

7 September 1973

(See 6.8)

MILITARY SPECIFICATION

LUBRICATING OIL, INSTRUMENT, BALL BEARING, HIGH FLASH POINT

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

1. SCOPE

1.1 This specification covers a specialty lubricating oil for use in precision instrument and miniature ball bearings.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Federal

P-D-680	Dry Cleaning Solvent
QQ-B-626	Brass, Leaded and Non Leaded, Rod, Shaped, Forgings, and Flat Products with Finished Edges (Board and Strip)
QQ-S-624	Steel Bar, Alloy, Hot Rolled and Cold Finished (General Purpose)
QQ-S-698	Steel Sheet and Strip, Low Carbon
QQ-S-766	Steel Plate, Sheet, and Strip-Corrosion Resisting

Military

MIL-S-13282	Silver and Silver Alloy
MIL-C-81302	Cleaning Compound, Solvent, Trichlorotrifluoroethane

FSC 9150

STANDARDS

Federal

FED-STD-791 Lubricants, Liquid Fuels, and Related Products;
Methods of Testing

Military

MIL-STD-105 Sampling Procedures and Tables for Inspection
by Attributes

MIL-STD-290 Packaging, Packing, and Marking of Petroleum
and Related Products

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM Standards Part 17 and 18

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

3. REQUIREMENTS

3.1 Qualification - The lubricating oil furnished under this specification shall be a product which has been qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.2.1 and 6.3). In addition, the retention of qualification for lubricating oil on the applicable qualified products list shall be dependent on periodic verification of continued compliance with the requirements of this specification (see 4.2.1.2).

3.1.1 Periodic qualification reevaluation - The lubricating oil shall pass a qualification reevaluation of samples taken from the first lot of lubricating oil, processed under a contract or order after the product has passed the qualification inspection, and at intervals as considered necessary by the qualification laboratory or procuring activity to verify the consistency of production quality.

3.2 Composition - The lubricating oil shall conform to the composition by weight shown in Table I:

TABLE I

Ingredient	Weight Percentage
Bis (2-Ethylhexyl) Azelate <u>1/</u>	63.3 \pm 0.4 percent
Pentaerythritol Tetracaprate <u>2/</u>	34.5 \pm 0.4 percent
Barium Dinonylnaphthalene Sulfonate <u>3/ 6/</u>	1.0 \pm 0.1 percent
Alkylated Phenylalphanaphthyl Amine <u>4/</u>	1.0 \pm 0.1 percent
Benzotriazole <u>5/</u>	0.20 \pm 0.05 percent

1/ Emery Industries

2/ Hercules Powder Co. "Hercolube "A"

3/ R.T. Vanderbilt Co. "NA-SUL-BSN"

4/ Geigy Chemical Company, Antioxidant

5/ Eastman Kodak or Sherwin Williams (see 6.6)

6/ See paragraph 6.5

Extreme care should be exercised to assure that the lubricating oil contains no silicone defoamer compounds.

3.3 Physical properties - The lubricating oil shall meet the physical properties appearing in Table II:

TABLE II

Physical Properties

Property	Requirement	Test Method
Color	5.0 (max.)	4.4.2
Appearance	Clear, bright	-
Acid Number	No requirement <u>1/</u>	4.4.2
Particulate matter	0.5 microns (max.) (see 3.8)	-
Viscosity, CS		
98.9°C (210°F)	3.45 (min.)	4.4.2
37.8°C (100°F)	14.0 (min.) <u>1/</u>	4.4.2
-53.9°C (-65°F)	13000 (max.)	4.4.2

TABLE II (Cont'd)

Property	Requirement	Test Method
Pour Point	-57°C (-70°F) (max.)	4.4.2
Low temperature stability	-57°C (-70°F) (max.) <u>2/</u>	4.4.2
Evaporation loss 176.7°C (350°F) percent (6 1/2 hrs.)	10 max.	4.4.2
176.7°C (350°F) percent (22 hrs.)	22 max.	4.4.2
Flash Point	210°C (410°F) min.	4.4.2

1/ Values needed for comparison purposes to determine compliance with 3.6.2.

