

MIL-B-7949E
 9 April 1981
 SUPERSEDING
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MILITARY SPECIFICATION

BEARINGS, BALL, AIRFRAME, ANTIFRICTION

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers antifriction bearings in the -65°F to 350°F temperature range as specified on the applicable military standard.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-P-416 Plating, Cadmium (Electrodeposited)

MILITARY

MIL-B-197 Bearings, Anti-Friction, Associated Parts and Sub-Assemblies, Preparation for Delivery of
 MIL-D-1000 Drawings, Engineering and Associated Lists
 MIL-G-23827 Grease, Aircraft and Instrument, Gear and Actuator Screw
 MIL-G-81322 Grease, Aircraft, General Purpose Wide Temperature Range

STANDARDS

MILITARY

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
 MIL-STD-810 Environmental Test Methods
 MIL-STD-831 Test Reports, Preparation of

(See supplement 1 for list of associated military standards (MS's).)

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASD/ENESS, Wright-Patterson AFB, OH 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American National Standards Institute

ANSI B46.1 Surface Texture, Surface Roughness, Waviness and Lay

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway Street, New York, New York 10018.)

3. REQUIREMENTS

3.1 Qualification. The bearings furnished under this specification shall be products which are qualified for listing on the applicable qualified product list at the time set for opening of bids.

3.3.1 Product design change. Any change in product design, description, materials or fabrication procedures will require requalification of the product to an extent determined by the qualifying activity.

3.2 Materials. The materials used shall be such that the finished bearings will conform to the requirements specified herein. The manufacturer shall use due care in subjecting metal to suitable check analysis and physical tests to satisfy the purchaser as to the uniformity of the material used.

3.2.1 Rings and balls. Alloy steels used shall conform to the applicable military standard.

3.3 Design and construction. The bearings shall be in accordance with applicable military standards and shall be designed and constructed as specified. Except as otherwise specified, the details of the working parts shall be optional. Only factory-new bearings shall be furnished.

3.3.1 Rings. Each outer and inner ring shall be of a single-piece construction.

3.3.2 Seals. Seals shall be provided to prevent the entrance of dust and to retain the lubricant and shall be tested and meet the requirements specified in 4.5.7.

NOTE: Bonded pop-in type seals are not permitted on internal self-aligned types.

3.3.2.1 Performance test. The seals shall be capable of withstanding the test requirement as specified in 4.5.7.1 without failure.

3.3.2.2 Seal retention. The seals shall be capable of withstanding the torque requirements as specified in 4.5.7.2 without failure.

3.4 Interchangeability. All parts having the same manufacturer's part number and MS dash number marked in accordance with 3.13 shall be functionally and

dimensionally interchangeable. The item identification and part number requirements of MIL-D-1000 shall govern the manufacturer's part numbers and changes thereto.

3.5 Physical properties

3.5.1 Radial strength

3.5.1.1 Limit load. When tested as specified in 4.5.3.1, the limit-load radial strength of the bearing shall be not less than the values specified on the applicable military standard.

3.5.1.2 Fracture strength. When tested as specified in 4.5.3.2, the minimum static fracture radial strength shall be not less than 1-1/2 times the radial limit-load value specified on the applicable military standard.

3.5.1.3 Radial dynamic load rating. When tested as specified in 4.5.3.3, the bearing shall have a radial dynamic load rating of not less than the values specified on the applicable military standard.

3.5.2 Axial strength

3.5.2.1 Limit load. When tested as specified in 4.5.4.1, the limit-load axial strength of the bearing shall be not less than the values specified on the applicable military standard.

3.5.2.2 Fracture strength. When tested as specified in 4.5.4.2, the minimum static fracture axial strength shall be not less than 1-1/2 times the axial load values specified on the applicable military standard.

3.6 Internal clearance. Radial or axial clearance shall be measured in accordance with 4.5.5 limits as specified on the applicable military standard.

3.7 Surface roughness. Surface roughness shall be as specified on the applicable military standard.

3.8 Hardness. The rings and balls shall be tested in accordance with 4.5.9. The limits shall be in accordance with values on the applicable military standard.

