

NOT MEASUREMENT SENSITIVE
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MIL-DTL-53131A

16 November 1998

SUPERSEDING

MIL-L-53131

10 February 1993

## DETAIL SPECIFICATION

LUBRICATING OIL, PRECISION ROLLING ELEMENT BEARING,  
POLYALPHAOLEFIN BASED

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

## 1. SCOPE

1.1 Scope. This detail specification covers the requirements for five grades of a synthetic hydrocarbon lubricating oil for use in the precision bearings of internal guidance gyros, accelerometers and other suitable instrument bearing applications (see 6.1).

1.2 Classification. The lubricating oils are of the following grades as specified (see 6.2).

Grade 4  
Grade 6  
Grade 9  
Grade 14  
Grade 40

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 and 4 of this specification, whether or not they are listed.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Tank-Automotive and Armaments Command, ATTN: AMSTA-TR-E/BLUE, Warren, MI 48397-500, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.
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AMSC N/A

FSC 9150

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATIONS

## FEDERAL

TT-T-656 - Tricresyl Phosphate

## STANDARDS

## FEDERAL

FED-STD-313 - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities  
 FED-STD-791 - Lubricants, Liquid Fuels and Related Products, Methods of Testing

(Unless otherwise indicated, copies of the above specification, and standards are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents. The following other Government documents form a part of the document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

## DEPARTMENT OF LABOR (DOL)

OSHA 29 CFR 1910.1200 Hazard Communication

2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASQC Z1.4 - Sampling Procedures and Tables for Inspection by Attributes

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- ANSI Z400.1      - Hazardous Industrial Chemicals – Material Safety Data Sheets - Preparation

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |  |
|-------------|--|
| ASTM A 240  | - Standard Specification for Heat-Resisting Chromium and Chromium-Nickle Stainless Steel Plate, Sheet, and Strip for Pressure Vessels (DoD Adopted). |
| ASTM A 666  | - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar (DoD Adopted).                     |
| ASTM A 693  | - Standard Specification for Precipitation-Hardening Stainless and Heat-Resisting Steel Plate, Sheet, and Strip (DoD Adopted).                       |
| ASTM D 92   | - Flash and Fire Points by Cleveland Open Cup (DoD Adopted).   |
| ASTM D 97   | - Pour Point of Petroleum Oils (DoD Adopted).  |
| ASTM D 445  | - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculations of Dynamic Viscosity) (DoD Adopted).                                   |
| ASTM D 664  | - Neutralization Number by Potentiometric Titration (DoD Adopted).   |
| ASTM D 972  | - Evaporation Loss of Lubricating Greases and Oils (DoD Adopted).  |
| ASTM D 974  | - Neutralization Number by Color - Indicator Titration (DoD Adopted).  |
| ASTM D 4057 | - Manual Sampling of Petroleum and Petroleum Products (DoD Adopted).   |
| ASTM D 4172 | - Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method) (DoD Adopted).   |
| ASTM D 4177 | - Automatic Sampling of Petroleum and Petroleum Products (DoD Adopted).  |
| ASTM D 4636 | - Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils (DoD Adopted).          |
| ASTM D 4898 | - Insoluble Contamination of Hydraulic Fluids by Gravimetric Analysis (DoD Adopted).   |

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

## MIL-DTL-53131A

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

SAE AMS 6440

-Carbon Alloy Steels: Grouped By ASIS Numbering System Chromium.

(Application for copies should be addressed to the Society of Automotive Engineers, Inc.,  
400 Commonwealth Drive, Warrendale, PA 15096.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Qualification. Lubricating oils furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL) before contract award (see 4.2 and 6.3).

3.2 Material safety data sheet (MSDS). Contractor shall furnish a separate MSDS for each individual item which is defined as hazardous in FED-STD-313, or which is required by the contract or order. The MSDS shall meet all requirements of the 29CFR 1910.1200 and should be in accordance with the 16 part format specified in the ANSI Z400.1 standard and shall include all information that is pertinent to the product. One copy of the MSDS shall be submitted to the address indicated in FED-STD-313 for the Service/Agency procuring the item, one copy to the contracting officer, and at least one copy per shipment unless otherwise specified in the contract or order.

3.3 Materials. The materials used in compounding the lubricant basestock shall consist solely of polyalphaolefin oligomers. The fluids shall contain additives as specified.