2/ No cloud or haze shall be permitted.

3.4 Protection - Not more than one panel out of five shall fail after being covered with a film of lubricating oil and tested as specified in 4.4.3 for 200 hours.

3.5 Corrosivity - When discs are prepared and tested for 35 days in accordance with 4.4.4, not more than 1 of the three discs shall show evidence of corrosion.

3.6 Corrosion and oxidation stability - When the lubricating oil is tested as specified in 4.4.5, it shall meet the following requirements.

3.6.1 Corrosion - The weight of the silver and steel strips shall not have changed by more than 0.2 milligrams per square centimeter of surface for each strip, and the copper strip shall not have changed by more than 0.4 milligrams per square centimeter of surface for each strip. There shall be no visible evidence of pitting, corrosion, or presence of soft sludge on the metals tested. There shall be no sludge or other insolubles in the oil tested. However, some adherent lacquer on cell walls is permitted.

3.6.2 Resistance to oxidation - After the oxidation corrosion test (4.4.5) is completed, the viscosity of the oil at 37.8°C (100°F) shall not have decreased by more than 5 percent nor increased by more than 15 percent. The acid number increase shall be not greater than 1.5. Comparison shall be made with values previously obtained with untested oil (see Table II and 3.3).

3.7 Thin film stability - After the oil has been subjected to the film stability test specified in 4.4.1, the weight loss shall be not more than 75 percent. The residue shall be a non-tacky liquid and shall contain no lacquer or sludge.

3.8 Workmanship - The lubricating oil shall be a homogeneous, clear and bright liquid free from any visible impurities. Immediately before the oil is packaged it shall be passed through a 0.5 micron membrane filter of nylon or regenerated cellulose or other ester-compatible filter medium (see 6.4). Filtration through glass fibre filters is not acceptable.

4. QUALITY ASSURANCE PROVISIONS

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

4.2 Compliance - Determination of compliance with provisions of the specification shall include the following:

(a) Qualification inspection

(a.1) Periodic qualification reevaluation

(b) Quality conformance inspection

4.2.1 Qualification inspection - The qualification inspection performed by the qualification laboratory shall consist of a review for approval of the submitted manufacturer's report, and subjecting the qualification sample (4.3.1) to examination and testing for all the requirements of this specification.

4.2.1.1 Periodic qualification reevaluation - The periodic qualification reevaluation inspection performed by the qualification laboratory shall consist of examining and testing the periodic qualification reevaluation sample (4.3.2) for all the requirements of this specification. Delivery of the lubricating oil will not be delayed pending completion of periodic qualification reevaluation. If the results of the periodic qualification reevaluation inspection are in accordance with the requirements of this specification, the consistency of production quality will be thereby verified. Failure of the lubricating oil to pass a periodic qualification reevaluation inspection shall require that the acceptance and further

shipment of lubricating oil to be withheld until the contractor has corrected the conditions which led to the failure (see 6.3.1). Further failure will constitute cause for rejection and removal from the Qualified Products List.

4.2.1.2 Retention of qualification - The retention of qualification of products approved for listing in the Qualified Products List (QPL) shall be maintained by periodic verification to determine compliance of qualified lubricating oil with the requirements of this specification. Periodic verification may be made by certification unless otherwise specified by the activity responsible for the Qualified Products List and shall be at intervals of no more than 2 years.

4.2.2 Quality conformance (lot by lot) inspection - The quality conformance inspection shall include examining and testing the quality conformance samples (4.3.2.2) for conformance to all the Section 3 requirements and an examination of samples of filled containers (4.3.2.3) for conformance with Section 5 packaging, packing, and marking requirements.