3.9 Plating. Except when fabricated of corrosion-resistant steel, all external steel surfaces, including metal seals or shields, except the inner ring bore, shall be cadmium plated in accordance with type I, class 2, of QQ-P-416. The plating thickness shall not exceed 0.0005 inch maximum.

3.10 Radial and lateral eccentricity. The nonself-aligning bearings shall be tested as specified in 4.5.2. Values shall not exceed the limits specified on the applicable military standard.

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* 3.11 Lubrication. The bearings shall be packed with grease conforming to MIL-G-81322 (-65°F to 350°F) or MIL-G-23827 (-65°F to 250°F), filled 80 percent minimum. The bearings shall be thoroughly cleaned before the lubricant is injected into the bearings. Bearings shall not have been lubricated more than 24 months prior to the date of delivery of the bearings under contract or order. The bore of all bearings and the outside diameter of the outer ring and the inside diameter of the self-aligning ring of the externally self-aligning bearing shall be coated with MIL-G-81322 or MIL-G-23827 grease. The bearing shall be coated with the same grease that is packed in the bearing.

3.12 Stability. The bearings shall be tested in accordance with 4.5.10 for dimensional stability.

3.13 Identification of product. The bearings shall be permanently and legibly marked with the manufacturer's name or trademark and part number. The individual bearing package shall be marked with the complete MS part number, the manufacturer's name and part number, and the date of lubrication.

3.14 Workmanship. The workmanship shall be in accordance with high-grade aircraft bearing manufacturing practice. Bearings shall be free from defects which may affect their durability and serviceability.

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 as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Test records. The manufacturer shall maintain a record showing quantitative results of all tests performed to the requirements of 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 and testing of the bearings shall be classified as follows:

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

4.3 Qualification tests.

4.3.1 Test reports. The contractor shall prepare a test report in accordance with MIL-STD-831 and furnish 3 complete copies of the report to the procuring activity (see 6.2). The report shall be accompanied by a dated drawing which shall describe in detail the manufacturer's product by specifying all dimensions and tolerances, material selected, lubricant, plating, and heat treatment.

4.3.2 Tests. The qualification tests shall include all of the examinations and tests specified under 4.5. The tests shall be conducted as specified in table I.

4.4 Quality conformance tests. The quality conformance tests shall consist of sampling tests specified in 4.4.3 on each lot of bearings.

4.4.1 Lot. A lot shall consist of bearings of one type and size offered for delivery at one time.

4.4.2 Sample for quality conformance inspection. A random sample of bearings shall be selected in accordance with MIL-STD-105, inspection level II.

4.4.3 Inspection for reliability provisions. Samples, as specified in 4.4.2 shall be examined for the following:

- a. Dimensions (4.5.1)
- b. Identification of product (4.5.1)
- c. Examination of product (4.5.1)
- d. Workmanship (4.5.1)
- e. Radial or axial play (4.5.5.1 or 4.5.5.2)

In addition, laboratory verification of all other tests shall be performed on random samples from periodic lots as specified by the procuring activity (see 6.2) to determine continued performance with the requirements of this specification.

4.5 Test methods

4.5.1 Examination of product. Each bearing shall be carefully examined to determine conformance with all requirements of this specification as to dimensions, lubrication, identification, and workmanship. In addition, all bearings shall be inspected by manual rotation and may be rejected if there is frequent and regular catching or binding as might be caused in interference of balls with loading slots or filling notches. Due regard shall be given to the fact that bearings without retainers or separators are likely not to have absolute freedom of rotation because of adjacent balls rubbing each other.

4.5.2 Radial and lateral eccentricity. Ten nonself-aligning bearings shall be checked. Each bearing shall be mounted on a vertical axis. The radial eccentricity of the bearing inner race shall be measured by rotating the inner race, while preventing rotation of the outer race and measuring variations on a dial indicator placed radially against the outer race. For lateral eccentricity, the dial indicator shall be placed axially as shown on figure 1. The outer race radial and lateral eccentricity shall be determined by holding the inner race in a fixed position and rotating the outer race.

