NOT MEASUREMENT SENSITIVE

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PERFORMANCE SPECIFICATION

LUBRICANT, SOLID FILM, HEAT 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 corrosion inhibiting, heat cured, solid film lubricants, hereinafter referred to as "lubricants", for the reduction of wear and prevention of galling, corrosion, and seizure of metals (see 6.1).

1.2 Classification. Lubricants are of the following colors (see 6.2 and 6.10):

Color 1 - Natural product color
Color 2 – Black (see 3.4.5)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/IE, Warren, MI 48397-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 9150

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 the list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 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 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

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

DEPARTMENT OF DEFENSE

MIL-PRF-372	-	Cleaning Compound, Solvent (for Bore of Small Arms and Automatic Aircraft Weapons).
MIL-A-8243	-	Anti-icing and Deicing - Defrosting Fluids.
MIL-A-8625	-	Anodic Coatings for Aluminum and Aluminum Alloys.
MIL-L-14107	-	Lubricating Oil, Weapons, Low Temperature.
MIL-DTL-16232	-	Phosphate Coating, Heavy, Manganese or Zinc Base.
MIL-PRF-23699	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-156.
MIL-L-46000	-	Lubricant, Semi-Fluid (Automatic Weapons).
MIL-H-46170	-	Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base.
MIL-PRF-63460	-	Lubricant, Cleaner and Preservative for Weapons and Weapons Systems.
MIL-DTL-83133	-	Turbine Fuels, Aviation, Kerosene Types, NATO F-34 (JP-8), NATO F-35, and JP-8+100.
MIL-PRF-85336	-	Lubricant, All-Weather (Automatic Weapons).

STANDARDS

FEDERAL

FED-STD-595	-	Colors Used in Government Procurement.
FED-STD-791	-	Lubricants, Liquid Fuels, and Related Products; Methods of Testing.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 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 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 SOCIETY OF TESTING MATERIALS (ASTM)

ASTM A108	-	Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality (DoD adopted).
ASTM A167	-	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip (DoD adopted).
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 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 D1141	-	Standard Practice for the Preparation of Substitute Ocean Water (DoD adopted).
ASTM D1186	-	Standard Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (DoD adopted).
ASTM D1193	-	Standard Specification for Reagent Water (DoD adopted).

ASTM D1400	-	Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base (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 D2649	-	Standard Test Method for Corrosion Characteristics of Solid Film Lubricants (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 F22	-	Standard Test Method for Hydrophobic Surface Films by the Water-Break Test.

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

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS-QQ-A-250/5	-	Aluminum Alloy Alclad 2024, Plate and Sheet (DoD adopted).

(Application for copies should be addressed to 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. The lubricants furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.1.1 and 6.3). Any change in the formulation of a qualified product will necessitate its requalification.

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. The bonded lubricant shall have a minimum endurance life of 450 minutes at a load of 4450 newtons (N) (see 4.3.3.1).

3.3.2 Load-carrying capacity. The bonded lubricant shall have a minimum load-carrying capacity of 11 120 N (see 4.3.3.2).

3.4 Interface requirements.

3.4.1 Film adhesion. The bonded lubricant shall adhere to applicable metal surfaces (see 4.3.4.1 and 6.1).

3.4.2 Film appearance and thickness. The bonded lubricant shall appear uniform in color and shall be smooth, free from any cracks, scratches, pinholes, blisters, bubbles, runs, sags, foreign matter, grit, rough particles, or separation of ingredients (see 4.3.4.2). The coating thickness shall be between 0.008 and 0.013 millimeters (mm) (see 4.3.4.2.1 and 4.3.4.2.2). Any measurement of coating thickness shall not be less than 0.005 mm or greater than 0.018 mm.

3.4.3 Solids content. The lubricant shall not contain less than 40 percent (%) by weight of solid material (see 4.3.4.3).

3.4.4 Volatile organic compound (VOC) content. The VOC content of the fluid lubricant shall not exceed 250 grams per liter (g/L) of lubricant less water and exempt volatile compounds (see 4.3.4.4).

3.4.5 Color. The lubricant supplied in Color 2 (see 1.2) shall not be lighter than color No. 36076 (gray) of FED-STD-595 (see 4.3.4.5 and 6.4).

