

NOT MEASUREMENT
SENSITIVE

MIL-PRF-46010H

13 November 2013

SUPERSEDING

MIL-PRF-46010G

06 August 2008

PERFORMANCE SPECIFICATION

LUBRICANT, SOLID FILM, HEAT CURED, CORROSION INHIBITING NATO CODE – S-1738

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

1. SCOPE

1.1 Scope. This specification establishes the requirements for a corrosion inhibiting heat cured solid film lubricant that is intended to reduce wear and prevent galling, corrosion, and seizure of metals (see 6.1). For aerospace component applications see 6.9 Notes.

1.2 Classifications. This specification establishes the following colors:

Color 1: - Natural product color.

Color 2: - Black color.

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>.

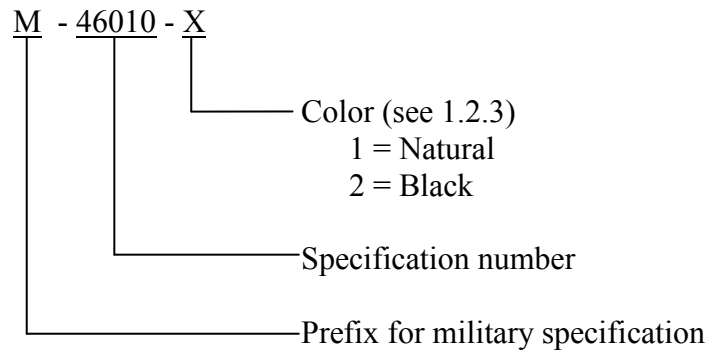
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DISTRIBUTION STATEMENT A. Approved for public release, distribution is unlimited.

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



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).

FEDERAL SPECIFICATIONS

VV-D-1078 - Damping Fluid, Silicone Base (Dimethylpolysiloxane)

FEDERAL STANDARDS

FED-STD-595/36076 - Gray, Flat or Lusterless
 FED-STD-595/37038 - Miscellaneous, Flat or Lusterless
 FED-STD-791 - Testing Method of Lubricants, Liquid Fuels, and Related Products

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys
 MIL-DTL-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base

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MIL-DTL-83133	- Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)
MIL-PRF-372	- Cleaning Compound, Solvent (For Bore of Small Arms and Automatic Aircraft Weapons)
MIL-PRF-14107	- Lubricating Oil, Weapons, Low Temperature
MIL-PRF-23699	- Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-156
MIL-PRF-46170	- Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base NATO Code Number H-544
MIL-PRF-63460	- Lubricant, Cleaner and Preservative for Weapons and Weapons Systems

(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 A108	- Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished (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 B209	- Specification for Aluminum and Aluminum-Alloy Sheet and Plate
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 D1193	- Standard Specification for Reagent Water (DoD adopted)
ASTM D1732	- Standard Practices for Preparation of Magnesium Alloy Surfaces for Painting (DoD adopted)

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| 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 D2832 | - Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings |
| ASTM D3960 | - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings (DoD adopted) |
| ASTM D4457 | - Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloromethane 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 (DoD Adopted) |
| ASTM F22 | - Standard Test Method for Hydrophobic Surface Films by the Water-Break Test (DoD Adopted) |

(Copies of these documents are available from www.astm.org or ASTM International, P.O. Box C700, West Conshohocken, PA 19428-2959.)

SAE INTERNATIONAL

- | | |
|---------|---|
| AMS1424 | - Deicing/Anti-Icing Fluid, Aircraft SAE Type I (DoD Adopted) |
|---------|---|

(Copies of these documents are available from www.sae.org or SAE Customer Service, 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 lubricant furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for award of bids (see 4.2 and 6.3). Any change in the formulation of a qualified product shall necessitate its requalification.

3.2 Materials. Component materials used in the manufacture of this lubricant shall consist essentially of finely powdered lubricating solids dispersed in a suitable liquid binder. The lubricant shall be effective when applied by brushing, dipping, or spraying. The applied film shall meet all requirements both after being cured for 1 hour at $204 \pm 15^\circ\text{C}$ and after being cured for 2 hours at $150 \pm 15^\circ\text{C}$. The curing time shall be counted from the time the part reaches the cure temperature, not when the part is first subjected to heat. The lubricants shall contain no lead or lead-containing compounds, ozone depleting substances, graphite, powdered metals, carbon black, charcoal or other forms of inorganic carbon (see 6.5 and 6.10).

