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MILITARY STANDARD

PROCESS FOR BARRIER COATING OF ANTI-FRICTION BEARINGS

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DEPARTMENT OF DEFENSE
WASHINGTON, DC 20361

PROCESS FOR BARRIER COATING OF ANTI-FRICTION BEARINGS

MIL-STD-1334B

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

The purpose of barrier film coating is to prevent migration of lubricating oil from bearings by rendering selected bearing surfaces unwettable to oil. Applying a thin but integral barrier film to inner and outer bearing ring faces and shields will keep a metered amount of oil lubricant inside the bearing both in operational use and during shelf storage.

Mechanically, the barrier film coating substitutes a very low surface energy interface of barrier film-to-air (10.6 dynes/centimeter) for the normally very high surface energy of steel-to-air (1200 dynes/cm). This renders the easily wettable steel surface nonwettable to a material with a higher surface energy value such as a synthetic diester oil (with a surface tension of 28 to 32 dynes/cm).

Chemically, barrier film consists of a fluoropolymer (poly-1H-1H, pentadecafluorooctylmethacrylate) in solution with a volatile carrier solvent so that polymer deposition can be accomplished by evaporation.

Barrier film coating also appears to be potentially useful in a much wider variety of non-bearing applications, e.g., protection of electrical contacts against lubricant contamination.

CONTENTS

FIGURES

1. SCOPE

1.1 This standard specifies the basic requirements for the application of barrier coatings to anti-friction bearings for the purpose of preventing lubricant loss by surface migration and spreading during storage and in service.

2. REFERENCED DOCUMENTS

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

STANDARDS

FEDERAL

FED-STD-209	- Clean Room and Work Station Requirements, Controlled Environment

SPECIFICATIONS

FEDERAL

QQ-S-763	- Steel Bars, Wire, Shapes and Forgings, Corrosion-Resisting

MILITARY

MIL-B-81705	- Barrier Materials, Flexible, Electro-Static Free, Heat Sealable.
MIL-B-81744	- Barrier Coating Solution, Lubricant Migration Detering
MIL-B-81793	- Bearing, Ball Precision, For Instruments and Rotating Components

3. DEFINITIONS (Not applicable)

4. GENERAL REQUIREMENTS

4.1 Contamination by barrier-coating. Since barrier coated surfaces cannot be lubricated, all precautions necessary to prevent the spread of barrier coating material to unwanted areas shall be exercised. Particular attention shall be given to maintaining cleaning solutions free of barrier coating material and to avoiding its accidental application to the working surfaces of bearings.

4.2 Toxicity of barrier coating solution and solvent. The toxic properties of the barrier coating and solvent have not been fully established. Adequate ventilation to avoid inhalation of vapor shall be provided.

5. DETAIL REQUIREMENTS

5.1 Facilities. Work areas for the cleaning of barrier coated bearings and for the removal or application of barrier coatings shall be isolated from all other types of bearing processing and handling operations. To avoid cross contamination of other bearing work areas, the tools and solvent systems shall be segregated from general use and never be returned to stock or moved out of the isolated barrier coating work area. All processes described in this Standard shall be performed in a clean environment meeting the requirements for Class 100 of FED-STD-209. A laminar flow clean work space has proven to be a suitable site for the successive steps required for barrier coating.

5.2 Materials.

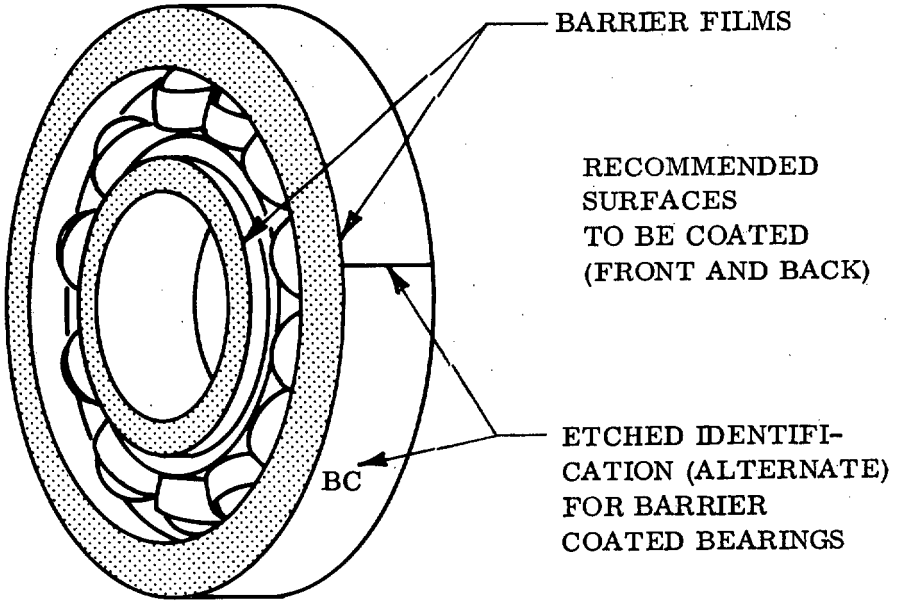
5.2.1 Barrier coating materials. The barrier coating solution shall conform to MIL-B-81744. The solution is supplied as a 0.18 ± 0.005 percent by weight solution of a fluoromethacrylate polymer (1H, 1H pentadecafluorooctylmethacrylate) in a fluorochemical solvent. It air dries to a thin film with a critical surface tension of wetting of 10.6 dynes per centimeter; it will not be wet by liquids with higher surface tensions. Coatings of this polymer are chemically inert and have a useful temperature range of -148° F (-100° C) to 347° F (175° C). Pre-application dilution and dilution to control increases of polymer concentration are not permitted. Use fresh solution to insure obtaining acceptable films.

