

NOT MEASUREMENT
SENSITIVE

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MILITARY 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 establishes the requirements for three types of heat cured solid film lubricant that is intended to reduce wear and prevent galling, corrosion, and seizure of metals (see 6.1).

1.2 Classifications. This specification establishes the following types and colors (for Type III only):

Type I - A cure temperature of 150 ± 15 °C and Endurance Life of 250 minutes. Type I will only be acceptable for military use 2 years after the publication date of this specification.

Type II - A cure temperature of 204 ± 15 °C and Endurance Life of 450 minutes. Type II will only be acceptable for military use 2 years after the publication date of this specification.

Type III - A low volatile organic compound (VOC) content lubricant with cure cycles of 150 ± 15 °C for 2 hours or 204 ± 15 °C for 1 hour and an Endurance Life of 450 minutes. Type III shall be used when performance is satisfactory for the desired application to meet VOC emission regulations.

Color 1: - Natural product color.

Color 2: - Black color.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: USA MOBILITY TECH CTR - BELVOIR, ATTN AMSTA-RBES, 10115 GRIDLEY STE 128, FT BELVOIR VA 22060-5843 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 9150

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

FEDERAL

- QQ-A-250 - Aluminum Alloy and Aluminum Alloy Plate Sheet.
- QQ-A-250/5 - Aluminum Alloy, Alclad 2024, Plate and Sheet.
- TT-N-95 - Naphtha, Aliphatic.
- VV-D-1078 - Damping Fluid, Silicone Base (Dimethyl Polysiloxane).

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- MIL-C-372 - Cleaning Compound, Solvent for Bore of Small Arms and Automatic Weapons.
- MIL-A-8243 - Anti-icing and Deicing - Defrosting Fluid.
- MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
- MIL-L-14107 - Lubricating Oil, Weapons, Low Temperature.
- DOD-P-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals).
- MIL-L-23699 - Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-156.
- MIL-L-46000 - Lubricant, Semi-Fluid (Automatic Weapon).
- MIL-H-46170 - Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base.
- MIL-L-63460 - Lubricant, Cleaner and Preservative for Weapons and Weapon Systems.
- MIL-T-83133 - Turbine Fuel, Aviation, Kerosene Types.
- DOD-L-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.

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-290 - Packaging of Petroleum and Related Products.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the STDZN DCMNT ORDER DESK, BLDG 4D, 700 ROBBINS AVE, PHILADELPHIA PA 19111-5094.)

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 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 FOR TESTING AND MATERIALS (ASTM)

- A 108 - Steel Bars, Carbon, Cold-Finish, Standard Quality.
- A 167 - Stainless and Heat-Resisting Chromium-Nickel-Steel Plate, Sheet and Strip.
- B 117 - Salt Spray (Fog) Test.
- B 244 - Measurement of Thickness of Anodic Coatings on Aluminum and Other Non-Conductive Coatings on Non-Magnetic Basis Metals with Eddy Current Instruments.
- B 499 - Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals.
- D 56 - Test Method for Flash Point by Tag Closed Tester.
- D 1141 - Substitute Ocean Water.
- D 1186 - Nondestructive Measurement of Dry Film Thickness of Nonmetallic Coatings Applied to a Ferrous Base.
- D 1193 - Reagent Water.
- D 1400 - Nondestructive measurement of Dry Film Thickness of Non-Conductive Coating Applied to a Non-Ferrous Metal Base.
- D 1475 - Density of Paint, Varnish, Lacquer, and Related Products.
- D 2369 - Volatile Content of Coatings.
- D 2510 - Adhesion of Solid Film Lubricants.
- D 2511 - Thermal Shock Sensitivity of Solid Film Lubricants.
- D 2625 - Endurance (Wear) Life and Load-Carrying Capacity of Solid Film Lubricants (Falex Method).
- D 2649 - Corrosion Characteristics of Solid Film Lubricants.
- D 2832 - Determining Nonvolatile Content of Paint and Paint Materials.
- D 3960 - Standard Practice for Determining Volatile Organic Content (VOC) of Paints and Related Coatings.

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- D 4017 - Water in Paints and Paint Materials by Karl Fischer Method.
- F 22 - Standard Test Method for Hydrophobic Surface Films by the Water-Break Test.