#### 3.3.1 Additives.

3.3.1.1 Oxidation inhibitor. The oxidation inhibitor shall be a hindered bis-phenol. (An example of a known suitable additive is 4,4-methylenebis (2,6-di-tertiary butyl phenol). A quantity of 0.45 to 0.55 percent by weight shall be used.

3.3.1.2 Antiwear agent. The antiwear agent shall be natural tricresyl phosphate conforming to TT-T-656 or synthetic tricresyl phosphate. A quantity of 0.9 to 1.1 percent by weight shall be used. The natural or synthetic tricresyl phosphate shall contain not more than one percent of the ortho-isomer.

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3.3.3 Toxic products and formulations. The material shall have no adverse effect on health of personnel when used for its intended purpose. Questions pertinent to the effort shall be referred by the contracting activity to the appropriate departmental medical service who will act as an advisor to the contracting agency.

3.4 Physical properties. The physical properties of the lubricating oil shall be in accordance with physical properties appearing in table I, when tested as specified in 4.5.2 through 4.5.2.2.

TABLE I. Physical properties.

Property	Requirements				
	Grade 4	Grade 6	Grade 9	Grade 14	Grade 40
Acid number, mg KOH/g (max)	0.1	0.1	0.1	0.1	0.1
Viscosity, mm <sup>2</sup> /s					
100 °C (212 °F), min.	3.5	5.4	9.0	13.5	38.0
40 °C (104 °F), max.	18.5	33.0	75.0	130.0	420.0
-40 °C (-40 °F), max.	3500	7900	30000	--	--
Pour point, °C (°F), min.	-62 (-80)	-57 (-70)	-54 (-65)	-40 (-40)	-27 (-15)
Flash point, °C (°F), min.	227 (440)	227 (440)	234 (453)	245 (473)	273 (523)
Evaporation % by weight, max.	5.0	3.0	3.0	2.0	1.0
22 hrs., 149 °C (300 °F)					

3.5 Corrosiveness and oxidation stability. When the lubricating oil is tested as specified in 4.5.1, it shall meet the following requirements:

3.5.1 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; the weight change for the aluminum shall be not more than 0.4 milligrams per square centimeter of surface, and the weight change for the copper shall be not more than 0.6 milligrams per square centimeter of surface.

3.5.2 Resistance to oxidation. After the oxidation corrosion test (see 4.5.1) is completed, the viscosity of the oil at 40 °C (104 °F) and the acid number shall not have changed by more than the values shown in table II.

TABLE II. Resistance to oxidation.

Corrosion-oxidation	Requirement				
	Grade 4	Grade 6	Grade 9	Grade 14	Grade 40
% Viscosity change @ 40 °C (104 °F), max.	+30.0	+10.0	+5.0	+5.0	+5.0
Change in acid No., max.	4.5	3.0	3.0	3.0	3.0

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3.6 Lubricity. When tested in accordance with 4.5, table V, wear scar values for the lubricating oil shall not exceed those specified in table III.

TABLE III. Wear scar values.

Test load, Newtons	Wear scar, mm, max.				
	Grade 4	Grade 6	Grade 9	Grade 14	Grade 40
400	0.90	0.90	0.90	0.90	0.90
150	0.35	0.35	0.35	0.35	0.35

3.7 Solid particle contamination. When tested in accordance with 4.5.2, the number of solid contaminant particles per 100 mL of the fluid shall not exceed the number specified in table IV. The weight of the residue by gravimetric analysis shall not exceed 0.3 mg/100 mL.

TABLE IV. Solid contaminant particles.

Particle size range (largest dimension) micrometers	Allowable number (max) each determination
5-15	150
16-25	45
26-50	23
51-100	10
Over 100	0

3.8 Storage stability. After 12 months of storage in accordance with 4.5 (FED-STD-791, method 3465), the fully blended product shall show no separation of ingredients nor evidence of crystallization. The blended product shall be clear and transparent when examined visually, and shall conform to the requirements of section 3, except particulate contamination.

3.9 Workmanship. The lubricating oil shall be a homogenous, clear and bright liquid free from any visible impurities.

3.10 Containment packaging. The unit of issue quantity of oil shall be packaged in an amber glass bottle (e.g. shape defined by the Glass Packaging Institute (GPI)). The container stability must minimize customer-handling problems. A poly seal cap shall be used to insure seals do not fail under normal handling. The protective containment package must contain the product so that neither the contents escape; maximize the product shelf-life; and prevent any contamination of the product.