5.2.2 Cleaning solvents. Unless otherwise specified in the contract, order or other document invoking this Standard, cleaning solvents shall be in accordance with best commercial practice.

5.3 Pre-coating processing.

5.3.1 Marking. Barrier coated bearings shall be permanently identified with the letters "BC" etched on the outer ring periphery, except that bearings whose small size (less than 0.1250 inch (3.18 mm) outside diameter or less than 0.046 inch (1.17 mm) width) makes such marking impractical shall be marked with a single etched line (0.020 inch (0.51 mm) wide maximum) on the outer ring periphery in a direction parallel to the bore axis, as shown in Figure 1. Marking shall be accomplished prior to cleaning in preparation for barrier coating.

5.3.2 Cleaning. Surfaces to be barrier coated shall be absolutely clean. Cleaning of items (bearing and bearing parts) to be barrier coated shall be in accordance with best commercial practice unless otherwise specified in the contract, order or other document invoking this Standard, except that the requirements of this Standard shall be complied with and in case of conflict, shall prevail.



THE SEALS AND SHIELDS SHOULD BE DIPPED IN THE BARRIER FILM MATERIAL AND OVEN CURED BEFORE ASSEMBLY

FIGURE 1. Typical barrier film application areas and identification of barrier coated bearings (See 5.3.1 and 5.4.5)

5.3.2.1 Bearing disassembly. All snap rings and shields shall be removed prior to cleaning.

5.3.2.2 Contamination and corrosion control. Surfaces to be barrier coated shall not be touched or otherwise contaminated during or after the final cleaning; cleaned items shall be protected against all forms of contamination and corrosion until the barrier coating and lubricant are applied.

5.3.2.2.1 Contaminating material. All cleaning systems and solvent shall be maintained free of silicones and barrier coating material. Items to be barrier coated shall not be cleaned in systems or with solvents which have been exposed either to silicones or barrier coating material or to items which have at any time been barrier coated or lubricated with silicones.

5.3.2.3 Cleaning of uncoated items. Items which are free of barrier coating material may be cleaned in either fluorinated or nonfluorinated solvents.

5.3.2.4 Removal of barrier coating. Removal of unacceptable, old or damaged barrier coatings from bearings is difficult. There is also the possibility that dissolved barrier coating may spread to unwanted areas. Therefore, defective, old or damaged barrier coatings on bearings shall not be removed. A new bearing shall be used.

5.4 Barrier coating application. There are several methods and devices which have been developed for the application of barrier coatings. The actual method to be employed is optional, provided it is consistent with the requirements of this Standard.

5.4.1 Silicone lubricated bearings. Bearings which have been previously lubricated with silicone oils or greases shall not be barrier coated. Such lubricants cannot be completely removed by solvents or any other practical procedure. Silicone residues will interfere with the adhesion of barrier coatings and with the wetting of the working surfaces of bearings by other types of lubricants.

5.4.2 Items previously barrier coated. Items, other than bearings, previously barrier coated and cleaned may be re-used if the coating is continuous, undamaged and has not spread to unwanted areas (see 5.4.5).

5.4.3 Disassembled bearings and bearing parts. Seals and shields which have been removed from bearings and cleaned separately, shall be barrier coated prior to reassembly.

5.4.4 Barrier coating thickness. The thickness of the barrier coating shall be no greater than 0.25 micron (9.84×10^{-6} inch). Films of greater thickness are increasingly subject to peeling and abrasion. An acceptable film is blue-brown to oblique light.

5.4.5 Bearing surfaces to be barrier coated. Figure 1 indicates surfaces required to be coated in order to control lubricant loss from a ball bearing of typical configuration. The coating shall not be applied to race lands, separators, balls, ball grooves or to any bearing surface requiring lubrication.

5.4.6 Barrier coating solution handling. All precautions and procedures necessary to prevent contamination of the barrier coating solution, either during or prior to its actual application to the items shall be observed. If portions of the barrier coating solution are withdrawn from the original container for storage in other containers, the latter shall be clean glass containers with ground glass cap or continuous thread cap with non-reactive liner. Portions of barrier coating solution withdrawn from the original container shall not be returned to the original container, in order to avoid the possibility of contaminating the bulk supply.

5.4.7 Barrier coating solution concentration. Barrier coating solution shall be applied at a concentration of 0.175 to 0.50 percent by weight of fluoromethacrylate polymer in the fluorochemical solvent. Concentrations in excess of 0.5 percent will make application difficult and result in skipped areas and excessive coating thickness. Although the evaporation rates of the solvent from the applicator surfaces will vary, it has been observed that in general a solution of 0.18 percent concentration at the start of a work day will remain at an acceptable concentration throughout that day.

5.5 Post-coating processing.

5.5.1 Handling. All handling and storage prior to final packaging of barrier coated items (including their installation in components) shall be accomplished in a manner which will prevent physical damage to and contamination of the coating. Tweezers designed to grip the uncoated outer or inner ring circumference, plastic-tipped tools and plastic containers are recommended to minimize the risk of mechanical damage. Contamination of the barrier coating by fingerprints or other substances will compromise its oil retention capability. Personnel handling items shall wear non-contaminative gloves or finger cots consistent with clean room requirements of 5.1.

