SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS85560 | REV. A

Issued 2004-11
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Superseding AS85560

(R) Bearings, Fiber Reinforced Plastic, Sleeve, Plain and Flanged, Self-Lubricating; General Specification For

RATIONALE

AS85560A was created to update the applicable documents section, eliminate all MIL-B-85560 references, amend product change and product manufacture sections, re-format tables, update language in quality assurance section, and update address for qualifying activity.

NOTICE

Under Department of Defense policies and procedures, any qualification material and associated qualified products lists are mandatory for DOD contracts. Any requirement 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 specification defines the requirements for fiber reinforced plastic (FRP) composite plain and flanged sleeve bearings that are self-lubricating and which are compatible with graphite-epoxy composites.

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 isue 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 recedence. 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.

AS8243 Anti-Icing and Deicing-Defrosting Fluids

AS85560/1 Bearing, Fiber Reinforced Plastic, Sleeve, Plain, Self-Lubricating, +250°F

AS85560/2 Bearing, Fiber Reinforced Plastic, Sleeve, Flanged, Self-Lubricating, +250°F

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.2 ANSI/ASME Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI/ASME B46.1	Surface Texture (Surface Roughness, Waviness and Lay)
ANSI/ASME Y14.100	Engineering Drawing Practices
ANSI/ASQC Z1 4	Sampling Procedures and Tables for Inspection by Attributes

2.3 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	Packaging of Bearings, Anti-Friction, Associated Parts and Sub-Assemblies
MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP-5/JP-8ST
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	Standard Practice Military Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-2073-1	DOD Standard Practice for Military Packaging

3. REQUIREMENTS

3.1 Aerospace Standard (AS) Sheets

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

3.2 Qualification

The bearings furnished under this specification shall be products which are qualified for listing on the applicable Qualified Products List (QPL-85560) at the time set for opening of bids (see 4.3 and 6.3).

3.2.1 Retention of Qualification

To maintain status on a Qualified Products List (QPL), certification shall be submitted to indicate continued compliance with the requirements of this specification (see 4.3.3).

3.2.2 Product Change

Any change in product design, description, materials or processing procedures (see 6.4) or plant location shall be reported to the qualifying activity and may require requalification of the product to the 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.

3.2.3 Product Manufacture

Except for the winding, bonding and curing operations, the manufacturer is permitted to sub-contract manufacturing operations without violating the requirements of 3.2.2. The winding, bonding and curing operations shall be performed in the plant listed on the Qualified Products List. The manufacturer may subcontract the winding process provided that (1) Process Specifications to control the winding process are established by the manufacturer and are imposed upon the subcontractor; and (2) the qualifying activity is notified during the qualification process of the subcontractor performing the winding process. Manufacture of the self-lubricating liner material may also be subcontracted. Any change in the materials used in the manufacture of the liner will require requalification to an extent determined by the qualifying activity.

3.3 Materials

Unless otherwise specified in the AS sheet, the materials used in the base composite shall be at the option of the bearing manufacturer. The materials shall be compatible with graphite-epoxy composite and meet the requirements of this specification. The materials shall be recorded in the certified test report (see 4.3.2). The self-lubricating portion of the bearing shall be incorporated in the bore of the bearing and, in flanged bearings, at the outer flange face in accordance with the applicable specification sheet. The self-lubricating material shall contain tetrafluoroethylene (TFE) and may be in the form of a liner bonded to a composite substrate or be an integral part of the composite.

3.4 Design

Bearing design shall conform to that shown in specification sheets AS85560/1 and AS85560/2.

3.5 Construction

The bearings shall be constructed in accordance with the manufacturer's process specifications and quality control documents. The manufacturing specifications shall be recorded by name and date in the certified test report (see 4.3.2). Except as otherwise specified on the applicable specification sheet, the details of the construction shall be optional.

3.5.1 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.

