EO 75-10-2B

ROYAL CANADIAN AIR FORCE

DESCRIPTION AND MAINTENANCE INSTRUCTIONS

ANTI-FRICTION BEARINGS

ISSUED ON AUTHORITY OF THE CHIEF OF THE AIR STAFF

17 JAN 57

LIST OF RCAF REVISIONS

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PART 1

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INTRODUCTION AND DESCRIPTION

INTRODUCTION

1 The processing, rework, inspection and corrosion control described herein is applicable to all anti-friction bearings except those identified as instrument bearings.

DESCRIPTION

General

2 An anti-friction bearing is a machine element which permits rotation of a member by rolling friction, as opposed to the sliding friction found in a journal bearing. A journal is supported by a wedge shaped oil film which is generated when the shaft turns. An anti-friction bearing may be visualized as one in which the oil film is replaced by a series of "rolling elements", i.e., balls, rollers, or needles. Thus the anti-friction bearing replaces sliding friction with rolling friction.

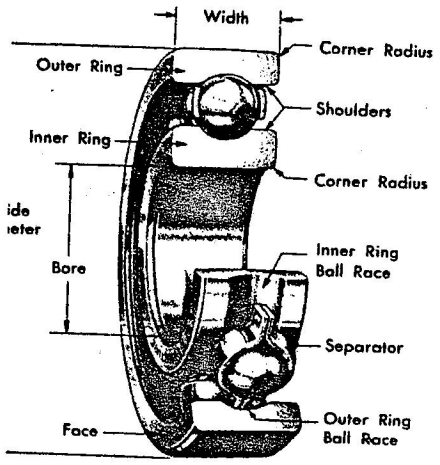
3 The pressures in an anti-friction bearing are exceedingly high, by normal standards. These pressures often exceeding 500,000 psi. The load on a bearing is borne by elastic deformation of the load carrying parts.

Types of Bearings

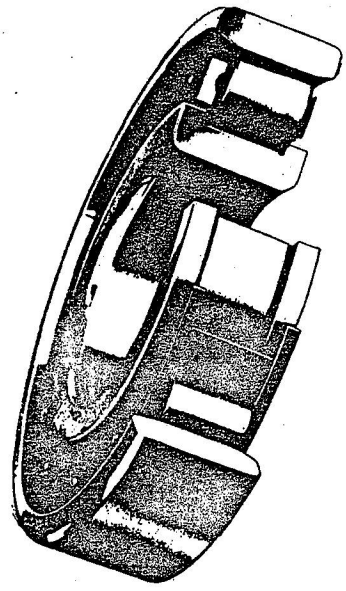
4 There are three types of anti-friction bearings; ball, roller and needle, see Figure 1-1. There is an infinite number of variations of these types, i.e., single and double row ball bearings, straight, tapered, spherical and hour-glass shaped rollers, drawn shell or ground ring needle bearings.

Advantages of Anti-Friction Bearings

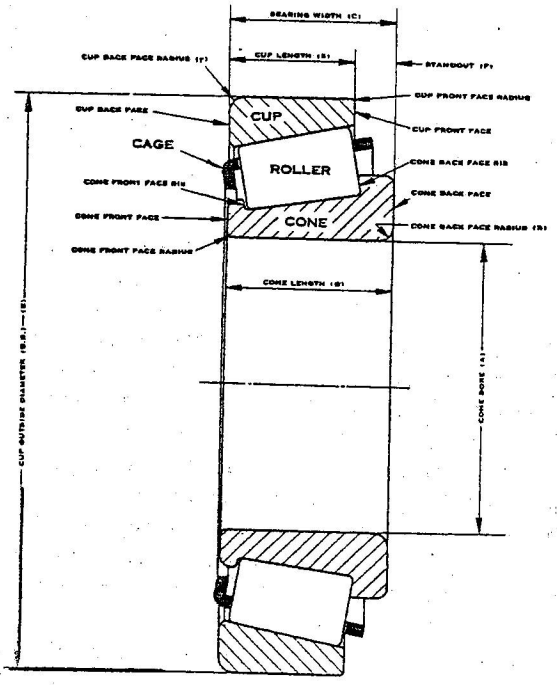
5 Anti-friction bearings actually consume less power than journal bearings. However, this advantage is probably less important than some of the following. No "breaking in" or "lapping in" is required. No wear (as normally known) takes place. Shafts are rigidly positioned for extreme accuracy. Starting friction is virtually the same as running friction. Relubrication is simplified, since it is required less frequently, thus reducing the contamination of the produce by over lubrication. Anti-friction bearings have a very high load capacity and an extremely long trouble-free life. In spite of the numerous advantages of anti-friction bearings over journal bearings, a certain amount of attention is required in all phases of their use.



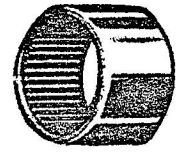
A - Ball Bearing

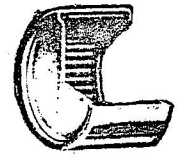


B - Cylindrical Roller Bearing



C - Tapered Roller Bearing





D - Needle Bearings

Figure 1-1 Types of Bearings

MATERIALS

Steel

6 The steel for a bearing must have certain properties in order to properly function for a trouble-free life. The most important are as follows:

Elasticity	Uniform structure
Great Strength	Fine grained texture
Great Hardness	High resistance to fatigue
Deep Penetration of Hardness	High resistance to wear
Uniform Hardness	Freedom of impurities, both metallic and non-metallic

NOTE

A good clean steel with a fine grain structure and uniform hardness penetration is required. There are notable exceptions, such as case hardened steel, the special stainless steels and beryllium copper. However, the majority of bearings are made from SAE 52100 steel. It is an electric furnace high carbon-chrome, steel alloy of the following nominal composition.

Carbon	0.95 - 1.10	Silicon	0.20 - 0.35
Chromium	1.30 - 1.60	Phosphorus	0.025 max
Manganese	0.25 - 0.45	Sulphur	0.020 max

Cage Material

7 The standard cage is made of steel, since it is elastic (stands repeated stretching without breaking) and introduces no problem from incompatible materials. Such cages are quite heavy and often leave something to be desired in regard to balance. Brass and bronze are used in some precision bearings. Brass is easily controlled in fabrication and quite common in small ball bearings. Bronze is more common in precision roller and ball bearings, although it is gradually being replaced with synthetic material, in high speed bearings. The relative importance of the retainer is rapidly gaining recognition. Silver plated bronze, monel and other light alloys are being currently used. It is probable that new synthetic materials, which overcome the present loss of strength at high temperature, will be used in the manufacture of cages in the future.

Cages

8 The function of a bearing cage is to provide spacing and alignment of rolling components. There is a tendency for each rolling element to resist going into the loaded zone. In order to keep the rolling components at properly spaced intervals, it is necessary that bearings be provided with a cage. The material for cages is usually divided into two classes, according to the type of manufacture and the material used. The first group contains all cages formed from strip metal by stamping and forming operations. Cages of this type are usually centered about the pitch circle, with the cage pressure being directed as nearly to the point of no motion as possible. Sliding friction is developed between the cage and ball. These cages are economical to manufacture, are light in weight and extremely resistant to high shock loads. The second group is formed from material by casting, forging or machining from the solid. As a general practice, high speed and precision bearings incorporate cages of this type. Cages made from the solid are often centered on the rolling elements as though made from strip material and are described as ball or roller guided. If the cage is positioned by either of the two rings, it is known as an inner-land riding or an outer-land riding type. The latter two types are generally used in high speed application.

9 Cages never carry the bearing load. The load is borne directly by the rings and rolling elements. However, in some bearings, particularly in the thrust washer type where high centrifugal loads are encountered, the cage must also confine the rolling elements to their orbit. When bearings are of a separable type, for example the magneto series and thrust washer type, the cage must perform the additional function of retaining the rolling elements when the assembly is separated.

10 The lack of a cage is not an indication of an inferior type of bearing, but rather an indi-

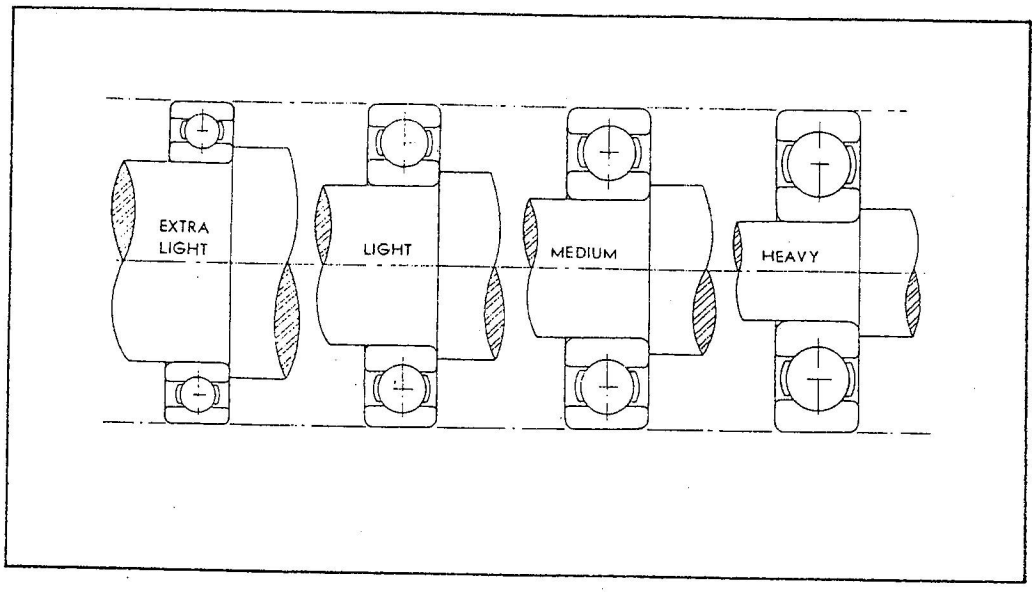


Figure 1-2 Basic Bearing Sizes

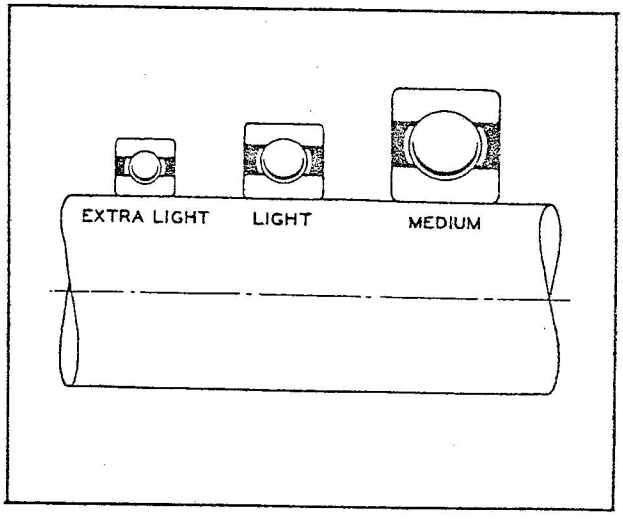


Figure 1-3 Basic Bearing Sizes

cation of a special purpose bearing. The rubbing velocities of full complement (cageless) bearings are high and these bearings are normally used only at low speeds. Full complement bearings are also required when the normal design will not permit sufficient capacity to carry the load in the space allotted.

11 When smaller bearing balls or rollers are placed in alternate positions to act as spacers, the balls might be considered a special type of cage. In this type of bearing, the alternate, small balls would carry none of the load transmitted through the bearing but would only act as spacers for the load carrying element. Full complement type ball bearings can be used at moderate speed, provided the parts are made with as close precision as possible and that a small positive thrust load, is provided at all times. Provisions for such a load can be the application of a spring to either race in order to ensure axial (thrust) load away from loader slots at all times. Bearings of this type are seldom specified for application in which noise is a limiting factor. Cageless bearings are difficult to test because of rubbing of the rolling elements. Airframe bearings are examples of this type.

MANUFACTURE

Bearing Balls

12 The raw material for bearing balls is usually coiled wire and bar stock. The majority of bearings made in this country utilize balls which are less than an inch in diameter. They are cold headed on automatic forging machines.

Bearing Bore		
*	M/M	Inches
00	10	.3937
01	12	.4724
02	15	.5906
03	17	.6693
04	20	.7874
05	25	.9843
06	30	1.1811
07	35	1.3780
08	40	1.5748
09	45	1.7717
10	50	1.9685
11	55	2.1654
12	60	2.3622
13	65	2.5591
14	70	2.7559
15	75	2.9528
16	80	3.1496
17	85	3.3465
18	90	3.5433
19	95	3.7402
20	100	3.9370
21	105	4.1339
22	110	4.3307
24	120	4.7244
26	130	5.1181
28	140	5.5118
30	150	5.9055
32	160	6.2992
34	170	6.6929
36	180	7.0866
38	190	7.4803
40	200	7.8740
42	210	8.2677
44	220	8.6614
46	230	9.0551
48	240	9.4488
50	250	9.8425
52	260	10.2362
56	280	11.0236
60	300	11.8110
64	320	12.5984

Figure 1-4 Basic Numbering System

The larger sizes are heated and forged much the same as bearing rings. The balls are passed between two grinding wheels with their axes offset; each surface is ground, the flash removed, and the balls are roughly ground to shape. Subsequent grinding, between similar grinding wheels, after hardening, brings the balls approximately to final form. Final grinding is performed between a grinding wheel and a cast-iron disc with the balls circulating continuously on a time cycle through the machine. Final lapping is usually performed with a manufactured abrasive suspended in a liquid and performed between one smooth and one grooved cast-iron disc. The balls are made in batch lots. Each lot is fairly uniform with regard to diameter. The final polish is obtained by tumbling. Sorting is done automatically by using a system of parallel bars or by electronic equipment. Grades and tolerances of bearing balls are contained in Spec. MIL-B-1083.

Rings

13 The grinding operation is performed on the face of the parts using surface grinders. The ODs are ground on centerless grinders. The grinding wheel is automatically dressed by a diamond tool after each pass and continuous readings are taken (often with a diamond point) to indicate the precise size of the work. Races are formed by form, plunge or oscillating grinding. In oscillating grinding, the motion of the piece of the wheel may be oscillating and by the nature of the machine, a true contour and surface are generated. Diameters of the inner and outer races are ground to a nominal dimension and rings are matched to a set of graded balls to give the desired radial and axial play. The bearing number is stamped while the ring is soft. Therefore, all information of a completely identified bearing cannot be included at this time. For example, similar rings may be used for bearings with shields and bearings without shields and it is not known, at this point of manufacture, whether a particular bearing will have one shield, two shields or none at all. Some bearings may have one number stamped on the bearing rings and another number stamped on the shields. In this event, the bearing number on the shield of a complete bearing is the correct identifying number.

Miscellaneous

14 Shield grooves, corner radii, chamfers, and snap ring grooves are usually completely finished at machining and are not ground later. Particular attention is paid to these points in machining. If concentricity of a seal groove is incorrect, it is obvious that the final seal installation will not be concentric. Instances are known where such a mis-operation may permit rubbing between the bearing inner ring and shield and cause sufficient heat to develop lubricant failures. Corner radii are not manufactured to a definite tolerance but are designed to clear a radius of a certain size. The dimensional standards used in manufacturing bearings are Johansen gauge blocks, maintained within two millionths of exact size that common interchangeable bearings are of the same size regardless of the manufacturer. Surface finishes are approximately as follows: Bore and OD surface 0.000050" rms; rolling element surfaces 0.000005" rms: faces 0.000060" rms: races 0.000010" rms.

APPLICATION

Cleanliness

15 Sources of bearing contamination may be either internal or external. Internal bearing contamination is almost absent in new packaged bearings. Manufacturers caution users not to unpackage bearings until they are ready for installation. Manufacturing processes provide laboratory-like cleanliness.

16 Open bearings are normally preserved with oil or a preservative compound. The preservative compound should be removed, before installation, in a bath of continuously filtered solvent, such as Spec. 3-GP-8, RCAF Ref. 33C/182, or warm mineral oil. Bearings preserved in oil require no depreservation prior to use.

17 External sources of contamination are common. There is always the danger of using dirty tools, assembling the component in an atmosphere which contains casting sand, filings or other shop dirt. It is particularly cautioned that the bearing should not be used as a "Go-No Go" gauge at the time of assembly, while the shaft or housing is worked to size.

18 Internal sources of contamination may develop or may be present at assembly. Gears and clutches in the vicinity of the bearing may wear and give off metal or other particles. Brakes adjacent to bearings will likewise provide a source of contamination. Any wear surface, such as brushes and commutators of electrical equipment, can present a source of possible contamination. Since contamination on shafts often prevents proper seating of the bearing shoulder, users are cautioned to provide conditions as nearly perfect as possible in assembly areas. Casting sand in housings must be removed or sealed in. Failure to remove loose flakes of paint or white lead, used to lubricate the shaft while mounting the bearing, will shorten bearing life. Galled shafts and housings, when bearings are re-installed, also provide a source of possible contamination. When open bearings are used with a circulating oil system, it is possible for the oil to carry contaminants. To control this, the oil should be filtered carefully and continuously, and the filter elements changed at frequent intervals. Equipment giving bearing trouble should be examined for sources of contamination.

19 Lubricating fittings are often found at fault. It is normal practice to wipe off lubricant fitting prior to injection of lubricant so that dirt, which may be present on the fitting is not forced into the bearing. Ineffective seals also cause short bearing life. In every operation, it is important that the bearings be kept clean. Contamination is the principle cause of short bearing life.