5.5.2 Bearing assembly. Bearings which have been disassembled shall be reassembled after application of the barrier coating and prior to lubrication. All barrier coated, shielded bearings shall be lubricated after installation of one shield and snap ring set, but prior to installation of the second.

5.5.3 Lubrication. Lubrication, including separator impregnation, shall be as specified in the contract, order or other document invoking this Standard such as MIL-B-81793.

5.5.4 Preservation-packaging and marking. Preservation-packaging and marking shall be as specified in the contract, order or other document invoking this

Standard. Unless otherwise specified, barrier coated bearings shall be individually packaged in ultra-clean, anti-static bags meeting the requirements of MIL-B-81705 Type II and marked "Barrier Coated".

5.5.5 Installation. Installation of barrier coated bearings in components and equipment shall be accomplished in a manner which precludes the formation of paths which will defeat the purpose of the barrier coating. Any uncoated surface such as a shim or cement squeeze-out, which bridges the coating and contacts the lubricant, will offer a path for lubricant migration.

5.6 Process control. The following tests are intended to provide a continuing check on cleaning, barrier coating application and suitability of barrier coating solution used. Tests shall be performed as often as is considered necessary to ensure continuing compliance with the requirements of this standard, but not less often than specified herein.

5.6.1 Cleaning. All items being cleaned together as a group, in preparation for barrier coating, shall be accompanied throughout the entire cleaning process by a steel test panel prepared in accordance with 5.6.1.1. The panel shall be cleaned in the same manner, with the same solvents, and otherwise be exposed to the same conditions, as the group it accompanies. A group shall be barrier coated only after conformance of the test panel which accompanies it with the requirements of 5.6.1.1 has been established. If the panel fails to conform, the group represented shall either be discarded or recleaned. The same test panel shall accompany the group through all recleaning operations and shall be retested in accordance with and conform to the requirements of 5.6.1.1 prior to barrier coating of recleaned group represented.

5.6.1.1 Surface cleanliness test. A finish ground panel of stainless steel conforming to Class 302 or 304 of Specification QQ-S-763 shall be abraded under running tap water with No. 600 waterproof silicon carbide paper and detergent until a random pattern has replaced the original grinding marks. The panel shall then be flushed with distilled water to remove all traces of abrasive and detergent. There shall be no area of test surface on which water tends to bead or draw up into droplets or pools. The panel, while still wet with water, shall be flushed with reagent grade acetone. (Proof of the required degree of acetone purity can be established by flushing a clean panel with acetone, drying and then conducting the above water-break test.) The panel shall then be dried and cleaned with the group of items represented. After completion of the cleaning process, the panel shall be dried and again flushed with distilled water. Formation of beads or pools of water on the test area shall constitute a failure and the group of items represented shall be rejected or recleaned.

5.6.2 Barrier coating application.

5.6.2.1 Sampling for tests. Representative samples shall be selected from each batch of coated items. A batch shall consist exclusively of similar items (e.g.,

all shields or all seals) coated consecutively by the same line (i.e., the same applicator or dipping container and associated equipment). Unless otherwise specified in the contract, order, or other document invoking this Standard, the number of items in a batch shall be no more than 10 percent of the number being procured under contract or order, except that a batch shall not exceed 100 items. In order to minimize rejects, it is recommended that the manufacturer or processor keep batch sizes to the minimum practicable, until experience indicates relaxation of the testing schedule is warranted.

5.6.2.2 Coating presence and continuity. Two samples shall be selected, one at random from that portion of the batch first coated and one at random from the portion of the batch last coated. The samples shall be sprayed by an atomizer with the oil to be used in lubricating the bearing or, in the case of a bearing to be grease lubricated, with an oil which is compatible with that grease. All applicable surfaces of the sample shall be examined under a 10x binocular microscope and the location of wetted and non-wetted areas noted. A non-wetted area (indicative of the presence of barrier coating material) will be characterized by a tendency for the oil to stand in beads, whereas wetting (indicative of the absence of barrier coating material) will be characterized by an even film of oil without beading. Absence of coating from surfaces required to be barrier coated, or a discontinuous coating containing "skips" or holidays, or the presence of coating on the working surfaces of bearings (including lands, races and balls), shall constitute a failure. If either sample fails, either the batch shall be rejected or items in the batch shall be individually tested for conformance with this requirement. Items which are acceptable may be sprayed with an appropriate solvent to remove the oil and returned to the line. Defective items shall be discarded. Production shall be discontinued on evidence of the first failure and shall not be resumed until the cause of the discrepancy has been corrected, as evidenced by repetition of the above test on an item coated subsequent to introduction of the corrected procedure.