4.5.2.1 Out-of-roundness. The out-of-roundness shall be within the out-of-roundness tolerances specified for dimensions B and D on the applicable military standard. Ten military standard bearings shall be tested.

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TABLE I. Qualification inspection samples.

| Examination or Test | Sample Number | | | | | | | | | | | | | | | | | | | | | | | | | Test Paragraph |
|---|---------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------------|
| Examination of product | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 4.5.1 |
| | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| Preservation, packaging packing and marking | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 4.6 |
| Radial and lateral eccentricity | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 4.5.2 |
| Out of roundness | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 4.5.2.1 |
| Radial limit load | | | | | | | | | | | X | X | X | | | | | | | | | | | | | 4.5.3.1 |
| Radial static fracture load | | | | | | | | | | | X | X | X | | | | | | | | | | | | | 4.5.3.2 |
| Axial limit load | | | | | | | | | | | | | | | | | X | X | X | | | | | | | 4.5.4.1 |
| Axial static fracture load | | | | | | | | | | | | | | | | | X | X | X | | | | | | | 4.5.4.2 |
| Radial play | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 4.5.5.1 |
| Axial play | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 4.5.5.2 |
| Radial dynamic load | | | | | | | | | | | | | | | | | | X | X | X | X | X | X | X | X | 4.5.3.3 |
| Plating | X | X | | | | | | | | | | | | | | | | | | | | | | | | 4.5.6 |
| Seals | | | | | | | | | | X | X | X | | | | | | | | | | | | | | 4.5.7 |
| Hardness | X | | | | | | | | | | | | | | | | | | | | | | | | | 4.5.9 |
| Surface roughness | X | X | X | | | | | | | | | | | | | | | | | | | | | | | 4.5.8 |
| Stabilization | | | | | | | | | | | | | | | | | X | X | X | | | | | | | 4.5.10 |
| Lubrication | X | X | X | | | | | | | | | | | | | | | | | | | | | | | 4.5.11 |

4.5.3 Radial strength

4.5.3.1 Limit load. Three bearings shall be tested in a rigid support as shown on figure 2. Each bearing shall be rotated by hand to determine smoothness of operation before testing. The pertinent radial limit load specified on the applicable military standard shall be applied for 1 minute. The load shall then be removed and the bearing shall be inspected for evidence of failure. In inspection by manual rotation after the radial load test, the bearing shall be subjected to a 5-1/2 pound radial load. If the smoothness of operation of the bearing has been lessened perceptibly, it shall be considered to have failed.

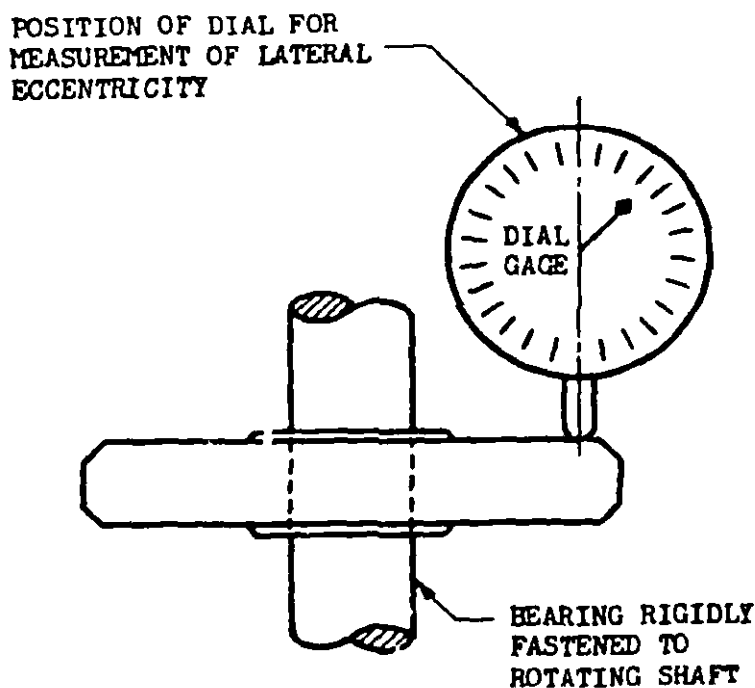


Figure 1. Test setup.