3.5 Support and ownership requirements.

3.5.1 Storage stability. The fluid lubricant shall conform to the requirements for endurance life (see 3.3.1), sulfurous acid-salt spray resistance (see 3.6.4), and salt spray (fog) resistance (see 3.6.5) following storage at 25 ± 3°C for a period of 365 ± 7 days (see 4.3.5.1).

3.5.2 Toxicity. The lubricant shall have no adverse effects on human health when it is used as intended (see 4.3.5.2 and 6.1).

3.5.3 Restricted materials. The lubricant shall contain no lead or lead-containing compounds, graphite, powdered metal, or ozone-depleting substances in either liquid or cured form (see 4.3.5.3 and 6.6).

3.6 Environmental requirements.

3.6.1 Resistance to fluids. After immersion in each of the fluids as specified in table I, the bonded lubricant shall not soften, lift, blister, crack, or peel (see 4.3.6.1).

TABLE I. Test fluids.

Test fluid	Specification
Anti-icing fluid	MIL-A-8243
Cleaning compound, solvent (for bore of small arms and automatic aircraft weapons)	MIL-PRF-372
Reagent water	ASTM D1193, Type III
Substitute ocean water	ASTM D1141
Hydraulic fluid, rust inhibited, fire resistant, synthetic hydrocarbon base	MIL-H-46170
Turbine fuel, aviation, kerosene type	MIL-DTL-83133, JP-8
Lubricating oil, aircraft turbine engine, synthetic base	MIL-PRF-23699
Damping fluid, silicone base (dimethyl polysiloxane)	VV-D-1078
Lubricating oil, weapons, low temperature	MIL-L-14107
Lubricant, semi-fluid (automatic weapons)	MIL-L-46000
Lubricant, cleaner and preservative for weapons and weapons systems	MIL-PRF-63460
Lubricant, all-weather (automatic weapons)	MIL-PRF-85336

3.6.2 Thermal stability. The bonded lubricant shall not flake, crack, or lift from 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 Aluminum corrosion resistance. Aluminum panels with bonded lubricant shall show no discoloration, pitting, formation of white deposits, or other evidence of corrosion when exposed to heat and high humidity (see 4.3.6.3).

3.6.4 Sulfurous acid-salt spray resistance. Steel panels with bonded lubricant shall show no resultant pitting, visible corrosion, or staining when exposed to sulfurous acid-salt spray (see 4.3.6.4).

3.6.5 Salt spray (fog) resistance. Steel panels with bonded lubricant shall not show more than three rust spots per panel following exposure to salt spray (see 4.3.6.5). Any rust spots shall not be greater than 1.0 mm in diameter.

4. VERIFICATION

4.1 Classification of inspections. 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. The qualification inspection shall consist of the tests specified in table II.

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

a. Endurance life (see 3.3.1).
b. Film adhesion (see 3.4.1).
c. Solids content (3.4.3).
d. Salt spray (fog) resistance (see 3.6.5).

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

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

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 verification methods required by this specification.

TABLE II. Qualification inspection tests.

Requirement	Test Method	Verification
Endurance life (3.3.1) 1/	ASTM D2625 Procedure A	4.3.3.1
Load-carrying capacity (3.3.2) 1/	ASTM D2625 Procedure B	4.3.3.2
Film adhesion (3.4.1)	ASTM D2510 Procedure A	4.3.4.1
Film thickness (3.4.2)		4.3.4.2
Aluminum	ASTM D1400 or ASTM B244	
Steel	ASTM D1186 or ASTM B499	
Solids content (3.4.3)	---	4.3.4.3
Volatile organic compound (VOC) content (3.4.4)	ASTM D3960	4.3.4.4
Color (3.4.5)	---	4.3.4.5
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
Resistance to fluids (3.6.1)	ASTM D2510 Procedure C	4.3.6.1
Thermal stability (3.6.2)	ASTM D2511	4.3.6.2
Aluminum corrosion resistance (3.6.3)	ASTM D2649	4.3.6.3
Sulfurous acid/salt fog resistance (3.6.4)	FED-STD-791, Method 5331	4.3.6.4
Salt spray (fog) resistance (3.6.5)	ASTM B117	4.3.6.5

1/ Surfaces of test pins and vee-blocks shall be pretreated with phosphate in accordance with MIL-DTL-16232, Type Z or M, Class 3. After abrasive-blasting and phosphating, the coating weight shall be 16 ± 5 g/m^2. Type M phosphate shall be the default.

