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SUPERSEDING
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PERFORMANCE SPECIFICATION

LUBRICANT, SOLID FILM, AIR CURED, CORROSION INHIBITING

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

1. SCOPE

1.1 Scope. This specification covers two types of corrosion inhibiting, air cured, solid film lubricants, hereafter known as "lubricants," which provide both lubrication and corrosion protection (see 6.1).

1.2 Classification. The lubricants are of the following types, forms, and colors, as specified (see 6.2).

1.2.1 Types. The lubricants are of the following types, as specified (see 6.2).

Type I - An air dry lubricant with an endurance life of 120 minutes and cure time of 18 hours.
Type II - An air dry lubricant with low volatile organic compound (VOC) content and an endurance life of 90 minutes and cure time of 24 hours.

1.2.2 Forms. The lubricants are of the following forms, as specified (see 6.2).

Form 1 - Bulk dispersion.
Form 2 - Aerosol propelled.

Comments, suggestions, or questions on this document should be addressed to U.S. Army RDECOM, Tank Automotive Research, Development and Engineering Center, ATTN: RDTA-EN/STND/TRANS MS #268, 6501 E. 11 Mile Road, Warren, MI 48397-5000 or emailed to usarmy.detroit.rdecom.mbx.tardec-standardization@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

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1.2.3 Colors. The lubricants are of the following colors, as specified (see 6.2).

Color 1 - Natural product color.
Color 2 - Black.

1.3 Part or identifying number (PIN). The PIN to be used for lubricants acquired to this specification are created as follows:

M - 46147 - X X X

- X: Color (see 1.2.3)
  - 1 = Natural
  - 2 = Black
- X: Form (see 1.2.2)
  - 1 = Bulk dispersion
  - 2 = Aerosol propelled
- X: Type (see 1.2.1)
  - 1 = Type I
  - 2 = Type II
- 46147: Specification number
- M: Prefix for military specification

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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 of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

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 cited in the solicitation or contract (see 6.2).

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FEDERAL SPECIFICATIONS

VV-D-1078	-	Damping Fluid, Silicone Base (Dimethyl Polysiloxane)

FEDERAL STANDARDS

FED-STD-313	-	Material Safety Data, Transportation Data, and Disposal Data for Hazardous Materials Furnished to Government Activities
FED-STD-595/36076	-	Gray, Flat or Lusterless

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-372	-	Cleaning Compound, Solvent (For Bore of Small Arms and Automatic Aircraft Weapons).
MIL-PRF-7808	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base.
MIL-PRF-14107	-	Lubricating Oil, Weapons, Low Temperature.
MIL-DTL-16232	-	Phosphate Coating, Heavy, Manganese or Zinc Base.
MIL-PRF-32033	-	Lubricating Oil, General Purpose, Preservative (Water-Displacing, Low Temperature).
MIL-PRF-46170	-	Hydraulic Fluid, Rust Inhibited, Fire-Resistant, Synthetic Hydrocarbon Base, NATO Code No. H-544.
MIL-PRF-63460	-	Lubricant, Cleaner and Preservative for Weapons and Weapons Systems.
MIL-DTL-83133	-	Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8 + 100 (NATO F-37).

(Copies of the above these documents are available online at http://quicksearch.dla.mil or from the Standardization Document Order Desk, 700 Robbins Ave, Bldg 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (see 6.2).

ASTM INTERNATIONAL

ASTM B117	-	Standard Practice for Operating Salt Spray (Fog) Apparatus (DoD Adopted).
ASTM B244	-	Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other

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		Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments (DoD Adopted).
ASTM B499	-	Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals (DoD Adopted).
ASTM D1193	-	Standard Specification for Reagent Water (DoD Adopted).
ASTM D2510	-	Standard Test Method for Adhesion of Solid Film Lubricants (DoD Adopted).
ASTM D2511	-	Standard Test Method for Thermal Shock Sensitivity of Solid Film Lubricants (DoD Adopted).
ASTM D2625	-	Standard Test Method for Endurance (Wear) Life and Load-Carrying Capacity of Solid Film Lubricants (Falex Pin and Vee Method) (DoD Adopted).
ASTM D3960	-	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings (DoD Adopted).
ASTM D4017	-	Standard Test Method for Water in Paints and Paint Materials by Karl Fischer Method (DoD Adopted).
ASTM D4457	-	Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.
ASTM D7091	-	Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non- Ferrous Metals
ASTM F22	-	Standard Test Method for Hydrophobic Surface Films by the Water-Break Test (DoD Adopted).