5.6.2.3 Coating adhesion and thickness. Two samples shall be selected (appropriate samples tested in accordance with 5.6.2.2 may be used) at random from that portion of the batch most recently coated and examined under a 10x binocular microscope. Holding the item by its outer circumference, manipulate it so that its coated face is obliquely illuminated by fluorescent light. Attempt to lift or peel the coating with a blunt-tipped needle by lightly pushing the tip through the coating. If the coating can be easily peeled or displaced, it shall be considered a failure. If both samples fail, either the batch represented shall be rejected or additional samples shall be selected and tested. In the latter case, if 3 consecutively coated samples pass, only that portion of the batch coated prior to those 3 samples shall be accepted. Tested samples and rejected items shall be discarded or reprocessed. Production shall be discontinued upon evidence of the second failure and shall not be resumed until the cause of the difficulty has been corrected, as evidenced by repetition of the above test on an item coated subsequent to introduction of the corrected procedure. Possible sources of difficulty include excessive coating thickness resulting from too high a solution concentration or inadequate cleaning of the substrate.

5.6.2.4 Heat curing. All batches of coated items shall be heat cured at 200 ±5° F (93 ±3° C) for at least fifteen (15) minutes.

5.6.3 Barrier coating solution.

5.6.3.1 Concentration. Whenever fresh solution has been added to an applicator reservoir or dipping container, but in no case less than once every calendar day of production, concentration of the barrier coating solution shall be determined by the following procedure: Weigh a measured volume of solution from each applicator reservoir or dipping container in a tared, clean, dry beaker. Allow the solvent to evaporate. Weigh the residue, then calculate the percent by weight of polymer. If the concentration is outside the allowable range, production shall be discontinued until the solution has been replaced by a fresh solution having a concentration within the allowable range. If any determination indicates a barrier coating solution concentration in excess of 0.40 percent, including all items coated in that line subsequent to the previous determination indicating a satisfactory concentration of solution, are suspect. Items deemed satisfactory by virtue of being in batches previously sampled and tested in accordance with 5.6.2.2 and 5.6.2.3 are excluded from the suspect group. For purposes of this requirement, the suspect group shall be considered a batch; its acceptability shall be determined in accordance with 5.6.2.2 and 5.6.2.3.

Custodians
Army - MU
Navy - AS
Air Force - 85

Review interest
Army - AV, EL, MI
Navy - SH, OS, EC
Air Force - 11, 17, 84

DSA - IS

Preparing activity
Navy - AS
(Project No. 3110-0491)

APPENDIX A

10. PURPOSE

10.1 The purpose of this Appendix is to provide materials and methods used in applying barrier film coating to anti-friction bearings.

10.2 The cleaning and/or application method selected shall be used in its entirety and shall not be changed in any way.

20. REFERENCED DOCUMENTS

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

SPECIFICATIONS

FEDERAL

O-A-51	-	Acetone, Technical
P-D-680	-	Dry Cleaning Solvent

MILITARY

MIL-B-131	-	Barrier Material, Water Vaporproof, Flexible
MIL-D-6998	-	Dichloromethane, Technical
MIL-C-81302	-	Cleaning Compound, Solvent Trichlorotrifluoroethane
MIL-T-81533	-	Trichloroethane, Technical

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

30. SPECIAL TOOLS AND TEST EQUIPMENT

30.1 Class 100 laminar flow work bench or equal clean room; temperature and humidity controlled to 72 $\pm$3° F (22 $\pm$2° C) and 40 $\pm$5 percent relative humidity.

30.2 Draftsman pen (cottonswab holder).

30.3 Porous Teflon-tipped applicator with micrometer setting hypodermic syringe.

30.4 Blotter applicator with pressurized fluid flow system.

30.5 Bearing handling tweezers.

30.6 Triceps, Model No. T-4.

30.7 Storage oven at 110 ±5° F (43 ±3° C).

30.8 Curing oven at 200 ±5° F (93 ±3° C).

30.9 Drying table rack, reversible.

40. CLEANING EQUIPMENT

40.1 Non-automatic Cobehn Cleaner Model B17-2SLQ, or equivalent.

40.2 Automatic Cobehn Cleaner Model 10-20BC-2S, or equivalent.

40.3 Bench type vapor degreaser designed to use MIL-C-81302 solvent.

40.4 Filtering apparatus (Millipore or equivalent).

40.5 Ultrasonic cleaner, Acoustica Model AS350 or equivalent.

50. SPECIAL MATERIALS

50.1 Barrier film conforming to MIL-B-81744. FC723 available from Minnesota Mining and Manufacturing Co., St. Paul, Minnesota or equivalent.

50.2 Precision cleaning solvent conforming to Type I, MIL-C-81302 (trichlorotrifluoroethane) clean room grade double filtered.

50.3 Degreasing solvent conforming to MIL-T-81533 (methyl chloroform) clean room grade particle count controlled and pre-filtered through a 0.45 micron filter.

50.4 Acetone (CP grade) conforming to O-A-51.

50.5 "Cobehn" (or equivalent) spray clean solvent.

50.6 Filtered-clean cleaning solvent conforming to Type A of MIL-D-6998, (dichloromethane).

50.7 Packaging material, intimate wrap, ultra-clean, anti-static polyethylene bags conforming to MIL-B-81705.

50.8 Non-ammoniated waterless watch cleaning solution, "L&R 222" or equivalent.

50.9 Acid washed filter paper or lintless watch paper.

50.10 Stoddard solvent conforming to P-D-680.

50.11 Paper backed foil bags conforming to MIL-B-131.

60. PREPROCESSING PROCEDURES

60.1 History. All bearings to be barrier coated shall have been cleaned in the normal precision bearing production cleaning facilities, visually inspected, dimensionally inspected and torque tested as specified by the procurement document.