3.3 Film appearance and thickness. The bonded solid film lubricant, when examined as specified in 4.5.1, 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. The coating thickness shall be between 0.008 mm and 0.013 mm. All readings of the coating thickness shall be not less than 0.005 mm or greater than 0.018 mm.

3.4 Film adhesion. A bare metal surface shall not be exposed after lifting the tape when tested as specified in 4.5. A uniform deposit of powdery material clinging to the tape shall be considered acceptable.

3.5 Resistance to fluids. After immersion in each of the fluids as specified in Table I, no bare metal surface shall be exposed after removing the tape as specified in 4.5. A uniform deposit of powdery material clinging to the tape shall not be considered a failure. Also, the bonded solid film lubricant shall not soften, lift, blister, crack, or peel after exposure to the fluids when tested as specified in section 4.5.

3.6 Thermal stability. When tested as specified in 4.5, the solid film lubricant shall not flake, crack, or lift and shall conform to the requirements for film adhesion (see 3.4).

3.7 Endurance life. When tested in four trials in accordance with 4.5, the bonded solid film lubricant shall have an average endurance life at 1000 pounds load (lbf) of 450 minutes. All individual tests shall be not less than 390 minutes.

3.8 Load carrying capacity. When tested in two trials in accordance with 4.5, the bonded solid film lubricant shall have a load capacity of 2500 lbf (11,120 N). All individual tests shall not be less than 2250 lbf (10,000 N).

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TABLE I. Test fluids.

Test Fluid	Specification
Anti-Icing Fluid	SAE AMS1424
Cleaning Compound, Solvent for Bore of Small Arms and Automatic 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-PRF-46170
Turbine Fuel, Aviation, Kerosene Types	MIL-DTL-83133, JP-8
Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	MIL-PRF-23699
Lubricating Oil, Weapons, Low Temperature	MIL-PRF-14107
Lubricant, Cleaner and Preservative for Weapons and Weapon Systems	MIL-PRF-63460
Damping Fluid, Silicone Base (Dimethylpolysiloxane)	VV-D-1078

3.9 Aluminum corrosion resistance. When subjected to heat and high humidity conditions as specified in 4.5 on anodized aluminum panels, the bonded solid film lubricant shall not show or cause discoloration, pitting, formation of white deposits, or other evidence of corrosion.

3.10 Sulfurous acid - salt spray. When applied to steel panels and exposed to sulfurous acid - salt spray in accordance with 4.5, there shall be no resultant pitting, visible corrosion, or staining.

3.11 Salt - spray (fog) test. After being applied to steel panels, the lubricant shall show not more than three rust spots per panel. Any spots shall be not greater than 1.0 mm in diameter, after 100 hours exposure to a 5% salt spray solution in a salt fog cabinet in accordance with 4.5.

3.12 Solids content. The lubricant shall contain not less than 40 percent by weight of solid material when tested in accordance with 4.5.2.

3.13 Storage stability. The fluid lubricant, after a minimum storage period as specified in 4.5.3, shall conform to the requirements for endurance life, (see 3.7), the sulfurous acid - salt spray, (see 3.10) and the salt-spray (fog) test (see 3.11) when tested in accordance with 4.5.

3.14 Volatile Organic Content. The lubricant shall contain not more than 250 g/L of volatile organic content when tested as specified in 4.5.

3.15 Toxicity. The lubricant shall have no adverse effects on human health when it is used as intended (see 6.1). Questions on toxicology shall be referred by the procuring activity to the appropriate departmental medical service after consulting the qualifying activity (see 6.3).

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3.16 Color. The lubricant supplied in Color 2 shall closely match color No. 37038 of FED-STD-595, but shall be not lighter than color No. 36076 of FED-STD-595.

3.17 Workmanship. The bonded solid film shall appear uniform in color, smooth, free from cracks, scratches, blisters, foreign matter, grit, rough particles, bubbles, pin holes, runs, or sags. The lubricant film shall also show no evidence of separation of ingredient materials.

3.18 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.

