SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE STANDARD

SAE AS81935 REV. A

Issued 1997-11
Revised 2001-12

Superseding AS81935

## Bearings, Plain, Rod End, Self-Aligning, Self-Lubricating, General Specification For



NOTICE

Under Department of Defense Policies and Procedures, any qualification requirements and associated qualified products lists are mandatory for DoD contracts. Any material relating to Qualified Products Lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

1. SCOPE:

1.1 Scope:

This specification covers plain rod end bearings which are self-aligning and self-lubricating by incorporating polytetrafluoroethylene (PTFE) in a liner between the ball and race for use in the temperature range -65 to +325 °F (-54 to +163 °C).

1.2 Classification:

Bearings shall be of the following classes, as specified (see 3.5.4):

Class 1 - Externally threaded shank
Class 2 - Internally threaded shank

2. APPLICABLE PUBLICATIONS:

2.1 Government Documents:

2.1.1 Specifications, Standards and Handbooks: The following specifications, standards and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS), and supplement thereto, cited in the solicitation.

SPECIFICATIONS

MILITARY

| | |
|---|---|
| MIL-STD-100 | Standard Practice for Engineering Drawings |
| MIL-STD-129 | Standard Practice for Military Marking |
| MIL-STD-130 | Identification Marking of U. S. Military Property. |
| MIL-DTL-197 | Packaging of Bearings, Anti-friction, Associated Parts and Subassemblies |
| MIL-HDBK-129 | Military Marking |
| MIL-HDBK-1599 | Bearings, Control System Components and Associated Hardware Used in the Design and Construction of Aerospace Mechanical Systems and Subsystems |

2.1.2 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

| | |
|---|---|
| AS14101 | Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Narrow, Grooved Race, -65°F to +325°F |
| AS14103 | Bearing, Plain, Self-Lubricating, Self-Aligning, Low Speed, Wide, Grooved Race, -65°F to +325°F |
| AS8879 | Screw Threads, Controlled Radius Root With Increased Minor Diameter, General Specification for |
| AS81820 | Bearing, Plain, Self-Aligning, Self-Lubricating, Low Speed Oscillation |
| AS81935/1 | Bearing, Plain, Rod End, Self-Aligning, Self-Lubricating, Externally Threaded, -65°F to +325°F |
| AS81935/2 | Bearing, Plain, Rod End, Self-Aligning, Self-Lubricating, Wide, Internally Threaded, -65°F to +325°F |
| AS81935/3 | Locking Device, Rod End |
| AS81935/4 | Bearing, Plain, Rod End, Self-Aligning, Self-Lubricating, Narrow, Externally Threaded, -65°F to +325°F |
| AS81935/5 | Bearing, Plain, Rod End, Self-Aligning, Self-Lubricating, Narrow, Internally Threaded, -65°F to +325°F |
| AMS-QQ-P-416 | Plating, Cadmium (Electrodeposited) |

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

| | |
|---|---|
| ASTM D 3951 | Practice for Commercial Packaging |
| ASTM E 1444 | Inspection, Magnetic Particle |

(Copies of specifications, standards, handbooks, drawings, publications and other documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other Publications:

The following document(s) forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

American National Standards Institute/American Society of Mechanical Engineers

| | |
|---|---|
| ANSI/ASME B46.1 | Surface Texture (Surface Roughness, Waviness and Lay) |
| ANSI/ASQC Z1.4 | Sampling Procedures and Tables for Inspection by Attributes |

(Application for copies should be addressed to the American National Standards Institute,11 West 42 nd Street, New York, NY 10036-8002 or the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5990.)

Uniform Classification Committee
Uniform Freight Classification Rules

(Application for copies of the above publication should be addressed to the Uniform Classification Committee, 202 Chicago Union Station, Chicago, IL 60606.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of Precedence:

In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or AS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS:

3.1 Specification Sheets:

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

3.2 Qualification:

Bearings furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List prior to the award of contract (see 4.4, 6.3 and 6.3.1).