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°C and at a relative humidity of 50 ± 20%.

4.3.2.2 Preparation of test panels (aluminum and corrosion resistant steel). The panels shall be made from:

a. Aluminum alloy conforming to SAE AMS-QQ-A-250/5, anodized to conform to MIL-A-8625, type II sulfuric acid anodized, measuring approximately 0.5 mm by 76 mm by 152 mm; and
b. Corrosion resistant steel conforming to ASTM A167, and measuring approximately 0.9 mm by 76 mm by 152 mm.

The panels shall be pre-cleaned with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, without causing damage to the surface being cleaned. Both faces and all edges of corrosion resistant steel panels shall be abrasive blasted with 180-220 grit aluminum oxide. The lubricant shall be applied to the panels in accordance with 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. The after-cure thickness of the lubricant shall be 0.005 to 0.013 mm. The desired film thickness shall be achieved with a maximum of 3 coats. Air drying (at 25 ± 3°C for 10 minutes maximum) between coats is allowed. After the final coat has been applied, the coated specimens shall be allowed to air dry for 1 hour minimum, or be flash-cured at 72 ± 7°C for 10 to 30 minutes until dry to touch. The specimens shall then be placed in an air circulating oven at 150 ± 15°C for 120 ± 5 minutes. The specimens shall be removed from the oven and allowed to cool to room temperature. At least two test panel specimens shall be used in each test method. A total of 30 aluminum panels, and two corrosion resistant steel panels are required for testing in accordance with performance requirements of this specification.

4.3.2.3 Preparation of test panels, disks, pins and vee blocks (steel). The panels shall be made from steel conforming to ASTM A108, and shall measure approximately 3.2 mm by 76 mm by 152 mm. The panels shall be pre-cleaned with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, without causing damage to the surface being cleaned. Both faces and all edges of the panels shall be abrasive blasted with 180-220 grit aluminum oxide. The panels shall be phosphate-coated in accordance with MIL-DTL-16232, type Z or M (type M preferred), using ASTM B499 or ASTM D1186 to measure the thickness of the phosphated panels. Phosphate coating weight shall be 16 ± 5 grams per square meter (g/m^2). The lubricant shall be applied in accordance with Appendix A in a well-ventilated area or hood where no flame or ignition source is present. The steel panels shall be dipped or sprayed to the same thickness as specified for the aluminum panels (see 4.3.2.2). After air drying for a minimum of 1 hour (or flash-curing at 72 ± 7°C for 10 to 30 minutes until dry to touch), bake the panels in an air circulating oven at 204 ± 15°C for 60 ± 5 minutes. The specimens shall be removed from the oven and allowed to cool to room temperature. At least two test panel specimens shall be used in each test method. A total of two steel panels, two steel disks and six sets of pins and vee blocks are required for testing in accordance with performance requirements of this specification.

4.3.3 Operating requirements verifications.

4.3.3.1 Endurance life. Test pins and vee blocks prepared per 4.3.2.3 shall be tested in accordance with ASTM D2625, Procedure A to verify the minimum endurance life of 450 minutes (see 3.3.1 and 6.5). The endurance life shall be determined by averaging the results

of four tests, with the result of no individual test being less than 390 minutes. The tests shall be conducted using the 4500-pound (20 000-N) load gage.

4.3.3.2 Load-carrying capacity. Test pins and vee blocks prepared per 4.3.2.3 shall be tested in accordance with ASTM D2625, Procedure B to verify the minimum load-carrying capacity of 11 120 N (see 3.3.2 and 6.5). The load-carrying capacity shall be determined by averaging the results of two tests, with the result of no individual test being less than 10 000 N. The tests shall be conducted using the 4500-pound (20 000-N) load gage.