4. VERIFICATION

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

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

4.2 Qualification inspection. The qualification inspection shall consist of the tests in 3.3 through 3.14.

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

- a. Endurance Life (see 3.7)
- b. Corrosion Protection (salt-spray) (see 3.11)
- c. Total Solids (see 3.12)
- d. Film Adhesion (see 3.4)

4.4 Inspection conditions.

4.4.1 Atmospheric conditions. Unless otherwise specified, all examinations and tests shall be performed at a temperature of $25 \pm 3^{\circ}\text{C}$ and at a relative humidity between 30 and 70 percent.

4.4.2 Preparation of test panels.

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4.4.2.1 Preparation of and application to test panels for solid film lubricant (aluminum and corrosion resistant steel). The panels shall be made from:

- a. aluminum alloy conforming to ASTM B209/5, anodized to conform to MIL-A-8625, type II sulfuric acid anodize, measuring approximately 0.05 cm by 7.6 cm by 15.2 cm (the thickness of the anodize should be between .005 and .013mm); and
- b. corrosion resistant steel conforming to ASTM A167, and measuring approximately 0.09 cm by 7.6 cm by 15.2 cm.

The panels shall be pre-cleaned with aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22. This cleaner shall not cause damage to the surface being cleaned. The corrosion resistant steel panels shall have both faces and all edges grit-blasted with 180 - 220 grit aluminum oxide. Application of the lubricant shall be performed 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 2.54 cm 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 solid film lubricant thickness alone (thickness tester zeroed to the blast profile or anodized surface), when performed in accordance with 4.5 after cure, shall be 0.005 to 0.013 mm. The desired film thickness shall be achieved with not greater than 3 coats. Air drying at $25 \pm 3^{\circ}\text{C}$ for ten minutes between coats is allowed. After the final coat has been applied, the coated specimens shall be allowed to air dry for not less than 60 minutes (A flash cure at 65°C - 79°C for 10 to 30 minutes until dry to touch is also permitted). The coated specimens shall then be placed in an air circulating oven at $150 \pm 15^{\circ}\text{C}$ for 2 hours. The coated 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 28 aluminum panels and 2 corrosion resistant steel panels are required for testing in accordance with performance requirements of this specification.

4.4.2.2 Preparation of and application to test panels for solid film lubricant (steel). The panels shall be steel panels approximately 0.32 cm by 7.6 cm by 15.2 cm conforming to ASTM A108. The panels shall be pre-cleaned with aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22. The cleaner shall not cause any damage to the surface being cleaned. The panels shall have both faces and all edges grit-blasted with 180-220 grit aluminum oxide. Phosphate the panels (weight should be 11 - 22 g/m²) in accordance with MIL-DTL-16232, using ASTM B499 or D7091 to measure the thickness of the phosphated panels. The steel panels shall be dipped or sprayed to the same thickness as specified for the aluminum panels (see 4.4.2.1). After air drying for 60 minutes (a flash cure at 65°C to 79°C for 10 to 30 minutes until dry to touch is also permitted), bake the panels in an air circulating oven at $204 \pm 15^{\circ}\text{C}$ for one hour. The coated 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.

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4.5 Test Methods. Tests shall be performed in accordance with Table II and 4.5.1 through 4.5.4.

4.5.1 Film thickness and appearance. The bonded solid film 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.

TABLE II. Qualification inspection tests.

Characteristic	Test Method		Requirement
	FED-STD-791	ASTM	
Film Thickness ¹ Aluminum Steel		D7091 or B244 D7091 or B499	3.3
Resistance to Fluids ^{2,7,8}		D2510 Procedure C	3.5
Thermal Stability ^{3,7,8}		D2511	3.6
Endurance Wear Life ^{4,7,9}		D2625 Procedure A	3.7
Load Carrying Capacity ^{4,7,9}		D2625 Procedure B	3.8
Aluminum Corrosion ^{5,8}		D2649	3.9
Salt Spray (Fog) ^{5,9}		B117	3.11
Sulfurous Acid/Salt Spray ^{6,9}	5331		3.10
Film Adhesion ⁸		D2510 Procedure A	3.4
Solids Content (see 4.5.2)			3.12
Storage Stability (See 4.5.3)			3.13
Volatile Organic Compound Content (see 4.5.4)		D3960	3.14