(Copies of the above docmuments are available from www.astm.org or from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

SAE INTERNATIONAL

SAE J1966	-	Lubricating Oils, Aircraft Piston Engine (Non-Dispersant Mineral Oil) (DoD Adopted).

(Copies of the above document are available from www.sae.org or from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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.

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3. REQUIREMENTS

3.1 Qualification. The lubricants furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.1.1 and 6.3).

3.2 Materials. Unless otherwise specified, the material selection is the prerogative of the contractor as long as all articles submitted to the Government fully meet the operating, interface, support and ownership, and environmental requirements specified.

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Operating requirements.

3.3.1 Endurance life. Type I lubricants shall have an average Falex endurance life of not less than 120 minutes under a gage load of 4480 newtons (N) (1000 pounds force (lbf)). Type II lubricants shall have an average Falex endurance life of not less than 90 minutes under a gage load of 4480 N (1000 lbf) (see 4.3.3.1).

3.3.2 Load-carrying capacity. The lubricants shall have an average Falex load-carrying capacity of not less than 11 200 N (2500 lbf) with no single test result less than 8950 N (2000 lbf) (see 4.3.3.2).

3.4 Interface requirements.

3.4.1 Film adhesion. The bonded lubricant shall adhere to applicable metal surfaces. No bare metal surface shall be exposed on test panels (see 4.3.4.1).

3.4.2 Film appearance and thickness. The bonded lubricant shall appear uniform in color and shall be smooth, free from any cracks, sags, foreign matter, grit, rough particles, or separation of ingredients. The coating thickness of the cured solid film lubricant alone (negating the phosphate film thickness) shall be between 0.008 millimeters (mm) and 0.013 mm with no single reading less than 0.005 mm or greater than 0.018 mm (see table II and 4.3.4.2).

3.4.3 Spray pattern and duration (lubricants in gas-pressurized containers only). The spray pattern shall be not less than 38 mm wide and shall be uniform in color, smooth, and free from bubbles. The spray shall be effective for not less than 290 seconds (see 4.3.4.3).

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3.4.4 Curing time. The lubricants shall be of such composition that at 25 ± 2.0 degrees Celsius (°C) (77 ± 3.6 degrees Fahrenheit (°F)), the lubricants shall be dry to the touch and fully cured in the following maximum times (see 4.3.4.4):

	Type I	Type II
Dry time:	30 minutes	90 minutes
Cure time:	18 hours	24 hours

3.4.5 Solids content.

3.4.5.1 Lubricants in non-pressurized cans. Lubricants supplied in non-pressurized cans shall contain not less than 24 percent (%) by weight of total solids (see 4.3.4.5.1).

3.4.5.2 Lubricants in gas-pressurized cans. Each gas-pressurized can shall contain not less than 30 grams (g) (1 ounce (oz)) of total solids (see 4.3.4.5.2).

3.4.6 VOC content (type II only). The VOC content of the fluid lubricant shall not exceed 250 grams per liter (g/L) (33.4 ounces/gallon (oz/gal)) of lubricants less water and exempt volatile compounds (see 4.3.4.6).

3.4.7 Color. The lubricants supplied in Color 2 (see 1.2.3) shall not be lighter than color No. 36076 (gray) of FED-STD-595 (see 4.3.4.7).

3.5 Support and ownership requirements.

3.5.1 Storage stability. Following storage at 25 ± 3.0°C (77 ± 5.4°F) for a period of 365 ± 7 days, the lubricant shall be readily dispersed by moderate shaking or stirring and shall meet all the requirements of this specification (see 4.3.5.1).

