

**(R) Bearing, Ball, Bellcrank, Antifriction, Airframe****RATIONALE**

It has been ten years since this document was converted directly from the MIL-STD-6038 (word-for-word) version. There are numerous changes that were needed to bring it up to date.

**1. SCOPE**

1.1 This specification covers antifriction bellcrank ball bearings intended primarily for airframe use.

**2. APPLICABLE DOCUMENTS**

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

**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](http://www.sae.org).

- AMS6440 Steel, Bars, Forgings, and Tubing 1.45Cr (0.93-1.05C)(SAE 52100) for Bearing Applications
- AMS6444 Steel ,Bars, Forgings, and Tubing, 1.45Cr (0.93-1.05C) (SAE 52100), Premium Aircraft-Quality, Consumable Electrode Vacuum Remelted
- AMS-QQ-P-416 Plating, Cadmium (Electrodeposited)
- AS20218 Bearings, Ball, Bellcrank, Anti-friction, Airframe

**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](http://www.astm.org).

- ASTM A304 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements
- ASTM A322 Steel Bars, Alloy, Standard Grades, Standard Specification for
- ASTM A108 Steel Bars, Carbon, Cold Finished, Standard Quality

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### 2.3 ANSI Publications:

Available from American National Standard Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, [www.ansi.org](http://www.ansi.org).

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

### 2.4 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Electronic copies may be obtained from <https://assist.daps.dla.mil/quicksearch>

MIL-DTL-197 Packaging of Antifriction Bearings, Associated Parts and Sub-Assemblies

MIL-PRF-23827 Grease; Aircraft and Instrument, Gear and Actuator Screw

MIL-STD-129 Military Marking for Shipment and Storage

MIL-STD-130 Identification Marking of U.S. Military Property

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

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

## 3. REQUIREMENTS

### 3.1 Preproduction:

This specification makes provisions for preproduction testing. (See 6.2)

### 3.2 Materials

Materials to be as specified in AS20218. Inner ring - AMS6440, Outer ring - AMS6440, AMS6444 or AMS6448, Balls - AMS6440, Seals - Nitrile butadiene or PTFE AMS3652 retained by 300 series stainless steel caps, Seal retainer - carbon Steel or CRES, Cage - carbon Steel or CRES.

### 3.3 Design and Construction

The bearings shall be designed and constructed to conform to the requirements specified herein and on Standard AS20218.

#### 3.3.1 Dimensions and Tolerances

The dimensions and tolerances shall be as specified on Standard AS20218.

#### 3.3.2 Hardness

The raceways shall be uniformly through-hardened HRC 58-62. The ball hardness shall be HRC 60-67. The hardness of the riveting flanges of the bearings shall be not greater than HRC 25 (see 4.5.2). Inner ring shall be HRC 58-64.

#### 3.3.3 Surface Texture

The raceways shall be ground or lapped to a surface finish of 4  $\mu$ m maximum in accordance with Standard ANSI B46.1. The bore and all external surfaces shall have a surface finish of 32  $\mu$ m maximum.

### 3.3.4 Plating

All bearing external surfaces and the bore shall be cadmium plated. The plating shall be in accordance with Type I, Class 2 of Specification AMS-QQ-P-416. The plating thickness shall not exceed 0.0005 inch maximum (see 4.5.4).

### 3.3.5 Seals

Closures shall be provided to prevent the entrance of contaminants and to retain the lubricant throughout the temperature range specified in 3.3.5.1.

#### 3.3.5.1 Type

The closures shall be of the positive contact type, consisting of external metal shields and positive seal washers that shall operate satisfactorily when tested as specified in 4.5.5. The closures shall be readily removable for inspection and relubrication and shall be of such construction that they may be replaced without undue difficulty. The closures shall withstand temperatures of -67 to +250 °F without warpage or embrittlement that will prevent retention of the lubricant. The closures shall be compatible with the lubricant specified herein.

### 3.3.6 Retainers

The retainers shall be of a suitable material consistent with the requirements of this specification. They shall be so constructed as to not limit the proper functioning of the bearings for which they are designed.

## 3.4 Internal Clearance

### 3.4.1 Radial Play

The radial play, measured before and after the radial static capacity and axial static capacity tests (4.5.8 and 4.5.10, respectively), shall not exceed the values specified on Standard AS20218 (see 4.5.6)

### 3.4.2 Axial Play

The axial play, measured before and after the radial static capacity and axial static capacity tests (4.5.8 and 4.5.10, respectively), shall not exceed the values specified on Standard AS20218 (see 4.5.7).

## 3.5 Radial Strength

### 3.5.1 Radial Static Capacity

The radial static capacity of the bearing shall be not less than the value specified on Standard AS20218.

### 3.5.2 Radial Fracture Load

The radial fracture load of the bearing shall be not less than one and one-half times the radial static capacity value specified on Standard AS20218.

## 3.6 Axial Strength

### 3.6.1 Axial Static Capacity

The axial static capacity of the bearing shall be not less than the value specified on Standard AS20218.