- Notes:
- 1 Film thickness is determined after panels are air dried then baked for 120 ± 5 minutes at $150 \pm 15^\circ\text{C}$ for aluminum or for 60 ± 5 minutes at $204 \pm 15^\circ\text{C}$ for steel.
 - 2 Test fluids shall be in accordance with Table I.
 - 3 Any condensation shall be removed with clean, dry compressed air. The dried panel shall then be subjected to the film adhesion test.
 - 4 The surface of test pins and vee-blocks shall be pretreated with phosphate in accordance with MIL-DTL-16232 type Z or M, Class 3 with a weight of $11\text{--}22\text{ g/m}^2$ after grit blasting (180-220 grit aluminum oxide, 50-60 RMS).
 - 5 All lubricants film thicknesses must conform to 3.3 when prepared in accordance with 4.5.2 before placing in salt fog cabinet in accordance with ASTM B117.
 - 6 The panels shall be subjected to 4 cycles. Each cycle shall consist of 2 hours spray time and 24 hours drying time before inspection.
 - 7 When performing ASTM D2510, D2625, or FED-STD-791 test methods, use

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naphtha, aliphatic followed by acetone or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22.

- 8 Treat the metal surfaces in accordance with 4.4.2.1.
- 9 Treat the metal surfaces in accordance with 4.4.2.2.

4.5.2 Solids content. Stir the lubricant thoroughly, weigh 5.0 ± 0.5 grams into a disposable weighing dish (e.g., Fisher Scientific catalog number 08-732 or equivalent). Place the dish and contents into a forced draft oven maintained at a temperature of $49 \pm 3^\circ\text{C}$ for 18 ± 1 hours. Remove dish from oven and place in desiccator. Raise temperature of oven to $204 \pm 3^\circ\text{C}$ and replace dish with residue into the oven for 1 additional hour. Remove dish and contents and cool in a desiccator. When cool, weigh dish and contents. Calculate percent by weight of solids in fluid lubricant as follows:

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

4.5.3 Storage stability. Set aside a one-quart qualification sample in a storage area maintained at $25 \pm 3^\circ\text{C}$ for a period of 365 ± 7 days. At the end of the storage period, determine the endurance life (see 3.7), of the cured lubricant film, the sulfurous acid - salt spray (see 3.10) and the salt-spray (fog) test (see 3.11).

4.5.4 Volatile organic compound content. The volatile organic compound content shall be determined in accordance with ASTM D3960; determine the non-volatile content in accordance with ASTM D2832; determine the water content in accordance with ASTM D4017, determine the density in accordance with ASTM D1475; and determine exempt solvents in accordance with ASTM D4457. The VOC content calculation shall be performed in accordance with ASTM D3960.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be 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 or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

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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 lubricant covered by this specification is intended for use on aluminum, aluminum alloys, copper, copper alloys, steel, stainless steel, titanium, chromium, and nickel bearing surfaces (see appendix for application instructions). It is useful under the following conditions:

- a. To touch up worn surfaces originally coated with lubricant conforming to MIL-L-46010 or MIL-PRF-46010.
- b. For sliding motion applications such as plain and spherical bearings, 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 temperatures 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 $204 \pm 15^\circ\text{C}$ for 1 hour.
- b. In operations consisting of rotary motion above 100 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 five years in indoor storage and approximately two 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 four years.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Color required (see 1.2).
- c. If required, the specific issue of documents referenced (see 2.2.1 and 2.3).
- d. Packaging, packing, and marking data with requirements in detail (see 5.1).
- e. FAR clause 52.223-3.
- f. Specify application and surface preparation requirements (see appendix).
- g. Hazardous material identification and material safety data. The contractor should certify that if any carcinogenic or potentially carcinogenic constituents are present as defined under the Hazard Communication Standards (HCS) 29 CFR 1910.1200, appropriate warnings (see HCS 29 CFR 1910.1200) shall be included on product labels.

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

6.3 Qualifications. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in qualified products list (QPL-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 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. The activity responsible for the qualified products list is: US Army Tank-Automotive Research, Development, and Engineering Center (TARDEC), AMSRD-TAR-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 Falex lubricant tester. Information pertaining to the Falex lubricant tester (see 3.7 and 3.8) can be obtained from the Falex Corp., 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.