3.5.2 Toxicity. The lubricants shall have no adverse effects on human health when used as intended (see 4.3.5.2).

3.5.3 Restricted materials. The propellant used for aerosol cans shall contain no ozone depleting substances (ODS). The lubricants shall contain no lead or lead-containing compounds, graphite, powdered metals, carbon black, charcoal or other forms of inorganic carbon (see 4.3.5.3 and 6.9).

3.6 Environmental requirements.

3.6.1 Fluid resistance. After immersion in each of the fluids specified in table I, the lubricant shall not flake or peel (see 4.3.6.1).

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TABLE I. Immersion fluids.

Fluid	Specification
Cleaning compound, solvent (for bore of small arms and automatic weapons)	MIL-PRF-372
Lubricating oil, general purpose, preservative (water displacing, low temperature)	MIL-PRF-32033
Hydraulic fluid, synthetic hydrocarbon	MIL-PRF-46170
Turbine fuel, aviation, kerosene type	MIL-DTL-83133, grade JP-8
Lubricating oil, aircraft	SAE J1966, SAE Viscosity Grade 50 (NATO Code O-117)
Lubricating oil, aircraft turbine	MIL-PRF-7808
Lubricant, cleaner and preservative for weapons	MIL-PRF-63460
Lubricating oil, low temperature, weapons	MIL-PRF-14107
Damping Fluid, Silicone Base (Dimethyl Polysiloxane)	VV-D-1078

3.6.2 Thermal stability. The lubricants shall not flake, crack, soften or lift from the test panels, and shall conform to the requirements for film adhesion (see 3.4.1), following exposure to temperature extremes (see 4.3.6.2).

3.6.3 Salt spray (fog) resistance. Phosphated steel panels with bonded lubricant shall not show more than three rust spots per panel after exposure to salt spray. Any rust spots shall not be greater than 1 mm in diameter (see table II and 4.3.6.3).

4. VERIFICATION

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

a. Qualification inspection (see 4.1.1).
b. Conformance inspection (see 4.1.2).

4.1.1 Qualification inspection. Qualification inspection shall consist of the tests specified in table II.

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TABLE II. Qualification inspection tests.

Requirement	Test Method	Verification
Endurance life (3.3.1) 1/	ASTM D2625 Procedure A 1/	4.3.3.1
Load-carrying capacity (3.3.2) 1/	ASTM D2625 Procedure B 1/	4.3.3.2
Film adhesion (3.4.1)	ASTM D2510 Procedure A 1/	4.3.4.1
Film thickness (3.4.2)		4.3.4.2
Aluminum	ASTM D7091 or ASTM B244	
Steel	ASTM D7091 or ASTM B499	
Spray pattern and duration (3.4.3)	---	4.3.4.3
Curing time (3.4.4)	---	4.3.4.4
Solids content (3.4.5)	---	4.3.4.5
Volatile organic compound (VOC) content (3.4.6)	ASTM D3960	4.3.4.6
Color (3.4.7)	---	4.3.4.7
Storage stability (3.5.1)	---	4.3.5.1
Toxicity (3.5.2)	---	4.3.5.2
Restricted materials (3.5.3)	---	4.3.5.3
Fluid resistance (3.6.1)	ASTM D2510 Procedure C 1/, 3/	4.3.6.1
Thermal stability (3.6.2)	ASTM D2511 1/, 2/	4.3.6.2
Salt spray (fog) resistance (3.6.3)	ASTM B117 1/	4.3.6.3

1/ For surface cleaning, use only non-ODS cleaning solvents in these test method procedures. A recommended substitute is aliphatic naphtha. An environmentally compliant cleaner may be used which sufficiently cleans surfaces to pass ASTM F22 but does not cause damage to the surface (for example, hydrogen embrittlement).

2/ Perform this test with the following exception: Use anodized aluminum panels as prescribed in ASTM D2510 and an oven temperature of 191 ± 3°C.

3/ Make two parallel scratches one hour after drying.

4.1.2 Conformance inspection. Conformance inspection shall consist of the following tests:

a. Endurance life (see 3.3.1).
b. Film adhesion (see 3.4.1).
c. Solids content (see 3.4.5).
d. Salt spray (fog) resistance (see 3.6.3).