(Application for copies should be addressed to: AMERCN SCTY FOR TEST & MTRLs, 1916 RACE STRET, PHILADELPHIA PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, (except for related associated detail specifications, specification sheets or MS standards), 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 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 4.3 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. Recycled materials may be used provided lubricant meets the requirements of the specification. The lubricant shall be suitable for application by brushing, dipping, or spraying. The applied film for type I shall be capable of being cured within 60 minutes at 150 \pm 15 $^{\circ}$ C. The applied film for type II shall be capable of being cured within 60 minutes at 204 \pm 15 $^{\circ}$ C. The applied film for type III shall be capable of being cured within 1 hour 204 \pm 15 $^{\circ}$ C or 2 hours at 150 \pm 15 $^{\circ}$ C and be of such a nature that it shall conform to the requirements of this specification when cured at either temperature. 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 lubricant shall contain no graphite, powdered metal or ozone depleting substances (see 4.6.1). Additionally, type III shall be a low VOC content material in accordance with 3.4.11. The contractor shall 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..

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3.3 Film appearance and thickness. The bonded solid film lubricant, when examined as specified in 4.6.2, 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 thickness of the cured film for types I, II and III shall be between 0.008 mm and 0.013 mm with no single reading less than 0.005 mm or greater than 0.018 mm.

3.4 Performance characteristics.

3.4.1 Film adhesion. The bonded solid film lubricant, when tested as specified in 4.6, shall not be lifted to expose any bare metal surface. A uniform deposit of powdery material clinging to the tape shall not be objectionable.

3.4.2 Resistance to fluids. The bonded solid film lubricant, after immersion in each of the fluids as specified in 4.6, shall not be lifted by the tape to expose any bare metal surface; nor shall the solid film lubricant soften, lift, blister, crack, or peel. A uniform deposit of powdery material clinging to the tape shall not be objectionable.

3.4.3 Thermal stability. The thermal stability of the bonded solid film lubricant shall be such that, when tested as specified in 4.6, the film shall not flake, crack, or lift and shall conform to the requirements for film adhesion, (see 3.4.1).

3.4.4 Endurance life. When tested in four trials in accordance with 4.6, the bonded solid film lubricant shall have an average endurance life at 1000 pounds load (lbf) as follows:

Type I	- 250 minutes with no single test less than 210 minutes
Type II & III	- 450 minutes with no single test less than 390 minutes.

3.4.5 Load carrying capacity. When tested in two trials in accordance with 4.6, the bonded solid film lubricant shall have the following capacity:

Type I & III	- 2500 lbf (11,120 N) with no single test less than 2250 lbf (10,000 N)
Type II	- 2000 lbf (8,900 N) with no single test less than 1750 lbf (7,780 N)

3.4.6 Aluminum corrosion resistance (types I & III). When subjected to heat and high humidity conditions as specified in 4.6, the bonded solid film lubricant on anodized aluminum panels as specified in 4.5.2.1 shall not show or cause discoloration, pitting, formation of white deposits, or other evidence of corrosion.

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3.4.7 Sulfurous acid - salt spray (types I & III). When applied to steel panels as specified in 4.5.2.2 and exposed to sulfurous acid - salt spray in accordance with 4.6, there shall be no resultant pitting, visible corrosion, or staining.

3.4.8 Salt - spray (fog) test (types II & III). The lubricant, after being applied to steel panels as specified in 4.5.2.2 shall show no more than three rust spots per panel, none 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 ASTM B 117.

3.4.9 Solids content. The lubricant shall contain not less than 40 percent by weight of solid material when tested as specified in 4.6.3.

3.4.10 Storage stability. The fluid lubricant, after a minimum storage period as specified in 4.6.4, shall conform to the requirements for endurance life, (see 3.4.4), and the sulfurous acid - salt spray, (see 3.4.7) for types I and III or the salt-spray (fog) test (see 3.4.8) for types II and III when tested as specified in 4.6.

3.4.11 Volatile Organic Content (type III). The lubricant shall contain not more than 250 g/L of volatile organic content when tested as specified in 4.6.

3.5 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). A material safety data sheet shall be submitted as specified in 4.6.7.

3.6 Application. The lubricant shall be applied in accordance with the appendix of this document over surfaces that have been pre-treated as per the appendix unless otherwise specified in the contract or purchase order.

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

3.8 Workmanship. The lubricant shall be processed in such a manner as to ensure that the lubricant shall produce a bonded solid film which 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 show no evidence of separation of ingredient materials.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible

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for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, and unless disapproved by the Government, the contractor's own or any other facilities suitable for the performance of the inspection requirements specified herein, may be used. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

- a.
Qualification inspection (see 4.3).
- b.
Quality conformance inspection (see 4.4).