Numbering Systems

20 The basic bearing numbering system is based upon the metric bore size. A similar numbering system is used for inch-series bearings, tapered roller bearings, some ball bearings, and the airframe bearing series. Further standardization is shown by three basic bearings, see Figure 1-2, with the same ODs but with progressively smaller bores, and increased widths. Correspondingly, there are

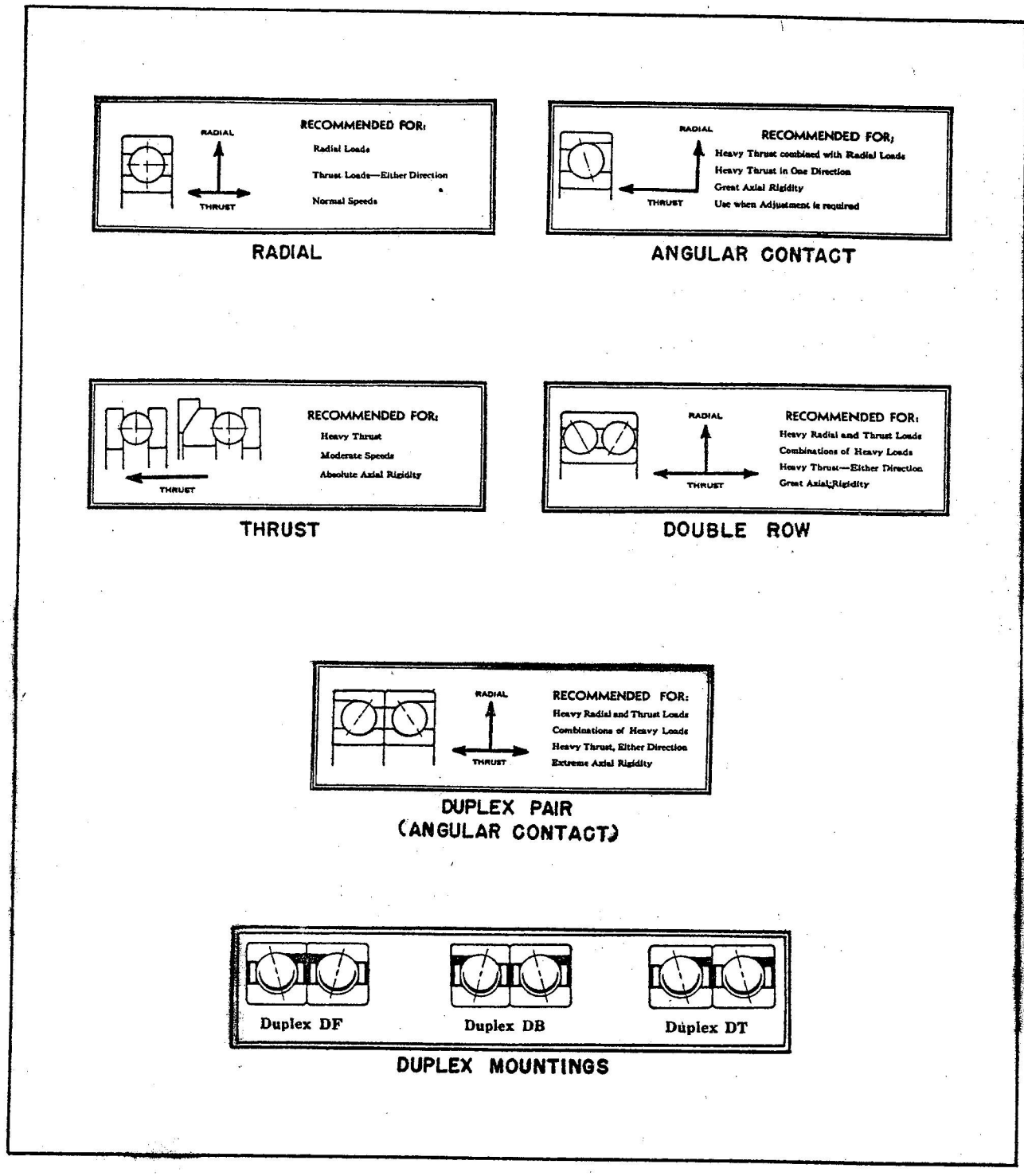


Figure 1-5 Selective Loads for Bearing Application

three bearings with the same bores, but with increasing ODs on a correspondingly increased widths, see Figure 1-3.

21 The series of a bearing is shown in the third digit of the part number, reading from left. Bearing bores in metric sized bearings are determined by multiplying the last two digits by five. This holds for all bearings above the 03 size. For example, a 5208 bearing has a (08 x 5) = 40 mm bore; an 05 bearing has a (05 x 5) = 25 mm bore, and so on. The 00, 01, 02 and 03 bearings do not follow this pattern. All numbering systems, see Figure 1-4, follow this basic pattern. This can be determined by comparing basic part numbers with bearing bore, or sometimes the OD sizes.

Application

22 The selection of the proper bearing is most important. Basically, there are three loads which can be imposed upon a bearing; thrust, radial, or a combination of the two, see Figure 1-5. The designers selection for type of bearing is based upon the kind of load which will be encountered.

Lubrication

23 The lubrication requirements of an anti-friction bearing must be provided in a positive manner, even though they are relatively simple. Bearings are often neglected because it is incorrectly presumed that lubricant is unimportant, since only rolling friction is present. Lubricants must fulfill the following prerequisites:

(a) Reduce slicing friction.

(b) Assist in excluding objectionable matter.

(c) Protect bearing surfaces from corrosion.

(d) Carry off heat in circulatory system.

NOTE

Either grease or oil may be used, depending upon the condition encountered in the system.

24 An anti-friction bearing does not have pure rolling motion. On either side of the position of pure rolling motion, there are zones of scuffing in which sliding friction exists. Therefore, lubricant is used to reduce this sliding friction. Sliding friction also exists between the rolling elements and the cage or if a cage is not used, between the rolling elements themselves.

25 In roller bearings, minute manufacturing discrepancies and thrust loading tend to load the rollers at the ends. Therefore, lubricant is required at this point. When cages are inner or outer land riding, a lubricant is required to reduce the sliding friction occurring between the cage OD or ID and its corresponding ring.

26 The exclusion of contaminating material is a function of a grease lubricated bearing. In the oil lubricated bearing, the oil can only exclude foreign material when it is kept clean. Circulating oil systems should always incorporate filtering. Particular attention is required when gear wear, brake wear or atmospheric contamination can enter the system.

27 Graphite greases are never recommended for anti-friction bearings. The graphite particles tend to separate and build up on the bearing surfaces and cause skidding and rough operation. Graphite may be considered a form of contamination no matter how finely divided the particles.

28 Extreme pressure lubricants are never recommended for anti-friction bearings. Some lubricants are not advisable because their sulphur or chlorine additives which, when present in appreciable amounts, attack the surfaces.

29 Specific lubrication problems encountered by the RCAF are simplified by the use of standard lubricants, outlined in the following specifications:

GREASE	RCAF REF.	OIL	RCAF REF.	PRESERVATIVE	RCAF REF.
3-GP-683A	34A/192	MIL-L-6085A	34A/201		
3-GP-682	34A/178			MIL-C-11796A	Class 3
3-GP-690	34A/122	3-GP-325a	34A/124	31-GP-3 (Not equivalent to MIL-C-11796A)	40D/587

NOTE

The correct grease, oil or preservative to be used is shown on the manufacturer's Drawings and in Engineering Orders. The method of lubrication of RCAF equipment is fixed by the designers. The frequency of relubrication is given in Engineering Orders for the equipment. Reference to this information will clearly indicate the requirements for lubrication. There are a few exceptions to the use of standard greases, particularly in newly developed equipment, and such greases are to be locally procured if they are not in stock.

GLOSSARY

ABEC - Annular Bearing Engineering Committee.

AFBMA - Anti-Friction Bearing Manufacturers' Association.

Angular Contact - A bearing whose rolling elements are designed to contact the races at some angle other than 0° for improved action under thrust loads.

Anti-Friction Bearing - A bearing assembly with rolling elements, i.e. balls, needles or rollers.

Axial Load - A load applied in the direction of the shaft.

Bore - The inside diameter of a bearing.

Brinnel - A smooth contour dent, caused by pressing a rolling element into a race resulting in a permanent set.

Cage - Retainer.

Closure - A seal or shield.

Combined Load - A load composed of both radial and thrust factors.

Complement - The set of matched rollers, balls, or needles assembled in a bearing.

Contact Seal - A seal which rubs on a ground surface of one ring.

Corrosion Control - Preservative treatment given bearings and bearing parts against corrosive elements.

DB - A mounting arrangement for a pair of duplex bearings in which the backs (non-counterbored faces) abut. A non-rigid mounting.

GLOSSARY (Cont'd)

Demountable	- A bearing so designed that it can be disassembled without destroying any parts.
DF	- A mounting arrangement for a pair of duplex bearings in which the counterbored faces abut. A rigid mounting.
DT	- A mounting arrangement for a pair of duplex bearings in which the face of one abuts the back of the other. A mounting for high thrust loads in one direction.
Duplex	- Bearings designed to be used in pairs.
Face	- The surfaces of a bearing which define its width.
Fits	- The clearance or interference of a bearing with the part on which it is mounted.
Fret Corrosion	- Oxidation (rusting) of metal occurring at the loaded surfaces subjected to slight relative motion.
Friction Oxidation	- See Fret Corrosion.
Full Complement	- Lacking a rolling element spacer.
Inch Series	- Bearings made to basic inch dimensions.
Integral	- Not demountable; cannot be removed without being destroyed.
Labyrinth Seal	- A bearing seal with multiple disc separated by a grease film with no rubbing parts.
Locknuts	- A special series of thin locknuts made for anti-friction bearings.
Lockwashers	- A special series of tabbed lockwashers for bearings.
Load Capacity	- A rating for a bearing based upon its speed and expected life.
Metric Series	- Bearings made to basic millimeter dimensions. Tolerances are expressed in inches.
OD	- The outside diameter of a bearing.
Preloading	- The application of a small initial load to absorb the initial bearing deformation.
Race	- The active part of a ring; the part in contact with the rolling elements.
Radial Load	- A load or resultant applied perpendicular to the shaft and through the centre of the bearing.

RBEC	- Roller Bearing Engineering Committee.
Retainer	- The spacer for the rolling elements.
Retainerless	- A full complement bearing, designed for use without a retainer.
Rockwell "C"	- "C" scale measurement of metal hardness.
Rolling Elements	- Balls, rollers or needles.
Seal	- A device to keep grease in, and dirt out, of bearing.
Separator	- A retainer or cage.
Shield	- A single member closure which acts like but is not so effective as a seal.
Single Row Radial	- A bearing with one row of balls, used principally for radial loads.
Snap Rings	- A positioning device installed in a groove around the OD of some bearings.
Standard Tolerances	- ABEC - RBEC numbers 1, 3, 5 and 7 expressing successively greater degrees of precision of external dimensions.

30 Shielded ball and roller bearings are to be cleaned and greased by means of lubricator anti friction bearing 1T/1425. This kit consists of a variety of clamping fixtures to fit all standard seal bearings and is used as follows:-

(a) Fit the proper size clamp to the bearing.

(b) By means of a grease gun, force sufficient grease through the bearing to ensure that all the old grease is forced out.

(c) Spin the bearing to check for signs of roughness, sticking or presence of grit. If any of these conditions exist, the bearing is to be rejected.

NOTE

Shielded bearings are only to be greased at reconditioning periods unless otherwise specifically detailed in the relevant aircraft EO, or, if doubt exists as to the condition.

31 Impregnated bearings (graphited bushing type) are not to be lubricated during maintenance inspections or reconditioning. They are to be cleaned at appropriate periodical inspections with a dry cloth only. No cleaning medium, such as cleaning fluid, is to be allowed to come in contact with these bearings.

PART 2

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PART 2

OVERHAUL INSTRUCTIONS

SECTION 1

PRELIMINARY EXAMINATION

GENERAL

1 The preliminary examination is a visual check of the external condition of anti-friction bearings removed from equipment undergoing overhaul and repair and those drawn from stocks where serviceability may be questioned. These bearings are received by bearing shops for purpose of examination and reconditioning as required. The examination is to be performed by processing personnel of the respective bearing shops for the purpose of assigning proper routing for either an individual bearing or a group of bearings through processing procedures and to prevent expenditure of time and materials in excess of requirements.

DESCRIPTION

2 In general, it is expected that more than 90% of all bearings will be found serviceable or of such contition that they may be reworked to a serviceable status. The preliminary examination is to follow the first steps in the cleaning procedure and should permit recognition of the conditions described in the following listings:

(a) Absolute causes for bearing rejection:

(1) Cracked, flaked, or broken parts.

(2) Bent or charred cages or retainers.

(3) Dented integral shields which interfere with rotation or permit ingress of contamination.

(4) Obvious alterations of original dimensions.

(b) Conditions which may be corrected by rework:

(1) Rust on accessible surfaces.

(2) Stains on accessible surfaces.

(3) Worn copper plating on bore and outer diameter surfaces (refers only to propeller stack bearings and those other bearings initially procured with copper plating only).

(4) Contamination by dirt or other foreign materials.

(5) Loose retainer rivets or tangs.

(6) Incomplete identification.

(7) Mismatched bearings and sets of bearings where identity is maintained by recognizable markings.

(8) Loose or missing removable seals or shields.

(9) Lubricant requiring change.

(c) Conditions which normally have little effect on bearing serviceability or which require only very minor attention:

(1) Fretted external surfaces.

(2) Pitted external surfaces.

(3) Rusty or dirty surfaces.

(4) Stains.

(5) Missing seal or shield.

(6) Missing identification markings.

ROUTING

3 Based on the preliminary examination, the routing for processing is determined on the basis that satisfactory bearing serviceability, and not compliance with new bearing standards, is required. An understanding of the extent of reconditioning that is possible and feasible is necessary if proper routing is to be effected. For convenience, bearings are logically considered to be of such condition that they may be categorized into the following:

(a) Those obviously defective and beyond repair.

(b) Those requiring rework.

(c) Those requiring further inspection.

(d) Those requiring recleaning.

(e) Those having parts suitable for cannibalization.

SECTION 2

PROCESSING

GENERAL

1 An understanding of the accuracy maintained in the manufacture and operation of anti-friction bearings is necessary in order to emphasize the care with which they must be processed. Technical facts about anti-friction bearings are given in Section 1. An understanding of the care given to make these machine elements so uniformly perfect will make it obvious that bearing maintenance must have quality workmanship as its primary aim.

WORKSPACE

2 The floors whether concrete, wood, or tile must be sealed. Dusty floors cannot be tolerated.

3 The walls and ceilings are to be painted with a non-chalking paint, and must be kept clean.

4 The work places or benches are to be covered with a hard or tempered board surface, such as masonite or formica. These surfaces are not to be painted. Glass surfaced bench tops are not desired because of the flare from lights which will cause undue eye fatigue. When bench top covers become worn and are a source of bearing contamination, they will be replaced.

5 An overall lighting of 30-40 foot candles is desired. The auxiliary illumination will be increased to a 50-60 foot candle level or more if desired for individual operation and operators.

6 Production must be scheduled so that unprotected bearings are not permitted to remain exposed to the air for more than two hours. Bearings can safely be submerged in oil, solvent, or soak tanks overnight. They cannot be left in vapour degreasers, fingerprint washers, on benches, or in unprotected tote pans.

7 Handling is to be kept to a minimum and mechanical methods used as much as practicable. The use of clean lint free gloves, such as surgical gloves or gloves made of neoprene and nylon, will be used where the bearings and parts are handled subsequent to the rework operations. Hooks or tongs may also be used. Supervisors and production workers must be alert at all times to see that bearings are being handled carefully and not dropped, thrown, bumped, or carelessly piled. The condition of bearings received from the overhaul shops must be observed continuously and corrective measures instituted to ensure their proper re-

moval, short time preservation, and timely delivery to the bearing shop.

8 The layout of the bearings shop is to be on a production line basis. The actual arrangement of the machinery will vary between installations, depending upon the equipment overhaul speciality. Changes in the placing of machines and materials handling aids should therefore be expected as the speciality changes. All bearings are not processed in the same manner, therefore the line must have the flexibility to permit an operation to be omitted or repeated.

9 The sequence of Operations Chart, Figure 2-1, points out a natural segration of the final and more important operations from the standpoint of cleanliness. The operations of final drying through first wrap or canning are the most critical and require special facilities to prevent dirt and condensate from destroying the usefulness of the bearing after packaging.

10 The area in which the inspection through first wrapping or canning operations are performed requires positive temperature and humidity control. The maximum temperature will be 26.7°C. (80°F.) and the humidity will have a maximum relative humidity factor of 4.4°C. (40°F.) at 26.7°C.(80°F.). The air will be constantly filtered to remove airborne dust particles over 10 microns in size and provide one air change each ten minutes. The bearings, packaging materials, measuring instruments and secondary standards should all be heat normalized within this area before use.

DESCRIPTIONS OF PROCESSING OPERATIONS

Handling

11 Anti-friction bearings must be handled with care at all stages. They are extremely susceptible to damage from rough handling, dirt and rust. Even exposure to normal shop atmosphere for unnecessarily long periods of time must be avoided. It is desirable, and in most cases absolutely essential, that they be removed at overhaul with the proper tools, given a protective cover of oil, wrapped in grease-proof paper or placed in covered containers, and transported carefully to the bearing shop. The care in handling should be the same as that accorded any package marked "Fragile". The timeliness of getting bearings to the bearing shop is also important, and should be accomplished at least once a day.

Unwrapping

12 The unwrapping of bearings is an important operation. If it is done properly, there will be no damage to the bearing; proper disposition of the old wraps will be made so that there is no fire hazard; bearings will require less handling later on, and contamination of the bearing will be minimized, thereby making the cleaning operations much easier. Extract and keep all required identification data with each item or lot and with each "tote" pan of each lot. A normal package can be opened by slitting the seal on the box, opening the flap and carefully sliding the bearing and its protective wrap from the box. Remove the intimate wrap and dispose of it.

Sorting

13 The purpose of sorting the bearings processing is to:

(a) Arrange bearings of a like size and type in lots for economical operation and to prevent excessive handling.

(b) Route bearings through the shop to assure correct sequence of processing operations.

(c) Assist in identification, accountability and packaging after processing by keeping like bearings together.

NOTE

The most obvious requirement for the sorting operation is to group like bearings for economical processing.

(d) Discard those bearings which have defects which render them incapable of repair.