4.2 Order of inspection. Perform environmental tests first, followed by the remaining verifications in any sequence.

4.3 Verification methods. The types of verification methods included in this section are visual, inspection, measurement, sample tests, full-scale demonstration tests, simulation, modeling, engineering evaluation, component properties analysis, and similarity to previously-approved or previously-qualified designs.

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4.3.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost-effective sampling procedures, to verify performance. See the contract for alternatives that replace verifications required by this specification.

4.3.2 Inspection conditions.

4.3.2.1 Atmospheric conditions. Unless otherwise specified, all examinations and tests shall be performed at a temperature of 25 ± 3.0°C (77 ± 5.4°F) and at a relative humidity of 50 ± 20%.

4.3.2.2 Preparation of aluminum test specimens. Test panels made from aluminum alloy 2024, shall measure approximately 0.5 mm by 76 mm by 152 mm and shall be sulfuric acid anodized and sealed. The panels shall be pre-cleaned with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans the surfaces to pass ASTM F22. The lubricant shall be applied to the panels in accordance with (IAW) Appendix A in a well-ventilated area or hood where no flame or ignition source is present. Only one side of each panel shall be fully coated, except for two of the anodized aluminum panels which shall have the lubricant applied to a 25.4 mm wide strip to enable measurement of the film thickness. A spray application technique shall be used to coat the panels for the tests specified herein. Test panels shall be cured at 25± 2.0°C (77 ±3.6°F) for a minimum of 18 hours for Type I and a minimum of 24 hours for Type II. Three coats shall be the maximum number required to obtain the specified film thickness (see 3.4.2). At least two test panel specimens shall be used in each test method. A total of 24 aluminum panels are required for testing IAW performance requirements.

4.3.2.3 Preparation of steel test specimens. The test panels shall measure approximately 3.2 mm by 76 mm by 152 mm. The panels shall be pre-cleaned with aliphatic naphtha or an EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. The panels shall have both faces and all edges grit-blasted with 180-220 grit aluminum oxide for a surface finish of 20-40 microinches (μin.). Phosphate the panels (weight should be 15 - 25 g/m^2) IAW MIL-DTL-16232, type M. The lubricant shall be applied IAW Appendix A in a well-ventilated area or hood where no flame or ignition source is present. A spray application technique shall be used to coat the panels for the tests specified herein. Test panels shall be cured at 25± 2.0°C (77 ±3.6°F) for a minimum of 18 hours for Type I and a minimum of 24 hours for Type II. Three coats shall be the maximum number required to obtain the specified film thickness (see 3.4.2). At least two test panel specimens shall be used in each method. A total of two steel panels and six sets of pins and vee blocks are required for testing IAW performance requirements.

4.3.3 Operating requirements verification.

4.3.3.1 Endurance life. Test pins and vee blocks shall be tested IAW ASTM D2625, Procedure A to verify the minimum endurance life of 120 minutes for type I or 90 minutes for type II (see 3.3.1). The endurance life shall be determined by averaging the results of four tests,

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with the result of no individual test being less than 100 minutes for type I or 75 minutes for type II. Prior to testing, panels shall be cleaned with aliphatic naphtha, followed by acetone or any environmentally safe cleaner that cleans surfaces to pass ASTM F22 (see 4.3.2.3).

4.3.3.2 Load-carrying capacity test. Test pins and vee blocks shall be tested IAW ASTM D2625, Procedure B to verify the minimum load-carrying capacity of 11 120 N (2500 lbf) (see 3.3.2). The load-carrying capacity shall be determined by averaging the results of two tests, with the result of no individual test being less than 8950 N (2000 lbf). The tests shall be conducted using the 20 000 N (4500 lbf) load gage. Prior to testing, panels shall be cleaned with aliphatic naphtha, followed by acetone or any environmentally safe cleaner that cleans surfaces to pass ASTM F22 (see 4.3.2.3).

4.3.4 Interface requirements verification.

4.3.4.1 Film adhesion. Test panels prepared per 4.3.2.2, shall be tested IAW ASTM D2510, Procedure A to verify that no bare metal surface is exposed (see 3.4.1). A uniform deposit of powdery material clinging to the removed test tape shall not be considered a failure.