3.2.1 Product Design Change: Any change in product design, description, materials or processing procedures will require requalification of the product to an extent determined by the qualifying activity. For the purposes of this specification "change in processing procedures" means a change in any of the following: (1) the company performing rod end body machining, (2) the company performing rod end body heat treating, or (3) the company performing thread forming.

3.3 Bearing Cartridge:

The bearing cartridge used in these rod ends shall be in accordance with AS14101 or AS14103, shall be qualified to AS81820 and shall have been subjected to and passed the Quality Conformance Tests of Section 4.4 of AS81820. If the bearing cartridge used in these rod ends was produced by another manufacturer, the Department of Defense regulations and policies regarding rebranding of products shall apply. These regulations state that when a company wishes to supply a qualified product carrying its own brand designations, but which is manufactured by another firm, the manufacturer shall be requested by the company to certify that the company is authorized to rebrand and distribute the product with its own brand designation. Additional information about these regulations may be obtained from Naval Air Systems Command, Code 435400A, 48110 Shaw Road Unit 5, Patuxent River, MD 20670-1906.



3.4 Materials:

The rod end body materials shall be in accordance with the applicable SAE specification sheet.

3.4.1 Cadmium Plating: The alloy steel rod end bodies shall be cadmium plated in accordance with SAE-AMS-QQ-P-416, Type II, Class 2. The plated bodies shall be heated to a temperature of 375 °F ± 25 °F within 4 hours after plating but before the chromate treatment and magnetic particle inspection, and held at this temperature for a minimum of 3 hours, after which the bodies shall be allowed to cool normally at room temperature.

3.4.2 Lubrication: Initial grease or oil lubrication of the bearing cartridge will not be permitted. Use of anti-fretting material between the bearing cartridge and the rod end body is permitted.

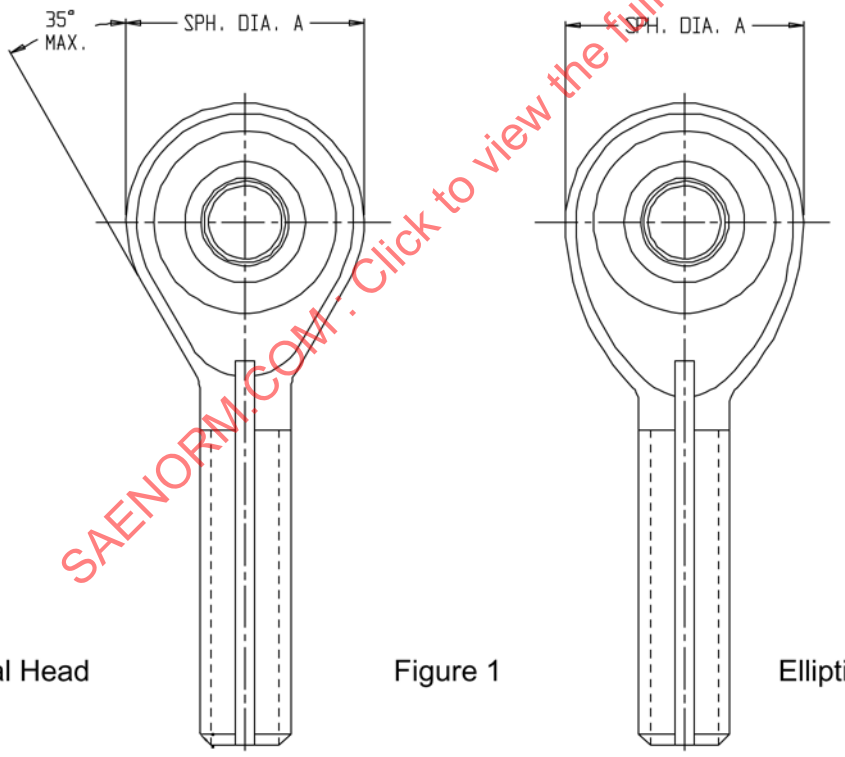
3.5 Design and Construction:

The design of the bearing shall conform to the requirements of AS81935/1, AS81935/2, AS81935/4 or AS81935/5. Construction shall be such that all relative motion will be between the liner and ball. Except as otherwise specified, the details of the working parts 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.