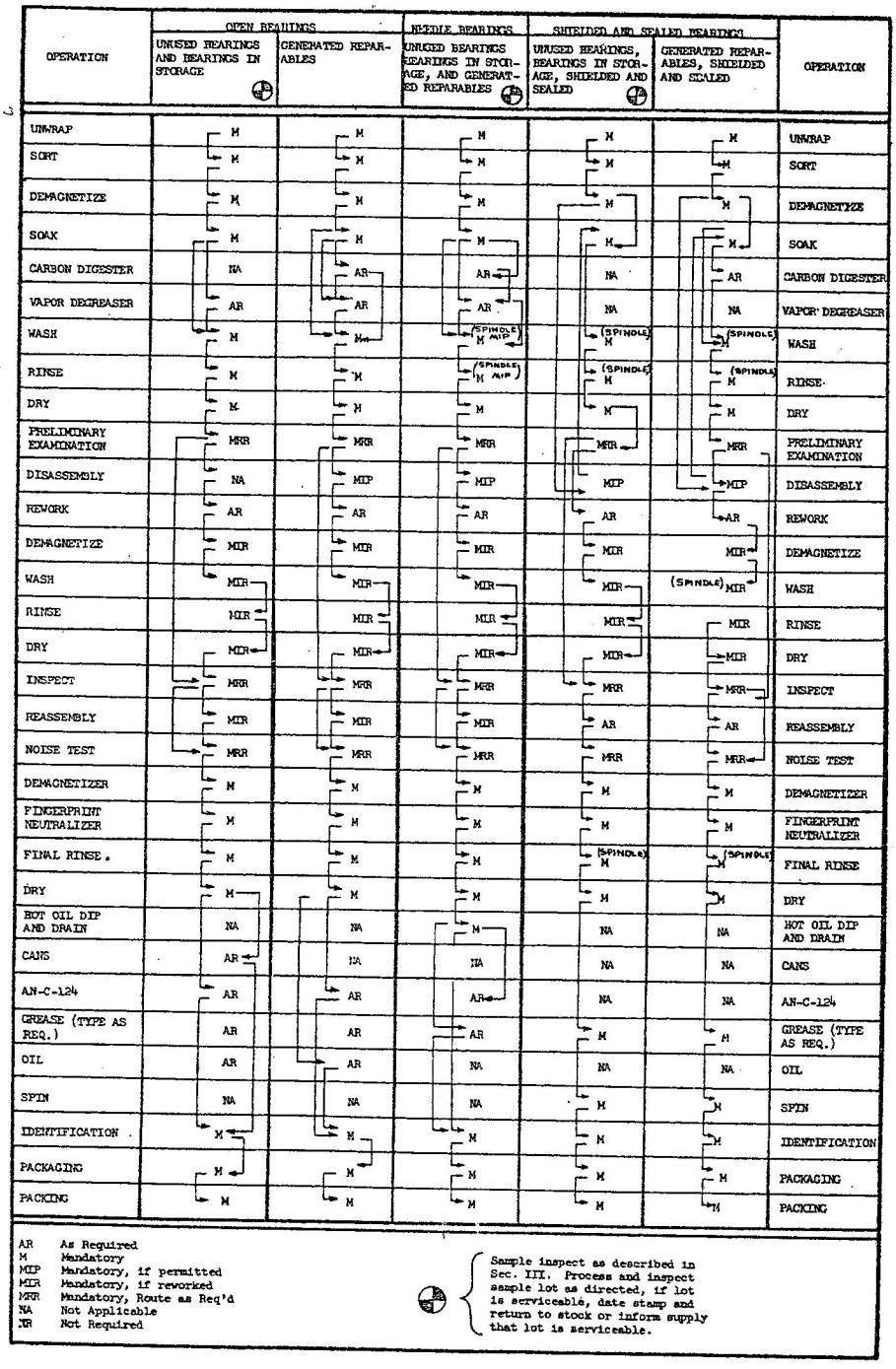

Figure 2-1 Bearing Process Sequence of Operation

(e) Place like bearings in tote pans with regard to position and quantity to minimize subsequent handling.

(f) Wire together for processing all bearings with serial numbered demountable rings, all pairs and all sets of bearings.

(g) Affix routing and identification tags as necessary.

(h) Account to Inspection and Production for bearings condemned and for those introduced to the production lines.

(j) Remove one or both shields or seals from bearings with removable shields or seals.

(k) Route all bearings of better than standard quality (ABEC#1) or (RBEC#1) for special careful handling.

(l) Identify the type of contaminant and determine the most logical method of removal.

(m) Send certain double closure bearings to inspection to determine whether processing is required.

Demagnetization

14 The purpose of demagnetization is to eliminate the residual magnetism which would cause ferrous particles to adhere to the bearing metal.

15 All bearings to be processed are presumed to be magnetized to some extent. Those which have been in rotating machinery may have operated in an electrical field. Even new bearings have been noise tested by rotation and can pick up an electrical charge. Bearings ready to be mechanically cleaned will be electrically "dead" as determined by a magnetometer on a continuous sampling basis.

16 Proper demagnetization will eliminate the tendency of ferrous particles to cling to the bearing parts. Without this operation, the magnetic attraction of these particles is sufficient to prevent their removal by any washing operation.

Soak

17 The purpose of this operation is to soften greases, preservative compound, adhering foreign matter, and oils for easier removal in washing operations.

18 When dirty, oily or greasy bearings are soaked in vats containing oil or petroleum solvent, the contaminant will be easier to remove. The oil soak solution, Spec. 3-GP-60a, RCAF Ref. 34A/29, will be elevated to a temperature of 107.2° - 121°C. (225° - 250°F.). However, the petroleum solvent, Spec. 3-GP-8, RCAF Ref. 33C/182, will be used at room temperature only.

19 The solvent action will loosen, soften and dilute the oils and greases. An agitator type tank will be used, since it will double the effectiveness of the soak by adding a mechanical action to the cleaning process. The duration of the soak will depend upon the type and amount of contaminant to be removed, the cleanliness of the soak bath and other such factors. Soak times vary from thirty minutes to several hours. Judgment is necessary to balance the requirement for soaking against extra, more expensive washing in the processes which follow.

20 The soak tanks must have a false bottom or filters for the collection of sludge. Unless controlled, the solvent will, after repeated usage, become dirty, waxy, and less effective. Periodic testing of all solutions is required, even with continuous filtration. Filters are to be removed and cleaned at frequent intervals.

Vapour Degreasing

21 The purpose of vapour degreasing is to remove residual oils and soft grease which are completely soluble in trichlorethylene.

22 The action of the vapour degreaser requires that the bearings be submerged in the vapours only, not in the liquid. The vapours condense on the bearing until it becomes as warm as the vapour, whereupon all cleaning action stops, Therefore, it is futile to expect extra cleaning by prolonged submerging in the

vapours. Repetition of the process, to obtain additional cleaning effects, requires that the bearings be removed and allowed to cool between degreasings.

23 The liquid will become contaminated, and will diminish due to drag out and evaporation.

24 The positioning of the bearing in the vapour bath should be such that draining of condensate is as complete as possible.

25 The use of vapour degreasing will be limited to those bearings which do not readily respond to the series of soak and wash operations or to those occasions when the number of bearings to be processed temporarily exceeds the capacities of the series of soak and wash tanks.

Solvent Wash

26 The purpose of this operation is to loosen and remove all foreign matter by agitation, spray wash or spindle wash.

27 Washing of bearings is always required after one or more of the reworking operations. The washing of double closure bearings is not always required and is determined at the sampling operation described in paragraph 32 (c).

28 The washing solvent normally used is Spec. 3-GP-8, Ref. 33C/182. If reprocessed solvent is used, it may only be used when it has been determined that it meets the requirements specified in Part 3.

29 Open type bearings and bearing parts will be washed by one or both of these two methods and facilities for both methods will be available in each bearing shop.

Agitator Tank Wash

30 Bearings and bearing parts will be placed flat in tote pans, one layer high, and lowered into the agitator type tank. Several tote pans may be hooked or fastened together, one above another, to utilize the full depth of the tank. The duration of the wash will depend upon the type and amount of contaminant to be removed and the cleanliness of the solution. Because of the large quantity of bearings that can be washed in one operation, agitator tank wash will be the preferred washing method.

Spray Wash

31 Bearings and bearing parts can also be washed by directing an air-solvent spray on them. The bearings should not be permitted to spin free under pressure of the spray while there is any possibility of dirt remaining in the bearings. When loose parts such as bearing rings and rollers are being spray washed, they cannot be permitted to tumble together, since the parts are hard and may damage each other. When the bearing has one seal or shield, the spray must be directed at the open face and not at the shield. Increasing the air volume, in air-solvent spray wash, is an effective way to decrease cleaning time and gives a more efficient use of the solvent.

32 There are three general types of double closure bearings and they will be washed as follows:

(a) Bearings with removable seals or shields will have one or both closures and the bearings will be washed as though they were an open type.

(b) Bearings which have the closure attached to the outer ring will be spindle washed by forcing the solvent between the inner ring land and the closure bore. Where felt seals are visible, the felt may be pierced with a scribe to assist the introduction of solvent.

(c) Bearings which have the closures attached to the inner ring will be spindle washed by introducing the solvent into the clearance at the outer rings. Examples of such bearings are the Fafnir KLLD series and the Torrington AT series.

33 For purposes of processing double closure bearings for supply, it may not be necessary to wash the grease from double closure bearings. Using the sample lot inspection procedures specified in Section 3, determine the serviceability of the grease by removing a seal

from sample bearings and noting the presence of oil and the absence of hard soap particles. These sample bearings shall be appropriately re-identified. An effective check without opening the bearings can be made by noise testing the bearing. Grease which is not oily, but is dry, and which contains hard soap particles requires that the grease residue be washed out and that the bearing be regreased.

Solvent Rinse

34 The solvent rinsing operation is needed to remove all traces of the washing solution from the bearing.

35 The washing solution will become quite dirty and waxy. Therefore it is necessary to remove all products from the washing solution which may be deposited upon the bearing surfaces. The principal washing and rinsing solvents are Spec. 3-GP-8, RCAF Ref. 33C/182. The frequency of changing the rinse solvent is dependent upon and is a measure of the effectiveness of the washing operation.

36 The procedure and equipment used to rinse both open and double closure bearings will be the same as those prescribed in paragraph 32 (c).

37 Correctly followed, these washing and rinsing operations will remove any protective film, thus leaving the bearing surfaces unprotected. To counteract this danger of corrosion, oil conforming to Spec. 3-GP-325a, RCAF Ref. 34A/124, will be added to the final rinse preceding inspection. The initial quantity of oil added, by volume, will be 3 to 5%.

Dry

38 The drying operation removes entrapped and excessive cleaning solvents and solutions,

39 Visual inspection is difficult or impossible to perform when the parts are heavily filmed with solvent. If they are perfectly dry, however, and the relative humidity is over 30%, oxidation takes place almost immediately. Therefore, this operation must not only remove entrapped cleaning solvents and condensates but must leave an oily film. This film must be thick enough to prevent rusting during inspection, but transparent enough so that inspection can be performed.

40 Drying may be performed by flowing filtered, heated, clean dry air under pressure over all parts.

41 A second method uses heat from ovens or infra red lamp batteries to warm the parts and speed evaporation. The ovens must be vented, preferably with forced air. Temperatures must not exceed 121°C. (250°F.) on the bearing itself.

42 A method that is acceptable for use with needle bearings, but used only after final washing, is the use of a hot oil bath at 107°C. (225°F.) to 121°C. (250°F.). It will be noted, particularly in small diameter needle bearings, that complete removal of solvents and condensates is very difficult. This is due to capillary attraction at the points when the needles touch the races and other needles. The hot oil will seep into the space and displace the solvent and condensate, allowing it to evaporate. The oil continuously filtered, should circulate in such a bath. Complete draining in a low humidity dust free atmosphere is required after the hot bath. Use the oil that is most nearly like that contained in the grease bearing as follows: (Spec. 3-GP-683a, Ref. 34A/192), (Spec. 3-GP-901, Ref. 34A/196), (Spec. 3-GP-690, Ref. 34A/122) and (Spec. 3-GP-60a, Ref. 34A/29), MIL-L-6085, Ref. 34A/201) and (Spec. 3-GP-682, Ref. 34A/178).

Cleaning Solutions

43 All cleaning solutions which are used in these processing operations are to be recirculated through 5 micron filters. This will provide that a portion of the solution be passed through the filter and result in longer life of the solution before reprocessing, renewing or discarding.

44 Control procedures and tests for all solutions are given in Part 3. The tests required by these standards presume the use of continuous filtering.

Sequence of Operations

45 Bearings will be processed in accordance with the sequence described in Figure 2-1.

SECTION 3

REWORK

GENERAL

1 The rework operation restores the bearing being processed to a state of serviceability so that it will perform its intended function for at least one more overhaul period. Rework operations performed in accordance with these instructions, and done in such a careful manner that the bearing will pass the inspection requirements, will ensure serviceable bearings. It is important to note that the determination of serviceability is based largely upon critical visual and audio inspection standards. This is particularly true with regard to visual appearance of the non-active parts of a bearing. There is to be no rework operation performed solely for improvement of appearance other than solvent cleaning.

2 The extra care taken in the work to be performed relates directly to the ABEC-RBEC dimensional tolerances of the bearing. The higher the ABEC-RBEC number, the more care should be expended. Bearing tolerances can be determined by reference to the bearing prints or a visual inspection of the bearing. Application is also a clue, if it is known. The price and ABEC-RBEC classification are both indications of quality and are given (or coded) in the stock list. The bearing prints may show the tolerances, another indication of precision since the closer the tolerance, the more care is required in manufacture. Rework operations must always be done carefully. Higher precision bearings necessitate additional care.

3 The extent of rework necessary to make it serviceable is determined by the preliminary examination. The routing established at that time depends entirely upon the condition of the bearing. No work will be performed which is not necessary to restore serviceability. It is often the case that no mechanical rework is required, but recleaning only is necessary.

DISASSEMBLY

Introduction

4 Bearings incorporating removable shields or seals, or being constructed of multiple or removable inner or outer race rings will be disassembled to the extent required to permit thorough cleaning and inspection. In no case is it permissible to drill out the retained rivets, bend retainer tangs, or remove retainer nuts or screws, to accomplish this disassembly.

5 All bearings are selective assemblies, and parts are seldom interchangeable between one bearing and another. It is required that when a bearing is disassembled, all of the parts, except retainer, be kept together and not mixed from one bearing to another. When a bearing is separable, serial numbers will usually appear on each of the principle assemblies and must be assembled with the same serial numbered parts unless rematched as explained in this section. In processing matched parts, matched bearing parts, or matched sets of bearings, they must be wired or otherwise fastened together to prevent mixing and to facilitate reassembly.

6 For those bearings which have retainers with bent tangs or two-piece retainers held together by rivets, bolts or drive screws, proper reassembly cannot be accomplished and therefore disassembly is not authorized.

7 Disassembly must be carefully accomplished so as not to damage any part of the bearing.

DISASSEMBLY OF BEARINGS BY TYPES

Double Shielded Bearings

8 This type will not be disassembled if the

shields are rolled or pressed in place to become integral shields. If the shields are held in place with snap rings or other removable retaining devices, one or both shields will be removed to facilitate cleaning, inspection and greasing.

Double Sealed Bearings

9 Integral seals will not be removed. Seals which are held in place with snap rings or other like device are removable. Plastic contact seals may be removable. One or both of all removable seals will be removed for cleaning, inspection and regreasing. The method of removal will be determined by the design of the seal. Removal of both seals will be accomplished when cleaning procedures are detrimental to the seals. However, integral seals must be removed when reprocessing and lubricating procedures are detrimental to the seals and reprocessing is absolutely essential, In the case of the latter type, re-identification of the bearing to its open bearing counterpart is necessary and the seals will not be replaced.

Single Row Ball Bearings (Open Type)

10 Bearings of this type are generally not demountable and will not be disassembled. Bearings with split (two piece) inner or outer rings can be disassembled. Bearings with continuous wire, spring type or snap type retainers can be disassembled. Bearings with ball complements loaded through a hole (not a filling notch) in either the inner or outer ring can be disassembled.

Single Row Radial Roller Bearings

11 Bearings of this type normally have one demountable ring. Further disassembly is accomplished when the retainer is of one piece construction, by holding the ends of one roller between soft metal vise pads and extracting one roller at a time until sufficient rollers are removed in this manner to permit disassembly by hand. A flat bar can sometimes be used to pry out the first few rollers, but this must be done very carefully so that the retainers will not be bent.

Double Row Bearings

12 Bearings of this type cannot normally be disassembled except within the scope of normal demountability, such as removal of removable shields, seals, etc. This is permitted.

Tapered Roller Bearings

13 Tapered roller bearings have a demountable ring. Further disassembly requires special press tools which are seldom warranted. If the necessity arises, thin shim stock can be inserted under the small end of each roller and the bearing pushed apart over the retainer lips.

Air Frame Bearings

14 Air frame bearings with integral seals or shields will not be disassembled. The newer type bearings produced under Spec. MIL-3-7949 and other applicable specifications may have removable plastic closures which will be removed (one or both) to facilitate maintenance.

Needle Bearings

15 The general line of needle bearings is not demountable except for inner ring removal. Further disassembly is determined as follows:

(a) Lockwires must not be sheared, but may be removed if designed for removal.

(b) Retainer lips will not be bent or deformed to remove needles. Where the retainer lip is notched for "short needle" removal, the needle complement may be removed if necessary. Pressed steel retainer lips may be removed only when it can be done without deformation which would prevent subsequent proper reassembly.

Self Aligning Bearings

16 The amount of disassembly permitted will be determined by the design of the bearing. It may be necessary to remove snap rings or merely turn the inner ring assembly 90° to demount the bearing.

REWORK OPERATIONS

Buffing and Polishing

17 For buffing and polishing, see NOTE.

Permissible Buffing Materials

18 Buffing is permitted on the following materials:

(a) Assembled bearings:-Jewellers' rouge, levigated alumina and crocus cloth.

(b) Demounted Parts:- Any abrasive, 180 mesh or finer, or abrasive wheel which will not result in a rougher surface finish than the original, provided the residue can be cleaned away. This will be determined by control procedures and tests on samples of surface finish roughness and final cleanliness.

How to Polish

19 For polishing, see NOTE:

(a) Rings or lapping fixture should be hand held.

(b) Rollers can be held in compartment trays.

(c) Retainers should be hand held while being buffed or may be bright dipped instead of polished.

(d) Wash and rinse must follow.

NOTE

Buffing is not permitted solely for improvement of appearance, such as discoloration, stains, etc.

Roller Matching - Cylindrical Roller Bearings, Roller Tolerances

20 In matching rollers for precision roller bearings, observe the dimensional tolerances $\pm$ .00005 for diameter, $\pm$ .0002 for component length or other tolerances that may be specified on manufacturer's Drawing. Spare rollers are to be accumulated from stocks of cannibalized bearings and segregated as to bearing type and manufacturer. Roller substitution can be made in precision roller bearings by observing the above limits and using rollers of a like manufacturer and part number. This must be followed with a check for radial clearance as specified on applicable Drawings.

Ball Matching

21 In ball bearings which can be disassembled, individual balls or ball complements may be replaced by using new balls. New balls in original packs are graded for tolerance and a series of radial check must follow.

Component Matching

22 Where demountable parts or assemblies are serial numbered, the parts must be processed together. If one part should be condemned or lost, it may be replaced by selecting a similar part of like manufacture and part number, and fitting it to proper dimensions. Serial numbers will be altered as necessary by electric etching to indicate the new assembly. Burrs will be stoned off after etching.

Retainer Rework

23 Mechanical straightening:-Retainers are selectively assembled and like types may be not selectively assembled and like types may be facture and part number; retainers must not be interchanged between different manufacturers. Retainers may be straightened with a fibre mallet on a surface plate and must be flat to within .005" by a feeler gauge.

24 Bright dipping:- This operation should be accomplished in the following five steps:

(a) Dip the retainer into a solution compounded of: 1 pint/gallon H_2O (water) - H_2SO_4 (acid sulphuric) plus 2-4 oz/gallon Na_2CrO_7 (sodium dichromate). Use at room temperature.

(b) Dip the retainer in a cold water rinse.

(c) Dip retainer in a solution compounded of: 3 lbs. Na_2CrO_7 (sodium dichromate). 300

ccs. H_2SO_4 (acid, sulphuric), 4 gallons H_2O (water).

(d) Dip the retainer in a hot water rinse maintained at 82°C. (180°F.).

(e) Thoroughly dry.

NOTE

Use the existing bright dip facilities wherever they exist, if determined satisfactory.