4.3.4.2 Film appearance and thickness. To determine conformance to 3.4.2, the bonded lubricant specimens shall be examined visually and microscopically at a magnification of 12X for uniformity in color, smoothness and evidence of cracks, scratches, pinholes, blisters, bubbles, runs, sags, foreign matter, grit, rough particles, and separation of ingredients.

4.3.4.2.1 Film thickness on aluminum panels. The thickness of bonded lubricant on aluminum panels prepared per 4.3.2.2 shall be measured IAW ASTM B244 or ASTM D7091 to verify the thickness requirement of 0.008 to 0.013 mm (see 3.4.2).

4.3.4.2.2 Film thickness on steel panels. The thickness of bonded lubricant on steel panels prepared per 4.3.2.3 shall be measured IAW ASTM B499 or ASTM D7091 to verify the thickness requirement of 0.008 to 0.013 mm (see 3.4.2).

4.3.4.3 Spray pattern and duration (lubricants in gas-pressurized cans only). Select a new, unused spray container. The temperature of the spray container and the ambient air shall be 25 ± 2.0°C (77 ± 3.6°F). In a vertical position, fasten either a sheet of white paper on which two parallel lines have been drawn 38 mm apart, or a sheet of rectangular coordinate graph paper containing lines 38 mm apart. Position the spray container 250 ± 12.5 mm from the paper. Open the valve fully and, with a stopwatch, determine the time required to exhaust the container. The spray shall be effective for a minimum of 290 seconds. Measure the width of the spray pattern using the parallel lines on the sheet of paper. Agitate the can frequently during the spray procedure (see 3.4.3). (The effective spray is one that carries the pigment together with the resin required for bonding.)

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4.3.4.4 Curing time. Maintain the test samples from 4.3.4.3 at 25 ± 2.0°C (77 ± 3.6°F). Examine the samples after 30 minutes (for type I lubricants) or 90 minutes (for type II lubricants) and verify that the applied lubricant is dry to the touch IAW 3.4.4. After 18 hours (for type I) or 24 hours (for type II), subject the test samples to film adhesion test IAW ASTM D2510, Procedure A. Lubricant shall be considered fully cured if no loss of adhesion is shown.

4.3.4.5 Solids content.

4.3.4.5.1 Lubricants in non-pressurized cans test. Stir the lubricants thoroughly to provide a uniform dispersion. Weigh 5.0 ± 0.5 g of the lubricant into a weighing dish with a diameter of approximately 70 mm (Fisher Scientific Co. Catalog No. 8-732-102 or equivalent). Place the dish and contents in a force-draft oven maintained at 49 ±3.0°C (120 ± 5.2°F) for 18 ±1 hour. Remove the dish and contents from the oven, place them in a desiccator, and allow them to cool to 25 ± 3.0°C (77 ± 5.4°F). Remove the dish and contents from the desiccator and weigh them. Repeat the procedure to constant weight. Calculate the percent by weight of the solid material in the fluid lubricant from the formula:

$$\text{Percent total solids} = \frac{\text{Weight of solid materials}}{\text{Weight of sample}} \times 100$$

Verify that the percent by weight of solids is not less than 24% (see 3.4.5.1).

4.3.4.5.2 Lubricants in gas-pressurized cans test. Select a new, unused spray container for the total solids test. Place it in an upright position in a solid carbon dioxide cabinet (dry ice cabinet) overnight to reduce the internal pressure. Remove the container from the cold cabinet and immediately pierce a small hole in the top of the container with a sharp punch. Permit the container to warm to 25 ± 3.0°C (77 ± 5.4°F) in an upright position, in a well-ventilated area. When all the gas has escaped from the container, remove the top of the container. Transfer quantitatively the contents of the container to a 600 milliliters (mL) (0.16 gal) beaker previously weighed to the nearest 0.1 g (0.004 oz). Rinse the container twice with an appropriate solvent (as recommended by the manufacturer) or distilled water for water based coating, and add the rinsings to the beaker. Remove the agitator (usually a glass marble or a small steel ball) from the beaker, rinse it with the solvent and return it to the empty container. Add the solvent rinsing used to clean the agitator to the beaker. Place the beaker in an explosion-proof oven operated at 49 ± 3.0°C (120 ± 5.2°F). Permit the beaker to remain in the oven overnight. Remove the beaker, permit it to cool to 25 ± 3.0°C (77 ± 5.4°F) and weigh to a constant weight. Calculate the weight of total solids from the following formula:

Weight of beaker and total solids - weight of beaker = Weight of total solids

Verify that each can shall contain not less than 30 g (1 oz) of total solids (see 3.4.5.2).