3.5.2 Surface Texture

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

3.5.3 Lubrication

Lubrication with grease or oil shall not be permitted.

3.5.4 Liner Condition and Bond Integrity

3.5.4.1 Visual Examination

The visual appearance of the exposed surface of the self-lubricating portion of the sleeve shall be uniform in texture and shall contain no imbedded contaminants. If a liner is used, it shall be positioned uniformly within the bore and on the flange face and shall be free of folds.

3.5.4.2 Bond Integrity

The liner condition shall exhibit a degree of workmanship consistent with proper manufacturing process controls (see 4.6.6). The liner edge condition and setback shall meet the applicable drawing requirements. The liner shall be tightly adherent to the substrate over at least 90% of the contact area and shall exhibit a peel strength of 1.5 lb-in minimum. No void shall be allowed which cannot be fully included within a circumscribing circle with a diameter equal to 25% of the race width or 0.25-in, whichever is smaller.

3.6 Performance

3.6.1 Radial Static Loads

3.6.1.1 Limit Load

When the radial static load listed in Table 1 has been applied in accordance with 4.6.1 and 4.6.1.1 the deflection shall not be greater than 0.0100 in. The permanent set after application of the radial static load shall not exceed 0.0030 in for M85560/1 or /2-04 through -22 sizes and shall not exceed 0.0045 in for M85560/1 or /2-24 through -32 sizes.

3.6.1.2 Ultimate Load

There shall be no crushing of the composite material when 1-1/2 times the radial static limit load listed in Table 1 has been applied at room temperature (see 4.6.1 and 4.6.1.2).

TABLE 1 - LOAD VALUES

Bearing Size	Static Limit Load (lb)	Dynamic Load (lb)
(0.500 in bore, 0.375 in L)	6,875	3,440
(1.000 in bore, 0.500 in L)	20,000	10,000
(1.500 in bore, 0.500 in L)	30,000	15,000

3.6.1.3 Creep Load

After 2/3 of the radial static load listed in Table 1 has been applied and held for 336 h at room temperature, the amount of creep (see 6.4) shall be not greater than 0.003-in and there shall be no crushing of the composite (see 4.6.1 and 4.6.1.3).

3.6.2 Oscillation Under Radial Load

When tested under the dynamic load specified in Table 1, the total wear of the bearing shall not be greater than 0.0045-in after 25,000 cycles and there shall be no crushing of the composite portion of the sleeve. If a bonded liner is used in the bore, there shall be no separation of the liner from the composite substrate. The bond integrity shall be as specified in 3.5.4.2. The measured loaded breakaway torque shall be measured and recorded before and upon completion of the oscillation test (see 4.6.2).

3.6.3 Fluid Compatibility

When tested under the dynamic load specified in Table 1, the bearings shall be compatible with the fluids listed in 4.6.3. The total bearing wear shall not be greater than 0.0045-in after 25,000 cycles and there shall be no crushing of the composite portion of the sleeve. If a bonded liner is used in the bore, there shall be no separation of the liner from the composite substrate. The bond integrity shall be as specified in 3.5.4.2.

3.6.4 High Temperature

When tested under the dynamic load specified in Table 1 at +250 °F, the total bearing wear shall not be greater than 0.0045-in after 25,000 cycles and there shall be no crushing of the composite portion of the sleeve (see 4.6.4). If a bonded liner is used in the bore, there shall be no separation of the liner from the composite substrate. The bond integrity shall be as specified in 3.5.4.2.

3.6.5 Subzero Temperature

When tested under the dynamic load specified in Table 1 at -10 °F, the total bearing wear shall not be greater than 0.006-in after 25,000 cycles and there shall be no crushing of the composite portion of the bearing (see 4.6.5). If a bonded liner is used in the bore, there shall be no separation of the liner from the composite substrate. The bond integrity shall be as specified in 3.5.4.2.

3.7 Interchangeability

All parts having the same part marking shall be interchangeable with each other with respect to installation and performance.