Copper Plate

25 Copper plating is often added by the manufacturer to bore and outer diameter surfaces of propeller stack-bearings and to a few other types to prevent galling of loose fitting housings or shafts. If the plating is worn away more than 25%, it may be restored. Plating baths will be used when approved.

Noise Testing

26 A production noise test will be used on reworked bearings, as required, after final cleaning to determine whether additional cleaning or rework is necessary. Routing of bearings for recleaning or rework will be dependent upon this inspection.

Rockwell Hardness Tester

27 When a visual inspection indicates blueing or possible exposure to excessive heat, and the hardness is in question, the bearing or part will be tested for hardness. Oxide treated bearings should not be confused with discolored ones. Tests will be made only on an inactive part, i.e. roller ends, ring faces. Active races, retainers, balls, rollers, or drawn shell needle bearing will never be tested. The test dent rim will be stoned flat if the part is serviceable and will be re-used.

Airframe Bearing Rework

28 Airframe bearings (MIL-B-7949) with integral seals or shields will not be disassembled. Those bearings with removable closures will have one or both removed to facilitate cleaning and greasing.

29 Determination of the extent of rework necessary will be made on the basis of individual or sample inspections.

30 Washing may be done individually on spindles. Bulk washing will be done only if both closures are removed.

31 Visual inspection will encompass all integral parts such as rod and shanks, threads, eyes, etc.

32 Bearings will be lubricated so as to leave them completely full of grease. They will not be purged.

33 These bearings are full complement (retainerless) bearings and are not to be spin tested.

34 Exterior surfaces will be smeared with the same grease as used internally, as a corrosion preventive. Plated surfaces do not require this protection.

SECTION 4

DETERMINING SERVICEABILITY BY VISUAL INSPECTION

INTRODUCTION

1 The information contained herein will familiarize personnel with the uniform and standardized practice of inspecting anti-friction bearings for serviceability. Visual inspection standards for serviceability are not the same as those used by industry for new bearing production; they are appreciably lower. Dimensional standards for serviceability are the same as industry standards.

2 Visual and aural inspection of anti-friction bearings will be accomplished on bearings processed by depots, and bearings receiving corrosion control treatment for preservation and packing.

3 The Figures in this Part illustrate the typical visual evidence of bearing deterioration. A study of these illustrations will help acquaint personnel with bearing operating characteristics and the factors that are detrimental to such operations. After becoming adequately experienced, it will be possible, by comparing the actual bearing with the description in the handbook, to determine whether the bearing in question is serviceable or unserviceable. More than 95% of all bearing troubles investigated are the result of defective mounting in the assembly, improper operating conditions, and similar causes which can be detected by visual inspection of the bearings. Many bearing "defects" do not affect serviceability in use and are not cause for bearing condemnation. It is expected that an average condemnation rate will be 5% or less of all bearings processed. Exceptions may be expected to occur in new equipment and rejections will be higher for a period of time. The following visual inspection standards are based on serviceability of all working parts and not upon new bearing standards. New bearing standards emphasize appearance as well as serviceability, and obviously a used bearing does not need to look new. The following information will be used as a guide in the inspection of all anti-friction bearings with the exception of instrument and bombsight bearings.

4 The degree to which the requirements for serviceability are established is based upon the degree of precision to which the bearings were made. Where a variable standard for visual or noise test inspection is possible, the additional inspections will be reserved for those bearings having a tolerance of ABEC3 or RBEC3 and higher. Information on the tolerance of the bearing may be obtained from the bearing markings, or from the blueprints.

ABSENCE OF TROUBLE, See Figure 2-2

Condition of Bearing

5 A satisfactory condition in a bearing which has operated under a thrust or radial load can easily be recognized. In Figure 2-2, the bearing was properly mounted, operated under good loading conditions, kept clean, and properly lubricated. The path of the balls in the highly polished race shows as a dulled surface wherein the microscopically fine grinding scratches have been smoothed out. There has been no removal of material from the surface, as indicated by the fact that there has been no measurable decrease in the diameter of the balls, although their entire surface has been dulled. Other indications that operating conditions have been satisfactory are the uniformity of the path, parallelism with the side of the races, indicating the bearing carried a radial or a balanced load. The outer race, if being used for the first time in a rotating inner ring installation, may show signs of ball contact on less than one-half the circumference. Properly operating roller or needle bearings operate in a straight path and are similarly

dulled in the loaded area, see Figure 2-2. The rollers will probably have high speed superficial circumferential scratches. The retainer will not be twisted or worn in the pockets and no sharp edges will have been raised from operation. Radial scratches may appear on the outer surface of the outer ring where it has crept in the housing. Axial marks across the width of both bore and OD surfaces occur in mounting and are normally expected in all anti-friction bearings.

Inspection

6 It is a characteristic of anti-friction bearings that any wear sufficient to be detrimental to the future operation of the bearing, or any physical or chemical decomposition present in the bearing may be detected through a visual inspection. This is a highly significant point and must be exploited to the greatest possible extent. It can be summed up as follows: A SIGNIFICANT DIMENSIONAL CHANGE IN A USED BEARING ASSEMBLY CAN BE DETERMINED BY A VISUAL INSPECTION. Therefore, the need for mechanical measurement, though seldom required, can be determined by visual inspection.

THE EFFECT OF FOREIGN MATTER

Condition

7 Ball bearings are particularly sensitive to dirt, lint, or other foreign matter; these substances are always more or less abrasive. The very high unit pressure between the balls and the races tends to crush the material into the races, and dents them. Roller bearings are less sensitive to dirt, but are susceptible to the same kind of damage. The rolling motion of the ball or roller complement tends to entrap foreign material particularly small particles.

8 Unsatisfactory operation of anti-friction bearings on "foreign matter" is frequently considered an alibi, nevertheless, this is the most common cause of damage. The foreign matter may get into the bearing during initial assembly; during repairs; by seepage from the lubricant. Such contamination results in a loss of the generally highly polished surfaces, and in more advanced stages, fine surface pits may be detected. Such surface pits are not necessarily detrimental although they are visible.

9 The character of the damage caused by different types of foreign matter getting into anti-friction bearings varies considerably with the nature of the foreign matter. Small particle matter or matter that is soft enough to be ground fine by the rolling action of the balls will have an effect the same as that which results from the presence of a fine abrasive or lapping material. The races become worn in the ball paths, the balls wear, and the bearings become loose and noisy. The lapping action increases rapidly as the fine steel particles removed from the bearing surfaces add more lapping material. Hard course foreign matter such as iron, steel, or other metallic particles introduced at the time of bearing assembly produce small depressions of a character considerably different from those produced by overload failure, acid etching, or corrosion. Jamming of the hard particles between the balls and the races may be extensive enough to cause the inner race to turn on the shaft or the outer race to turn in the housing, due to the resulting binding action. A visual inspection of the bore and OD surfaces will detect such a condition, see paragraphs 59 to 61.

10 Water, acid and corrosives formed by deterioration of the lubricant, and other corrosive materials produce a type of failure that is indicated by a reddish brown coating and very small etched holes over the entire exposed surface of the races. Frequently, the etching does not show on the ball path because the rolling action of the balls pushes the corrosive portion of the lubricant away from the ball path. The corrosive oxides formed act as lapping agents that cause wear and produce a dull gray colour on the balls and the ball paths, as contrasted with reddish brown colour of the remainder of the surface.

Inspection

11 A dull or satin finish surface on the raceways and rolling elements is not cause for rejection of the bearing unless the lapping action has progressed to the point where there

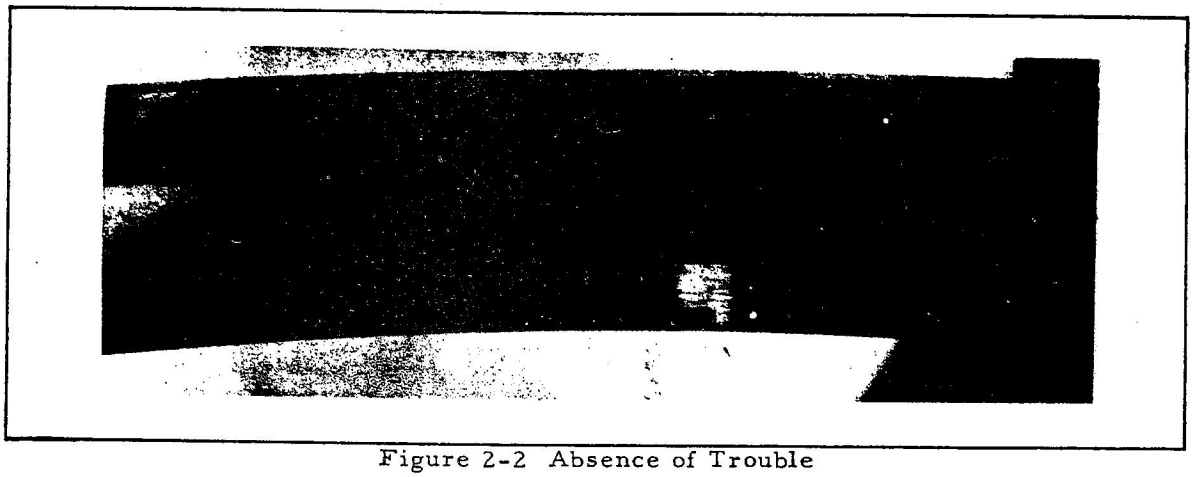

Figure 2-2 Absence of Trouble

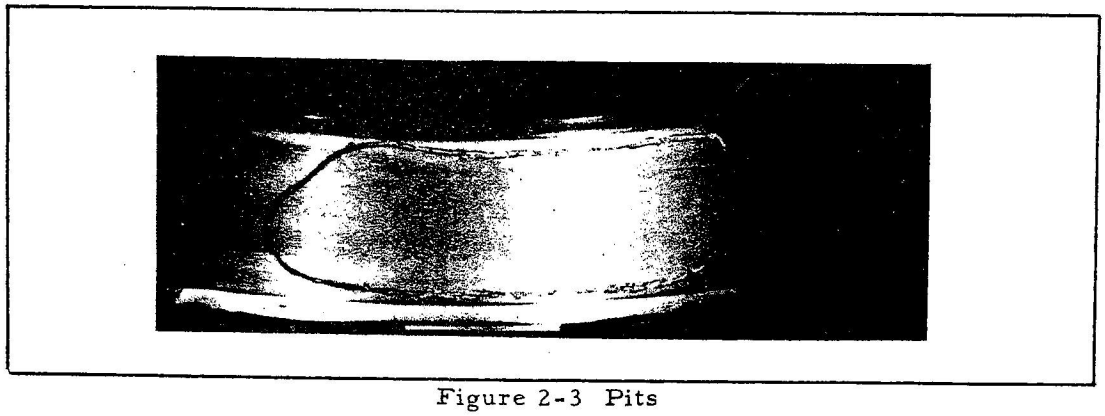

Figure 2-3 Pits

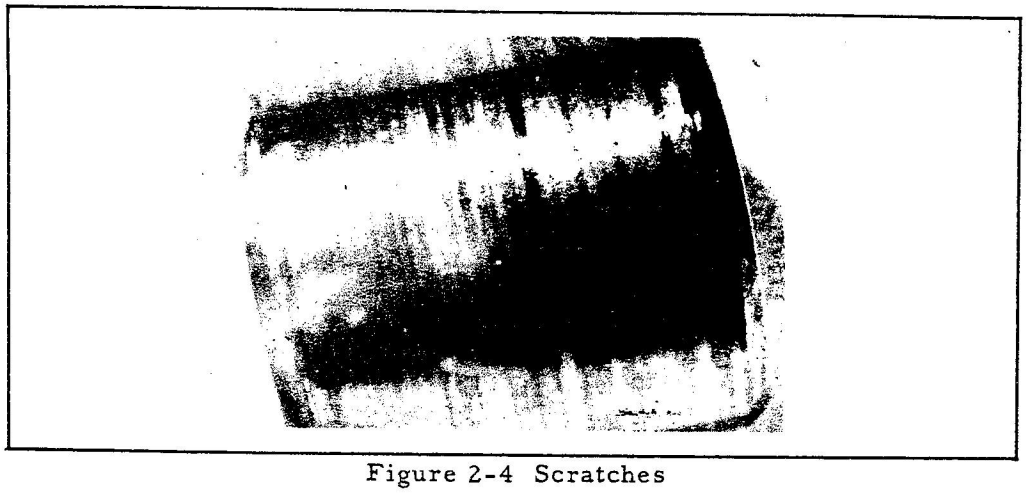

Figure 2-4 Scratches

are visible pin-point surface pits under no magnification. Such "pits" must meet the definition contained in paragraphs 13 to 17 to be cause for rejection.

Correction

12 Buff polish and/or chemically clean. In the advance stage of pit corrosion, no correction is possible.

PITS, see Figure 2-3

Condition

13 A pit (for the purpose of this manual) is a small irregular cavity, in the active part of the race or rolling element, which can be felt with a 0.030 inch "radius scribe". A pit that can be readily felt with a 0.030 inch "radius scribe" is approximately 0.015" wide. It is usually dark in appearance.

Inspection - Ball Bearings

14 Pits are cause for rejection when found in the active part of a ball bearing race or on a ball. All borderline cases will be passed or rejected on a basis of a noise test inspection. Since adequate visual inspection cannot be made on all ball bearings, it will be necessary to rely almost entirely on the noise test.

Roller Bearings

15 Pits on the active parts of rollers or races are not cause for rejection unless single pits exceed 0.015" wide or a cluster of more than 3 pits is in an area of 1/4" diameter.

Non-Active Surfaces - All Bearings

16 Pits sufficient to cause loss of more than 20% of the area of contact on bore or outside diameter surface are cause for rejection. Pits effecting face squareness over more than 20% of the circumference are cause for rejection.

Correction

17 None.

DENTS

Condition

18 Dents are slight depressions or hollows on a surface caused by pressure or blows by hard objects against the finish surfaces. Dents generally appear the same as the unmarred surface around them and are visible only by virtue of light reflection caused by the change in uniformity of the surface.

Inspection - Active Surfaces

19 Dents are not cause for rejection unless they exceed 0.030" in length and can readily be felt with an 0.030" radius scribe.

Non-Active Surfaces

20 Dents sufficient to cause loss of more than 20% of the area of contact on bore or outside diameter surface are cause for rejection. Pits affecting face squareness over more than 20% of the circumference are cause for rejection.

Correction

21 None.

SCRATCHES, see Figure 2-4

Condition

22 Scratches are linear abrasions of the surface other than grinding, honing polishing or lapping marks.

Inspection - Active Surfaces

23 Circumferential scratches which cannot be felt with a 0.030" radius scribe and do not exceed 3/4" in length are not cause for rejection. Scratches across the raceway which, cannot be felt with a 0.030" radius scribe and are not longer than 0.090" are not cause for rejection. Scratches, regardless of length or direction are not cause for rejection unless any part of the scratch can be readily felt with an 0.030" radius scribe.

Non-Active Surfaces

24 Scratches are not cause for rejection.

Correction

25 None.

CIRCUMFERENTIAL BANDS
See Figure 2-5

Condition

26 As stated (for bearing balls only).

Inspection

27 Circumferential bands on balls are not a cause for rejection unless bearing fails to pass a noise test. The bands caused by axial loads are largely an optical illusion and have no measurable depth. EXCEPTION: Airframe bearings, Spec. MIL-B-7949, and propeller blade bearings in which 1/16" width and/or deep bands are permitted on the balls.

Correction

28 None.

CORROSION, see Figure 2-6

Condition

29 Black or reddish rust.

Inspection

30 Rust will be removed from all load carrying surfaces and the inspection made as described in sub-paragraph 4 (d). Loose corrosion products must be removed to prevent further contamination.

Correction

31 Buff, polish and/or chemically clean.

FATIGUE, see Figure 2-7

Condition

32 Spalling of the bearing metal appearing on the load carrying surfaces.

Inspection

33 Absolute cause for rejection.

Correction

34 None.

WORN RETAINERS, METALLIC AND NON-METALLIC, see Figure 2-8

Condition

35 As stated.

Inspection

36 Reject the complete bearing or the non-demountable assembly containing the retainer if the pockets are elongated; if the retainer is charred or cracked; if there are excessive loose fibres; if the retainer is plated; if the plating has started to peel. Reject if the faces are chipped or if the bore is warped, causing rubbing in two or more spots. Inner or outer land-riding retainers, which are positioned by one of the bearing rings, may show slight uniform wear on the sliding surface.

Correction

37 None.

TRUE BRINELLING, see Figure 2-9

Condition

38 Brinells are small smooth depressions on the surface of the loaded area.

39 Both ball and roller bearings may be brinelled by improper installation procedures and extremely high stock or impact loads at zero rpm.