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4.3.4.6 VOC content (type II only) test. The VOC content shall be determined IAW ASTM D3960 to verify the maximum value of 250.0 g/L (33.4 oz/gal) (see 3.4.6). For the calculation of the VOC content, the weight percent of water shall be determined IAW ASTM D4017, and the weight percent of the exempt solvents shall be determined IAW ASTM D4457.

4.3.4.7 Color. To verify conformance to 3.4.7, the Color 2 lubricant (see 1.2.3) shall be visually examined to verify that its color is not lighter than Gray No. 36076 of FED-STD-595.

4.3.5 Support and ownership requirements verification.

4.3.5.1 Storage stability.

4.3.5.1.1 Lubricant in non-pressurized cans. To determine conformance to 3.5.1, set aside a one quart qualification sample in a storage area maintained at 25 ± 3.0°C (77 ± 5.4°F) for a period of 365 ± 7 days. At the end of the storage period, the lubricant shall be subjected to and pass all applicable tests of this specification.

4.3.5.1.2 Lubricant in gas-pressurized cans. To determine conformance to 3.5.1, select two new, unused spray cans and place them in a storage area maintained at 25 ± 3.0°C (77 ± 5.4°F) for a period of 365 ± 7 days. At the end of the storage period, the lubricant shall be subjected to and pass all applicable tests of this specification.

4.3.5.2 Toxicity. The qualifying activity (see 6.3), shall be consulted by the appropriate departmental medical service to verity that the lubricant does not adversely effect human health (see 3.5.2).

4.3.5.3 Restricted materials. The contractor shall provide certification attesting that no ozone depleting substances, graphite, lead or lead-containing compounds, powdered metals, carbon black, charcoal or other forms of inorganic carbon are used in the manufacturing of either liquid or applied forms (see 3.5.3).

4.3.6 Environmental requirements verification.

4.3.6.1 Fluid resistance. To verify conformance to 3.6.1, the test panels shall be tested IAW ASTM D2510, Procedure C to verify that no bare metal surface is exposed. A uniform deposit of powdery material clinging to the removed test tape shall not be considered a failure. Prior to testing, panels shall be cleaned with aliphatic naphtha, followed by acetone or any environmentally safe cleaner that cleans surfaces to pass ASTM F22.

4.3.6.2 Thermal stability. To verify conformance to 3.6.2, the test panels shall be tested IAW ASTM D2511 to verify the absence of flaking, cracking, softening or lifting of the lubricants (see 3.4.1). Any condensation shall be removed from the test panels with clean,

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compressed air prior to the panels being subjected to the film adhesion test. Prior to testing, panels shall be cleaned with aliphatic naphtha, followed by acetone or any environmentally safe cleaner that cleans surfaces to pass ASTM F22.

4.3.6.3 Salt spray (fog) resistance. To verify conformance to 3.6.3, the test panels shall be exposed to a 5% salt spray solution for 100 hours in a salt fog cabinet IAW ASTM B117. Following the exposure, the panel shall be examined, and evidence of more than three rust spots, or any rust spots greater than 1 mm in diameter, shall result in failure of the test (see 3.6.3). Bonded lubricant thickness on test panels shall conform to 3.4.2.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel 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 solid film lubricants covered by this specification is military unique due to requirement that its performance should not be degraded as a result of exposure to the military unique fluids specified in table I. The lubricant is intended for use on aluminum, aluminum alloys, copper and copper alloys, steel, stainless steel, titanium, and chromium and nickel bearing surfaces. Solid film lubricants are often used on weapons, ground vehicles, and ground handling equipment. They are used for thin film lubricant for sliding motion application and under conditions where heavy-load capacity, solvent resistance, and long term corrosion protection are needed. All end items should have the lubricant applied IAW Appendix A of this document. It is useful under the following conditions:

a. Where conventional lubricants are difficult to apply or retain.
b. Where dust and dirt contamination on lubricated surfaces is deleterious.
c. Where temperatures may range from -67.0°C to +93.0°C (-88.6°F to 199.4°F).
d. In mechanisms operated at infrequent intervals.
e. In mechanisms that are lubricated for the life of the mechanism.
f. Where long-term corrosion protection is required.
g. Where a dull, dark gray or black non-reflective surface is required.