3.8 Identification of Product

Each bearing shall be permanently and legibly marked in accordance with MIL-STD-130 with the manufacturer's CAGE code, manufacturers lot number, and Aerospace Standard part number as a minimum. Any additional marking is optional. Metal impression stamping shall not be allowed.

3.9 Workmanship

The bearings shall be free of tool marks, chatter waves, grinding scratches, interlayer fracture and other defects that may adversely affect the serviceability 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. 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 right 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 Qualification Test Records

The manufacturer shall maintain a record showing quantitative results for all tests required by this specification. The record shall be available to the purchaser and shall be signed by an authorized representative of the manufacturer or the testing laboratory, as applicable.

4.2 Classification of Inspections

The inspection requirements specified herein are classified as:

1. Qualification inspection (see 4.3).

2. Quality conformance inspection (see 4.4).

4.3 Qualification Inspection

Qualification inspection shall be as specified in Table 2.

4.3.1 Sampling Instructions

Qualification inspection samples shall consist of 35 bearings with 1.000-in bore, 0.500-in length and 15 bearings of each of the additional bore diameters and widths specified below for which qualification is desired. Bearings necessary for tests specified herein shall be furnished by the manufacturer. Samples shall be identified as required (see 3.8) and forwarded to the activity designated in the letter of authorization (see 6.3 and 6.3.1). Because of the preponderance of tests performed on the 1.000-in bore, 0.500-in length bearing, this size must be approved before any other sizes may be approved.

Approval of bearings with 0.500-in bore, 0.375-in length will qualify bearings on AS85560/1 and AS85560/2 with dash numbers 04 to 09, inclusive.

Approval of bearings with 1.000-in bore, 0.500-in length will qualify bearings on AS85560/1 and AS85560/2 with dash numbers 10 to 18, inclusive.

Approval of bearings with 1.500-in bore, 0.500-in length will qualify bearings on AS85560/1 and AS85560/2 with dash numbers 20 to 32, inclusive.

TABLE 2 - QUALIFICATION INSPECTION

Inspection	Requirement Paragraph	Test Method Paragraph	Samples to be Inspected
Examination of product	3.5.4.1	4.5.1	5
Bond integrity	3.5.4.2	4.6.6	3
Radial static limit	3.6.1.1	4.6.1.1	6
Radial static ultimate load	3.6.1.2	4.6.1.2	6
Radial static creep load	3.6.1.3	4.6.1.3	3 (1.000 in bore, 0.500 in L)
Oscillation under radial load	3.6.2	4.6.2	3
Fluid compatibility	3.6.3	4.6.3	18 (1.000 in bore, 0.500 in L)
High temperature	3.6.4	4.6.4	3 (1.000 in bore, 0.500 in L)
Subzero temperature	3.6.5	4.6.5	3 (1.000 in bore, 0.500 in L)

4.3.2 Certified Test Report

The manufacturer shall furnish a certified test report showing that the manufacturer's product satisfactorily conforms to this specification (see 6.3.1). The test report shall include, as a minimum, actual results of tests specified herein, materials (see 3.3), and a list of the manufacturing process specifications used in the manufacture of the bearing (see 3.5). When the report is submitted, it shall be accompanied by a dated drawing that completely describes the manufacturer's product by specifying all dimensions, tolerances and materials. The manufacturer's part number for each size shall be included on the drawing.

4.3.3 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 specification and with standardization regulations. As part of that verification process, each manufacturer must compete 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.

4.3.4 Periodic Retest for Retention of Qualification

In addition to the certification requirement of 4.3.3, each manufacturer shall retest a sample of bearings from recent production at five year intervals beginning in 1998. The tests to be performed shall be as follows:

a. 4.6.2 Oscillation Under Radial Load.

b. 4.6.3 Fluid Compatibility, using MIL-PRF-83282 Hydraulic Fluid.

c. 4.6.4 High Temperature.

d. 4.6.6 PTFE Liner Condition.