4.5.3.2 Radial static fracture loads. The minimum static fracture radial load of 1-1/2 times the pertinent rated limit load specified on the applicable military standard shall be applied to the bearings for 1 minute. After removal from the load, the bearings shall be examined. Bearings not capable of being turned by hand or having parts broken or cracked shall be considered to have failed. Three military standard bearings shall be tested.

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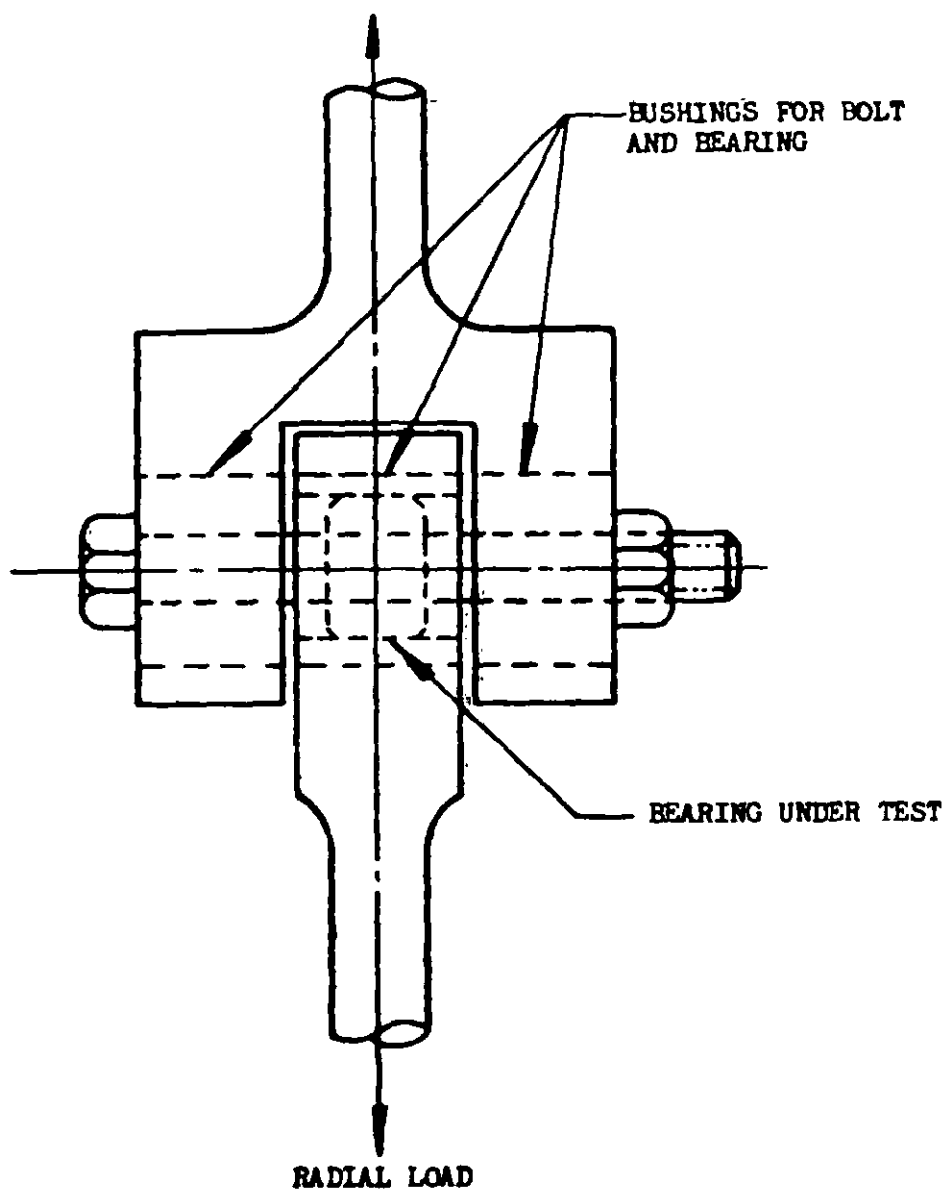


Figure 2. Radial load.