4.3 Sampling and acceptability criteria -

4.3.1 Qualification samples - The qualification sample shall consist of 2 1 qt. containers of lubricating oil for which qualification is desired. The sample shall be accompanied by a report from the manufacturer or a commercial laboratory. The report shall show individual and average results for all requirements of this specification. The samples and reports shall be forwarded to Aero Materials Laboratory, Vehicles Technology Department, NADC, Warminster, Pa. 18974. The samples shall be plainly identified by securely attached durable tags or labels marked with the following information:

Sample for qualification inspection
LUBRICATING OIL, INSTRUMENT, BALL BEARING, HIGH FLASH POINT
Military Specification MIL-L-81846
Name of manufacturer
Product code name
Date of manufacture
Contract or order number
Batch number

4.3.2 Periodic qualification reevaluation - The periodic qualification reevaluation sample shall consist of 2 1-qt containers of lubricating oil selected at random from first lot of lubricating oil processed under the first contract or order after the product has passed the qualification inspection. Additional qualification reevaluation samples may be taken at such intervals as considered necessary to verify the consistency of production quality. Periodic qualification reevaluation samples shall be forwarded to the laboratory responsible for qualification (see 4.3.1). The samples shall be plainly identified by securely attached durable tags or labels marked with the following information:

Sample for qualification reevaluation
LUBRICATING OIL, INSTRUMENT, BALL BEARING, HIGH FLASH
POINT

Specification MIL-L-81846

Name of manufacturer

Product code number

Date of manufacture

Contract or order number

Batch number

4.3.3 Quality conformance samples - The quality conformance sample shall consist of a sample for tests (4.3.3.2) and a sample of filled containers (4.3.3.3). Samples shall be labeled completely with information identifying the purpose of the sample, name of product, purchase description number, date of manufacture, date of sampling, and contract number. Individual samples shall not be mixed, shall be placed in separate air-tight and water-tight containers, and shall be nearly filled, covered and sealed to prevent atmospheric effects.

4.3.3.1 Inspection lot - A lot shall consist of material produced by one manufacturer under essentially the same manufacturing conditions. Each batch shall constitute a lot.

4.3.3.2 Sample for tests - The sample for tests shall be one container of lubricating oil, taken at random from each lot of lubricating oil to be offered for delivery under a contract or order. A lot shall be unacceptable if a sample fails to meet any of the test requirements specified.

4.3.3.3 Sample for examination of filled containers - A random sample of filled containers and a sample of shipping containers fully prepared for delivery shall be selected from each lot of lubricating oil in accordance with MIL-STD-105 at inspection level II and acceptable quality level (AQL) = 2.5 percent defective.

4.4 Test methods - Tests shall be performed in accordance with Table III and 4.4.1 to 4.4.5.

4.4.1 Thin film stability - A 0.35 ± 0.05 gram sample of the lubricating oil shall be transferred to a stainless steel planchet (5 cm. diameter and 1 cm. deep). The planchets (see 6.7) containing the lubricating oil shall be held for 6 1/2 hours in a thermostated, gravity convection oven maintained at $177 \pm 2^{\circ}\text{C}$ ($350 \pm 4^{\circ}\text{F}$). The weight loss of the oil and the final appearance of the oil shall be noted.

4.4.2 The following tests shall be performed in accordance with the applicable method in Federal Test Method Standard No. 791 or ASTM Standards on Petroleum Products and Lubricants.

TABLE III
Test Methods

Requirement	FED STD 791	ASTM Standard
Kinematic viscosity at 210°F (98.9°C)		D445
Kinematic viscosity at 100°F (37.8°C)		D445
Kinematic viscosity at -65°F (-53.9°C)		D445
Low Temperature stability	3458	
Evaporation <u>1/</u>		D972
Pour point		D97
Flash point		D92
Acid number		D974
Color		D1500

1/ Determination of evaporation loss to be made after 6 1/2 hours as well as after 22 hours.

4.4.3 Protection -

4.4.3.1 Five panels shall be cut from steel conforming to QQ-S-698. The size of the panels and the location of the holes shall be as specified in figure A-7 of ASTM Method D-1748. All burrs, sharp edges and corners, including edges of holes, shall be removed. Immediately prior to use, the panels shall be polished to a high polish with 3/0 emery paper. The panels shall be cleaned by washing in solvent conforming to P-D-680 (Type I), drained thoroughly, followed by rinsing in boiling 95 percent methanol. After cleaning, the panels shall be cooled in a desiccator. Care must be taken during the cleaning and preparation that the surfaces are not contaminated with finger prints. The panels shall be handled with tongs during the cleaning operation and with hooks during and after dipping.