60.2 Marking. With a typed stencil, electroetch "BC" on each bearing on the outer diameter. If the bearing is too small to accommodate the letters, etch a line across the bearing on the outer diameter.

60.3 Final cleaning procedures

60.3.1 Bearings to be barrier film coated must be subject to additional cleaning steps in order to prepare the surface for the coating process. Cleaning procedures for separable and non-separable bearings are different due to construction.

60.3.2 Cleanliness of the surfaces to be coated is important to barrier film adhesion. The cleaner the surface, the tighter the film will bond to it. It is necessary to follow closely the specified cleaning procedures to insure a clean bearing.

NOTE

When automatic spray units are not available, hand spray units incorporating air filters, pressure regulators, air heaters and high velocity, finely atomized spray patterns shall be used; however, the automatic bearing cleaner is preferred because of its controlled oscillatory mode of operation.

CAUTION

Aluminum, magnesium, and zinc are destructive catalysts for all chlorinated solvents mentioned herein. Hydrochloric acid or reacted metallic chlorides will produce corrosion of bearing metal if aluminum, magnesium or zinc are present during cleaning.

60.4 Final cleaning of non-separable bearings - Batches of one size non-separable instrument bearings will be limited to a number convenient to handle and will be cleaned by one of the following methods.

60.4.1 Method I

60.4.1.1 Ultrasonically clean each bearing in non-ammoniated waterless watch cleaning solution (L&R 222 or equivalent) for five minutes. The ultrasonic unit shall be of crystal transducer type emitting two and one half to three (2-1/2 to 3) watts per square inch at the bottom of the tank.

60.4.1.2 Rinse the bearings in P-D-680 (Stoddard Solvent) to remove the watch solution. Hand agitate and soak for 30 seconds.

60.4.1.3 Remove the bearings from the rinse and thoroughly remove the Stoddard Solvent by one of the following methods:

60.4.1.3.1 Spray rinse the bearings with MIL-T-81533.

60.4.1.3.2 Immerse the bearings in MIL-C-81302 vapor.

60.4.1.4 Immerse each lot of bearings in (dichloromethane) MIL-D-6998 and soak for a minimum of 15 minutes.

NOTE

Dichloromethane shall be filtered through lintless filter paper, Whatman No. 1 or equivalent. This solvent shall conform to MIL-D-6998, Type A.

60.4.1.5 Remove the bearings from the soak, using tweezers, triceps, or any other authorized handling device, and further clean by one of the following methods:

60.4.1.5.1 Place the bearings on the Cobehn (or equivalent) Cleaner spindles, MIL-T-81533 solvent spray and then dry the bearings.

60.4.1.5.2 Hand spray with MIL-T-81533 solvent and warm air dry (110° - 129° F) (43° - 53° C) each individual bearing, going thru at least two cycles.

60.4.1.5.3 Place the bearings in a shallow basket that is suspended in a MIL-C-81302 vapor degreaser.

NOTE

All cleaning solutions shall be changed daily.

60.4.2 Method II

60.4.2.1 Ultrasonically clean in doubly filtered MIL-C-81302 for five minutes. The ultrasonic unit shall be of the crystal transducer type emitting two and one-half to three (2-1/2 to 3) watts per square inch on the bottom of the tank.

60.4.2.2 Hand spray with MIL-T-81533 solvent and warm air dry (110° - 120° F) (43° - 49° C), each individual bearing going thru at least two cycles.

60.4.2.3 Place the bearings in a shallow basket that is suspended in a MIL-C-81302 vapor degreaser.

60.4.3 Method III

60.4.3.1 All cleaning and operations may be accomplished utilizing an automatic Cobehn Cleaner Model 10-20BC-2S spray cleaner or equivalent.

60.4.3.1.1 Different solutions may be used in the same machine by simply changing bottles between cleaning steps. The entire lot of bearings shall be cleaned with one type of solvent before changing solutions. The cleaning process is as follows:

60.4.3.2 Hold bearings with appropriate tweezers and spray all bearings with MIL-C-81302 solvent.

60.4.3.3 Completely dry bearings with filtered warm air (110° - 129° F) (43° - 53° C).

60.4.3.4 Change solution bottle and spray all bearings with Cobehn (or equivalent) Cleaning solution.

60.4.3.5 Repeat 60.4.3.3

60.4.3.6 Change solution bottle and spray all bearings with acetone conforming to O-A-51 (CP grade).

60.4.3.7 Repeat 60.4.3.3.

60.5 Final cleaning of separable bearings

60.5.1 Before separable bearings (spin axis) are barrier film coated, the rings will have been cleaned in the normal instrument bearing line and visually and dimensionally inspected as per procurement specification. The non-metallic separators will have a specified impregnated lubricant.

NOTE

The separators shall not be assembled into the outer races until after the ring or rings are barrier film coated.

60.5.2 When the inner and outer rings are matched, the two rings must remain together during all cleaning operations.

60.5.3 When the outer and inner shafts or cones are not matched, cross interchanging of rings can be tolerated, and cleaning processes may be simplified.

60.5.4 Cleaning process. The cleaning process for separable bearings shall be exactly the same as Method I (60.4.1), Method II (60.4.2), or Method III (60.4.3), with the following exception:

60.5.4.1 Both rings of matched sets shall be placed together (side by side, or inner race within outer race) in divided (stainless steel) baskets for different cleaning operations.