4.5.3.3 Radial dynamic load. Ten bearings shall be mounted on a test fixture having suitable support bearings and drive linkages to cause oscillation of the inner ring. The radial dynamic load specified on the applicable military standard shall be applied and maintained within ± 1 percent. The bearings shall be oscillated through an arc of 90 degrees and back to the starting position for 15,000 cycles. The bearings shall be removed and examined for excessive roughness and looseness. Any bearing that does not operate smoothly because of ball or raceway defects shall be considered to have failed. Any bearing that does not operate smoothly because of ball or raceway defects shall be considered to have failed. Five bearings shall be disassembled and inspected for ball and raceway defects. No more than 5 bearings shall have failed this test.

4.5.4 Axial strength

4.5.4.1 Limit load. Three bearings shall be individually subjected to the pertinent axial limit load specified on the applicable military standard, applied for 1 minute as indicated on figure 3. The load shall then be removed and the bearings shall be inspected for evidence of failure. The bearings shall then be turned over and the test repeated. In inspection by manual rotation after the axial load test, the bearings shall be subjected to 5-1/2 pound axial load. If the smoothness of operation of the bearings has been lessened perceptibly, they shall be considered to have failed.

4.5.4.2 Axial static fracture load. The minimum static fracture axial load of 1-1/2 times the pertinent rated limit load specified on the applicable military standard shall be applied to the bearings for 1 minute, as indicated on figure 3. The bearings shall then be turned over and the test repeated. Bearings not capable of being turned by hand after the test, or having parts broken or cracked shall be considered to have failed. Three military standard bearings shall be tested.