### 3.6.2 Axial Fracture Load

The axial fracture load of the bearing shall be not less than one and one-half times the axial static capacity value specified on Standard AS20218.

### 3.7 Wobble

The total wobble, measured before and after the radial static and axial static capacity tests (4.5.8 and 4.5.10, respectively) shall be not greater than the value specified on Standard AS20218.

### 3.8 Radial Endurance

The load applied to the bearing in the radial endurance test (4.5.13) shall be as specified on Standard AS20218.

### 3.9 Lubrication

Unless otherwise specified, the bearing shall be filled with grease conforming to Specification MIL-PRF-23827, completely filling the bearing voids. The bearing shall be thoroughly cleaned and dried before being lubricated.

### 3.10 Stabilization

The bearing components shall not vary more than 0.0001 inch dimensionally for operation from -67 to +250 °F.

### 3.11 Interchangeability

All parts having the same part number shall be both functionally and dimensionally interchangeable.

### 3.12 Identification of Product

The bearings shall be permanently and legibly marked for identification in accordance with Standard MIL-STD-130. The identification data applied to the bearings shall be as follows:

- a. Complete part number
- b. Manufacturer's name or trademark

### 3.13 Workmanship

The bearings shall be free of tool marks, chatter waves, rust, grinding scratches, pits, or any other defects that may adversely affect their serviceability.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Inspection Responsibility

The supplier is responsible for the performance of all inspection requirements as specified herein.

### 4.2 Classification of Tests

The inspection and testing of bearings shall be classified as follows:

- a. Qualification Inspection (4.3)
- b. Conformance Inspection (4.4)

### 4.3 Qualification Inspection

#### 4.3.1 Sampling

The test samples shall consist of 20 bearings of each part number and shall be representative of the production equipment. The bearings shall be tested at a laboratory designated by the procuring activity or, when so stated in the contract, at the contractor's plant under the supervision of the procuring activity (see 6.2).

#### 4.3.2 Tests

The Qualification Inspection shall include all the examinations and tests of this specification in accordance with par 4.4.3.

#### 4.4 Conformance Inspection

##### 4.4.1 Lot

The inspection lot shall consist of finished bearings having a single part number manufactured by the procedures established for the originally qualified bearings and produced as one continuous batch which receives final inspection at the same location. The inspection lot shall be identified by a unique number (manufacturers lot control number) to be included on the bearing, in the packaging marking and on the associated certification that accompanies the shipping paperwork. The manufacturer's lot control number shall be traceable to the finished bearing assembly and the quality conformance inspection or acceptance tests. The samples taken for acceptance testing shall be randomly selected to ensure that they are representative of the product run/lot.

##### 4.4.2 Sampling

Samples shall be examined for conformance to the test listed in par 4.4.3. The sample bearings shall be selected at random from each inspection lot in accordance with Table 1 . 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 100% inspected for each defective characteristic found, and all defective parts shall be removed from the lot.

TABLE 1 - SAMPLING PLAN FOR QUALITY CONFORMANCE TESTS

| Lot Size    | Sample Size                                    |                       |
|-------------|------------------------------------------------|-----------------------|
|             | "A" indicates the entire lot must be inspected |                       |
|             | Major Characteristics                          | Minor Characteristics |
| 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                    |

##### 4.4.3 Tests

The acceptance tests of the bearing shall consist of the following:

- Examination of product(4.5.1)
- Hardness(4.5.2)
- Surface texture(4.5.3)
- Radial play(4.5.6)
- Axial play(4.5.7)

f. Wobble(4.5.12)

g. Lubrication(4.5.14)

#### 4.5 Test Methods

##### 4.5.1 Examination of Product

Each sample bearing shall be inspected for conformance to this specification and Standard AS20218 with respect to dimensions, identification, finish, lubrication, and workmanship.

##### 4.5.2 Hardness

Two bearings of each part number shall be disassembled and tested for hardness on the inner ring, the outer ring, and on three balls. The tests on the inner and outer rings shall be made on rolling raceways with a standard hardness tester, using the Rockwell "C" scale. The hardness shall be as specified in 3.3.2.

###### 4.5.2.1 Hardness of Riveting Flanges

The hardness of the riveting flanges shall be tested, using the Rockwell "C" scale, and the hardness shall be as specified in 3.3.2.

##### 4.5.3 Surface Texture

The surface texture shall be measured in accordance with Standard ANSI B46.1. The test shall be made on the bearings disassembled for the tests specified in 4.5.2.

##### 4.5.4 Plating

The plating shall be tested for conformance with 3.3.4 and Standard AS20218. Two bearings of each part number shall be tested.

##### 4.5.5 Seals

The seals shall be subjected to temperatures of  $-67 \pm 10$  °F and  $275 \pm 10$  °F for 100 hours each. The seals shall then operate in a test chamber at 3 revolutions per minute (rpm) while tested in accordance with the high temperature tests, Method 501.5 Procedure II, and the low temperature tests, Method 502.5 Procedure II, of Specification MIL-STD-810. Seals that show warpage, embrittlement, nonretention of lubricant, incompatibility to Specification MIL-PRF-23827 grease, or ingress of dust into the bearing shall be considered seal failure. Three bearings of each part number shall be tested (see 3.3.5).