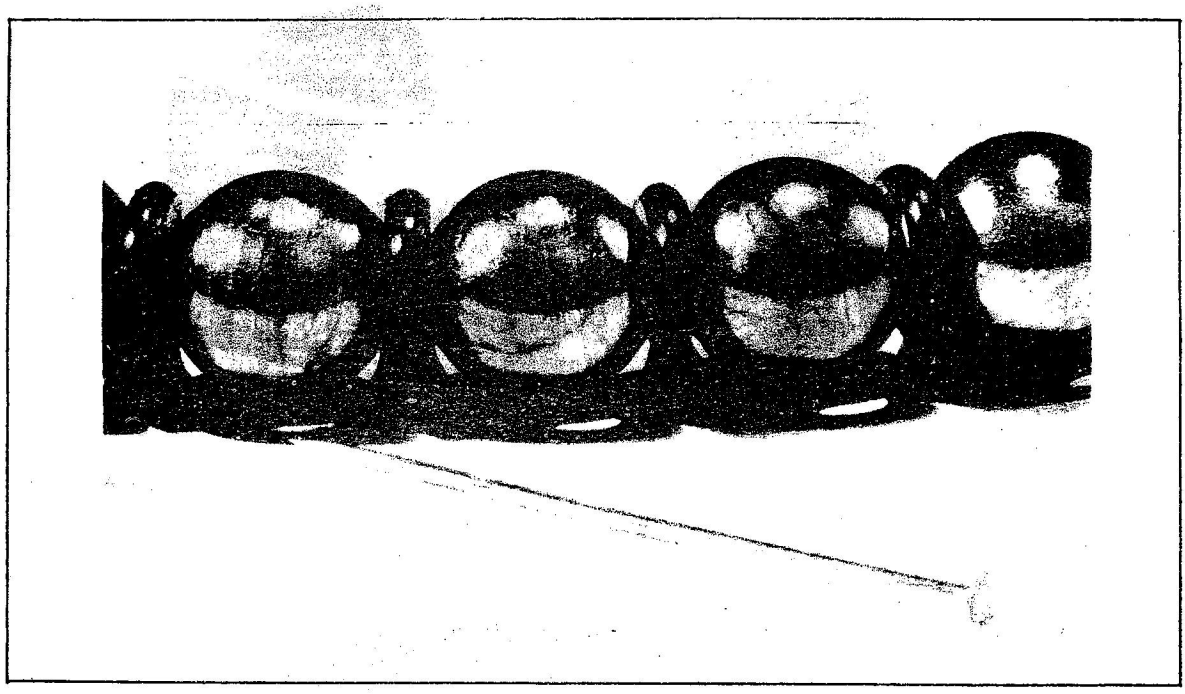

Figure 2-5 Circumferential Bands

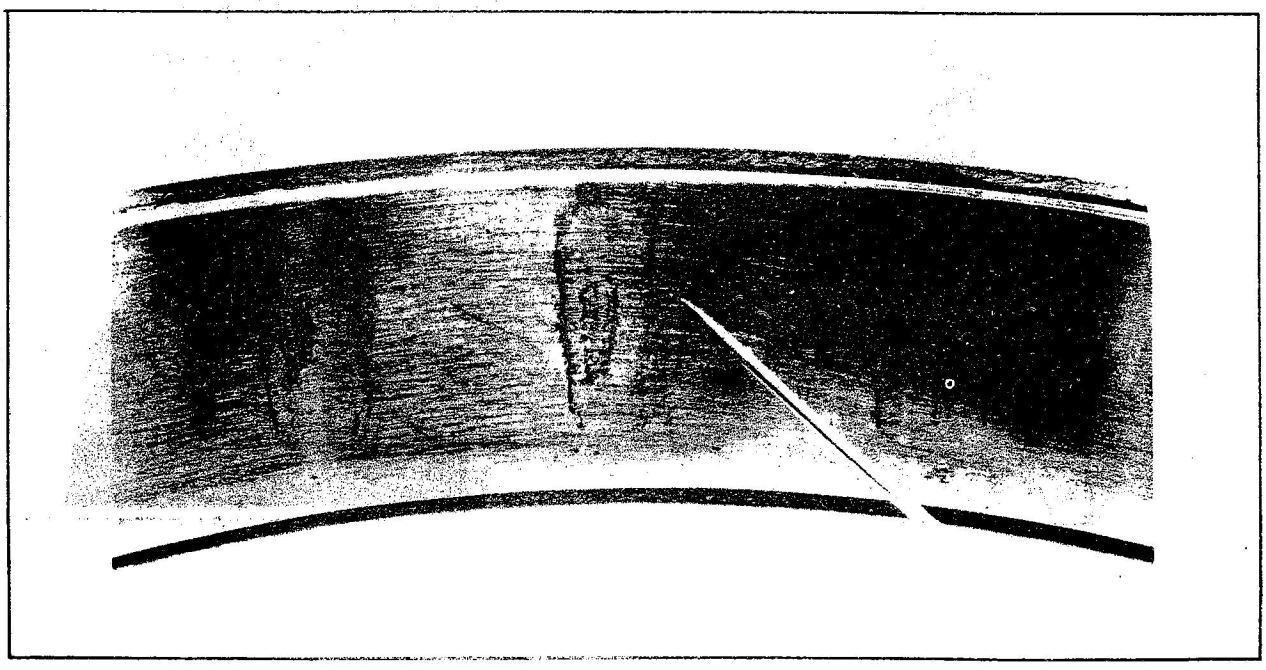

Figure 2-6 Corrosion

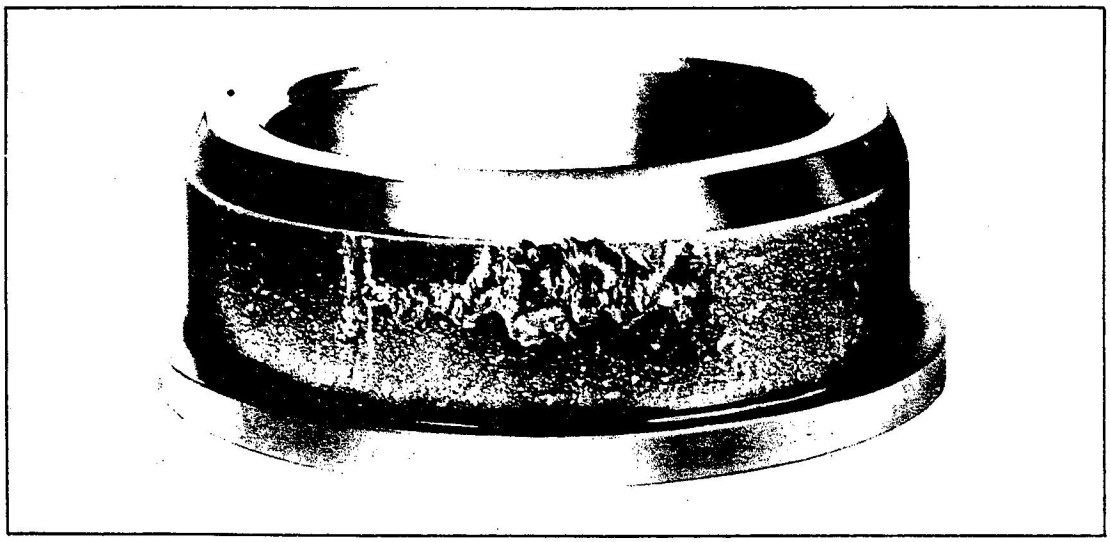

Figure 2-7 Fatigue

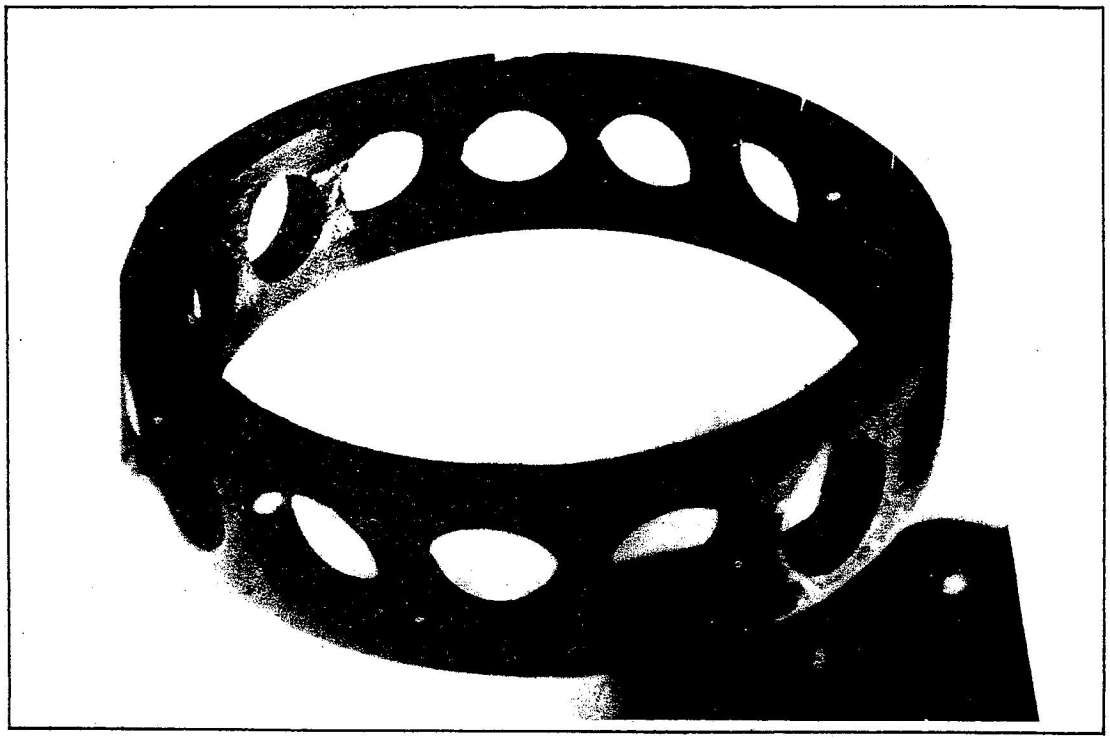

Figure 2-8 Worn Retainer

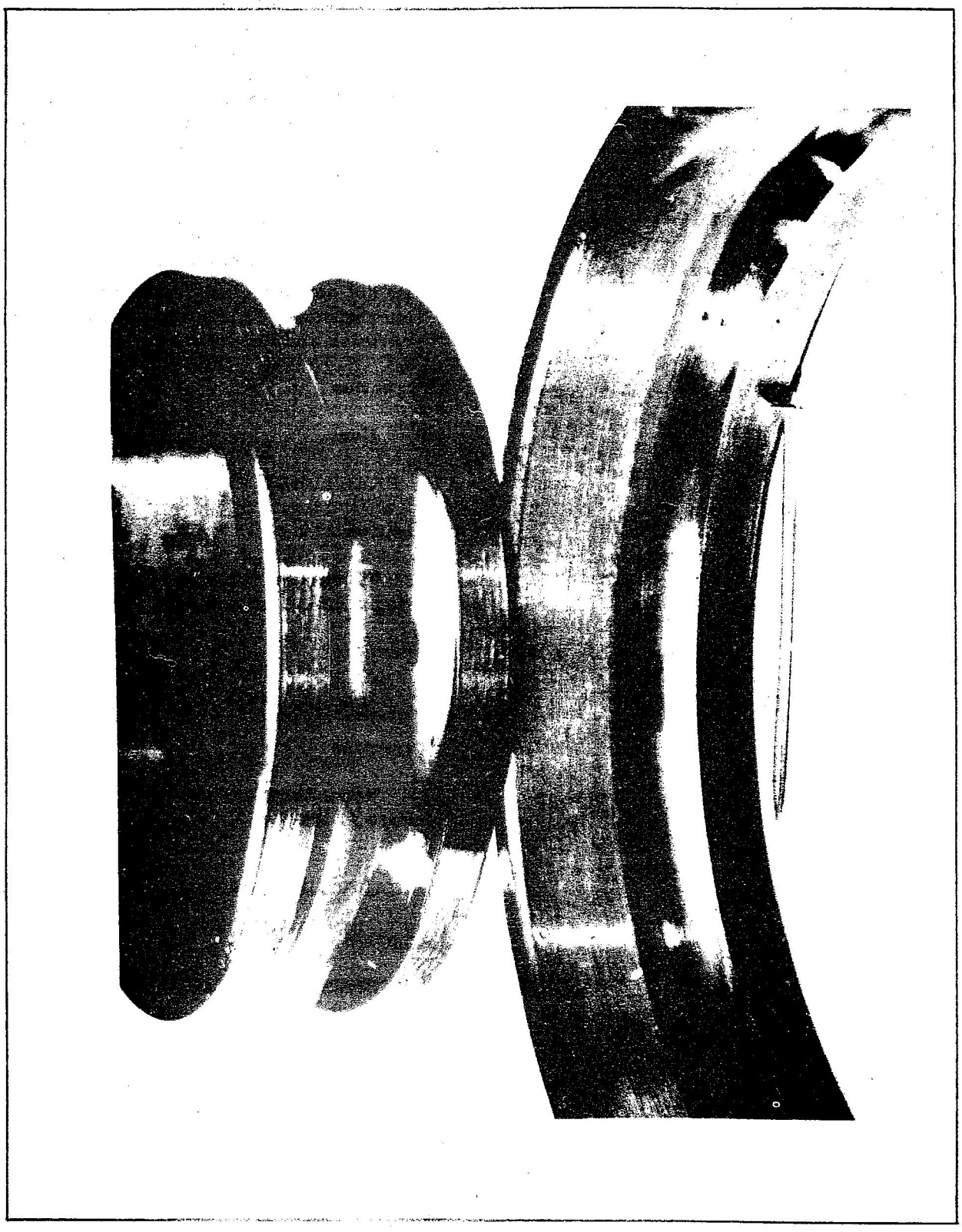

Figure 2-9 True Brinelling

40 Ball bearings - When examined under no magnification by reflected light, brinells may be seen, and their distance apart will correspond to the ball spacing.

41 Roller bearings - Brinelling usually occurs as a series of shallow depressions in the load area of the raceway. These indentations have the same surface appearance as the surrounding area and the contour of the indentation is the same as the roller radius. Brinelling usually occurs when the bearing is stationary; seldom when it is rotating.

Inspection

42 Pass or reject on basis of noise test.

Correction

43 None.

FALSE BRINELLING

Condition

44 A specialized form of fretting, occurring only at the rolling contact surfaces of the bearing races. It may be recognized by the occurrence of a series of shallow indentations in the race at each roller position on the loaded side of the bearing. Very often, red oxide of iron may be found where false brinelling has occurred.

Inspection

45 Noise test and visual inspection.

Correction

46 None.

HEAT FAILURES, see Figure 2-10

Condition

47 The bearings' surfaces appear blued or burned.

Inspection

48 Reject bearings which have localized or complete discoloration (blueing) on any part. Check borderline cases only. Reject all steel bearings below 58 Rockwell C Hardness, or three points below the minimum hardness specified by the blueprints. When required, take average of three evenly spaced readings taken on inactive surfaces only. Stone indentations after testing.

CAUTION

Do not confuse black oxide finishes with overheating. Check blueprints for type of finish and hardness.

Correction

49 None.

FRACTURED PARTS, see Figure 2-11

Condition

50 Cracked or broken inner or outer ring; rolling element or retainer.

Inspection

51 Absolute cause for rejection.

Correction

52 None. Rematch components as described in Part 3, Section 2.

CARBONED SURFACE, see Figure 2-12

Condition

53 Black or brownish oxide on bearing.

Inspection

54 After cleaning, pass or reject on basis of noise test.

Correction

55 Removal by chemical or mechanical means.

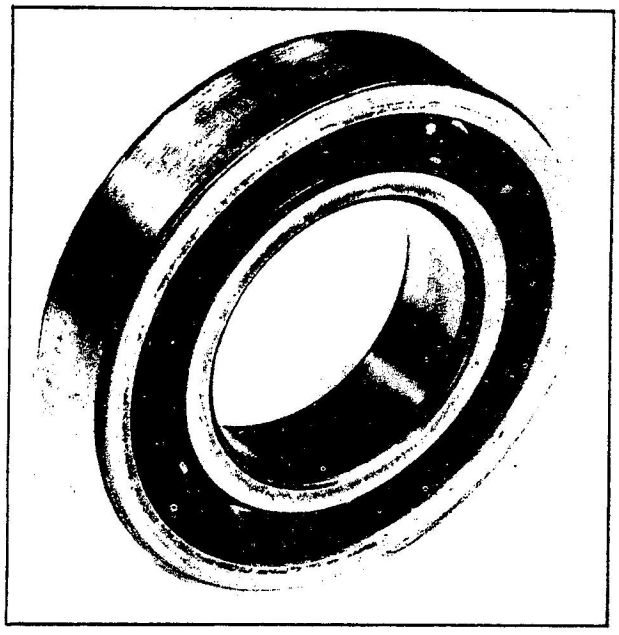

Figure 2-10 Heat Failure

STAIN, see Figure 2-13

Condition

56 Black, brown or red discoloration on any part of the bearing assembly.

Inspection

57 Stains have no appreciable thickness. They do not affect serviceability on any inactive part of the bearing assembly and are not cause for rejection if on these parts. They usually do not affect serviceability on the active parts of the bearing. Serviceability can be determined by noise test, fingernail test or visual inspection.

Correction

58 Rework to serviceable status may be accomplished when necessary by buffing of accessible parts, or by chemical cleaning.

SCRATCHES ON BORES AND OUTER SURFACES

Condition

59 Circumferential scratches are normal and are not cause for rejection unless the parts have been overheated, enlarged or reduced, and provided the desired shaft and housing fits can be obtained. Galling may occur from loose fits, but is not easily confused with circumferential scratches.

Inspection

60 Inspect for an overheated condition as described in Part 4, Section 2 (n). Visually inspect for conditions which indicate a possible enlargement of bore size or reduction of outside diameter. Measure border line cases only.

Correction

61 Buff and polish.

INSPECTING DOUBLE CLOSURE BEARINGS

General

62 Double sealed and shielded type bearings are also subject to deterioration. However, since bearings with integral seals or shields, cannot be visually inspected, it is necessary to inspect such bearings with the noise and vibration test explained in sub-paragraph 4 (u) of this section.

63 In this type of bearing, the lubricant becomes oxidized and roughness can be detected in the form of hardened lumps of grease within the bearing. Such bearings are washed by flushing filtered solvent under pressure through the bearing. After these bearings are thoroughly cleaned and air dried, they will be pressure-lubricated with the correct type of lubricant prescribed for the application to which the bearings are put. Following the lubrication of such bearings, they will be rotated at not more than 1800 rpm to relieve the bearing of excessive lubricant, this will be indicated by cessation of grease overflow. Sufficient grease will be removed from the bearing compartment to leave the bearing compartment approximately one-third to one-half full.

64 Removable seals which are installed on some anti-friction bearings may be taken off,

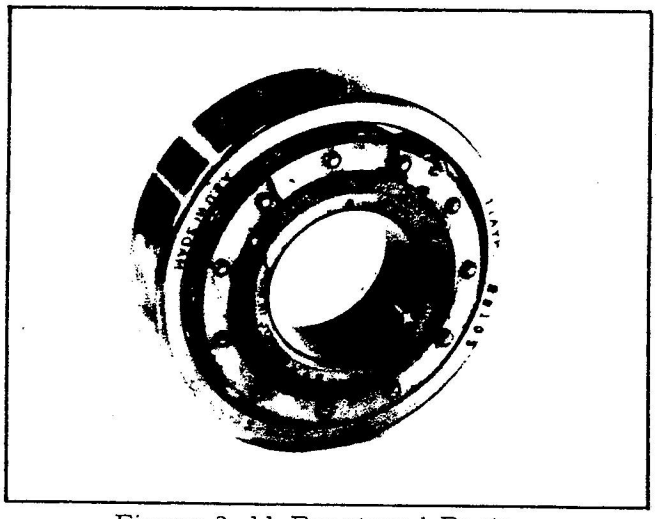

Figure 2-11 Fractured Parts

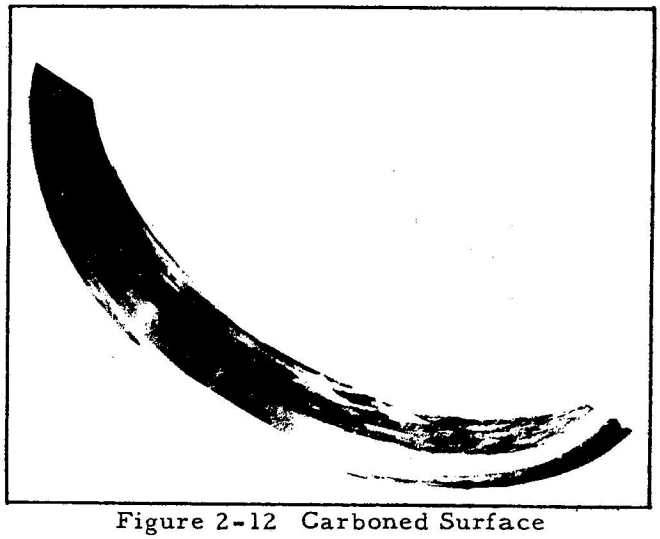

Figure 2-12 Carboned Surface

providing the component parts of the bearing are not destroyed in this process. Seals may be replaced, if serviceable. Replacement seals, obtained by local purchase or supply action should be used in each possible case rather than resort to manufacture.