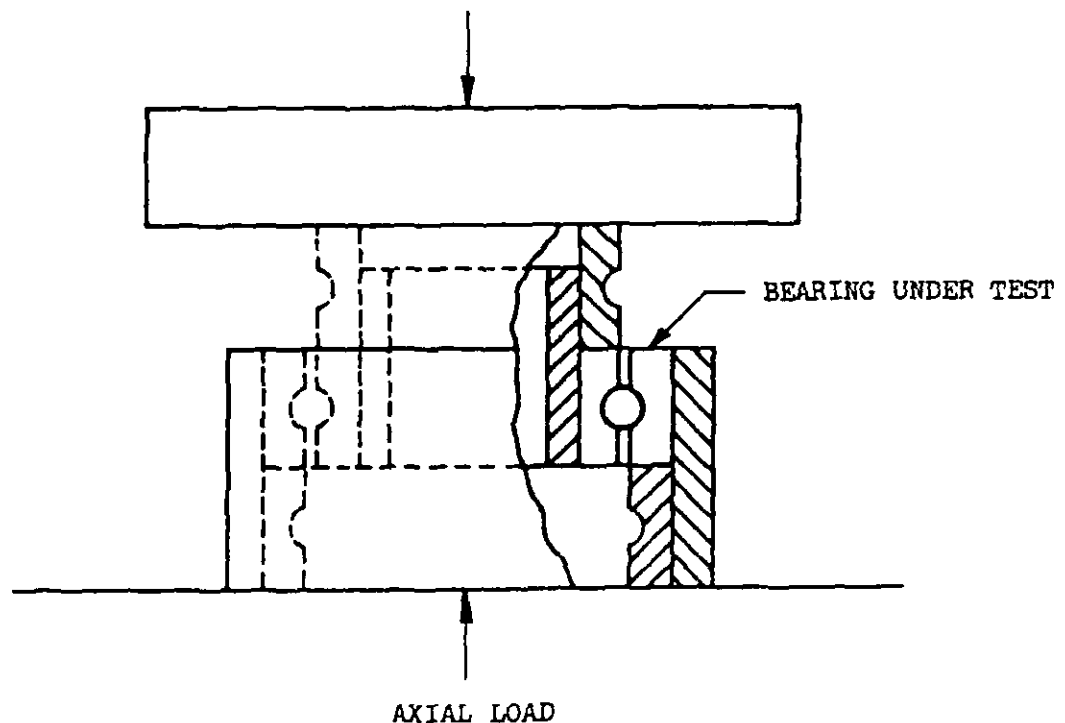


Figure 3. Axial load.

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4.5.5 Internal play

4.5.5.1 Radial. Ten bearings shall be tested at normal room temperature for radial play. The radial play shall be measured by means of a dial indicator with the bearings subjected to a 5-1/2 pound radial load applied alternately in opposite directions.

4.5.5.2 Axial. Ten bearings shall be tested at normal room temperature for axial play. The axial displacement shall be measured by means of a dial indicator with the bearings subjected to a 5-1/2 pound axial load applied alternately in opposite directions.

4.5.6 Plating. Tests to determine the thickness of plating shall be made on two military standard bearings to determine conformance to QQ-P-416.

4.5.7 Seal qualification

* 4.5.7.1 Performance test. At least 1 bearing of each MS size shall be held at -65°F for 100 hours, then at 300°F for 100 hours while being operated in the test chamber at 3 revolutions per minute (RPM). The bearings shall be subjected to the sand and dust test, procedure I, of MIL-STD-810. Seal deterioration or ingress of dust that is detrimental to the bearing performance shall be considered seal failure. At least 50 percent of the lubricant by weight shall be retained in the bearing at the end of this test. Bearings shall be qualified with MIL-G-81322 grease only.

4.5.7.2 Seal retention. The seal retention test shall be performed in both directions on three bearings of each MS size shown in table II. The test shall be conducted by inserting a bolt through the bore of the bearing and applying a torque as shown in table II in the direction which would tend to cause the seal to be dislodged. The inner race shall then be rotated 90 degrees with respect to the other ring and the above test repeated. Figure 4 shows the test fixture to be employed in the test. Any seals that become loose, damaged or dislodged shall be considered failures and the complete lot rejected.

NOTE: Bolt head diameter must be less than diameter A specified for the applicable MS bearing.

4.5.8 Surface roughness. Surface roughness shall be measured in accordance with ANSI B46.1. Any failure to comply with the applicable MS shall be cause for rejection. Use the same bearings specified in 4.5.9.

4.5.9 Hardness. One bearing of each MS size shall be disassembled and tested for hardness of the inner ring, outer ring, and of three balls. The test shall be made on ground and polished flat cross sectional areas of the inner and outer ring adjacent to the raceway (as near as possible). Reading for the balls shall be taken on a flat surface. Hardness limits shall be as specified on the applicable MS. A standard Rockwell hardness tester shall be used for this test.

* TABLE II. Test torque for seal misalignment.

| MS No. 27645 | Min Torque to dislodge Seal In/Lbs | MS No. 27643 | Min Torque to dislodge Seal In/Lbs |
|-----------------|--|-----------------|--|
| -3A | 4 | -3 | 8 |
| -4A | 6 | -4 | 12 |
| -5A | 10 | -5 | 28 |
| -6A | 8 | -6 | 45 |
| -3 | 6 | -8 | 60 |
| -4 | 5 | -10 | 78 |
| -5 | 16 | | |
| -6 | 18 | | |
| -8 | 20 | | |
| -10 | 25 | | |

4.5.10 Stabilization (qualification). Three bearings of each MS size submitted for qualification shall be tested at $250^{\circ} \pm 10^{\circ}\text{F}$ for 300 hours, allowed to return to room temperature, then measured. Any bearings that show a dimensional change of more than .0001 inch per inch of diameter shall be considered to have failed. The bearings shall then be cold soaked at $-65 \pm 10^{\circ}\text{F}$ for 4 hours, allowed to return to room temperature, then measured. Any bearings that show a dimensional change of more than .0001 inch per inch of diameter from the last reading shall be considered to have failed. All measurements shall be made at room temperature and shall be made at a single reference position on the bearing outside diameter.