4.4.3.2 Procedure - The five panels shall be dipped in a sample of lubricating oil that is maintained at 77 \pm 2°F (25 \pm 1°C), removed, and allowed to drain at that temperature from glass, monel, or stainless steel supports. At the end of this period, the panels shall be suspended in a

humidity cabinet conforming to ASTM Method D-1748 for a period of 200 hours and in such a manner that the drippings from the supports do not fall on the panels. The humidity cabinet shall be maintained at 100 percent humidity and a dry bulb temperature of $120 \pm 2^{\circ}\text{F}$ ($49 \pm 1^{\circ}\text{C}$) for the 200 hour exposure period. The panels shall be removed from the cabinet, cleaned with naphtha, and examined. A panel shall be considered as having failed the Protection test if, at the end of the test period, one of the following conditions exists in significant areas as defined by ASTM Method D-1748 considering both sides of the panel:

- (a) A corroded area of 2-millimeter maximum dimension or larger
- (b) Two or more spots between 1 and 2 millimeters maximum dimension

4.4.4 Corrosivity test -

4.4.4.1 Preparation of panels -

4.4.4.1.1 Steel discs - Three discs 1/2 inch thick shall be cut from 1-inch diameter bar stock conforming to QQ-S-624, Composition FS E52100. The discs shall be heat treated to hardness of Rockwell C-62 (rollers that may be obtained from roller bearings, and that have similar chemical, physical, and dimensional properties to the above bar stock after heat treatment, can be substituted for the formation of the discs. In this case no further treatment is necessary). The discs shall now be slowly surface ground on one side to a finish of less than 20 microinches rms. If coolant is used in grinding, the discs shall be slushed in absolute methanol. The discs shall then be abraded on the surface-ground side by successive applications of emery polishing paper graded 1/0, 2/0, 3/0, and finally 4/0. There shall be no scratches remaining from papers more coarse than 4/0. Paper incorporating iron oxide as the polishing medium, and wet-dry type papers, shall not be used. The discs shall be wiped clean with sterile absorbent gauze and examined under 10X magnification for any signs of corrosion or other defects. Defective specimens shall not be used. The discs shall be stored in a desiccator containing silica gel until ready for use.

4.4.4.1.2 Brass clips - Three clips shall be fabricated from commercial 0.0225 inch brass sheet conforming to QQ-B-626, spring temper. The size and shape of the clips shall be as illustrated in Figure 1. The clips shall then be immersed for 20 seconds in the following etching solution:

- 450 ml water
- 225 ml conc. nitric acid
- 300 ml conc. sulphuric acid
- 8 ml conc. hydrochloric acid

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After etching, the clips shall be washed free of acid in cold running tap water and finally dried with acetone. The clips shall then be stored in a desiccator containing silica gel desiccant until ready for use.

4.4.4.2 Procedure - The three discs shall be coated with the test oil by dipping a stirring rod in the test oil and allowing the oil from the rod to drop on the polished side of the discs. The drops shall be spread so as to completely cover the discs. The brass clips shall then be clamped over the coated discs and the assemblies placed in a test chamber which is maintained at 80°F (26.7°C) and 50 percent relative humidity, for a period of 35 days. After exposure, the assemblies shall be removed and the area covered by the brass clips outlined on the discs using the clips as templates. The clips shall then be removed and the test oil wiped from the discs. The discs shall be examined under 10X magnification for signs of corrosion, pitting or other detrimental effects.

