

AEROSPACE RECOMMENDED PRACTICE

SAE ARP5448/1

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Plain Bearing Radial Limit and Ultimate Load Tests

1. SCOPE:

1.1 Purpose:

This test method outlines the recommended procedure for performing radial limit load and ultimate load tests on low speed airframe and high speed helicopter rotor head bearings.

1.2 Classification:

Bearings covered by this test method shall be plain sleeve or spherical type in either annular or rod end configuration.

2. REFERENCES:

2.1 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, supercedes applicable laws and regulations unless a specific exemption has been obtained.

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

ASTM E 4 Standard Methods of Verification of Testing Machines

ASTM E 83 Method of Verification and Classification of Extensometers

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on this Technical Report, please visit
<http://www.sae.org/technical/standards/ARP5448/1>**

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

ANSI/NCSL Z540-1 Calibration Laboratories and Measuring and Test Equipment-General Requirements

- 2.1.3 ISO Publications: Available from ISO, Case Postale 56, CH-1211 Geneve 20, Switzerland.

ISO 10012-1 Quality Assurance Requirements for Measuring Equipment

2.2 Definitions:

PERMANENT SET: Permanent set is the displacement of the bearing in the load path during one excursion from a specified pre-load to limit load and return to pre-load.

RADIAL LIMIT LOAD: The radial limit load is the maximum load that should be applied to the bearing. A defined limit for permanent set is established corresponding to the specified limit load.

RADIAL ULTIMATE LOAD: The radial ultimate load is 1.5 multiplied by the radial limit load. After application of the radial ultimate load there may be significant permanent deformation of the bearing components. There shall not, however, be any cracked or broken components.

3. GENERAL REQUIREMENTS:

3.1 Test Apparatus:

- 3.1.1 Testing Machine: The testing machine shall be capable of applying the required radial load at a controlled rate. The calibration system for the machine shall conform to ANSI/NCSL Z540-1 and ISO 10012-1. Its accuracy shall be verified every 12 months by a method complying with ASTM E 4. The limit and ultimate loads of the bearings tested shall be within the loading range of the testing machine as defined in ASTM E 4.

- 3.1.2 Deflection Measuring Device: The measuring device shall be a mechanical or electronic linear indicator with a definition of 0.0002 inch and an accuracy of ± 0.0001 inch, or an extensometer with a precision of at least 1% of the indicated joint deflection at the limit load being applied. If using an electronic linear indicator, an autographic recorder with an accuracy of 0.5% of the indicated joint deflection at the limit load should be used in conjunction with it, and be calibrated in accordance with ASTM E 83. If using a dial indicator to measure deflection, sufficient data points should be recorded to plot a load versus deflection curve manually. Load and deflection ranges shall be used which give the initial part of the load extension curve a slope ideally between 45 and 60 degrees. The measuring device does not need to be attached directly to the fixtures.

3.1.3 Test Fixtures: The test fixtures shall be as shown in Figure 1a thru 1d. The test housing and strut shall be fabricated from steel and heat treated to a hardness of HRC 40 minimum. The test pin shall be fabricated from high strength tool steel or equivalent, heat treated to a hardness of HRC 50 minimum. For economy it is permissible to use adapter housings and bushings that permit one housing and strut assembly to be used for a variety of bearing sizes. Other techniques are acceptable provided that they can be calibrated to account for fixture deflection.

3.2 Specimen:

3.2.1 Quantity: The number of test specimens shall be as specified in the referencing document.

3.2.2 Disposition After Test:

3.2.2.1 Bearings subjected to limit and ultimate load tests: Unless otherwise specified by the applicable specification or contract, bearings that have been subjected to these tests may have deformed components and shall not be shipped.

4. DETAILED REQUIREMENTS:

4.1 Installation:

4.1.1 Sleeves: The sleeve shall be installed in the test fixture as shown in Figure 1a or 1b (as applicable) using a 0.0000 to 0.0011 inch interference fit with the housing for steel bearings, 0.0001 to 0.0016 inch interference fit for aluminum bearings, and a 0.002 to 0.004 inch loose fit with the pin. The use of differential temperatures for installation is acceptable.

4.1.2 Plain Spherical Bearings: The bearing shall be installed in the test fixture as shown in Figure 1c using a 0.0000 to 0.0010 inch loose fit with the housing, and a 0.0000 to 0.0010 inch loose fit with the pin. The use of differential temperatures for installation is not allowed.