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h. Where a sacrificial lubricant is necessary to carry extremely heavy loads developed in the initial start-up of heavily loaded mechanism designed for fluid lubrication. In operations consisting of reciprocating motion, loaded to 15 pounds per square inch (psi) (103 kilopascals (kPa)) or less, where contamination with conventional fluid lubricants are probable.
i. To touch up worn surfaces originally coated with lubricant conforming to MIL-PRF-46010.
j. For sliding motion applications such as plain and spherical bearings, flap tracks, hinges, threads, and cam surfaces.

6.1.1 Use limitations. The lubricants should not be used under the following conditions:

a. In operations consisting of rotary motion above 100 revolutions per minute (rpm) under heavy loads where the possibility of conventional fluid lubricant contamination exists. The cured lubricant film is highly resistant to conventional fluid lubricants, but the high fluid pressures developed in heavily loaded sleeve type bearings drastically reduces the wear life provided by the solid film lubricant film.
b. On bearings containing rolling elements.

6.1.2 Corrosion protection life. This lubricant can be expected to provide corrosion protection for five years in indoor storage and approximately two years protection in outdoor storage when the lubricant is applied over phosphated steel to a thickness of 0.013 mm. Where maximum corrosion protection of steel is desired, the lubricant should be applied over phosphated steel to a thickness of 0.025 mm. This heavier coating can be expected to provide outdoor corrosion protection for approximately four years.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Type of lubricants, form of container (pressurized or non-pressurized cans), and color required (see 1.2).
c. If required, the specific issue of documents referenced (see 2.2.1 and 2.3).
c. Quantity of lubricants required.
d. 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 set for contract award, qualified 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 contractor is called to this requirement, and 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 orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Fuels and Lubricants Technology Team, AMSRD-TAR-D/210 (FLTT), U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI

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48397-5000, and information pertaining to qualification of products may be obtained from that activity. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Subject term (key word) listing.

Aerosol cans
Dry lubrication
Gas-pressurized
Protection
Volatile organic compound

6.5 Reserved.

6.6 End item testing. When possible, it is recommended that film thickness and adhesion be tested when the lubricant has been applied to an end item. Testing with laboratory coupons and test panels does not always correlate with lubricant performance when applied to an actual end item.

6.7 Material Safety Data Sheets (MSDS). Contracting officers should identify those activities requiring copies of MSDS's prepared IAW FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313; and 29 CFR 1910.1200 requires that the MSDS for each hazardous chemical used in an operation must be readily available to personnel using the material. Contracting officers should identify the activities requiring copies of the MSDS.

6.8 Explanation of restricted materials. (See 3.5.3)

6.8.1 Exclusion of graphite and powdered metals. In previous experience, graphite, powdered metals, carbon black, charcoal or other forms of inorganic carbon have caused accelerated corrosion, due to the galvanic reaction that occurs between the coated surface and the coating. The exclusion of graphite permits the use of this product in high vacuum, since graphite is not a lubrication solid without moisture or adsorbed air.

6.8.2 Exclusion of lead and lead compounds. Historically, products under MIL-PRF-46147 were permitted to contain lead compounds because no alternative existed. Products have since been developed that conform to the requirements of this specification but do not require the use of lead compounds. The exclusion is inserted in order to prevent lead pollution.

6.9 Definitions.

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6.9.1 Lead-containing compound.

a. Any chemical compound that contains the chemical element Pb.
b. Chemical mixtures containing compounds that contain the chemical element Pb are also considered lead-containing compounds.