The test bearings shall be a single size from normal production. The bearings shall be M85560/1-16-16 bearings. Three samples each of test (a), (b) and (c), and seven samples of test (d) 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.

4.4 Quality Conformance Inspections

The quality conformance inspections shall be as specified in Table 3.

TABLE 3 - QUALITY CONFORMANCE INSPECTIONS

Inspection	Requirement Paragraph	Test Method Paragraph	AQL
(a) Dimensions	3.5.1	4.5.1	4.0
(b) Identification of product	3.8	4.5.1	1.0
(c) Workmanship	3.5.4.1, 3.9	4.5.1	1.0
(d) Inspection for packaging		4.6.7	1.0
(e) Liner condition	3.5.4.1	N/A	10.0
(f) Bond integrity	3.5.4.2	4.6.6	2.5

4.4.1 Inspection Lot

The inspection lot shall consist of finished bearings having a single part number, manufactured according to the same procedures as the parts originally qualified and produced as one continuous run or order or portion thereof.

4.4.2 Sampling

4.4.2.1 Sample for Quality Conformance Tests (a) Through (e)

The sample bearings shall be selected from each inspection lot in accordance with ANSI/ASQC Z1 4 inspection level II.

4.4.2.2 Sample for Quality Conformance Test (f)

The sample bearings shall be selected from each inspection lot in accordance with ANSI/ASQC Z1 4, inspection level S-2.

4.4.3 Quality Assurance Certification

For each inspection lot, the manufacturer shall maintain for seven years and supply to the purchaser upon demand:

a. Certified copies of all records of quality conformance inspections specified in 4.4 and the purchase order.

b. Certification that the materials, manufacturing procedures, and processes used in producing the bearings are the same as those of the bearings originally qualified.

These records and certifications shall identify the manufacturer of the bearings, the address of the plant where they were manufactured, the purchaser, and the purchase order number.

4.5 Examinations

4.5.1 Examination of Product

The bearings shall be examined to determine conformance to this specification and the applicable specification sheet for material, dimensions, finish, identification of product, workmanship and requirements not covered by tests.

4.6 Test Methods

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

4.6.1 Radial Static Loads

The bearings shall be exposed to 95% relative humidity at 120 °F ± 5 °F for not less than ten days and not more than fourteen days before limit load and ultimate load testing. Humidity exposure is to verify that the bearing composite is not excessively affected by high humidity conditions. The test shall be initiated within 1 h after removal of the bearing from the humidity chamber. The bearings shall be installed in a test fixture as shown in Figure 1 using a 0.0001- to 0.0016-in interference fit with the housing and a 0.0005- to 0.0030-in loose fit with the pin.