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

4.3.1 Qualification samples. The qualification sample shall consist of 1 gallon of the lubricant from one batch provided in 1-gallon containers, and two copies of the supplier's report for the product for which qualification is desired. The report shall show the product inspection results for all the requirements of this specification and shall refer specifically to the applicable paragraphs in the specification. The samples, reports and Material Safety Data Sheets for each component and the confidential formula for the product shall be forwarded to the Commander, US Army TACOM Mobility Technology Center - Belvoir, ATTN AMSTA-RBF, 10115 Gridley Rd., Ste 128, Ft. Belvoir, VA 22060-5843. The samples shall be plainly identified by securely attached durable tags or labels marked with the following information:

Sample for qualification inspection.
LUBRICANT, SOLID FILM, HEAT CURED, CORROSION INHIBITING (NATO Code Number S-1738), Type I, or Type II, or Type III'

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Name of manufacturer.

Product code number.

Date of manufacture.

Submitted by (name) (date) for qualification inspection in accordance with MIL-L-46010 under authorization of (reference authorizing letter) (see 6.3).

4.3.2 Retention of qualification. In order to retain qualification of a product approved for listing on the qualified products list (QPL), the manufacturer shall verify by certification to the qualifying activity, that the manufacturer's product complies with the requirements of this specification. The time of periodic verification by certification shall be in five-year intervals from the date of original qualification. The Government reserves the right to re-examine the qualified product whenever deemed necessary to determine that the product continues to meet any or all of the specification requirements.

4.4 Quality conformance inspection. The quality conformance inspection shall consist of inspection of samples for tests (see 4.4.2) for all of the tests specified in table I, (except for thermal stability [see 3.4.3], aluminum corrosion resistance [see 3.4.6], and storage stability [see 3.4.9]), and inspection of samples of filled containers (see 4.4.3) for conformance to section 5 packaging. Samples shall be labeled completely with information identifying the purpose of the sample, name of product, specification number, lot and batch number, date of sampling, and contract number.

4.4.1 Lot and batch. All lubricant manufactured as one batch shall be considered a lot and shall be numbered as such for purposes of inspection. A batch is defined as the end product of all the raw materials mixed or blended in a single operation.

4.4.2 Sample for tests. The sample for test shall consist of 4 separate quarts of lubricant selected at random from each lot of lubricant. The lot shall be unacceptable if a sample fails to meet any of the test requirements specified.

4.4.3 Sample for examination of filled containers. A random sample of filled containers shall be selected from each lot of lubricant in accordance with MIL-STD-105 at inspection level II.

4.5 Inspection conditions.

4.5.1 Atmospheric conditions. Unless otherwise specified, all examinations and tests shall be performed at a temperature of 25 ± 3 °C and at a relative humidity between 30 and 70 percent.

4.5.2 Preparation of test panels.

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

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QQ-A-250/5, anodized to conform to MIL-A-8625, type II sulfuric acid anodize, and measuring approximately 0.05 cm by 7.6 cm by 15.2 cm; and corrosion resistant steel conforming to ASTM A 167, and measuring approximately 0.09 cm by 7.6 cm by 15.2 cm. The panels shall be pre-cleaned with aliphatic naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22. This cleaner shall not cause damage (i.e. hydrogen embrittlement, etc) 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 flames or ignition sources are 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, after cure, shall be 0.005 to 0.013 mm. Three coats shall be the maximum number required to obtain the desired film thickness. Air drying at 25 ± 3 °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 30 minutes for type I and 60 minutes for type III (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 ± 15 °C for one hour (type I) or 2 hours (type III). 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 30 aluminum panels and two corrosion resistant steel panels are required for testing in accordance with performance requirements of this specification.

4.5.2.2 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 A 108. The panels shall be pre-cleaned with Aliphatic Naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22. The cleaner shall not cause any damage (i.e. hydrogen embrittlement, etc) 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 DOD-P-16232, using ASTM B 499 or D 1186 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 4.5.2.1). After air drying 30 minutes for types I & II or 60 minutes for type III (A flash cure at 65 °C - 79 °C for 10 to 30 minutes until dry to touch is also permitted), bake the panels in an air circulating oven at 150 ± 15 °C (type I) or 204 ± 15 °C (type II & III) 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,

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two steel disks and six sets of pins and vee blocks are required for testing in accordance with performance requirements of this specification.

4.6 Methods of inspection. Methods of inspection shall be in accordance with table I and 4.6.1 through 4.6.5.

4.6.1 Restricted materials. The contractor shall submit for the contracting officer's approval certification that no graphite, powdered metal, or ozone depleting substances are present in the product furnished under this specification.

4.6.2 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.