3.5.1.1 Rod end spherical head geometry shall conform to the dimensional requirements of AS81935/1, AS81935/2, AS81935/4 or AS81935/5. The manufacturer has the option of qualifying either a "Conical Head" or "Elliptical (Olive) Head" as referenced by Figure 1. The manufacturer shall utilize the head geometry used on the original qualification lot and shall not deviate without first obtaining approval from the Naval Air Systems Command, code 435400A, 48110 Shaw Road, Unit 5, Patuxent River, MD 20670-1906.






Conical Head Figure 1 Elliptical or Olive Head

FIGURE 1

3.5.2 Surface Texture: Surface textures shall be in accordance with the applicable AS sheet and ANSI B46.1. Bearings shall be free of any defects which may be detrimental to satisfactory installation, performance or bearing life, as defined by this specification.

3.5.3 Hardness: Each rod end body shall be tested for hardness as specified in 4.7.5. Alloy steel rod ends shall be tested after heat treatment but before plating. Only rod end bodies with Rockwell readings in the range allowed by the applicable SAE specification sheet shall be acceptable.

3.5.3.1 Hardness Sampling: Rod end bodies, heat treated and tempered in furnaces qualified and maintained in accordance with AMS 2750, may be sample hardness tested in accordance with ANSI/ASQE Z1.4, General Inspection Level II, AQL 1.0, provided the ten (10) previous lots of each part number were found acceptable to 100% hardness testing.

3.5.4 Threads:

3.5.4.1 Class 1 Rod Ends (External Thread): Dimensions, form and contour shall conform to AS8879. Threads shall be rolled after heat treatment. Rerolling of threads to correct dimensional deficiencies shall not be permitted.

3.5.4.2 Class 2 Rod Ends (Internal Thread): Threads shall conform to AS8879.

3.5.5 Magnetic Particle Inspection: All rod end bodies shall be examined by magnetic particle inspection as specified in 4.7.6.1. Any rod end bodies having discontinuities equal to or exceeding the limitations specified herein shall be rejected. Care must be exercised to avoid confusing cracks, as described herein, with other discontinuities.

3.5.5.1 Cracks: Rod end bodies shall be free of cracks in any direction or location. A crack is defined as a clean crystalline break passing through the grain or grain boundary without the inclusion of foreign elements.

3.5.5.2 Laps and Seams: Rod end bodies may possess laps and seams, except in locations specified in 3.5.5.4 and 3.5.5.5. Except as noted, the depths shall not exceed the amounts specified in Table 1. A lap is a surface defect appearing as a seam caused by folding over hot metal fins or sharp corners and then rolling or forging them into the surface, but not welding them. A seam is an unwelded fold or lap which appears as an opening in the raw material as received from the source.

TABLE 1 - Discontinuity Depths 1/

| Bearing Size | -4 and -5 | -6 | -7 | -8 thru –16 |
|---|---|---|---|---|
| Seam Depth (inch) (maximum) | 0.005 | 0.006 | 0.007 | 0.008 |

1/Depth of discontinuity shall be measured normal to the surface at the point of greatest penetration.

3.5.5.3 Inclusions: Rod end bodies shall show no evidence of surface or subsurface inclusions at the thread root, hoop-to-shank fillet or in the 3 to 6 to 9 o'clock positions of the hoop (see Figure 2) when inspected in accordance with 4.7.6. Small inclusions in other parts of the rod end body not indicative of unsatisfactory material quality, shall not be cause for rejection.