60.6 Storage of cleaned bearings. Cleaned bearings may be placed in covered petri dishes and stored in an oven controlled at 110° ±5° F (43 ±3° C) for barrier film coating at a later date.

60.7 Barrier film solution control

60.7.1 General information. A very thin barrier film coat, approximately 0.25 micron (9.84×10^{-6} inch) thick is adequate to assure lubricant retention. A film that is too thick can easily be damaged or displaced. Applied barrier coat films have been observed to be adequate throughout the work day, when initial solution concentration is 0.18 percent by weight. Concentrations in excess of 0.50 percent shall be discarded and fresh 0.18 percent solution used to coat bearing surfaces. Discarded used and concentrated (above 0.5 percent by weight) solutions may be used to dip coat shields and seals.

60.7.2 Solution quality control. If there is doubt as to the concentration of the original barrier film solution, weigh out a sample volume of the solution in a tared clean, dry beaker. Allow the solvent to evaporate completely and weigh the residue (barrier film polymer). Dividing the weight of the residue by the weight of the solution and multiplying the answer by 100 determines the percent, by weight, of the barrier film solution.

60.8 Barrier coating procedures.

60.8.1 Non-separable bearings.

60.8.1.1 Method I

60.8.1.1.1 The applicator is a micrometer adjustment Gilmont Model S-1200 (or equivalent) hypodermic syringe. All components of the applicator are glass, teflon, or stainless steel. The wick or swab of the applicator is made from a one-inch thick block of porous teflon (Chem-Plast trade name POREX or equivalent). The wicks are plug cut into 1/8 inch diameter by one inch long rods. The rods are pressed into a stainless steel support barrel which clamps directly around the hypodermic needle. The needle penetrates the porous teflon material and thereby releases the barrier coating solution directly into the center of the swab (Figure 2). The swab is shaped to fit the face width of the bearing ring by a sharp razor blade. A nylon cap fits snugly over the end of the stainless steel barrel to prevent evaporation of solvent when applicator is not in use.

60.8.1.1.2 The applicator is moistened by turning the micrometer adjustment until the tip is moistened. The applicator is held in the vertical position for proper application.

60.8.1.1.3 Place bearing on holding spindle to facilitate handling.

60.8.1.1.4 Coat face of inner and outer race with barrier coating material, being very careful not to allow barrier material to get inside bearing, on the balls or cage. Use of a low power microscope for better vision helps accomplish the operation quickly, and avoids having the material dry out and become tacky before a full smooth coat is applied.

NOTE

Only one 360 $^{+5}_{-0}$ degrees application is required. Do not make additional rotations on a coated surface to prevent excessive build-up of the coating.

CAUTION

In order to prevent coating active bearing surfaces, the applicator tip must contact ring face surfaces only.

60.8.1.1.5 Place the bearings on adequate drying rack or spindle. Repeat steps 60.8.1.1.3 and 60.8.1.1.4 for other bearings in the batch.

60.8.1.1.6 Invert the bearings and coat the opposite face as in 60.8.1.1.3, 60.8.1.1.4, and 60.8.1.1.5.

60.8.1.1.7 Place drying rack, filled with the barrier coated bearings into the drying oven preheated to 200 $\pm$5° F (93 $\pm$3° C) for a minimum of 15 minutes.

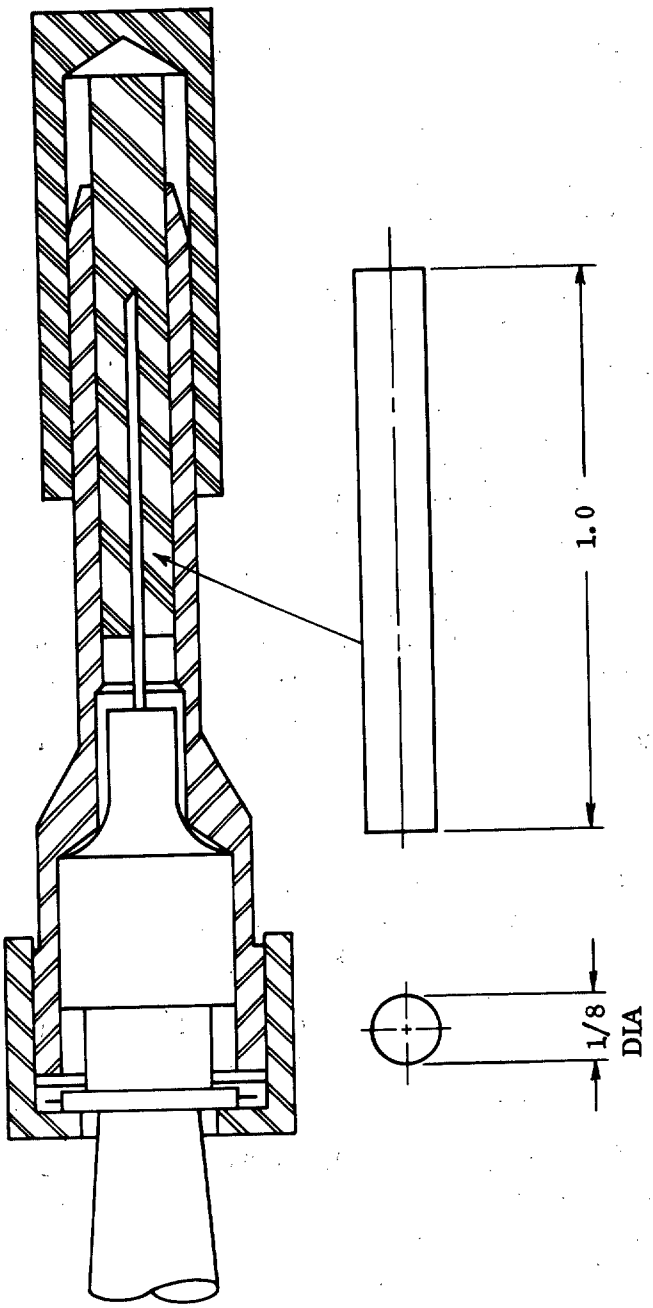


FIGURE 2. Method 1 applicator.