4.6.3 Solids content. Stir the lubricant thoroughly, weigh 5.0 \pm 0.5 grams into a disposable weighing dish (Fisher Scientific catalog number 08-732). Place the dish and contents into a forced draft oven maintained at a temperature of 49 \pm 3 °C for 18 \pm 1 hour. Remove from oven and place in desiccator. Raise temperature of oven to 204 \pm 3 °C and replace dish with residue into 204 °C 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:

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

4.6.4 Storage stability. Set aside a one-quart qualification sample in a storage area maintained at 25 \pm 3 °C for a period of 1 year \pm 7 days. At the end of the storage period, determine the endurance life (see 3.4.4), of the cured lubricant film, the sulfurous acid - salt spray (see 3.4.7) for types I & III, and the salt-spray (fog) test (see 3.4.8) for types II & III.

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TABLE I. Qualification inspection tests.

Characteristic	Test Method		Requirement Paragraph
	FED-STD-791	ASTM	
Film Thickness ^{1/} Aluminum Steel		D 1400 or B 244 D 1186 or B 499	3.3
Film Adhesion		D 2510 Procedure A	3.4.1
Resistance to Fluids ^{2/7/}	-	D 2510 Procedure C	3.4.2
Thermal Stability ^{3/7/}		D 2511	3.4.3
Endurance Wear Life ^{4/7/}		D 2625 Procedure A	3.4.4
Load Carrying Capacity ^{4/7/}		D 2625 Procedure B	3.4.5
Aluminum Corrosion ^{5/}		D 2649	3.4.6
Sulfurous Acid/Salt Fog ^{6/}	5331		3.4.7
Salt Spray (Fog) ^{5/}		B 117	3.4.8
Solids Content (see Para 4.6.3)			3.4.9
Storage Stability			3.4.10
Volatile Organic Compound Content		D 3960 D 2369 D 1475 D 4017	3.4.11

- ^{1/} Film thickness is determined after panels are air dried then baked for 120 \pm 5 minutes at 150 \pm 15 °C for aluminum or for 60 \pm 5 minutes at 204 \pm 15 °C for steel.
- ^{2/} Test fluids shall be in accordance with table II.
- ^{3/} Any condensation shall be removed with clean, dry compressed air. The dried panel shall then be subjected to the film adhesion test.

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- 4/ The surface of test pins and vee-blocks shall be pretreated with phosphate in accordance with DOD-P-16232 type Z or M, Class 3 with a weight of 11-22 g/m₂ 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 B 117.
- 6/ The panels shall be subjected to 4 cycles. Each cycle consisting of 2 hours spray time and 24 hours drying time before inspection.
- 7/ When performing ASTM D2510, D 2625, or FED-STD-791 test methods, use naphtha, aliphatic conforming to TT-N-95 followed by acetone or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, instead of MIL-T-27602, trichloroethylene, MIL-C-81302, trichlorotrifluoroethane, or MIL-T-81533, 1,1,1-trichloroethane.

TABLE II. Test fluids.

Test Fluid	Specification
Anti-Icing Fluid	MIL-A-8243
Cleaning Compound, Solvent for Bore of Small Arms and Automatic Weapons	MIL-C-372
Reagent Water	ASTM D1193, Type III
Substitute Ocean Water	ASTM D1141, Vol. 31
Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base	MIL-H-46170
Turbine Fuel, Aviation, Kerosene Types	MIL-T-83133, JP-8
Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	MIL-L-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 Weapon Systems	MIL-L-63460
Lubricant, All Weather (Automatic Weapons)	DOD-L-85336

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4.6.5 Volatile organic compound content. The volatile organic compound content shall be determined in accordance with ASTM D 3960; determine the non-volatile content in accordance with ASTM D 2832; determine the water content in accordance with ASTM D 4017, determine the density in accordance with ASTM D 1475; and determine exempt solvents in accordance with ASTM D 4457. The VOC content calculation shall be performed in accordance with ASTM D 3960-93.

4.6.6 Examination of filled containers. Each filled container selected in accordance with 4.4.3 shall be examined for defects of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each sample container shall also be weighed to determine the amount of the contents. If the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, failure of the lot shall be indicated.

4.6.7 Toxicity. A material safety data sheet conforming to FED-STD-313 is required for each component of the product at the time of qualification.

5. PACKAGING

5.1 Packaging, packing, and marking. The lubricant shall be packaged, packed, and marked in accordance with MIL-STD-290. The type and size of containers and the level of packaging and packing shall be as specified by the acquiring activity (see 6.2).

5.2 Precautionary marking. In addition to the marking specified in 5.1, the individual containers and the shipping containers shall be marked to show the date of manufacture, recommended conditions for storage, and flash point by ASTM D 56, and the marking shall include the following information:

- a. WARNING! Do not use this lubricant in food processing or food handling equipment or on surfaces that may contact foods.
- b. CAUTION! Use only in a well ventilated area or in a hood where no flames or other ignition sources are present (type I & II only).
- c. NOTE. Use this lubricant no later than 12 months from date of manufacture.