4.1.3 Rod End Bearings: The bearing shall be installed in the test fixture as shown in Figure 1d using a 0.0000 to 0.0010 inch loose fit with the pin. The use of differential temperatures for installation is not allowed. An appropriately threaded attachment shall be installed on the rod end shank permitting a thread engagement of at least 1½ times the thread pitch diameter.

4.2 Radial Limit Load Test:

Apply a preload equal to four to six percent of the specified radial limit load and maintain for a minimum of three minutes. (Note: Rod end bearing tests shall be performed such that the bearing load places the shank in tension.) Engage the deflection measuring device and "zero" the autographic recorder. Increase the load to the specified limit load at a rate of a minimum of one percent of the specified load per second. Maintain the radial limit load for a minimum of two minutes. Remove the load, at the same rate as during loading, to the initial preload. NOTE: When a bearing specimen is to be subjected to the radial ultimate load test, it will not be necessary to remove that bearing from the test fixture after completing the radial limit load test.

4.3 Radial Ultimate Load Test:

(Note: Rod end bearing tests shall be performed such that the bearing load places the shank in tension.) Increase the load to the specified ultimate load at a rate of one percent of the specified load per second. Remove the load at the same rate as during loading.

4.4 Test Duration:

Testing shall continue until the test is successfully completed (when the appropriate load rating of the bearing has been met) or until failure as defined in the applicable specification has occurred.

4.5 Post Test Evaluation:

4.5.1 Radial Limit Load: The data shall be reviewed for conformance to the performance criteria (i.e. deflection at load, permanent set, etc.) as required by the applicable specification.

4.5.2 Radial Ultimate Load: Examine the test specimen. Deformation of the outer race is acceptable. There shall be no cracked or broken components.

5. NOTES:

5.1 Intended Use:

This test method is intended to provide means for evaluating the performance under static loads on low speed airframe bearings and for high speed helicopter rotor head bearings. Specific test and data requirements are given in the applicable document. The following note shall be used to reference this test method:

NOTE: The bearings shall be tested in accordance with ARP5448/1

The slash number refers to the specific test method.

5.2 Test Data:

5.2.1 Test Parameters: Specific test requirements are given in the referencing document. Test requirements shall include the following test parameters as applicable:

- a. Test specimen design envelope.
- b. Shaft and housing configuration.
- c. Radial limit load.
- d. Radial ultimate load.
- e. Loading rates for limit and ultimate load tests.
- f. Deflection at radial limit load.
- g. Permanent set.
- h. Test duration.
- i. Failure criteria (breakage, etc.).

5.2.2 Test Records: A log shall be maintained during the test and shall include a record of start and stop times, loads, maintenance performed on the test facility, and any other pertinent information relating to the test. If using a dial indicator to measure deflection, data indicating the progress of the test shall be recorded at sufficient intervals to produce an accurate plot of recorded test parameters versus time. If the load versus deflection graph is recorded from an electronic plotter, the horizontal and vertical axes should be labeled, and the chart identified. Data sheets shall be filled out when data is taken during the test. Test data sheets shall be in a format similar to the sample test data sheet shown in Table 1. Readings from oscillographs, temperature controls or any other recording devices shall then be taken at specified intervals and the records maintained sufficiently to support recording of the test results.

5.2.3 Test Report: The recorded data shall be summarized in report form and (as applicable) shall contain the following:

- a. Bearing description.
 - 1. Part number
 - 2. Lot identification.
 - 3. Manufacturer.
 - 4. A dated drawing completely describing the test bearing, including the dimensions, material and ratings.
- b. Test machine description.
 - 1. Model number, serial number and a brief description.
 - 2. Calibration data.
- c. Test parameters.
- d. Data sheets.
- e. Plots of recorded test parameters.
 - 1. Radial limit load versus deflection.
 - 2. Radial ultimate load versus deflection.
- f. Any test malfunction resulting in an invalid test or in an interruption in the test shall be noted
- g. Results of all inspections.
- h. To ensure accuracy of test data, the bearing supplier (or testing laboratory) shall certify that the data presented is the performance data for all bearings tested in the report and that no data has been deleted.

5.3 Keyword Listing:

Bearing tests
Loads, radial limit
Loads, radial ultimate

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