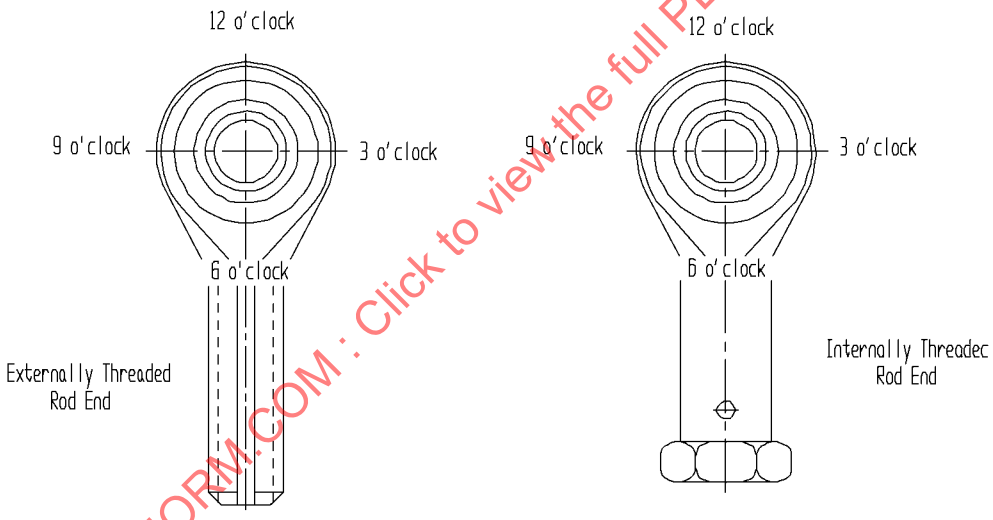
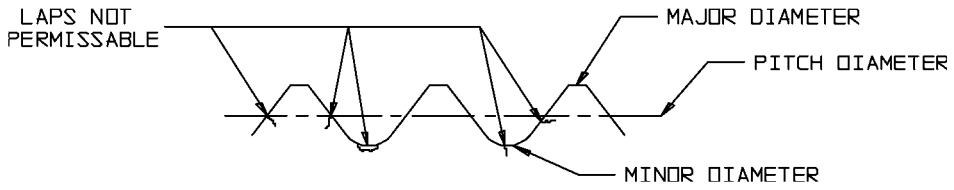



FIGURE 2 - Hoop Position Designations



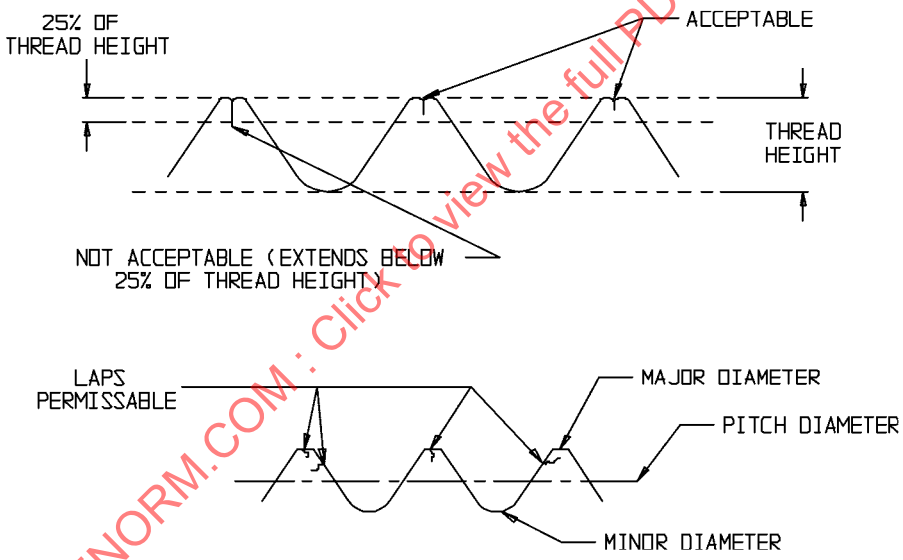
3.5.5.4 Hoop and Hoop-to-Shank Fillet Discontinuities (Seams and Folds): The rod end body shall not have seams or folds in the 3 to 6 to 9 o'clock positions of the hoop or in the hoop-to-shank fillet. Seams or folds in the 9 to 12 to 3 o'clock positions of the hoop not exceeding the limits of Table 1 shall not be cause for rejection.