3.11 Labeling: Each containment bottle will contain the following special label markings in addition to all markings required by the contract or order.

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PRECISION ROLLING ELEMENT BEARINGS POLYALPHAOLEFIN BASED SYNTHETIC OIL. IF OIL CONTAINS NATURAL TRICRESYL PHOSPHATE, THE UNIT CONTAINER SHALL BE MARKED AS FOLLOWS:

**WARNING**

THIS OIL CONTAINS NATURAL TRICRESYL PHOSPHATE – CAN PRODUCE PARALYSIS IF TAKEN INTERNALLY. DO NOT ALLOW ON FOOD MACHINERY OR ON SURFACES THAT MAY CONTACT FOOD OR USE FOR ANY MEDICINAL PURPOSE. DO NOT ALLOW THE OIL TO CONTAMINATE FOODSTUFF, AS WELL AS CIGARETTES OR OTHER TOBACCO PRODUCTS.

AVOID EXTENDED SKIN EXPOSURE. DISPOSAL/WASTE MANAGEMENT: MANY STATES CLASSIFY WASTE LUBRICANTS AS “HAZARDOUS”, WHICH MEANS DISPOSAL ONLY BY A LICENSED FIRM. CONSULT LOCAL, STATE, AND FEDERAL REGULATIONS APPLICABLE TO YOUR AREA.

#### 4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 Qualification inspections. Qualification inspections consist of tests for all of the requirements specified in section 3 and may be conducted in any plant or laboratory approved by the qualifying activity.

4.3 Conformance inspections. Conformance inspections tests shall consist of the tests specified in 4.5 through 4.5.2.2 except the following:

- Corrosiveness and oxidation stability (see 4.5.1)
- Lubricity (see 4.5, table V)
- Storage stability (see 4.5, table V)

#### 4.4 Sampling.

4.4.1 Sampling for the examination of filled containers. Take a random sample of filled containers from each lot of lubricating oil in accordance with ANSI/ASQC Z1.4.

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4.4.2 Sampling for tests. Take samples from bulk or packaged lots (see 6.4) for tests in accordance with ASTM D 4057 or D 4177, as appropriate.

4.4.2.1 Inspection. Perform inspection in accordance with FED-STD-791, method 9601.

4.4.2.2 Examination of filled containers. Examine samples taken in accordance with 4.4 with regard to fill, closure, sealing, leakage, packaging, packing and marking requirements. Reject any container having one or more defects or under the required fill. A lot shall be accepted when zero defects are found and rejected when one or more defects are found.

4.5 Test methods. Perform tests in accordance with table V and with 4.5.1 through 4.5.2.2, as applicable.

TABLE V. Test methods.

Requirement	Test method
Kinematic viscosity	ASTM D 445
Acid number	ASTM D 974 or D 664
Pour point	ASTM D 97
Flash point	ASTM D 92
Four-ball wear	ASTM D 4172
Evaporation	ASTM D 972
Storage stability	FED-STD-791, method 3465

4.5.1 Corrosion and oxidation stability. The corrosion and oxidation stability shall be performed at 150 °C (302 °F) in accordance with ASTM D 4636 with the modifications specified herein. The test shall be run for 72 hours. An electrolytic grade silver test square shall be substituted for the cadmium plated steel square. The mild, carbon steel test square shall be replaced with a steel square conforming to SAE AMS 6440. The magnesium square shall be replaced with a type 410 steel conforming to ASTM A 240, ASTM A 666, and ASTM A 693. The viscosity at 40 °C (104 °F) shall be performed within six hours of the completion of the oxidation test period.

4.5.2 Solid particle contamination.

4.5.2.1 Particle size. Particle size shall be measured by the use of automatic particle counters (HIAc counter, models PC-202, PC-203, PC-305, PC-320 or equivalent) or the optical procedure detailed in FED-STD-791, method 3009. Directions in the manual for the respective instruments shall be followed.

4.5.2.2 Gravimetric method. A gravimetric determination shall also be made in accordance with ASTM D 4898 using two 0.45 micrometer filter membranes.