4.4.5 Corrosion and oxidation stability - The corrosion and oxidation stability shall be performed at 350°F (177°C) in accordance with Method 5308 of FED-STD-791 with the following modifications: An electrolytic grade silver (conforming to MIL-S-13282, Grade A) test square shall be substituted for the cadmium plated steel square. The aluminum test square shall be replaced with a square conforming to QQ-S-624, Composition FS E52100. The magnesium square shall be replaced with a Type 410 steel square conforming to QQ-S-766. The viscosity at 100°F (38°C) shall be performed within six hours of the completion of the oxidation test period. The sludge content after the 350°F (177°C) test shall be determined as follows: The oil shall be decanted from the test tube through a preweighed 10 micron membrane filter fabricated from nylon or regenerated cellulose and the filtrate separately retained for measurement of viscosity and acid number tests. The test tube shall be rinsed until clean with petroleum ether and the washings decanted through the membrane filter. Finally, the filter shall be rinsed with at least 2 portions of petroleum ether to remove the remaining oil. The filter shall be dried for 20 minutes at 50°C (122°F) and reweighed.

5. PREPARATION FOR DELIVERY

5.1 Packaging - Unless otherwise specified, packaging shall be Level A.

5.1.1 Level A - The lubricating oil shall be packaged in 4 oz. wide-mouthed brown glass bottles. Screwcaps shall be polyethylene or polypropylene with a liner of aluminum foil. The caps shall be compatible with diester oil. The bottles shall be rinsed with filtered MIL-C-81302 and dried with clean filtered air.