65 Where facilities do not permit the procedure as outlined herein, the bearings will be carefully inspected by the noise and vibration test, see paragraphs 68 to 70 to ascertain the condition of the raceways and rolling elements.

66 All double sealed and shielded bearings which, during inspection, do not indicate the presence of sufficient lubrication will be relubricated.

67 Bearings which have dented, distorted, or collapsed seals or shields will be carefully inspected to ascertain whether such damage will cause interference between the rotating parts of the bearing. If there is no interference between the closure and the moving parts; if the closure does not protrude beyond the inner ring; and if it is securely attached; it will be continued in service. The damaged closure may be replaced within the limits given directly above, or the bearing may be re-identified and returned to stock as a single closure or open bearing under the appropriate stock number.

NOISE AND VIBRATION TEST

Introduction

68 A uniform low level noise in a hearing under test indicates serviceability. Harsh or intermittent noise will also indicate the presence of contamination, pitted or flaked raceways, flat balls, defective components, improper dimensional fits, and other imperfections. When bearings cannot readily be inspected visually, the noise and vibration test is the most informative indication of a bearing's serviceability. This test can be accomplished by either of two methods:

Quiet Spindle Technique, see Figure 2-14

69 Accomplish this test as follows:

(a) Place a few drops of light spindle oil in the bearing raceways.

(b) Load the outer race of the bearing with the thumbs, keeping them parallel with the table and 82°C. (180°F.) apart in the ring. Turn the inner ring of the bearing with a rotating adaptor mounted on a dental lathe shaft. Loads

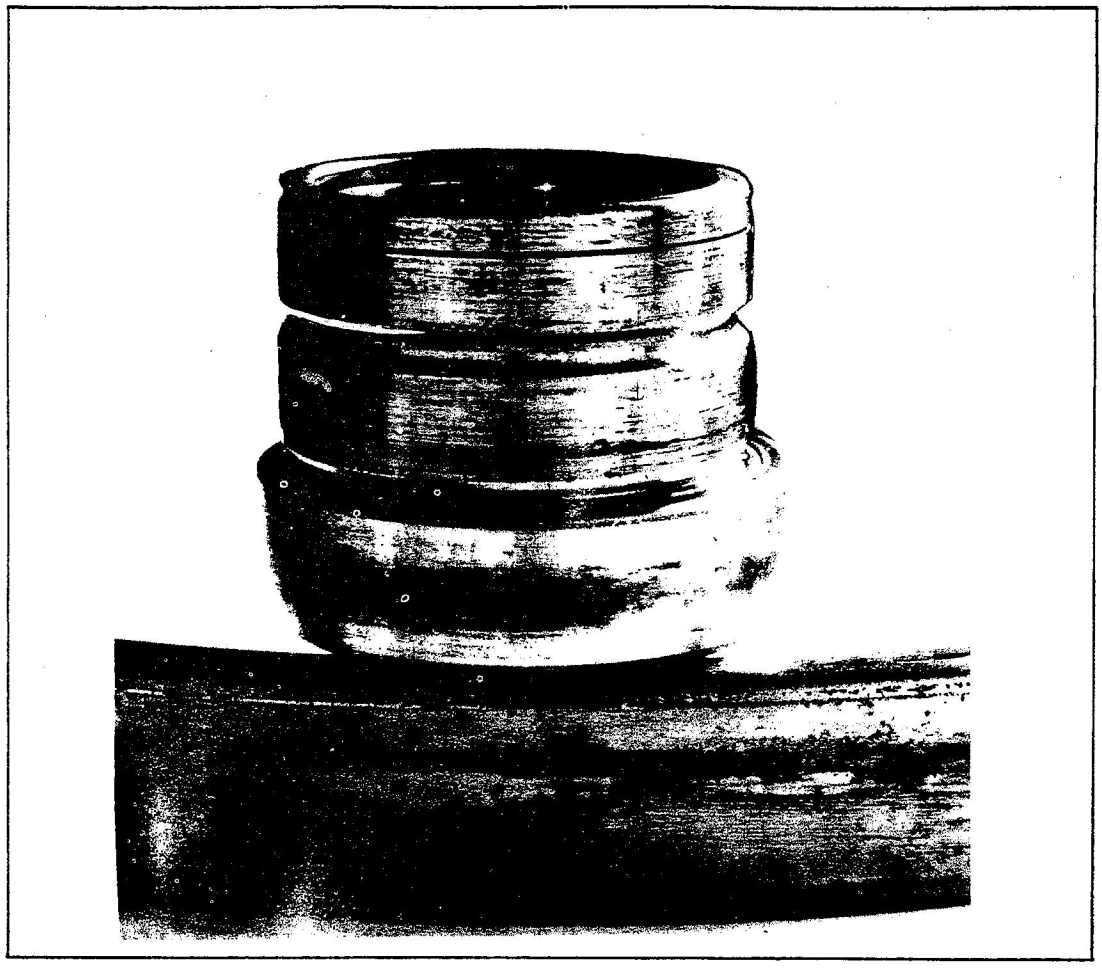

Figure 2-13 Stain

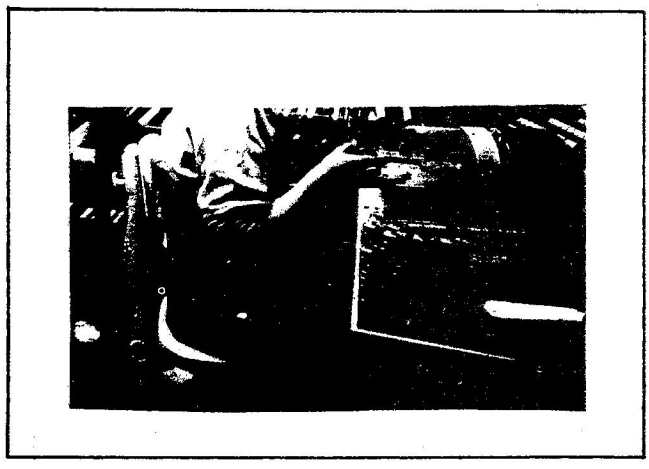

Figure 2-14 Quiet Spindle Technique

to be applied should approximate gauging load pressures, which are:

OD Size in MM	Load in Pounds
0-50	5 1/2
50-120	11
120-200	22
over 200	44

(c) Rotate the bearing assembly from 1150 to 3350 rpm. Defects within a bearing may be detected by the noise and vibration set up during this rotation.

(d) Test angular contact bearings, the side marked "Thrust" only; test radial type bearings on both sides.

(e) New bearings when subjected to this test do not run silently, hence a used bearing subjected to this test will also make a certain amount of noise. A slight uniform noise is not an indication of bearing failure and is not cause for rejecting the bearing. Sounds of large magnitude and non-uniform noises (clicks, etc.) are the most general characteristics in determining the unserviceability of bearings. Training and the use of shop standards is necessary for proper noise test use.

Hand Rotation

79 Anti-friction bearings having bore diameters over approximately 60 mm (2.36") will be inspected by the following procedure:

(a) Hold the bearing in one hand and apply pressure while slowly rotating the inner race with the other hand. The bearing should exhibit no roughness when rotated in this manner. Repeat this operation with the bearing reversed so that both sides of the raceways are tested. If roughness is indicated, recleaning is mandatory since dirt is the most common cause of roughness.

SECTION 5

MEASUREMENTS

PURPOSE

1 The purpose of this Section is to furnish dimensional tolerance on anti-friction bearings and to establish methods and procedures for obtaining proper measurements of such tolerances. This part established a precise definition of what is meant by the tolerances for bore and outside diameters and outlines instructions for making measurements of such tolerances.

2 It must be realized that it is seldom necessary to resort to actual measurement to determine serviceability of bearings. The forces which work to alter the original size will leave visual evidence of such alterations by scuffing, galling, burnishing, abrading or blueing. A few instances in which measurements are necessary includes sizing for selective fitting, identification of bearing with respect to external dimensions or internal clearance, component matching, and check of dimensions thought to be altered by use.

TABLES OF AFBMA STANDARD SPECIFICATIONS

3 AFBMA standard specifications are listed in the following Tables:

(a) Table 1 - ABEC 1 - RBEC 1 - Tolerances of Metric Annular Ball and Roller Bearings Except Magneto Bearings.

(b) Table 2 - ABEC 3 - RBEC 3 - Tolerances of Metric Annular Ball Bearings Except Magneto Bearings.

(c) Table 3 - ABEC 5 - Tolerances of Metric Annular Ball Bearings Except Magneto Bearings.

(d) Table 4 - ABEC 1 - Tolerances of Magneto Type Ball Bearings.

(e) Table 5 - ABEC 1 - Tolerances of Inch Type Ball Bearings.

(f) Table 6 - ABEC 3 - Tolerances of Inch Type Ball Bearings.

(g) Table 7 - ABEC 5 - Tolerances of Inch Type Ball Bearings.

(h) Table 8 - ABEC 7 - Tolerances of Metric Annular Ball Bearings Except Magneto Bearings.

METHOD OF PERFORMING MEASUREMENT OPERATION

4 The bores or outside diameters of the relatively thin hardened rings are not true cylinders in shape. When measuring with a 2-point gauge, different readings may be obtained in different locations. Such variations may not be discovered when using a round plug gauge. For instance, if the plug gauge for the upper bore limit does not enter, the bore may still be oversize an objectionable amount at some other point of the bore not reached by the gauge. In this way, an objectionable bearing may be passed. In another case, the Go Gauge may not enter, not because the bearing bore is too small on an average, but, because the ring has gone slightly out-of-round after the bore was ground. So long as the average diameter is within limits, that is, the bore circumference is correct, the minimum diameter due to this slight out-of-roundness should not be cause for rejection because when mounted on the shaft with a light press fit, the ring resumes its round shape.

5 Similarly, a slight oversize or undersize of outside diameter in one location, due to slight out-of-roundness, is not objectionable as the ring will take the shape of the housing under load.

6 The specifications herein include methods for measuring boundary dimensions and eccentricities for ball bearings, cylindrical and self-aligning roller bearing; also, parallelism of side, side run-out and groove parallelism with side for ball bearings made up to and including Specification ABEC 7. The tolerances applying to these measurements are shown in Tables 1 to 8 inclusive, with indication on each table of the specific bearing type to which the table is applicable.

7 The following are definitions for bearing measurements, inner and outer ring:

(a) Bore - For determining bore diameter use apparatus arranged for 2-point measuring. If out-of-roundness and taper exist in a particular bearing, a minimum diameter reading d_{min} and a maximum diameter reading d_{max} may be obtained. The bore diameter, dm, of the bearing in question is defined as the arithmetical average of these two readings, d_{min} and d_{max}. Large diameter rings with thin cross sections should be placed in a horizontal position when measuring, see Figure 2-15.

(b) Width of Inner Ring - The tolerances for width of the bearings apply to individual rings and not to the total width of the bearing. Outer ring is free and the inner ring that is to be measured is supported on one side by three buttons. Apply indicator against other side directly over one button and take reading while rotating the ring, see Figure 2-16.

(c) Parallelism of Sides - Parallelism of sides is the difference between the largest and smallest width. Outer ring is free and the inner ring that is to be measured is supported on one side by three buttons. Apply indicator against other side directly over one button and take reading while rotating the ring see Figure 2-16.

(d) Eccentricity - Mount bearing on arbor having a very slight taper (.0001 to .0002" on diameter per inch of length). Apply indicator on centre of stationary outer ring. The eccentricity is the difference between the minimum and maximum reading when rotating the arbor one revolution. Corrections must be made for the inaccuracy of the arbor, see Figure 2-17.

(e) Side Run-Out - Mount bearing on arbor having a very slight taper (.0001 to .0002" on diameter per inch of length). Apply indicator against side of inner ring. The side run-out is the difference between the maximum and minimum reading when rotating the arbor one revolution, see Figure 2-18.

(f) Groove Parallelism With Side - Mount bearing on arbor having very slight taper (preferably .0001 to .0002" on the diameter per inch of length). Support outer ring in horizontal position and apply indicator to side of inner ring. The groove parallelism with side is the difference between the maximum and minimum readings when rotating arbor one revolution, see Figure 2-19.

(g) Outside Diameter - For determining the outside diameter, use apparatus arranged for

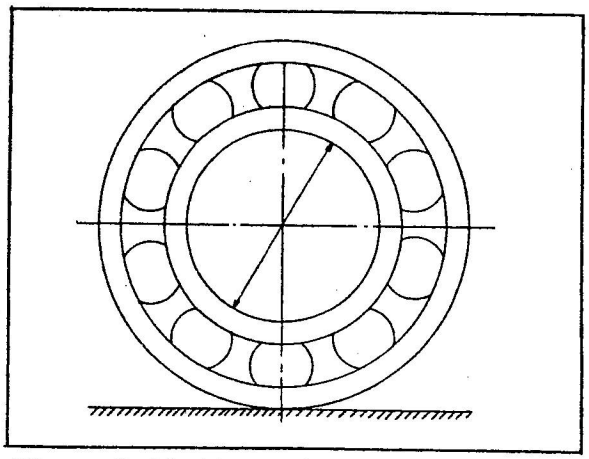

Figure 2-15 Measuring Bore Diameter

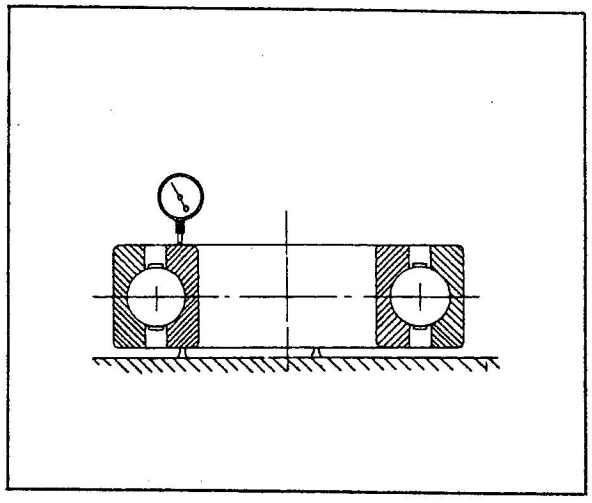

Figure 2-16 Measuring Width of Inner Ring

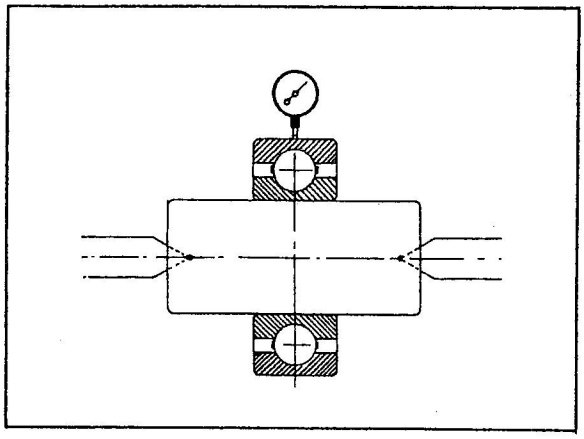

Figure 2-17 Eccentricity

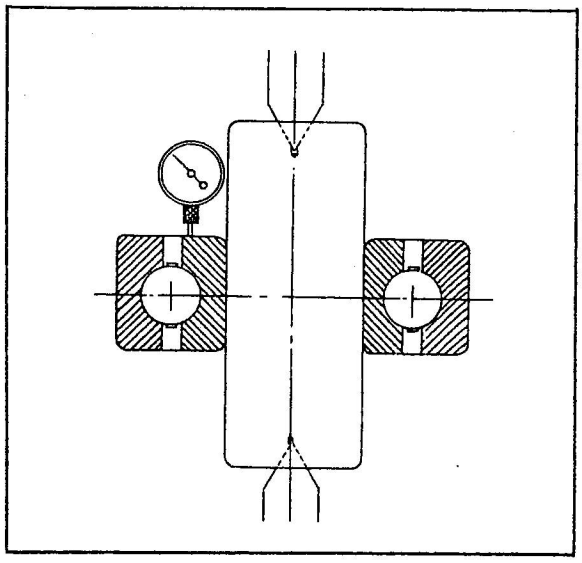

Figure 2-18 Side Run Out

measuring between a flat surface and a rounded indicator point. If out-of-roundness and taper exist in a particular bearing, a minimum diameter reading d_{min} and a maximum diameter reading d_{max} may be obtained. The outside diameter, dm, of the bearing in question is defined as the arithmetical average of these two readings d_{min} and d_{max}. When measuring thin section rings, the measuring pressure should be small so as to avoid distortion of the rings. Large diameter rings with thin sections should be placed in a horizontal position when measuring, see Figure 2-20.

(h) Width of Outer Ring - The tolerances for width of the bearings apply to the individual rings and not to the total width of the bearing. Inner ring is free and the outer ring that is to be measured is supported on one side by three buttons. Apply indicator against other size directly over one button and take reading while rotating the ring, see Figure 2-21.

(j) Parallelism of Sides - Parallelism of sides is the difference between the largest and smallest width. Inner ring is free and the outer ring that is to be measured is supported on one side by three buttons. Apply indicator against the other side directly over one button and take reading while rotating the ring, see Figure 2-21.

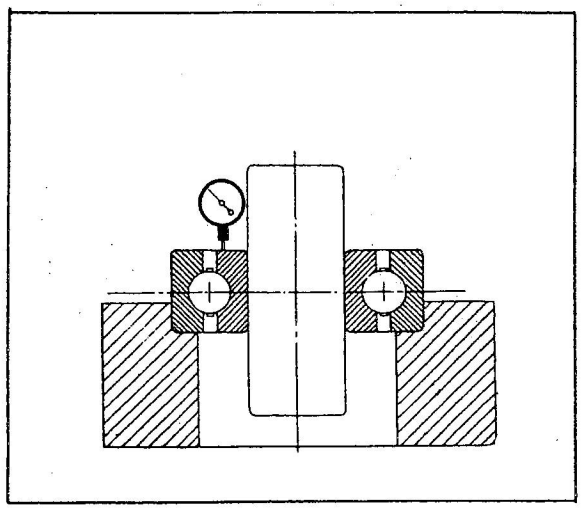

Figure 2-19 Groove Parallelism With Side

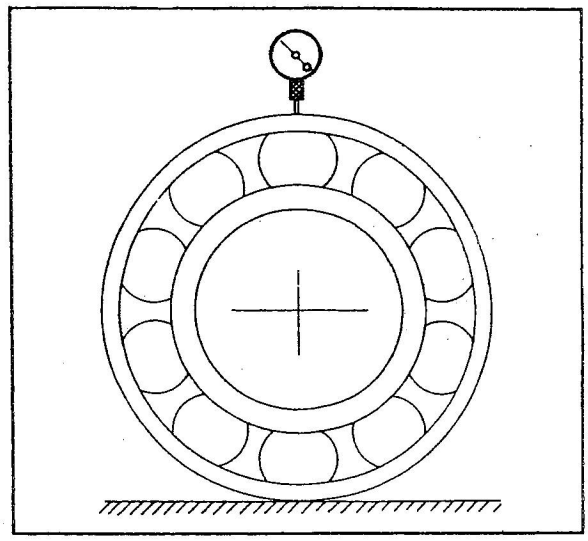

Figure 2-20 Measuring Outside Diameter

(k) Eccentricity - Mount bearing on arbor having a very slight taper (.0001 to .0002" on diameter per inch of length). Apply indicator on centre of outer ring. The eccentricity is the difference between the minimum and maximum reading when rotating outer ring one revolution with arbor stationary, see Figure 2-17.

