial static test and the axial static test, as specified in 3.17.1 or 3.17.2. The radial and axial static ultimate load and the permanent set shall be recorded upon completion of the test. Bearings from the limit load tests can be used for the ultimate load tests in regard to both axial and radial tests, in which case the permanent set for the ultimate load tests would be calculated by the addition of the limit and the ultimate load permanent set measurements.

3.17.4 Requirements for Dynamic Test

The samples specified in Table 3 shall meet the requirements of 3.17.4.1 through 3.17.4.5. Test data shall be analyzed in accordance with the methodology described in 4.8 and shall meet the qualification approval criteria listed in Table 1. Data indicating the progress of the test shall be recorded at sufficient intervals to produce an accurate plot of wear and bearing housing temperature versus hours. If fan cooling is utilized to maintain the bearing housing temperature at a lower operating level, then the volume of cooling air shall also be recorded to indicate the cubic feet per minute (CFM) of cooling air. Before and after testing, the static breakaway torque of the bearing under load shall be measured and recorded. After the test, the bearing liner shall be inspected and the observations recorded.