60.8.1.1.8 Remove the rack filled with barrier coated bearings from the oven and allow them to cool. Select several bearings at random for sample inspection and subject them to the oil drop test 60.9.1.1.

60.8.1.2 Method II

60.8.1.2.1 The application of the barrier coating solution is the same as in Method I, except that the applicator is different.

60.8.1.2.2 Roll a small tuft of surgical cotton or make a swab of untreated lens tissue and hold in a draftsman's ruling pen. Dip the swab into the barrier film solution, remove the excess fluid from the swab and coat.

60.8.1.2.3 Coat bearings following steps 60.8.1.1.3 through 60.8.1.1.8.

60.8.1.3 Method III

60.8.1.3.1 Preparing Applicator. (See Figure 3)

60.8.1.3.1.1 The applicator must be air tight. The solution is added to the assembled applicator by pouring it into the funnel until the solution in the funnel stem rises to the level of at least the bottom of the stopper.

60.8.1.3.1.2 The screen disc is suspended in solution by applying pressure to the bulb, driving the barrier film solution up the funnel stem and to the disc.

60.8.1.3.1.3 Gently release the bulb pressure to return the solution to the culture tube.

60.8.1.3.1.4 Use a stainless steel pointed probe for rotating the disc 180° around its horizontal axis, draining off excess solution.

NOTE

Step 60.8.1.3.1.1 thru 60.8.1.3.1.4 inclusive shall be repeated every 5 bearing faces for all bearings with O.D. less than 0.875 inch (22.23 mm).

60.8.1.3.1.5 Place the modified funnel inside of the long stem funnel. (The purpose of the modified funnel is to prevent the disc from rotating during coating and to release the disc from the bearing upon removal of the bearing.) The applicator is now ready for barrier film coating.