(l) Groove Parallelism With Side - Mount bearing on arbor having a very slight taper (preferably .0001 to .0002" on the diameter per inch of length). Apply a true running weight to the outer ring. Support arbor in a vertical position and apply indicator to side of outer ring. The groove parallelism with side is the difference between the maximum and minimum reading when rotating outer ring one revolution, see Figure 2-12.

(m) OD Square With Side - One side of the outer ring to be supported on a flat plate of suitable dimensions (with inner ring free) and held against a stop located close to the lower corner of the outside diameter. The indicator is applied directly above the stop close to the upper corner of the outside diameter. OD square with side is the difference between the minimum and the maximum reading of the indicator when rotating the outer ring one revolution, see Figure 2-23.

INTERNAL FIT-UP WITHIN THE BEARING

8 Except for special bearings, the internal fit-up or radial and lateral looseness in anti-friction bearings does not have a uniform standard dimension for bearings manufactured by different contractors, however, all bearings are generally classified into one of the following groups:

(a) Standard Fit-Up - In this class, internal unmounted clearances to be of such magnitude that, as a result of the bearings' internal design, when mounted with standard ABEC fits for revolving shafts, the average radial clearances will be those best suited for single row annular bearing service.

(b) Loose Fit-Up - In this class, internal unmounted clearances to be of such magnitude that, as the result of the bearings' internal design, the bearings can accommodate heavier press fits, or when normal press fits are used, will have a small amount of radial clearance.

(c) Tight Fit-Up - In this class, internal unmounted clearances to be of such magnitude, that, as the result of the bearings' internal design, when mounted with standard ABEC fits for revolving shafts, the bearings' operating fit-up will be an actual preloaded condition.

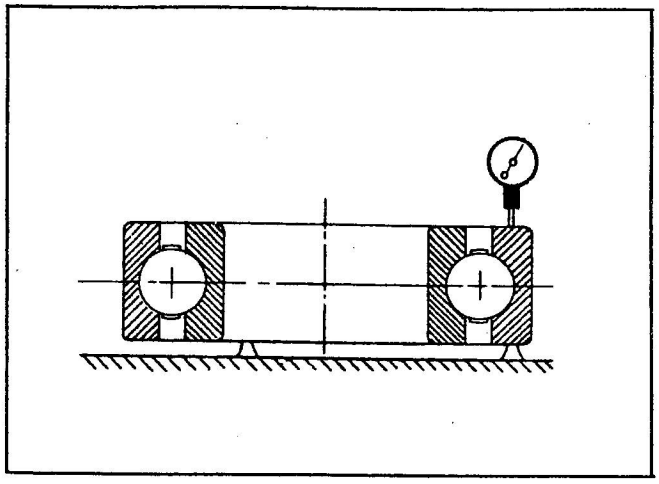

Figure 2-21 Measuring Width of Outer Ring

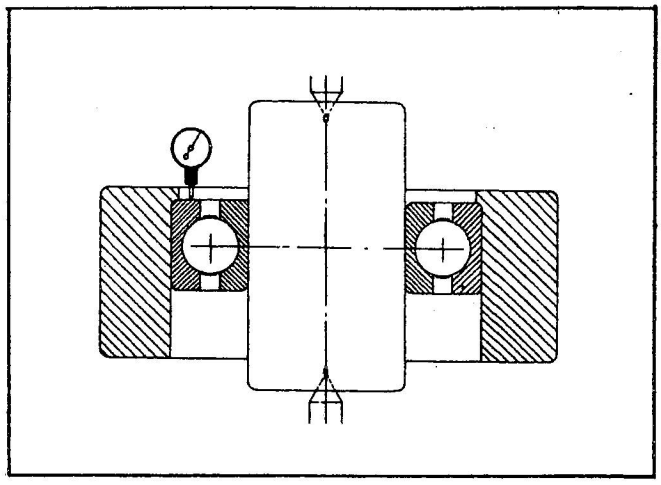

Figure 2-22 Groove Parallelism With Side

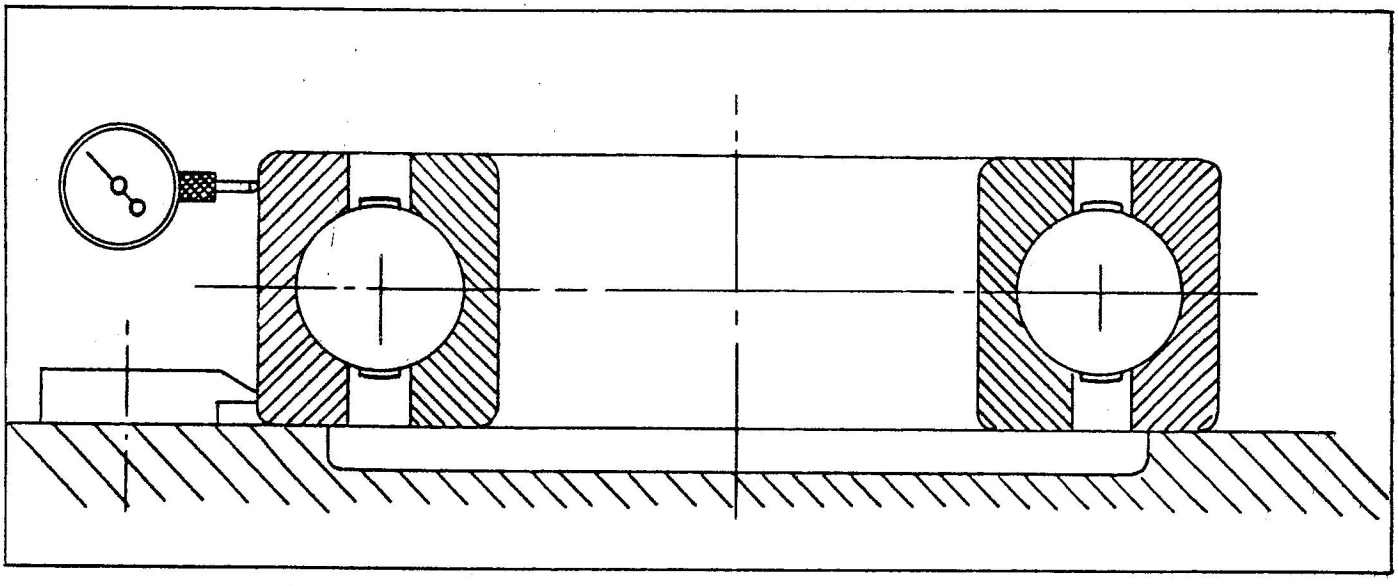

Figure 2-23 OD Square With Side

IDENTIFYING AND CLASSIFYING ANTI-FRICTION BEARINGS BEING OVERHAULED BY BEARING BRANCH

9 When anti-friction bearings are identified and classified by the Bearing Branch extreme care must be taken to classify such bearings correctly. The following example and information are submitted as a guide on the correct procedures in this matter:

(a) By referring to Table 9, the specifications of New Departure bearings, #C88504X1C and #C88504X3C, will be noted. Such specifications have been abstracted from the tables as covered by paragraph 3 of this Section. It will further be noted that these bearings are identically the same with the exception of bearing tolerances. In classifying the two example bearings so that the correct part numbers and stock numbers are applied, one of the following procedures will be followed.

(b) When an ABEC 3, ABEC 5, or ABEC 7 bearing is removed from an application and it is known that such an application requires a special tolerance bearing such bearings should be tagged with the correct part number and forwarded to the Bearing Branch for processing. During this procedure, the bearing will retain its identity and will be classified as an ABEC 3, ABEC 5, or ABEC 7, depending upon its original identity when it has met the inspection standards and has been declared serviceable.

(c) When a C88504 bearing is received in the Bearing Branch without proper identification with regard to its classification of tolerance, it will be classified as an ABEC 1 bearing. If it is desired, however, to check the high and low limits of bearing tolerances in accordance with instructions contained herein to ascertain the ABEC classification of the bearing, such checking may be accomplished and the bearing will then be identified as either meeting the ABEC 1, ABEC 3, ABEC 5, or ABEC 7, classification so that the correct part numbers can be assigned.

(d) From the foregoing, it will be noted that the C88504X1C and C88504X3C are not interchangeable and should be correctly identified so as to indicate the respective tolerances. Where emergency requirements exist, and an ABEC 3, ABEC 5, or ABEC 7 bearing may be substituted for an ABEC 1 bearing, but substitution of an ABEC 1 bearing for any other classification is not authorized.

PRESERVATION AND PACKING

General

10 Preservation and packing is to be accomplished in accordance with EO 75-10-17 and RCAF Specification - PACK 2-1, current issue.

TABLE 1

AFBMA STANDARD SPECIFICATION
ABEC 1 - RBEC 1
TOLERANCES OF METRIC ANNULAR BALL AND ROLLER BEARINGS
EXCEPT MAGNETO BEARINGS
TOLERANCES IN .0001"

INNER RING

BORE IN MM		TOL. FOR BORE				ECC.
		DM				
OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0	9	-3	+0	-4	+1	3
9	18	-3	+0	-4	+1	4
18	30	-4	+0	-5	+1	5
30	50	-5	+0	-7	+2	6
50	80	-6	+0	-8	+2	8
80	120	-8	+0	-11	+3	10
120	180	-10	+0	-13	+3	12
180	250	-12	+0	-16	+4	16
250	315	-14	+0	-18	+4	20
315	400	-16	+0	-20	+4	24
400	500	-18	+0	-23	+5	26

OUTER RING

O. D. IN MM		TOL. FOR OUTER DIAMETER				ECC.
		DM		DIA SERIES 2		
OVER	INCL.	HIGH	LOW	D MAX.	D MIN.	
0	18	+0	-4	+1	-5	6
18	30	+0	-4	+1	-5	6
30	50	+0	-5	+2	-7	8
50	80	+0	-5	+2	-7	10
80	120	+0	-6	+3	-9	14
120	150	+0	-8	+3	-11	16
150	180	+0	-10	+3	-13	18
180	250	+0	-12	+4	-16	20
250	315	+0	-14	+4	-18	24
315	400	+0	-16	+4	-20	28
400	500	+0	-18	+5	-23	32
500	630	+0	-20	+6	-26	40

BEARINGS OTHER THAN DUPLEX
WIDTH OF INDIVIDUAL
INNER OR OUTER RING

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	180	0	50
180	315	0	100
315	400	0	160
400	500	0	180
500	630	0	220

DUPLEX BEARINGS *
TOTAL WIDTH OF
INNER OR OUTER RINGS

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	80	0	200
80	180	0	300
180	315	0	400
315	400	0	500

* IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS

TABLE 2

AFBMA STANDARD SPECIFICATION
ABEC 3 - RBEC
TOLERANCE OF METRIC ANNULAR BALL AND ROLLER BEARINGS
EXCEPT MAGNETO BEARINGS
TOLERANCES IN .0001"

INNER RING

BORE IN MM		TOL. FOR BORE				
		DM				
OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	ECC.
0	9	-2	+0	-3	+1	2
9	18	-2	+0	-3	+1	3
18	30	-2	+0	-3	+1	3
30	50	-3	+0	-5	+2	4
50	80	-4	+0	-6	+2	4
80	120	-5	+0	-8	+3	5
120	180	-6	+0	-9	+3	6
180	250	-7	+0	-11	+4	8
250	315	-8	+0	-12	+4	10

OUTER RING

O. D. IN MM		TOL. FOR OUTER DIAMETER				ECC.
		DM		DIA SERIES 2		
OVER	INCL.	HIGH	LOW	D MAX.	D MIN.	
0	18	+0	-3	+1	-4	4
18	30	+0	-3	+1	-4	4
30	50	+0	-3	+2	-5	4
50	80	+0	-4	+2	-6	5
80	120	+0	-4	+3	-7	7
120	150	+0	-5	+3	-8	8
150	180	+0	-6	+3	-9	9
180	250	+0	-7	+4	-11	10
250	315	+0	-8	+4	-12	12
315	400	+0	-9	+4	-13	14
400	500	+0	-10	+5	-15	16

BEARINGS OTHER THAN DUPLEX
WIDTH OF INDIVIDUAL
INNER OR OUTER RING

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	180	0	50
180	315	0	100
315	400	0	160
400	500	0	180
500	630	0	220

DUPLEX BEARINGS *
TOTAL WIDTH OF
INNER OR OUTER RINGS

NOMINAL BORE INM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	80	0	200
80	180	0	300
180	315	0	400
315	400	0	500

*IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS

TABLE 3

AFBMA STANDARD SPECIFICATION
ABEC 5
TOLERANCES OF METRIC ANNULAR BALL BEARINGS
EXCEPT MAGNETO BEARINGS
TOLERANCES IN .0001"

INNER RING

BORE IN MM		BORE TOL.		ECC.	PARALLELISM OF SIDES	SIDE RUN-OUT WITH BORE	GROOVE PARALLELISM WITH SIDE
OVER	INCL.	D MIN.	D MAX.				
0	9	-2	+0	2	2	3	3
9	18	-2	+0	2	2	3	3
18	30	-2	+0	2	2	3	3
30	50	-2	+0	2	2	3	3
50	80	-3	+0	2	2	?	3
80	120	-3	+0	3	3	3	4
120	180	-4	+0	3	3	4	4
180	250	-5	+0	4	4	4	5
250	315	-5	+0	5	5	5	6

OUTER RING

O.D. IN MM		O.D. TOL.		ECC.	PARALLELISM OF SIDES	O.D. SQUARE WITH SIDE RUN-OUT	GROOVE PARALLELISM WITH SIDE
OVER	INCL.	D MAX.	D MIN.				
0	18	+0	-2	2	2	3	3
18	30	+0	-2	2	2	3	3
30	50	+0	-2	2	2	3	3
50	80	+0	-3	3	2	3	4
80	120	+0	-3	4	3	3	5
120	150	+0	-4	4	3	4	5
150	180	+0	-5	5	3	4	6
180	250	+0	-5	5	4	4	6
250	315	+0	-5	6	5	5	7
315	400	+0	-6	7	5	5	8
400	500	+0	-7	8	6	6	9

BEARINGS OTHER THAN DUPLEX
WIDTH OF INDIVIDUAL
INNER OR OUTER RING

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	180	0	50
180	315	0	100
315	400	0	160
400	500	0	180
500	630	0	220

DUPLEX BEARINGS *
TOTAL WIDTH OF
INNER OR OUTER RINGS

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	80	0	200
80	180	0	300
180	315	0	400
315	400	0	500

* IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS

TABLE 4

AFBMA STANDARD SPECIFICATION ABEC 1
TOLERANCES OF MAGNETO TYPE BALL BEARINGS
TOLERANCES IN .0001"

INNER RINGS						
BORE IN MM		BORE TOLERANCES				ECCENTRICITY
		DM				
OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0	9	-3	+0	-4	+1	3
9	18	-3	+0	-4	+1	4
18	30	-4	+0	-5	+1	5

OUTER RINGS						
O.D. IN MM		O.D. TOLERANCES				ECCENTRICITY
		DM				
OVER	INCL.	HIGH	LOW	D MAX.	D MIN.	
0	18	+4	-0	+5	-1	6
18	30	+4	-0	+5	-1	6
30	50	+5	-0	+7	-2	8
50	80	+5	-0	+7	-2	10

INNER AND OUTER RINGS		
BORE IN MM		WIDTH
ALL SIZES	INDIVIDUAL RINGS	+.000 TO -.005
	ASSEMBLED BEARINGS	+.005 TO -.005
	PAIR OF INNER OR OUTER RINGS DUPLEXED	+.000 TO -.020

NOTE: IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED IN DUPLEXING, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS.

TABLE 5

AFBMA STANDARD SPECIFICATION ABEC 1
TOLERANCES OF INCH TYPE BALL BEARINGS - SERIES S
TOLERANCES IN .0001"

INNER RINGS							
BORES IN INCHES INCLUSIVE	CORRESPONDING METRIC GROUPING		BORE TOLERANCES				ECCEN-TRICITY
			DM				
	OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0- 1/4	0	9	-3	+0	-4	+1	3
3/8- 5/8	9	18	-3	+0	-4	+1	4
3/4-1-1/8	18	30	-4	+0	-5	+1	5
1-1/4-1-1/2	30	50	-5	+0	-7	+2	6

OUTER RINGS							
O.D. IN INCHES INCLUSIVE	CORRESPONDING METRIC GROUPING		O.D. TOLERANCES				ECCEN-TRICITY
			DM				
	OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0- 5/8	0	18	+0	-4	-5	+1	6
3/4-1-1/8	18	30	+0	-4	-6	+1	6
1-3/8-1-7/8	30	50	+0	-5	-7	+2	8
2 -2-5/8	50	80	+0	-5	-7	+2	10

INNER AND OUTER RINGS
WIDTH OF INDIVIDUAL RINGS, ALL SIZES +0 TO -50
WIDTH OF PAIR OF INNER OR OUTER RINGS, DUPLEXED, ALL SIZES +0 TO -200

NOTE IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED IN DUPLEXING, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS.

TABLE 6

AFBMA STANDARD SPECIFICATION ABEC 3
TOLERANCES OF INCH TYPE BALL BEARINGS - SERIES S
TOLERANCES .0001"

INNER RINGS							
BORES IN INCHES INCLUSIVE	CORRESPONDING METRIC GROUPING		BORE TOLERANCES				ECCENTRICITY
			DM				
	OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0- 1/4	0	9	-2	+0	-3	+1	2
3/8- 5/8	9	18	-2	+0	-3	+1	3
3/4-1-1/8	18	30	-2	+0	-3	+1	3
1-1/4-1-1/2	30	50	-3	+0	-5	+2	4
OUTER RINGS							
O.D. IN INCHES INCLUSIVE	CORRESPONDING METRIC GROUPING		O.D. TOLERANCES				ECCENTRICITY
			DM				
	OVER	INCL.	HIGH	LOW	D MAX.	D MIN.	
0- 5/8	0	18	+0	-3	+1	-4	4
3/4-1-1/8	18	30	+0	-3	+1	-4	4
1-3/8-1-7/8	30	50	+0	-3	+2	-5	4
2 -2-5/8	50	80	+0	-4	+2	-6	5
INNER AND OUTER RINGS							
WIDTH OF INDIVIDUAL RINGS, ALL SIZES +0 TO -50 WIDTH OF PAIR OF INNER OR OUTER RINGS, DUPLEXED, ALL SIZES +0 TO -200							

NOTE: IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED IN DUPLEXING, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS.