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4.6 Tolerances. The lubricating oil supplied under contract shall be identical, within permissible tolerances assigned by the qualifying activity, for the properties listed in 3.4, to the product receiving qualification. The values resulting after the application of the tolerances shall not exceed the maximum nor fall below the minimum limits specified herein (see table I through IV and 3.5.1 through 3.7).

## 5. PACKAGING

5.1 Packaging. For acquisition purpose, the packaging requirements shall be as specified in the contract or order (see 3.2 and 3.10). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

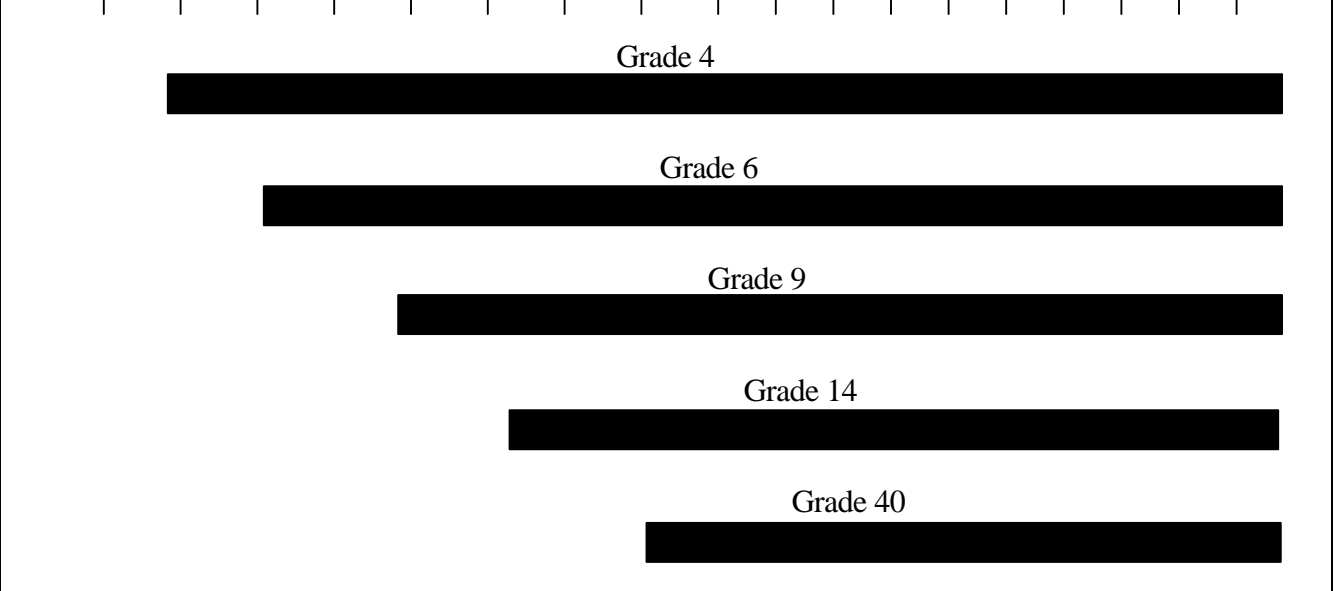
## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The lubricants covered by this specification are military unique. The lubricated oils are intended for use in the precision bearings of inertial guidance gyros, accelerometers and other suitable instrument bearing applications. To allow the user the option of using a specified oil with the optimum viscosity and operation temperatures for the application, the lubricants in this specification are classified into five different grades of oils according to their viscosity properties. Prior to using these oils, their performance should be verified in each application. Recommended ambient temperature ranges for the five grades of oil are shown in table VI. The lubricants covered by this specification were formulated for use in critical military applications, such as aircraft, systems, and various weapon systems. Because of its specific applications and harsh temperature range, there are no other commercial specifications available to cover these military applications.

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TABLE VI. Recommended ambient temperature range.

EXPECTED AMBIENT TEMPERATURE	
°F	-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100>
°C	-57 -51 -46 -40 -34 -29 -23 -18 -12 -7 -1 4 10 16 21 27 32 38>
 <p>Grade 4</p> <p>Grade 6</p> <p>Grade 9</p> <p>Grade 14</p> <p>Grade 40</p>	

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number and date of this specification.
- b. Grade of lubricating oil required (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- d. Quantity.
- e. Size and type of containers (see 3.10 and 5.1).
- f. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Product List QPL NO.53131 whether or not such products have actually been so listed by that date. The attention of the contractor is called to these requirements, manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the U.S. Army TACOM, ATTN: AMSTA-TR-D/210, Warren, MI 48397-5000.