4.3.4 Interface requirements verifications.

4.3.4.1 Film adhesion. Test panels prepared per 4.3.2.2 shall be tested in accordance with 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. 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 (see 3.4.2).

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 in accordance with ASTM B244 or ASTM D1400 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 in accordance with ASTM B499 or ASTM D1186 to verify the thickness requirement of 0.008 to 0.013 mm (see 3.4.2).

4.3.4.3 Solids content. After stirring the lubricant thoroughly, weigh 5.0 ± 0.5 grams (g) (measurement shall be to a resolution of 0.1 g or better.) into a disposable weighing dish (Fisher Scientific catalog number 08-732 or equivalent). Place the dish and contents into a forced draft oven maintained at a temperature of 49 ± 3°C for 18 ± l hours. Remove dish from oven and place in a desiccator charged with calcium sulfate. Increase temperature of oven to 204 ± 3°C and place dish with residue into the oven for l additional hour. Remove dish from oven, and place in the desiccator. When cool, weigh dish and contents. Calculate percent by weight of solids in fluid lubricant as follows:

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

Verify that the percent by weight of solids is not less than 40% (see 3.4.3).

4.3.4.4 VOC content. The VOC content, expressed as the mass of VOC per unit volume of coating less water and exempt volatile compounds, shall be determined in accordance with ASTM D3960 to verify the maximum value of 250 g/L (see 3.4.4). For the calculation of the VOC content, the weight percent of water shall be determined in accordance with ASTM D4017, and the weight percent of the exempt solvents shall be determined in accordance with ASTM D4457.

4.3.4.5 Color. The Color 2 lubricant (see 1.2) shall be visually examined to verify that its color is not lighter than gray No. 36076 per FED-STD-595 (see 3.4.5).

4.3.5 Support and ownership requirements verifications.

4.3.5.1 Storage stability. Set aside a one-quart qualification sample in a storage area maintained at 25 ± 3°C for a period of 365 ± 7 days. At the end of the storage period, conduct the tests for the endurance life (see 4.3.3.1), sulfurous acid-salt spray resistance (see 4.3.6.4), and salt spray (fog) resistance (see 4.3.6.5) of the cured lubricant film (see 3.5.1).

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

4.3.5.3 Restricted materials. The contractor shall provide certification to verify that the lubricant does not contain any of the materials listed in 3.5.3.

4.3.6 Operating environment requirements verifications.

4.3.6.1 Resistance to fluids. Test panels prepared per 4.3.2.2 shall be tested in accordance with ASTM D2510, Procedure C to verify that no bare metal surface is exposed (see 3.6.1). 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. Test panels prepared per 4.3.2.2 shall be tested in accordance with ASTM D2511 to verify the absence of flaking, cracking, or lifting of the lubricant (see 3.6.2). Any condensation shall be removed from the test panels with clean, 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 Aluminum corrosion resistance. Test panels prepared per 4.3.2.2 shall be tested in accordance with ASTM D2649 to verify the absence of corrosion (see 3.6.3). Bonded lubricant thickness on test panels shall conform to 3.4.2.

4.3.6.4 Sulfurous acid-salt spray resistance. Test panels prepared per 4.3.2.3 shall be tested in accordance with FED-STD-791, Method 5331 to verify the absence of pitting, corrosion, or staining (see 3.6.4). The panels shall be subjected to four cycles, with each cycle consisting of a 2-hour spraying period and a 24-hour drying period.

4.3.6.5 Salt spray (fog) resistance. Test panels prepared per 4.3.2.3 shall be exposed to a 5% salt spray solution for 100 hours in a salt fog cabinet in accordance with ASTM B117 to verify the minimum quantity of three rust spots per panel (see 3.6.5). 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 which may be helpful, but is not mandatory).