TABLE 7

AFBMA STANDARD SPECIFICATION ABEC 5
TOLERANCES OF INCH TYPE BALL BEARINGS - SERIES S
TOLERANCES IN .0001"

INNER RINGS							
BORES IN INCHES INCLUSIVE	CORRESPONDING METRIC GROUPING		BORE TOLERANCES				ECCENTRICITY
			DM				
	OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0- 1/4	0	9	-3	+0	-4	+1	3
3/8- 5/8	9	18	-3	+0	-4	+1	4
3/4-1-1/8	18	30	-4	+0	-5	+1	5
1-1/4-1-1/2	30	50	-5	+0	-7	+2	6
OUTER RINGS							
O.D. IN INCHES INCLUSIVE	CORRESPONDING METRIC GROUPING		O.D. TOLERANCES				ECCENTRICITY
			DM				
	OVER	INCL.	LOW	HIGH	D MIN.	D MAX.	
0- 5/8	0	18	+0	-4	-5	+1	6
3/4-1-1/8	18	30	+0	-4	-5	+1	6
1-3/8-1-7/8	30	50	+0	-5	-7	+2	8
2 -2-5/8	50	80	+0	-5	-7	+2	10
INNER AND OUTER RINGS							
WIDTH OF INDIVIDUAL RINGS, ALL SIZES +0 TO -50 WIDTH OF PAIR OF INNER OR OUTER RINGS, DUPLEXED, ALL SIZES +0 TO -200							

NOTE IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED IN DUPLEXING, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS.

TABLE 8

AFBMA STANDARD SPECIFICATION ABEC 7
TOLERANCES OF METRIC ANNULAR BALL BEARINGS
EXCEPT MAGNETO BEARINGS
TOLERANCES IN .0001"

INNER RING

BORE		BORE TOL.		ECC.	PARALLEL-ISM OF SIDES	SIDE RUN-OUT WITH BORE	GROOVE PARALLEL-ISM WITH SIDE
OVER	INCL	D MIN.	D MAX.				
0	9	1-1/2	+0	1	1	1	1
9	18	1-1/2	+0	1	1	1	1
18	30	1-1/2	+0	1-1/2	1	1-1/2	1-1/2
30	50	2	+0	1-1/2	1	1-1/2	1-1/2
50	80	2	+0	1-1/2	1-1/2	2	1-1/2
80	120	2-1/2	+0	2	1-1/2	2	2
120	180	3	+0	3	2	3	3
180	250	4	+0	3	2	3	3

OUTER RING

O.D.		O.D. TOL.		ECC.	PARALLEL-ISM OF SIDES	O.D. SQUARE WITH SIDE RUN-OUT	GROOVE PARALLEL-ISM WITH SIDE
OVER	INCL.	D MIN.	D MAX.				
0	18	+0	2	2	1	1-1/2	2
18	30	+0	2	2	1	1-1/2	2
30	50	+0	2	2	1	1-1/2	2
50	80	+0	2	2	1	1-1/2	2
80	120	+0	3	2	2	2	2
120	150	+0	4	3	2	2	3
150	180	+0	4	3	2	2	3
180	250	+0	4	4	3	3	4
250	315	+0	5	4	3	3	4
315	400	+0	5	5	3	4	5

BEARINGS OTHER THAN DUPLEX
WIDTH OF INDIVIDUAL
INNER OR OUTER RING

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	180	0	50
180	250	0	100

DUPLEX BEARINGS *
TOTAL WIDTH OF
INNER OR OUTER RINGS

NOMINAL BORE IN MM		WIDTH TOLERANCE	
OVER	INCL.	+	-
0	80	0	200
80	180	0	300
180	250	0	400

* IF OTHER THAN A PAIR OF BEARINGS IS INVOLVED, THE TOLERANCE IS IN PROPORTION TO THE NUMBER OF BEARINGS.

TABLE 9

Specifications by New Departure Bearings
XC88504X1C and #C88504X3C

	C88504X1C					C88504X3C				
	DM		D	D		DM		D	D	
	LOW	HIGH	MIN	MAX	ECC	LOW	HIGH	MIN	MAX	ECC
BORE .7874"	-4	+0	-5	+1	5	-2	+0	-3	+1	3
O.D. 1.8504"	-4	+0	-5	+1	6	-3	+0	-4	+1	4
WIDTH INNER RING .6988"	-50	+0				-50	+0			
WIDTH OUTER RING .550"	-50	+0				-50	+0			

NOTE: ALL TOLERANCE IN .0001"

PART 3

TABLE OF CONTENTS

PRESERVATION CONTROL PROCEDURES AND TESTS

PRESERVATION CONTROL PROCEDURES AND TESTS

INTRODUCTION

1 This Section describes the procedures and tests determined appropriate and necessary to assure that the materials, equipment, procedures, techniques, and workmanship, employed in the preservation processing of anti-friction bearings and bearing parts, are maintained within specified limits and in accordance with sound industrial practices. The procedures and test described herein will provide accurate and adequate technical and historical data for detection and correction of unsatisfactory conditions and a reasonable reliance that the condition of bearings is of a quality that will satisfy all serviceability requirements.

2 The checking and testing required will be accomplished by adequately trained technical personnel at the intervals recommended, unless experience relative to the particular bearing shops and workloads indicates that greater frequency is required or reduced frequency is adequate.

3 Personnel records and historical data will be so maintained at the respective bearing shops so that they may be conveniently and completely cross referenced with work performed and described by the assigned "lot number" assigned as required in this Section.

CONTROL OF CLEANING SOLVENTS AND SOLUTIONS

Control of Hot Oil, Spec. 3-GP-60a, RCAF Ref. 34A/29, Bath or Soak (Viscosity Test)

4 Proceed as follows:

(a) Mechanical filters will be installed on all hot oil bath (or soak) tanks to remove solid contaminants five microns in size or larger and the entire contents of each tank will be cycled through the filter at least four times per hour during operation of the tank.

(b) The oil bath (or soak) will be maintained at 107°C. (225°F.) to 121°C. (250°F.).

Test Procedures

5 Test in the following manners:

(a) Draw approximately 100 ml samples of oil from each tank. The samples shall not be drawn from the surface of the bath or from the bottom of the tank. Samples shall be drawn only when the oil is being circulated through the filters.

(b) Allow the samples to come to room temperature 24 °C. (75 °F.) plus or minus 15 °C. (5 °F.)

(c) Fill a Gardner-Holdt sample tube to the lower of the two etched markings and fit with a cork stopper of suitable size so that the bottom of the cork is in line with the upper etched marking. Care must be exercised to exclude solid contaminants from the sample tubes.

(d) Invert the sample tube and the comparison standard tube to equalize the tubes.

(e) Re-invert the tubes and compare the rate of rise in the bubble in the sample tube with that of the standard tube.

(f) When the bubble speed of the sample reaches that of a Gardner-Holdt comparison standard tube "Y", the maximum allowable contamination has been reached and the oil is to be discarded and fresh material instituted in the respective tank or tanks.

Frequency, Records and Corrective Action Required

6 It is recommended that the above control test be performed on each oil tank twice during each eight-hour shift; preferably at the start and midpoint of each shift. The following information will be recorded:

(a) Date and time of performance of the testing.

(b) Identification of the respective tank (tank number) tested.

(c) Temperature of the oil at the time the sample was drawn.

(d) Results - "The time rate of bubble rise". If determined "unsatisfactory" use of the tank will be stopped and an entry will be made indicating the time the tank was actually stopped and the time the condemned oil was discarded and replaced.

(e) Identification of the technician who performed the test.

Control of Cleaner Fluid Spec. 3-GP-8, RCAF Ref. 33C/182

7 Mechanical filters will be installed on all process cleaning tanks to remove solids content to 5 microns in size. All solvent will be cycled through the filters at least four times per hour. The extent of control testing required for this solvent depends upon whether the continuous distillation or the batch distillation system of recovery is used.

Test Procedures

8 Test in the following manner:

(a) Neutrality test:

(1) Place 50 ml of the solvent and 15 ml of distilled water in a 250 ml flask.

(2) Warm to 66 °C. (150 °F.) and shake thoroughly.

(3) Allow to cool to normal room temperature 24 °C. (75 plus or minus 31 °C. (5 °F.) and transfer 5 ml of the aqueous layer to each of the two test tubes by means of a pipette.

(4) Add one drop of 0.1% methyl orange solution (1 g. methyl orange per 1000 ml distilled water) to one test tube and one drop of 1% phenolphthalein solution (1 g. phenolphthalein added to 50 ml of methyl or ethyl alcohol 50 ml distilled water) to the other.

(5) Report as ACID if colour turns red with methyl orange, as ALKALINE if red with phenolphthalein, and NEUTRAL if no colour change takes place in either.

(b) Contamination test:

(1) Place 100 ml of the solvent in a tared (weighed) porcelain evaporating dish.

(2) Evaporate to dryness of a steam bath under a fume hood.

(3) Cool in desiccator and reweigh dish and residues.

(4) Determine weight of residue by difference and record as grams per 100 ml of solvent.

Frequency, Records and Corrective Action Required

9 Samples will be drawn from individual tanks while filters are in operation. Never drain samples from the surface of the solvent or from the bottom of the tanks.

10 It is recommended that the determination for contamination be carried out twice during each eight-hour working shift; preferably at the start and midpoint; for each tank containing cleaner fluid Spec. 3-GP-8, RCAF Ref. 33C/182 when batch distillation is utilized. When the solvent is used for rinse operations, redistillation is required when the contamination exceeds 5 gr./100 ml of solvent. The amount of contamination of solvent used for wash purposes should not exceed 10 gr./100 ml solvent.

11 If a continuous distillation system is used, the testing may be reduced to once during each eight-hour working shift. If the amount of contamination exceeds 5 gr./100 ml of solvent, the frequency of redistillation must be increased. If the amount of contamination is less than 2 gr./100 ml of solvent, for economy of operation, the frequency of redistillation may be reduced.

12 The same frequency is recommended for the neutrality testing of solvent within the wash and rinse tanks or within the system. It is further recommended that each batch of newly procured or freshly distilled (when batch distillation is employed) solvent be checked for its neutrality before it is used.

13 All solvent will be replaced when tests detect an acid condition. The following information will be recorded:

(a) Date and time of performance of the testing.

(b) Identification of the respective tank (tank number) systems, batch tested.

(c) Results of the test (e.g. "Acidic", "Neutral", or "Alkaline" for the NEUTRALITY TEST and gr./100 ml solvent for the CONTAMINATION TEST). Out of control solvent will not be used and a record of the corrective action taken will be maintained.

(d) Identification of the technician who performed the tests.

Controls for Vapour Degreaser, Trichlorethylene (MIL-T-7003, RCAF Ref. 33C/163)

14 Draw a sample of approximately 250 ml of trichlorethylene from each vapour degreaser, taking care that the sample is not drawn from the surface of the solvent or from the bottom of the tank.

15 Process each sample through the following tests:

(a) Test for free chlorine content:

(1) Add 100 ml of the sample to 100 ml of freshly boiled and cooled distilled water in a 250 ml glass stoppered mixing cylinder.

(2) Add 1.0 ml of a 10% aqueous solution of potassium iodide and a 0.5 ml of a 1% starch solution to the cylinder and shake for two minutes.

(3) The presence of a blue colour in the aqueous layer indicates the presence of free chlorine.

(b) Contamination test:

(1) Prepare capillary tubes approximately two inches in length, sealed off at point approximately 1/4" from one end.

(2) Place 3 ml of the solvent in a small test tube (approximately 10 mm diameter x 75 mm long).

(3) Attach a capillary tube to a thermometer and place in the test tube so that the bulb and capillary are near the bottom.

(4) Suspend the assembly in a water bath and heat until a steady stream of bubbles emerges from the capillary tube.

(5) Remove from the heated water bath and cool slowly while agitating the bath.

(6) Record the temperature at which the last bubble emerges from the capillary and before the liquid rises in the tube.

(7) The boiling (vapourizing) temperature for new trichlorethylene will be 87°C. (188.8°F.). The maximum allowable is 92°C. (198.2°F.). When a temperature in excess of 92°C. (198.2°F.) is detected, the trichlorethylene will be replaced or redistilled.

(c) Acidity - Alkalinity (neutrality) test:

(1) A 25 ml sample shall be placed in a 250 ml beaker containing 75 ml of freshly boiled and cooled distilled water.

(2) The solution shall be mechanically stirred while the pH value is determined by using a suitable pH meter employing a glass and a calomel electrode.

(3) Depending upon whether the initial pH is above or below the neutral value 7, the solution shall be titrated with 0.01N hydrochloric acid or 0.01N sodium hydroxide, respectively, until the neutral value of 7.0 plus or minus 0.3 persisting for thirty seconds, is attained.

(4) The acidity or alkalinity will then be calculated as follows:

$\frac{a(0.00146\ A)}{(\text{Spec Grav of Sol})}$ = % acidity; where "A" is ml of 0.01N NaOH required to neutralize the 25 ml sample

$\frac{b(0.0016\ B)}{(\text{Spec Grav of Sol})}$ = % alkalinity; where "B" is ml of 0.01N HCL required to neutralize the 25 ml sample

Allowable Limits for Control Tests

16 Trichlorethylene is out of control and corrective action is required when the following conditions are found to exist:

(a) Free Chlorine Content: There shall be no evidence of free chlorine present.

(b) Non-Volatile (contaminant) Content: Not more than 30% by weight of non-volatile matter shall be present.

(c) Alkalinity-Acidity: The acidity of the material shall not exceed 0.02% by weight when calculated as hydrochloric acid.

Frequency

17 It is recommended that a determination of free chlorine be made once per eight hours of degreaser operation.

Records

18 Adequate records shall be maintained showing the identification of the degreaser; the date, time and test results for each of the control tests; identity of the technician performing the tests, and the corrective action.

Control of Cleaning Compound, Finger Print Removing (MIL-C-15074, RCAF Ref. 34A/211)

19 There is no practicable analysis procedure for this solvent. The two checks considered adequate for determination of its usability are given below:

(a) Visual examination of the Finger Print Removing Conpound:

(1) Draw an amount of compound from tank into a clean test tube and visually examine for cloudiness and/or separation. If cloudiness or separation is evident the compound is no longer usable and must be replaced.

(b) Rinsability of Finger Print Remover Compound:

(1) Periodic visual checks shall be made of representative samples of bearings to determine if the compound is rinsed away by Cleaner Fluid, Spec. 3-GP-8, RCAF Ref. 33C/182. Retention of any of the compounds cannot be tolerated and will appear on bearing surfaces as smudges. If bearing surfaces are not rinsed, clean by Cleaner Fluid, Spec. 3-GP-8, RCAF Ref. 33C/182, the compound must be replaced.

Frequency and Records

20 It is recommended that the visual examination for cloudiness be accomplished at the start of each eight-hour working shift, for each tank containing compound MIL-C-15074.

21 It is recommended that the check for rinsability be accomplished at the start and mid-point of each eight-hour working shift.

22 Adequate records will be maintained for each tank showing date of tests, results, identification of technician making the checks and any corrective action taken.

CONTROL OF PACKAGING

23 To ensure that the can closing and the bag sealing is adequate, a "quick leak test" will be performed by activities accomplishing long-term storage packaging of anti-friction bearings.

24. The "quick leak test" is designed to detect any leaks in the can closures or bag seals. It is recommended that the "quick leak test" be performed twice during each eight-hour working shift; preferably near the start and mid-points. The test should include one-half of one percent (0.5%) of all packages (but never less than ten, or more than thirty packages).

25 The "quick leak test" is to be made before the individual packages are over-packaged in any way.

26 Make the "quick leak test" by cooling a completed package to 10°C. (50°F.), or lower, and then immersing it in warm water and observing for air bubbles. The water should not be above 37.8°C. (100°F.). The object is to create a light pressure within the package and force air through any holes or slits. Do not immerse packages more than an inch under the water surface, and observe each side or face of the package by rotating it to a position just under and parallel to the water surface. Immersion of a package to a depth greater than one inch may create enough water pressure on the package to drive water into the package through any existing leaks and prevent the appearance of air bubbles. Also, leaks in a side or face of the package not just under the surface will not show, due to greater water pressure at greater depths, therefore, it is necessary to rotate each face parallel to and just under the water surface. Leave packages in cooling boxes long enough to cool them to the desired temperature and quickly transfer to water so that packages do not warm up during the transfer. Observation of each face should be short (5 to 10 seconds) so that not all the air pressure in the package will be lost through one leak, and thus fail to reveal other possible leaks. Whenever there is doubt as to the presence of pressure throughout the leak test; recool the package and repeat the immersion and the rotation to the other faces.

27 If any leaks are detected, a second sampling of twice the quantity will be subjected to the "quick leak test". If any leaking packages are found within the second sampling, the entire lot of all packages involved, or suspected of including similar leakers, will be opened and the bearings will be appropriately reprocessed and repackaged.

CORROSION CONTROL

28 To provide reasonable assurance that the using activities receive anti-friction bearings that are free of deterioration from corrosion or other damage resulting from inadequate protection during storage, a percentage check will be made prior to shipment. Since closed-

type bearings are not unit packaged for long-term storage, only the open-type bearings are involved in the checking recommended. Open-type bearings and bearing parts, preserved for long-term storage using method 1A-8 and having a processing date more than two years prior to the shipping date, will be checked as follows:

(a) Two percent of the quantity being prepared for shipment (but no fewer than ten bearings unless the requisition if for less than ten) will be opened. The bearings will be cleaned as described in Section 3, and inspected for corrosion, physical damage, and all other defect that might detract from serviceability. If two percent or less of the sample is unserviceable the entire quantity will be passed as adequately preserved.

(b) If more than two percent are found unserviceable, a second sample of ten percent of the quantity being prepared will be checked in the same manner. If less than two percent of the second sample is unserviceable, the entire lot will be passed as adequately preserved.

(c) If more than two percent of each second sample is unserviceable, the entire quantity will be inspected and reprocessed.

(d) Bearings and bearing parts unpackaged for inspection will be appropriately reprocessed.

29 Open-type bearings and bearing parts preserved for long-term storage using method 1A-6 need not be checked in the manner described above.

GENERAL SURVEILLANCE

30 In addition to ascertaining the adequacy of specified materials and equipment, inspectors will establish and conduct a program of progressive inspection during which at least twice during each eight-hour working period, representative samples of bearings will be spot inspected to evaluate such conditions as: cleanliness, lack of magnetism, comparison with acceptance and rejection standards, lubrication, preservative, identification, packaging, etc.