5.2 Packing and marking - Packing and marking shall be in accordance with MIL-STD-290.

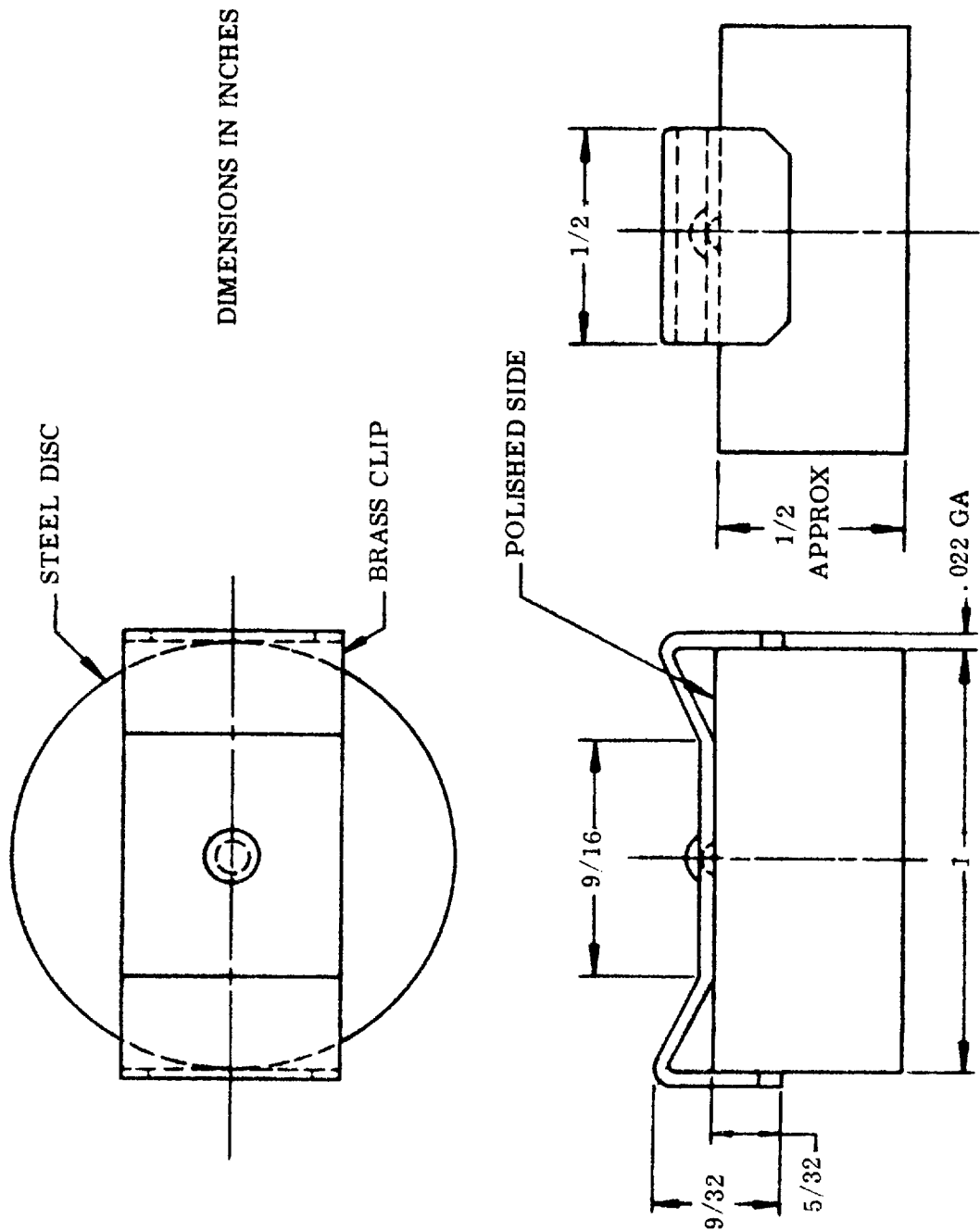


FIGURE 1. Typical Test Specimens for Corrosivity Test

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6. NOTES

6.1 Intended use - This oil is intended for use in precision instrument and miniature ball bearings, for the temperature range of -55°C (-67°F) to 150°C (302°F).

6.2 Ordering data - Procurement documents should specify the following:

- (a) Title and number of this specification
- (b) Levels and details of packaging and packing
- (c) Details of marking
- (d) Quantity desired

6.3 Qualification - With respect to products requiring qualification, awards will be made only for such products as have prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to provision, and manufacturers are urged to arrange to have the products they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command, Department of the Navy, Washington, D.C. 20360; however, information pertaining to qualification of products may be obtained from the Aero Materials Laboratory, Vehicle Technology Department, NADC, Warminster, Pa. 18974.

6.3.1 The lubricating oil furnished under contract should be identical within commercial limits to the qualification samples which have been inspected and approved. In the event that the lubricating oil furnished under contract is found to deviate from the composition of the approved product, or if the product fails to meet all the requirements of this specification, or that the product fails to perform satisfactorily, approval of such products will be subject to immediate withdrawal from the Qualified Products List.

6.4 To obtain maximum benefit from filtration thru filters (0.5 microns or smaller) and to maintain product cleanliness, the filling operation should take place under clean room conditions, or in a laminar flow clean bench. The filter membrane shall be fabricated from either nylon, regenerated cellulose or other ester-compatible filter medium. Glass filters are not acceptable.

6.5 The barium dinonylnaphthalene sulfonate to be used in the formula of Table I should be dissolved in heptane or other distillable light petroleum solvent. The heptane or light petroleum fraction solution of the barium dinonylnaphthalene, usually supplied in 50 percent concentration,

should be added to a sufficient amount of percolated bis (2 ethyl hexyl) azelate to make about a 50 percent concentrate after the solvent is removed by stripping. The solvent is then boiled off in a rotary flask evaporator using a hot water bath or by other appropriate means. An analysis of the barium content of the azelate concentrate must be performed so that the correct proportion of the additive may be incorporated into the final formulation. After the evaporation of the heptane the final formulation may then be blended in the proportions given in Table I.

6.6 Materials from other suppliers have occasionally resulted in an unsatisfactory formulation which will not conform to Section 3 requirements. Use of the suggested sources does not guarantee a satisfactory product. It is suggested that materials 1/ and 2/ be separately passed thru a column of activated Florisil to remove possible polar contaminants prior to formulation.

6.7 Planchets may be obtained from Laboratory Products P.O. Box 1802 Ann Arbor, Michigan 48106.

6.8 Supersession data - This specification supersedes Naval Air System Command Purchase Description AS 2844 dated 18 March 1971.

Custodians:

Army - MR
Navy - AS
Air Force - 11

Preparing Activity:

Navy - AS
Project No. 9150-0357

Review Interest:

Army - WC, MU, EL
Navy - OS, SH
Air Force - 71, 84