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6.4 Definitions.

6.4.1 Bulk lot. An indefinite quantity of a homogeneous mixture of lubricating oil, offered for acceptance in a single, isolated container; or manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in the ingredient materials.

6.4.2 Packaged lot. An indefinite number of unit containers of identical size and type, offered for acceptance, and filled with a homogeneous mixture of lubricating oil from a single, isolated container; or filled with a homogeneous mixture of hydraulic fluid, manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, which no change in ingredient materials.

6.4.3 Batch. A batch is defined as that quantity of material which has been manufactured by some unit chemical process and subjected to some physical mixing operation intended to make the final product substantially uniform.

6.5 Disposal actions.

6.5.1 Background. The product may contain 1.0 percent natural tricresyl phosphate which may be absorbed through the skin and produces paralysis if taken internally. Accumulated waste liquids should have the exterior of the outer pack marked as containing natural tricresyl phosphate to assist disposal facilities to manage the product according to regulations promulgated by the U.S. Environmental Protection Agency under Public Law 94-580, Resource Conservation and Recovery Act of 1976.

6.5.2 Handling and safety precautions. Personnel handling the product should wear appropriate impervious clothing to prevent repeated or prolonged skin contact. Local appraisal is required for exact health and safety implications. Sheets (MSDS) information should be used by safety and health office of using activity to prescribe precise application of protective measures. If skin or clothing becomes moistened with the product, personnel should promptly wash with soap or mild detergent and water. Respirators are not required unless there is the possibility of an inhalation exposure to mists.

6.5.3 Disposal.

6.5.3.1 Field operations. Depending on the size of spills, paper towels or absorbents should be used to absorb the liquid. Contaminated soil should be removed and placed in a box with absorbents or towels. This box with spill clean-up wastes should either be buried along with ordinary refuse at a rate not to exceed 10 pounds of clean-up waste per spill event or be incinerated in a permitted municipal waste incinerator. Bulk wastes and contaminated product should be collected centrally for commercial recycling by a commercial reprocessing firm. Recycling by DoD military field activities, including depot-type operations, is not authorized at this time. Liquid products used for heat recovery are regulated by the Environmental Protection Agency under Public Law 94-580, Resource Conservation and Recovery Act of 1976. Heat recovery is required to meet the standard in 40 CFR 266, subpart E, Used Oil, burned energy recovery.

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6.5.3.2 Container disposal. Container disposal depends on specific site, state and local laws governing disposal hazardous materials.

### 6.6 Subject term (key word) listing.

Instrument lubricant

Instrument oil

Tricersyl Phosphate

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:

Army - AT

Navy - AS

Air Force -11

Preparing activity:

Army - AT

(Project 9150-A820)

Review activity:

Air Force – 68

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

### I RECOMMEND A CHANGE:

#### 1. DOCUMENT NUMBER

MIL-DTL-53131A

#### 2. DOCUMENT DATE (YYMMDD)

981116

#### 3. DOCUMENT TITLE

Lubrication Oil, Precision Rolling Element Bearing, Polyalphaolefin Based

#### 4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

#### 5. REASON FOR RECOMMENDATION

#### 6. SUBMITTER

##### a. NAME (Last, First, Middle Initial)

##### b. ORGANIZATION

##### c. ADDRESS (Include Zip Code)

##### d. TELEPHONE (Include Area Code)

(1) Commercial  
(2) AUTOVON  
(If applicable)

##### 7. DATE SUBMITTED (YYMMDD)

#### 8. PREPARING ACTIVITY

##### a. NAME

##### b. TELEPHONE (Include Area Code)

(1) Commercial (810) 574-8745 (2) AUTOVON 786-8745

##### c. ADDRESS (Include Zip Code)

Commander  
U.S. Army Tank-automotive and Armaments Command  
ATTN: AMSTA-TR-E/BLUE  
Warren, MI 48397-5000

IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:  
Defense Quality and Standardization Office  
5203 Leesburg Pike, Suite 1403  
Falls Church, VA 22041-3466  
Telephone (703) 756-2340 AUTOVON 289-2340