6.1 Intended use. The lubricant covered by this specification is military unique due to the 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 and aluminum alloys, copper and copper alloys, steel, stainless steel, titanium, and chromium and nickel bearing surfaces (see appendix for application instructions), and is useful under the following conditions:

a. To touch up worn surfaces originally coated with lubricant conforming to MIL-L-8937, MIL-L-46010 or MIL-PRF-46010.
b. For sliding motion applications such as plain and spherical bearing, flap tracks, hinges, threads, and cam surfaces.
c. Where conventional lubricants are difficult to apply or retain, or where other lubricants may be easily contaminated with dirt and dust.
d. Where temperature may range from –68°C to +204°C (although intermittent exposure to +260°C is acceptable)
e. If mechanisms are operated at infrequent intervals or are lubricated for life.
f. Where long-term corrosion protection is required under static conditions.

g. Where a solvent-resistant coating is required.
h. Where a lubricant requires extremely heavy load ability in the initial start-up of heavy loaded mechanisms designed for fluid lubrication.

6.1.1 Use limitations. This lubricant should not be used under the following conditions:

a. On materials which will be adversely affected by the curing temperatures of 204 ± 15°C.
b. 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 lubricant film.
c. On bearings containing rolling elements.
d. Where there is potential contact with liquid oxygen.
e. If more than 12 months have elapsed since the date of manufacture.

6.1.2 Corrosion protection life. This lubricant, when under static conditions, can be expected to provide corrosion protection for 5 years in indoor storage and approximately 2 years protection in outdoor storage when lubricant is applied over phosphated steel to a thickness of 0.013 mm. Where maximum corrosion protection on steel is desired, the lubricant should be applied over phosphated steel to a thickness of 0.025 mm. The heavier coating can be expected to provide outdoor corrosion protection for approximately 4 years.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.
b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
c. Color required (see 1.2).
d. Packaging requirements (see 5.1).
e. Federal Acquisition Regulation clause 52.223-3.
f. Specify application and surface preparation requirements (see appendix).

6.2.1 Age limitation. The lubricant should not be ordered for use beyond 12 months from the date of manufacture.

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 Products List (QPL No. 46010) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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 purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from US Army Tank-automotive and Armaments Command, AMSTA-TR-D/210 (FLTT), Warren, MI 48397-5000. Products will not be considered for inclusion in QPL-46010 until such time as appropriate departmental medical activity has reviewed all pertinent material safety data sheets (FED-STD-313).

6.4 Color. The lubricant (see 3.4.5) should closely match color No. 37038 (black) of FED-STD-595.

6.5 Falex lubricant tester. Information pertaining to the Falex lubricant tester (see 4.3.3.1 and 4.3.3.2) can be obtained from the Falex Corporation, 1020 Airpark Drive, Sugar Grove, IL 60554. The attention of the operator is called to the fact that repeatable and reproducible test results can only be obtained if the test instrument is in proper calibration.

6.6 Explanation of restricted materials. (See 3.5.3).

6.6.1 Exclusion of graphite and powdered metals. In previous experience, graphite and powdered metals have cause 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 lubricating solid without moisture or adsorbed air.

6.6.2 Exclusion of lead and lead compounds. Historically, products under MIL-L-46010 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.

6.7 Application to end item. The lubricant should be applied in accordance with appendix A (unless otherwise specified in the contract or purchase order) over surfaces that have been pre-treated as specified in appendix A (unless otherwise specified in the contract or purchase order).

6.8 End item testing. When possible, it is recommended that film thickness and adhesion be tested when lubricant has been applied to an end item. Testing with laboratory coupons and test panels may not fully support lubricant performance when applied to actual end item.

6.9 Disposal. Place in non-leaking containers and dispose of containers in accordance with latest EPA, state and local regulations.

6.10 Classification changes. MIL-PRF-46010F eliminates the type I and type II lubricants specified in MIL-L-0046010E, which have been superseded for aerospace component applications by SAE Aerospace Standard AS5272, types I and II, respectively. The lubricant specified herein meets VOC content restrictions of a maximum 250 g/L. It can be cured at either 150 ± 15°C for 2 hours or 204 ± 15°C for 1 hour. When cured at either temperature, it will meet all performance requirements in this specification (performance requirements will often be exceeded by the lubricant when cured at the higher temperature).

6.11 Material Safety Data Sheets (MSDS). Contracting officers will identify those activities requiring copies of MSDS's prepared in accordance with 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 will identify the activities requiring copies of the MSDS.

6.12 Definitions.

6.12.1 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.