3.5.5.5 Thread Discontinuities (Laps, Seams and Surface Irregularities): Threads shall have no multiple or single laps at the root or on the sides (Figure 3), except that laps are permissible at the crest which do not exceed 25 percent of basic thread depth, and on the sides outside the pitch diameter (see Figure 4). Deviation from the thread contour is permissible at the crest of the thread as shown in Figure 4. The incomplete thread at each end of the thread may also deviate from contour.




Note: For limits see 3.5.5.2 and 3.5.5.3.

FIGURE 3 - Nonpermissible Laps, Seams and Inclusions




Note: For limits see 3.5.5.5.

FIGURE 4 - Permissible Laps, Seams and Inclusions



3.6 Performance:

3.6.1 Ultimate Static Load: No fracture of the rod end body shall occur when the ultimate static load specified on the applicable rod end AS sheet is applied in accordance with 4.7.1.

3.6.2 Axial Static Proof Load: No pushout of the bearing cartridge from the rod end body shall occur when the axial proof load on the applicable AS sheet is applied as specified in 4.7.2.

3.6.3 Fatigue Load: The rod end bearings shall be capable of withstanding a minimum of 50,000 cycles of loading when tested in accordance with 4.7.3.

3.6.4 Self-Alignment: The bearing shall be self-aligning and permit the angular displacement specified on the applicable AS sheet.

3.6.5 No-Load Rotational Breakaway Torque: When tested in accordance with 4.7.4, the no-load breakaway torque shall be within the limits of the values specified on the applicable rod end AS sheet.

3.7 Interchangeability:

All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. The drawing number requirements of MIL-STD-100 shall govern changes in the manufacturers' part numbers.

3.8 Identification of Product:

Each bearing shall be permanently and legibly marked with the military identifying part number, the manufacturer's name or trademark, and manufacturer's part number. Where practicable, identification shall appear on the side face of the rod end body; otherwise identification shall appear on the periphery of the rod end body. Metal impression stamping is prohibited. (Marking in accordance with MIL-STD-130.)

3.9 Workmanship:

The bearing shall be free of tool marks, chatter waves, rust, grinding scratches, pits, cracks or any other defects that may adversely affect their 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 purchase 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 Responsibility for Compliance: All items must meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the supplier's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the supplier of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Qualification Test Records:

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

4.3 Classification of Inspection:

The examination and testing of the bearings shall be classified as:

a. Qualification inspection (4.4).
b. Quality conformance inspection (4.5).

4.4 Qualification Inspections:

4.4.1 Sampling Instructions: Qualification inspection samples shall consist of ten bearings of sizes -6, -8, -12 for each class (1 and 2) for which qualification is desired. The test bearings shall be furnished by the manufacturer. The bearings shall be identified and forwarded to the Naval Air Systems Command, code 435400A, 48110 Shaw Road, Unit 5, Patuxent River, MD 20670-1906.

Approval of the bearing sizes in column I will extend to approval of the corresponding sizes in column II.

TABLE 2 - Order of Qualifying Bearings

Wide Series

| I | II |
|---|---|
| M81935/1-06 | M81935/1-03, -04, -05, -06 |
| M81935/1-08 | M81935/1-07, -08, -10 |
| M81935/1-12 | M81935/1-12, -14, -16 |
| M81935/2-06 | M81935/1-03, -04, -05, -06 |
| M81935/2-08 | M81935/1-07, -08, -10 |
| M81935/2-12 | M81935/1-12, -14, -16 |

Narrow Series

| I | II |
|---|---|
| M81935/4-06 | M81935/4-03, -04, -05, -06 |
| M81935/4-08 | M81935/4-07, -08, -10 |
| M81935/4-12 | M81935/4-12, -14, -16 |
| M81935/5-06 | M81935/5-03, -04, -05, -06 |
| M81935/5-08 | M81935/5-07, -08, -10 |
| M81935/5-12 | M81935/5-12, -14, -16 |



4.4.2 Certified Test Report: The manufacturer shall furnish a certified test report showing the manufacturer's product satisfactorily conforms to this specification. The test report shall include, as a minimum, actual results of the tests specified herein. When the report is submitted, it shall be accompanied by a dated drawing which completely describes the manufacturer's product by specifying all dimensions and tolerances, the part number of the bearing cartridge, anti-fretting material if used, coating or plating, and heat treatment. The manufacturer's part number for each size shall be included on the drawing.