* 4.5.11 Lubricant. The lubricant shall conform to MIL-G-81322 or MIL-G-23627, and shall be inspected for quality and cleanliness.

5. PACKAGING

5.1 Preservation and packaging. Preservation and packaging of the bearings shall be in accordance with level A or C of MIL-B-197, as specified (see 6.2).

5.2 Packing and marking. The bearings shall be packed in accordance with level A, B, or C, as specified, and marked in accordance with MIL-B-197 (see 6.2).

6. NOTES

* 6.1 Intended use. The sealed antifriction bearings covered in this specification are intended for use in aircraft control systems. These bearings are not intended for applications involving high-rotative speeds. These bearings are not intended to be relubricated.

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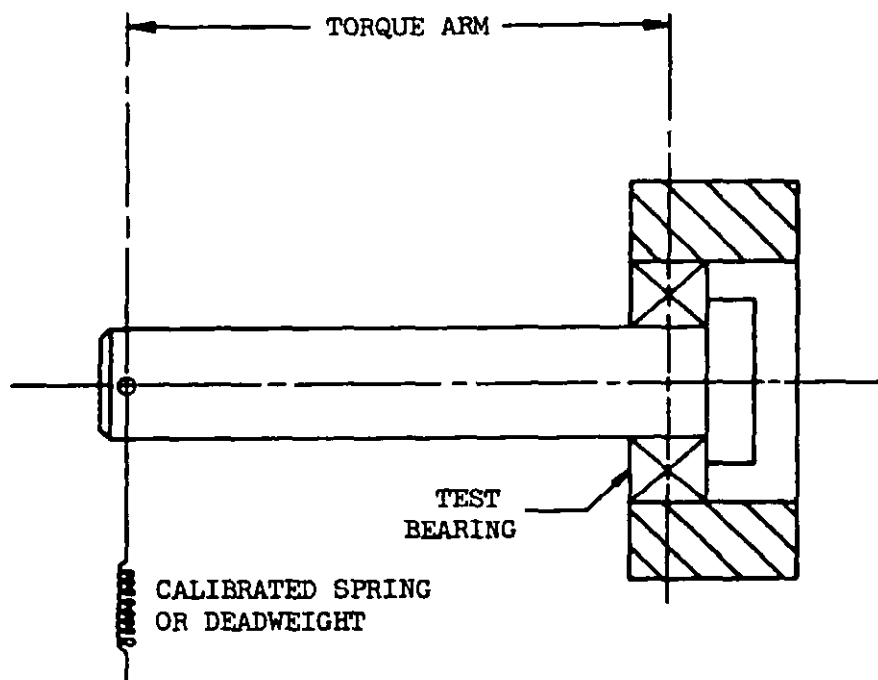


Figure 4. Test fixture used to determine torque required to dislodge seals in "KSP" bearings.

- 6.2 Ordering data. Procurement documents should specify the following:
- a. Title, number, and date of this specification
 - b. Complete MS part number (see supplement 1)
 - c. Quantity
 - d. Test report (see 4.3.1)
 - e. Laboratory verification (see 4.4.3)
 - f. Selection of applicable levels of packaging and packing required (see 5.1 and 5.2).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer the Federal Government tested for qualification in order that they may be eligible to be awarded

contracts or orders for the product covered by this specification. The activity responsible for the Qualified Products List is the Aeronautical Systems Division, Attn: ENFL, Wright-Patterson Air Force Base, Ohio 45433, and information pertaining to qualification of products may be obtained from that activity.

6.4 International standardization agreement. Certain provisions of this specification are the subject of International Standardization Agreement ASCC 17/37. When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

- 6.5 Changes from previous issue. The margins of this specification are marked with an asterisk to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationships to the last previous issue.

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Preparing activity:
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Review activities:
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