6.13 Subject term (key word) listing.

Adhesion
Friction
Surface
Wear

6.14 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.

APPENDIX A

INSTRUCTIONS FOR APPLYING LUBRICANT, SOLID-FILM, HEAT-CURED, CORROSION INHIBITING

A.1 SCOPE

A.1.1 Scope. This appendix establishes the surface pretreatment, temperature, and baking time required to cure the lubricant when it is applied over the bearing surfaces of manufactured parts of various metals. This appendix is a mandatory part of this specification, except for fastener hardware applications. 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 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

MILITARY

MIL-M-45202 - Magnesium Alloy, Anodic Treatment of.

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

A.2.2 Non-Government publications. The following documents form a part of this document to the extend 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 issue of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)

A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

APPENDIX A

D1125 - Standard Test Methods for Electrical Conductivity and Resistivity of Water.

(Application for copies should be addressed to American Society Of Testing Materials 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 pretreated surfaces with the fingers. Stir the lubricant until thoroughly mixed, using a low shear mixing blade. A mechanical paint shaker is not recommended, as excessive foaming with waterborne products may occur. Minor viscosity adjustments may be made by adding deionized water according to A.3.1.1. Ordinary tap water shall not be used. Apply the lubricant 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. Permit the coated parts to air dry for at least 30 minutes (or flash cure at 65 to 70°C for 10 to 30 minutes) to assure complete removal of solvent. Bake the part so that the coated surface remains at 204 ± 15°C for at least one hour or 150 ± 15°C for at least two hours. The curing time shall be counted from the time the part reaches the cure temperature, not when the part is first subjected to heat. This may require that the coated piece remain in the oven for a period longer than that specified to assure compliance with this requirement. The use of a thermocouple attached to the coated surface to indicate the temperature of the coating has been found to be satisfactory for determining the beginning of the timed baking period. In addition, 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 for dilution. Any deionized water used shall have a resistivity not less than 1 megohm·centimeter (MΩ·cm), when tested in accordance with ASTM D1125.

A.3.2 Application on aluminum and aluminum alloys. Preclean the surfaces to be coated with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the metal surface (i.e. hydrogen embrittlement, etc). Anodize and seal the surface in accordance with MIL-A-8625, types I, II, or III, class l.

A.3.3 Application on copper and copper alloys. Preclean the surfaces to be coated with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Abrasive-blast the surfaces with 180-220 grit clean, dry sand. Form a black oxide finish on the surfaces.

A.3.4 Application on magnesium and magnesium alloys. Preclean the surfaces to be coated with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Anodize the surface in accordance with MIL-M-45202, type I, class A, B, or C.

A.3.5 Application on steel. Preclean the surfaces to be coated with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not damage the surface (i.e. hydrogen embrittlement, etc.). Abrasive-blast the surface with 180-220 grit aluminum oxide. Phosphate coat in accordance with MIL-DTL-16232, type M, class 3 or type Z, class 3. Coating weight shall be 16 ± 5 g/m^2.

A.3.6 Application on stainless steels. Preclean the surfaces to be coated with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Abrasive-blast the surfaces with 120-220 grit aluminum oxide. Passivate the surfaces in accordance with ASTM A967, nitric 1, nitric 2 or nitric 3 as applicable.

A.3.7 Application on titanium and titanium alloys. Degrease the surfaces to be coated with any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Abrasive-blast 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 9150-1241)

Review Activities:
Army - AL, AR, AV, MD, MI, SM
Navy - SA, SH
Air Force - 03, 11
DLA - GS, PS

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, 6, and 7, and send to preparing activity.

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-PRF-46010F	2. DOCUMENT DATE *(YYYYMMDD)* 20000810

3. DOCUMENT TITLE LUBRICANT, SOLID FILM, HEAT CURED, CORROSION INHIBITING

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) DSN *(If applicable)*	7. DATE SUBMITTED *(YYYYMMDD)*

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN (810) 574-8745 786-8745
c. ADDRESS *(Include Zip Code)* Commander U.S. Army Tank-automotive and Armaments Command ATTN: AMSTA-TR-E/IE Warren, MI 48397-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888