4.4.3 Inspections: Qualification inspections shall include all the examinations and tests of this specification. The minimum number of samples per test shall be in accordance with Table 3.

TABLE 3 - Qualification Inspection Samples

| Examination and Test | Paragraph No. | Samples To Be Tested |
|---|---|---|
| Examination of product | 4.6.1 | 5 |
| Preparation for delivery | 4.6.2 | 5 |
| Ultimate static load | 4.7.1 | 3 |
| Axial static proof load | 4.7.2 | 1/3 |
| Fatigue load | 4.7.3 | 3 |

1/Satisfactory test results for Class 1 bearings will apply toward qualification of Class 1 and Class 2.

4.4.4 Retention of Qualification: The retention of qualification shall consist of periodic verification and shall be by certification unless otherwise specified by the activity responsible for the Qualified Products List and shall be at intervals of not more than five years.

4.5 Quality Conformance Inspections:

4.5.1 Bearing Cartridge Inspection: The bearing cartridge installed in the rod end body shall meet the requirements of paragraph 3.3. The bearing supplier shall maintain and supply to the purchaser upon demand:

a. Certified copies of all records of quality conformance tests specified in 4.4 of AS81820.
b. Certification that the materials and manufacturing procedures used in producing the bearing cartridge are the same as those of the bearings originally qualified.

4.5.2 Rod End Bearing Inspection: The rod end quality conformance inspections shall consist of the inspections listed in Table 4.

4.5.3 Inspection Lot: The inspection lot shall consist of finished rod end bearings, having a single part number, manufactured by the procedures established for the original qualified rod ends, which can be defined by means of in-house processing records.

4.5.4 Sampling:

4.5.4.1 Sample for Quality Conformance Tests (a) through (d) (Table 4): The sample rod ends shall be selected at random from each inspection lot in accordance with Table 5. If no defect is found in the sample, the lot shall be accepted for these tests. If any defects are found in the sample, the entire lot shall be inspected 100% for each defective characteristic found, and all defective parts shall be removed from the lot.

4.5.4.2 Sample for Qualification Conformance Tests (e) and (f): Inspection shall be 100% of the lot. All defective parts shall be removed from the lot.

4.6 Examinations:

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

4.6.2 Inspection of Preparation for Delivery: Preservation, packaging, packing and marking shall be inspected to determine conformance of Section 5.

TABLE 4 - Qualify Conformance Inspections
For Class 1 (External Thread) and Class 2 (Internal Thread) Rod Ends