6.10. Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

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INSTRUCTIONS FOR APPLYING LUBRICANT, SOLID FILM, AIR CURED (CORROSION INHIBITING)

A.1. SCOPE

A.1.1 Scope. This appendix covers in detail the surface pretreatment, temperature, and time required to cure the solid film lubricant when it is applied over the bearing surfaces of various metals. This appendix is a mandatory part of the specification unless otherwise specified in the contract, purchase order, end item drawing or end item specification. This appendix is NOT mandatory for fastener hardware unless otherwise specified. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.2.1 Government documents.

A.2.1.1 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 cited in the solicitation or contract (see 6.2).

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys.

(Copies of the above these documents are available online at http://quicksearch.dla.mil or from the Standardization Document Order Desk, 700 Robbins Ave, Bldg 4D, Philadelphia, PA 19111-5094.)

A.2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents are those cited in the solicitation or contract (see 6.2).

ASTM INTERNATIONAL

ASTM A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts (DoD Adopted).
ASTM D1125 - Standard Test Methods for Electrical Conductivity and Resistivity of Water (DoD Adopted).
ASTM D1732 - Standard Practices for Preparation of Magnesium Alloy Surfaces for Painting

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(Copies of the above docmuments are available from www.astm.org or from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

A.3. REQUIREMENTS

A.3.1 General application instructions for all metals. Do not touch the pre-treated surfaces with fingers. Stir the lubricants until thoroughly mixed, using a low-shear mixing blade. A mechanical paint shaker may be used for type I, but is not recommended for type II as excessive foaming with waterborne products may occur. Minor viscosity adjustments to type II may be made by adding deionized water IAW A.3.1.1. Ordinary tap water shall not be used. Apply the lubricants by brushing, dipping, or spraying to a nominal film thickness of 0.010 mm with no reading less than 0.005 mm or greater than 0.018 mm and permit the coated parts to air dry. The application of the coating to parts shall be as specified in A.3.2 through A.3.7 unless otherwise specified in the contract or purchase order.

A.3.1.1 Deionized water. Any water used for dilution of water-based lubricants shall have a resistivity not less than 1 megaohm-centimeter (MΩ-cm) when measured IAW ASTM D1125.

A.3.2 Application on aluminum and aluminum alloys. Preclean the aluminum surface with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. Sulfuric acid anodize IAW MIL-A-8625 and seal the surface.

A.3.3 Application on copper and copper alloys. Preclean the copper surface with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. Sandblast the surfaces with 180-220 grit aluminum oxide. Form a black oxide finish on the surfaces.

A.3.4 Application on magnesium and magnesium alloys. Preclean the magnesium surface with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. Anodize the surface in accordance to ASTM D1732 Class II Type II or III.

A.3.5 Application on steel. Preclean the steel surface with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. Sandblast the surfaces with 180-220 grit aluminum oxide. Phosphate IAW MIL-DTL-16232 (weight should be 11-22 g/m^2), type M, class 3 or type Z, class 3.

A.3.6 Application on stainless steels. Preclean the steel surface with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. Sandblast the surfaces with 120-grit aluminum oxide. Passivate the surfaces with ASTM A967, types nitric 1, nitric 2 or nitric 3, as applicable.

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A.3.7 Application on titanium and titanium alloys. Degrease the surfaces to be coated with aliphatic naphtha or any other EPA compliant cleaner that sufficiently cleans surfaces to pass ASTM F22. Sandblast the surface with 180-220 grit aluminum oxide and alkaline anodize.

A.3.8 Engineering tolerances. The operating thickness of this lubricant averages from 0.008 to 0.013 mm per lubricated surface. This thickness seldom requires alteration of established clearances between moving parts. There is one exception. The lubricant coating thickness must be considered in the case of small parts that normally operate with very little clearance. The cured lubricant film is relatively soft and any interference produced by the thickness of the lubricant will cause rapid wear of the lubricant film to the point where interference is eliminated

Custodians:
Army - AT
Navy - AS
Air Force – 68

Preparing Activity:
Army - AT

(Project 9150-2013-008)

Review Activities:
Army - AV, MD, MI
Navy - OS
Air Force - 11
DLA - GS, PS

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