##### 4.5.6 Radial Play

Five bearings of each part number in the sample shall be tested for radial play. The inner ring shall be held rigidly and a radial load of 5½ pounds applied alternately in opposite directions to the outer ring. A dial indicator shall be used to indicate this movement. The radial play is the total movement from application of a 5½-pound load on one side to the load application on the opposite side (see 3.4.1).

##### 4.5.7 Axial Play

Five bearings of each part number in the sample shall be tested for axial play. One ring shall be held rigidly and an axial load of 5½ pounds applied alternately in opposite directions to the other ring. A dial indicator shall be used to indicate this movement. The axial play is the total movement from application of a 5½-pound load on one side to the load application on the opposite side (see 3.4.2).

#### 4.5.8 Radial Static Capacity

The bearing shall be mounted in a rigid support as shown on Figure 1 and rotated manually to determine operational smoothness before testing. The starting friction torque shall be measured. The appropriate static capacity load specified on Standard AS20218 shall be applied for 1 minute. The load shall be removed and the bearing inspected for evidence of failure. If the starting friction torque has increased 100 percent or more, the bearing shall be considered to have failed. Three bearings of each part number shall be tested.

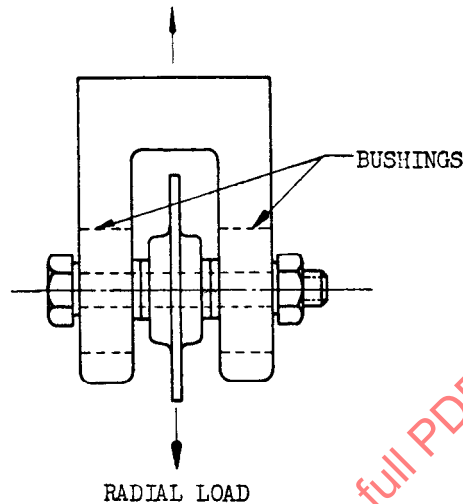


FIGURE 1 - RADIAL STATIC CAPACITY SETUP

#### 4.5.9 Radial Fracture Load:

The radial fracture load of one and a half times the pertinent radial static capacity value shown on Standard AS20218 shall be applied to the bearing for 1 minute. After removal of the load, the bearing shall be examined for failure. Bearings that cannot be turned by hand, or that have parts fractures, shall be considered to have failed. Three bearings of each part number shall be tested.

#### 4.5.10 Axial Static Capacity

The bearing shall be mounted in a rigid support as shown on Figure 2 and rotated manually to determine operational smoothness before testing. The starting friction torque shall be measured. The appropriate static capacity load specified on Standard AS20218 shall be applied for 1 minute. The load shall be removed and the bearing inspected for evidence of failure. If the starting friction torque has increased 100 percent or more, the bearing shall be considered to have failed. Three bearings of each part number shall be tested.

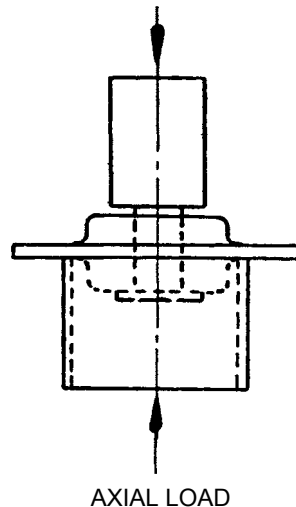


FIGURE 2 - AXIAL STATIC CAPACITY TEST SETUP

#### 4.5.11 Axial Fracture Load

The axial fracture load of one and one-half times the pertinent axial static capacity value shown on Standard AS20218 shall be applied to the bearing for 1 minute. After removal of this load, the bearing shall be examined for failure. Bearings that cannot be turned by hand, or that have parts fractured, shall be considered to have failed. Three bearings of each part number shall be tested.

#### 4.5.12 Wobble

The bearing shall be tested for total wobble as indicated on Figure 3. The wobble shall be measured at three points equally spaced about the bearing axis, and which lie in a plane that is parallel to the faces of the bearing flange. Ten bearings of each part number shall be tested.

#### 4.5.13 Radial Endurance

The bearing shall be subjected to the radial endurance load specified on Standard AS20218 for 50 000 reversals of rotation at the rate of 40 reversals per minute. Each reversal shall consist of one-fourth of a revolution (90 degrees) of the bearing. The endurance test shall be made as indicated on Figure 4, with the inner race of the bellcrank bearing bolted between the inner races of the two supporting bearings so that the inner races of the three bearings rotate as a unit. The oscillating motion shall be uniform throughout each reversal so that no impact load will be applied either at the beginning or end of a reversal. The specified radial endurance load shall be applied to the flange of the bearing in a manner that will not permit rotation of the outer race. The inner race of the bearing shall then be subjected to the required oscillating motion. Three bearings of each part number shall be tested.