6.5 Explanation of restricted materials.

6.5.1 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. Also, the exclusion of graphite permits the use of this product in high vacuum; graphite is not a lubricating solid without moisture or adsorbed air.

6.5.2 Exclusion of lead and lead compounds. Historically, products under the MIL-L-46010 specification were permitted to contain lead compounds because no alternative existed.

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Products have been developed that conform to the specification but do not require the use of lead compounds. The exclusion is inserted in order to prevent lead pollution.

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

6.7 End Item Testing. When possible, film thickness and adhesion should be tested when 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 actual end item.

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

6.9 Aerospace Components. Types I and II lubricants previously found under MIL-L-0046010E are now under SAE Aerospace Standard AS5272. The SAE document still allows the use of lead material to meet aerospace application requirements. For other than aerospace applications products under MIL-PRF-46010 shall be used. (Use of MIL-PRF-46010 in aerospace applications must first be validated.)

6.10 Definitions.

Lead-containing compound –

1. Any chemical compound that contains the chemical element Pb.
2. Also, chemical mixtures containing compounds defined in 1) above are also considered lead-containing compounds.

6.11 Subject term (key word) listing.

Dry Film Lubrication
Dry Lubrication
Solid Lubrication

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

6.13 International Standardization Agreement. This specification implements STANAG 1135 “Interchangeability of Fuels, Lubricants and Associated Products Used by the Armed Forces of The North Atlantic Treaty Nations”. When amendment, revision, or cancellation of this specification is proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at <https://assist.dla.mil>.

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APPENDIX A

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

A.1. SCOPE

A.1.1 Scope. This Appendix describes the surface pretreatment, temperature, and baking time required to cure the solid film lubricant when it is applied over the bearing surfaces of manufactured parts of various metals. This Appendix is not a mandatory part of the specification. The information contained herein is intended to aid in 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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

- | | | |
|--------------|---|--|
| MIL-DTL-5541 | - | Chemical Conversion Coatings on Aluminum and Aluminum Alloys |
| MIL-F-495 | - | Finish, Chemical, Black, for Copper Alloys |

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

A.2.2 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 are those cited in the solicitation or contract.

ASTM INTERNATIONAL

- | | | |
|-----------------|---|---|
| ASTM A967/A967M | - | 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 (DoD Adopted). |

(Application for copies should be addressed to: ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, or at www.astm.org)

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APPENDIX A

SAE INTERNATIONAL

AMS2488 - Anodic Treatment - Titanium and Titanium Alloys
Solution pH 13 or Higher

(Copies of these documents are available from www.sae.org or SAE Customer Service, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

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. Do not use mechanical paint shakers, because excessive foaming 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 and 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 at $204 \pm 15^\circ\text{C}$ for one hour or at $150 \pm 15^\circ\text{C}$ for 2 hours. The coated surface of the piece must remain at the cure temperature for the specified time. 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 M Ω -cm, when tested in accordance with ASTM D1125.

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

A.3.3 Application on copper and copper alloys. Preclean the surfaces to be coated with aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Sandblast the surfaces with 180-220 grit clean, dry sand. Form a black oxide finish on the surfaces in accordance with MIL-F-495.

A.3.4 Application on magnesium and magnesium alloys. Preclean the surfaces to be coated with aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans

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surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Anodize the surface in accordance with ASTM D1732, class 2, type I, II or III.

A.3.5 Application on steel. Preclean the surfaces to be coated with aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Sandblast the surfaces with 180-220 grit aluminum oxide. Phosphate in accordance with MIL-DTL-16232 (weight should be 11 - 22 g/m²), type M, class 3 or type Z, class 3.

A.3.6 Application on stainless steels. Preclean the surfaces to be coated with aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Sandblast the surfaces with 120 grit aluminum oxide. Passivate the surfaces in accordance with ASTM A967/A967M, 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 aliphatic naphtha or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F22, but does not harm the surface (i.e. hydrogen embrittlement, etc.). Sandblast the surface with 180-220 grit aluminum oxide and alkaline anodize per SAE AMS2488.

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.

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