| | Examination or Test | | Major Char. | Minor Char. | Special Insp. Plan | Requirement Paragraph | Test Paragraph |
|---|---|---|---|---|---|---|---|
| (a) | Dimensions | | | | | | |
| | Bore | "B" | X | | | 3.5.1 | 4.6.1 |
| | Outside Sph. Dia | "D" | | X | | 3.5.1 | 4.6.1 |
| | Shank/Head Fillet Radius | | | X | | 3.5.1 | 4.6.1 |
| | 35° Max. Angle | | | X | | 3.5.1 | 4.6.1 |
| | .06/.12 Radius | (2) | | X | | 3.5.1 | 4.6.1 |
| | Min. Thread Length | "L" (2) | | X | | 3.5.1 | 4.6.1 |
| | Thread Length | "L" (1) | | X | | 3.5.1 | 4.6.1 |
| | Thread Size | "E" | X | | | 3.5.1 | 4.6.1 |
| | C-Line Ball to End | "F" | | X | | 3.5.1 | 4.6.1 |
| | C-Line Drill to End | "G" (2) | | X | | 3.5.1 | 4.6.1 |
| | Ø .070 Witness Hole | (2) | | X | | 3.5.1 | 4.6.1 |
| | Shank Dia. | "N" (2) | | X | | 3.5.1 | 4.6.1 |
| | Ball Width | "W" | X | | | 3.5.1 | 4.6.1 |
| | Body Width | "H" | | X | | 3.5.1 | 4.6.1 |
| | Ball Shoulder Dia. | "A" | | X | | 3.5.1 | 4.6.1 |
| | Max. Housing ID | "J" | | X | | 3.5.1 | 4.6.1 |
| | Tap Drill Depth | "M" (2) | | X | | 3.5.1 | 4.6.1 |
| | Ht Across Wrench Flat | "C" (2) | | X | | 3.5.1 | 4.6.1 |
| | Width of Wrench Flat | "R" (2) | | X | | 3.5.1 | 4.6.1 |
| | Ball Tilt Angle Min. | "Q" | | X | | 3.5.1 | 4.6.1 |
| | Keyway Flat Depth | "P" | | X | | 3.5.1 | 4.6.1 |
| | Keyway Width | "K" | | X | | 3.5.1 | 4.6.1 |
| | Keyway Corner Radii | | | X | | 3.5.1 | 4.6.1 |
| | Keyway Perpendicularity | | | X | | 3.5.1 | 4.6.1 |
| (b) | Identification of Product | | | X | | 3.8 | 4.6.1 |
| (c) | Workmanship | | | X | | 3.9 | 4.6.1 |
| (d) | Preparation for Delivery | | | X | | | 4.6.2 |
| (e) | Breakaway Torque | | | | 100% | 3.5.1 | 4.6.1 |
| (f) | Mag. Part. Inspection | | | | 100% | 3.5.5 | 4.7.6.1 |
| (g) | Hardness | | | | 3.5.3.1 | 3.5.1 | 4.7.5 |
| (h) | Cad. Plating | | | | Certification Only (3) | | |

(1) Inspection required only on Class 1 (External Thread) Rod Ends.
(2) Inspection required only on Class 2 (Internal Thread) Rod Ends.
(3) Inspection shall consist of verification of plating certification from plating vender / source.

TABLE 5 - Sampling Plan for Quality Conformance Inspections
Zero-Based Acceptance Plan (C=0)

| LOT SIZE | SAMPLE SIZE<br>Acceptance number in all cases is zero.<br>"A" indicates entire lot must be inspected.<br>Major Characteristic | Minor Characteristic |
|---|---|---|
| 1-2 | A | A |
| 3-8 | A | 3 |
| 9-12 | A | 3 |
| 13-15 | 13 | 3 |
| 16-25 | 13 | 3 |
| 26-50 | 13 | 5 |
| 51-90 | 13 | 6 |
| 91-150 | 13 | 7 |
| 151-280 | 20 | 10 |
| 281-500 | 29 | 11 |
| 501-1200 | 34 | 15 |
| 1201-1249 | 42 | 18 |
| 1250-3200 | 42 | 18 |
| 3201-10,000 | 50 | 22 |



4.7 Test Methods:

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

4.7.1 Ultimate Static Load: The bearing shall be installed in a test fixture as shown on Figure 5, using a 0.0000 to 0.0015-inch loose fit for the shaft. The appropriate ultimate static load specified on the rod end AS sheet shall be applied at the rate of one percent per second.

4.7.2 Axial Static Proof Load: The bearing shall be mounted on a rigid fixture as shown on Figure 6, so that only the rod end body is supported. The axial static proof load shall be applied at the rate of one percent per second to the race face and maintained by the bearing for 30 seconds.

4.7.3 Fatigue Load: The bearing shall be installed in a fatigue machine using a test fixture as shown on Figure 5, with a 0.0000 to 0.0015-inch loose fit for the shaft. The loading shall be tension-tension with the maximum load equal to the fatigue load on the applicable AS sheet and the minimum load equal to 10 percent of the fatigue loads. Loads shall be maintained within ±2 percent. Testing speeds shall not exceed 2800 cycles per minute.