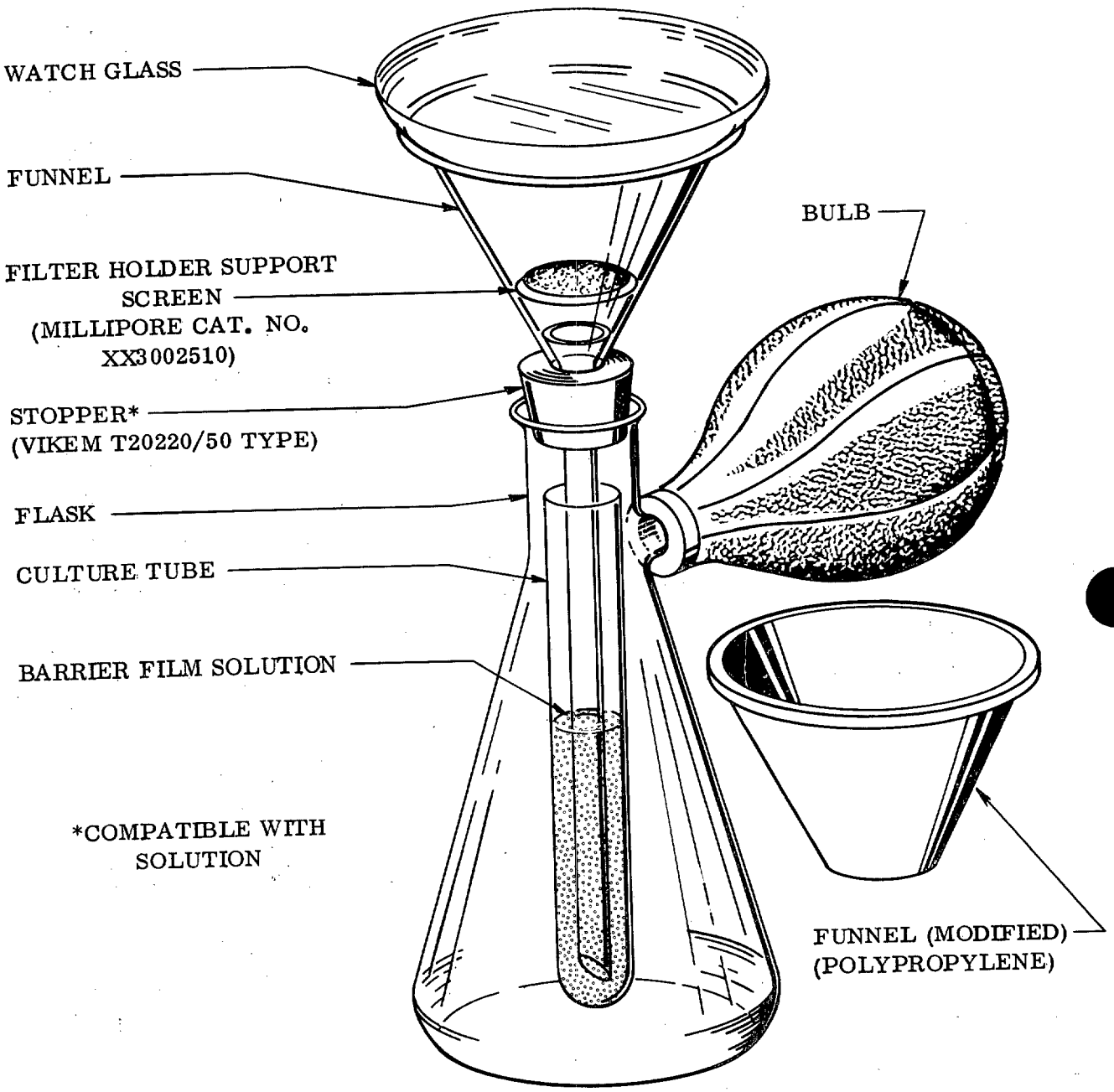


FIGURE 3. Screen-disc plain-funnel barrier film applicator/method III.

60.8.1.3.2 Barrier Film Coating.

60.8.1.3.2.1 Take the bearing from the drying rack using the proper handling device (e.g., bearing tongs or tweezers). Barrier film coat the bearing ring faces by carefully releasing the bearing from the tongs face down two to four millimeters above the disc.

60.8.1.3.2.2 Remove the bearing from the applicator and set it on a drying rack.

60.8.1.3.2.3 Repeat Steps 60.8.1.3.2.1 and 60.8.1.3.2.2 until the rack is filled or the batch is completed, whichever occurs first.

60.8.1.3.2.4 Invert the bearings and coat the opposite face as in 60.8.1.3.2.1 through 60.8.1.3.2.3.

60.8.1.3.3 Remove coated bearings and place on drying rack. After both sides are coated, bake dry as specified in 60.8.1.1.7.

60.8.1.3.4 Remove the rack filled with barrier coated bearings from the oven and allow them to cool. Select several bearings at random for sample inspection and subject them to oil drop test (60.9.1.1).

60.8.2 Separable bearings. Separable bearings shall be coated in the same manner as non-separable bearings.

NOTE

Do not attempt to apply barrier film coating onto faces of assembled bearings with non-metallic separators. Separable bearings with close-fitting non-metallic separators can wick up barrier film solution by capillary action, thus making active areas of the bearing non-wettable by lubricants.

60.8.3 Shields and seals.

60.8.3.1 Shields and seals shall be cleaned by the same method selected for the bearings.

60.8.3.2 Shields and seals shall be coated by dipping into the barrier film solution. Touch bottom of the shield or seal against inside of bottle to remove excess fluid.

60.8.3.3 Bake dry as specified in 60.8.1.1.7.

60.8.3.4 Remove the rack of shields or seals from the oven and allow them to cool. Select at random several shields or seals for sample inspection and subject them to the oil drop test (60.9.1.1).

60.9 Assembly, oil drop test, and lubrication

60.9.1 After all bearing components are cleaned, barrier coated and heat cured, they are ready for assembly, oil drop test, and lubrication.

CAUTION

Do not subject the cleaned and coated bearings to any additional cleaning solutions after the barrier coating has been applied and cured. Further cleaning dilutes the barrier coating and allows it to be redeposited on active areas of the bearing, thus making the surfaces unwettable with the specified lubricants.

60.9.1.1 Select, at random, 2 bearings, shields, or seals from a batch of 17 to 25 components or 1 component from a batch of 16 or less that have been coated and subject them to the following test.

60.9.1.1.1 Place the bearing on the stage of a binocular microscope set at low power (7X to 10X) and adequate illumination.

60.9.1.1.2 Put a microdrop of the specified oil on the inner and outer ring faces. With the point of a needle, contact the drop of oil, being careful not to touch the ring face. Attempt to drag the drop around the ring face. If the barrier film is complete and intact, the drop can easily be dragged around the entire circumference without "wetting" any point. If the film is missing in any area, the drop will wet the bare metal.

60.9.1.1.3 After the drop has been successfully dragged around the bearing circumference, drag the drop toward the active surface until it literally jumps to the land, retainer and ball area. Observe the wettability of the oil in these areas. If the oil tends to bead up, then it can be assumed that the entire surface has been coated or is dirty.

60.9.1.1.4 For shields or seals there should not be any wettable areas on either side.

60.9.1.1.5 If components pass the oil drop test then they shall be sprayed with degreasing solvent conforming to MIL-T-81533 to remove the oil. Warm air dry and return to the rack for assembly and lubrication.

60.9.2 Install one barrier coated shield and snap ring per bearing. Invert the bearing and place the open side up. Lubricate the bearing with the specified grease or oil, taking care not to touch or get lubricants onto the bearing faces. After lubrication install the remaining shield and snap ring. Place the bearings in pre-marked, ultra-clean, anti-static polyethylene bags conforming to MIL-B-81705 and heat seal. Place bags in MIL-B-131 paper back foil bags for shipment.

60.9.3 Spin axis bearings may be shipped in sealed tubes with nylon separators to prevent lubricants from transferring by contact with the package.

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PROCESS FOR BARRIER COATING OF ANTI-FRICTION BEARINGS

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A
☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

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