4.6.1.1 Limit Load

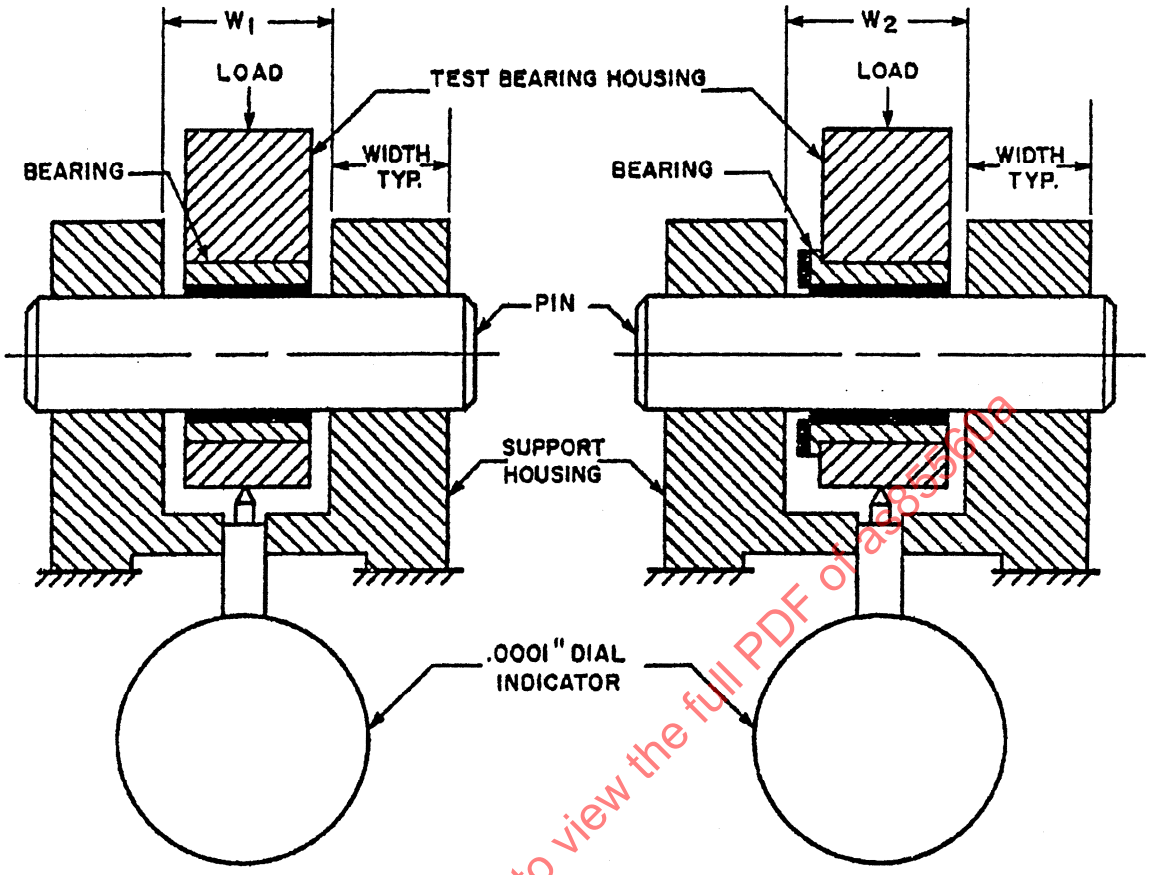
A preload of 4 to 6% of the radial static limit load shall be applied to the bearing for 3 min, and the measuring device set at zero. The load shall then be increased at the rate of 1% of the specified radial static limit load per second until it equals the specified radial static limit load value. The limit load shall be maintained for 3 min. The bearing deflection shall then be recorded. The load shall then be reduced at the same rate to the preload value. The permanent set shall be the measuring device reading at the preload value. The true bearing deflection shall be defined as the difference between the measuring device reading after 3 min at the limit load and the measuring device reading from the control test on a metallic bushing of the same size at the same load (see 4.6.1). Upon completion of the limit load test, the ultimate load test shall be conducted on the same test sample.

4.6.1.2 Ultimate Load

The ultimate radial load shall be applied at the rate of 1% of the specified load per second and the load then removed at the same rate.

4.6.1.3 Creep Load

Using a new test sample bearing that has had the specified humidity exposure, the radial creep load shall be applied at the rate of 1% of the specified load per second. When the specific load has been obtained, the indicator shall be set at zero. This load shall be maintained for 336 h at room temperature with periodic indicator readings taken to make a plot of time versus deflection.



PIN: DIAMETER = (SEE PARA. 4.6.1)
MATERIAL = STEEL 50 Rc MIN
FINISH = 8μ" MAX AND SHALL BE HONED, POLISHED OR SIMILARLY FINISHED SUBSEQUENT TO GRINDING.
NOTE: TAPER ONE END 1/2" MIN LENGTH, TAPERED END TO EXTEND BEYOND SUPPORT HOUSING WHEN ASSEMBLED

TEST BEARING HOUSING: BORE = (SEE PARA. 4.6.1)
WIDTH = L MAX + .002 −.000
LENGTH = 2 D MIN

SUPPORT HOUSING: BORE = PIN DIA MAX + (.0002 TO .0027)
MIN SUPPORT WIDTH = L NOMINAL
LENGTH = (2) (PIN DIA MIN)
W_1 = L +. (.025 TO .030)
W_2 = L + F + (.025 TO. 030)

FIGURE 1 - RADIAL LOAD TEST FIXTURE

4.6.2 Oscillation Under Radial Load

The bearing shall be installed in a steel housing, using a 0.0001- to 0.0016-in interference fit with the housing and a 0.0005- to 0.003-in loose fit with the pin. The bearing shall be so installed as to place the pin in double shear. A dial indicator or electronic pickup shall be so mounted that any radial movement of the pin or the bore of the bearing with respect to the bearing outside diameter can be measured. The dynamic load specified in Table 1 shall be applied and held statically for 15 min. At the end of this time the indicating device shall be set at zero and the oscillating test shall be started. Wear readings shall include the wear from the fifth cycle on. The test shall be run in such a manner that the pin is oscillating +25 degrees, return through 0 degrees to -25 degrees, and return to 0 degrees at 20 cpm for 25,000 cycles. Sufficient readings during the test shall be recorded to plot a graph of wear (thousandths of an inch) versus life (cycles). The loaded breakaway torque shall be measured and recorded as specified in 3.6.2. Before and after measurements of the bushing bore with the bearing installed in the housing shall be made with tapered parallels for measuring bores or a similar type of tool. Where there is conflict between the dial indicator wear readings and the measured wear readings, the measured wear readings shall prevail.

The pin shall have a hardness of not less than Rc 45 and shall have a surface finish of not more than Ra 8. The surface shall be buffed, honed, polished, or similarly finished after grinding.

4.6.3 Fluid Compatibility

Eighteen bearings with a 1.000-in bore and 0.500-in length (three for each fluid) shall be immersed for 24 h in each of the following fluids at 160 °F ± 5 °F, except for (a) which shall be at 110 °F ± 5 °F:

a. MIL-DTL-5624, turbine grade fuel.

b. MIL-PRF-7808 lubricating oil.

c. MIL-PRF-5606 hydraulic oil.

d. AS8243 anti-icing fluid.

e. MIL-PRF-83282 hydraulic fluid.

f. Distilled water.

Within 1/2 h after removal from the test fluid and without removing the fluid from the bore surface, the bearing shall be tested in accordance with 3.6.3 and 4.6.2.

4.6.4 High Temperature

Three bearings with a 1.000-in bore and 0.500-in length shall be subjected to the tests of 4.6.2, except that the bearing shall be heated in such a way that the pin sleeve interface is maintained at a temperature of not less than +250 °F.

4.6.4.1 Calibration of High Temperature Control System

Because it is impossible to measure the temperature at the pin/sleeve interface during an oscillation wear test, a temperature monitoring point slightly remote from the interface is necessary. To assure an accurate test, the remote sensing position shall be on either the pin or the sleeve and shall be calibrated against the actual interface temperature in a static test set-up. For the calibration, the interface shall be instrumented for temperature measurement by inserting a thermocouple between the sleeve and the pin. (A slit may be made in either the pin or the sleeve to accommodate the thermocouple.) The assembly shall be heated and the interface allowed to reach a steady temperature of not less than 250 °F. When the interface and the remote sensing position have reached steady temperatures, the remote sensing position temperature shall be recorded. During actual high temperature testing, heating of the sleeve bearing shall be applied in the same manner as in the calibration except that there shall be no thermocouple installed between the sleeve and the pin. Heating shall be applied during testing so as to maintain the remote sensing point at the temperature recorded during the calibration.