5.2.1 Additional marking. The individual containers shall be marked with the following application instructions:

- a. Degrease and clean component part thoroughly.
- b. Nominal thickness shall be 0.01 mm with no reading less than 0.005 mm or greater than 0.018 mm.

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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 and copper alloys, steel and stainless steel, titanium, and 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-8937 or MIL-L-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. For use within 12 months from the date of manufacture.
- e. Where temperatures may range from -68 °C to 204 °C, intermittent exposure to 260 °C are acceptable.
- f. If mechanisms are operated at infrequent intervals or are lubricated for life.
- g. Where long-term corrosion protection is required under static conditions.
- h. Where a solvent-resistant coating is required.
- i. Where a lubricant requires extremely heavy load ability in initial start-up of heavy loaded mechanism 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 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.

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

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heavier coating can be expected to provide outdoor corrosion protection for approximately four years.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this 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. Type and color required (see 1.2).
- d. Packaging, packing, and marking data with requirements in detail (see 5.1).
- e. Quantity (see 6.2.1.1).
- f. Specify application and surface preparation requirements.
- g. Hazardous material identification and material safety data.

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

6.2.2 Packaging options. In the preparation of contracts or orders, it must be noted that various options, choices and alternatives, as indicated in MIL-STD-290, may be exercised in the preparation of this lubricant for delivery.

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-46010D) 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: Director, US Army TACOM Mobility Technology Center - Belvoir, ATTN: AMSTA-RBF, 10115 Gridley Rd., Ste 128, Fort Belvoir, VA 22060-5843. Products will not be considered for inclusion in QPL-46010D 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 3.4.4) can be obtained from the Falex Corp., 2055 Comprehensive Dr., Aurora, IL 60505. 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 Material Safety Data Sheets. The contracting officer should identify those activities requiring copies of completed Material Safety Data Sheets.

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

6.7 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.

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

6.9 Classification changes. MIL-L-46010D provides a limited availability for type I and type II lubricants. These products will no longer be acceptable for use in military applications after two years beyond the publication date of this document. A type III lubricant has been added which meets VOC content restrictions of a maximum 250g/L. Type III can be cured at either 150 \pm 15 °C for 2 hours or 204 \pm 15 °C for 1 hour. When cured at either temperature, type III will meet all performance requirements in this specification (performance requirements will often be exceeded by the lubricant when cured at the higher temperature).

6.10 Subject term (key word) listing.

Dry Lubrication
Solid Lubrication
Dry Film Lubrication

6.11 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. The following major changes have been incorporated:

- Cover Page:
- a. Added two color classifications.
 - b. Limited use of Type I & II lubricants to 2 years from date of publication.
 - c. Added low volatile organic content (VOC) Type III lubricant.
- Section 2:
- a. Deleted obsolete documents and added new documents as required.
- Section 3:
- a. Added requirements for Type III lubricant to include cure temperatures and times, maximum volatile organic content (VOC), endurance life and load carrying capacity.
 - b. Added black color requirements for Color 2.

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- Section 4:
- a. Eliminated use of 1,1,1-trichloroethane as degreaser for precleaning test panels.
 - b. Eliminated trichlorotrifluoroethane as a test fluid in Table II.
 - c. Added test method for determining VOC content of Type III lubricant.

- Section 6:
- a. Added Application to End Item paragraph.
 - b. Added Classification Changes paragraph.

- Appendix:
- a. Changed appendix to mandatory part of specification unless otherwise specified in contract or purchase order.
 - b. Eliminated use of 1,1,1-trichloroethane as degreaser for precleaning surfaces.

Custodians:
Army - ME
Navy - AS
Air Force - 20

Preparing activity:
Army - ME

Project 9150-1096

Review activities:
Army - AR, AV, MI, AL, SM, AT, MD
Navy - SH
Air Force - 68
DLA - GS

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

10. SCOPE

10.1 Scope. This appendix is a mandatory (not mandatory for fastener hardware applications unless otherwise specified) part of the specification unless otherwise specified in the contract, purchase order, end item drawing or end item specification. The information contained herein is intended for 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.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 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

FEDERAL

QQ-P-35 - Passivation Treatments for Corrosion-Resisting Steel.

MILITARY

MIL-F-495 - Finish, Chemical, Black, for Copper Alloys.
MIL-M-3171 - Magnesium Alloy, Process for Pretreatment and Prevention of Corrosion on.
MIL-C-5541 - Chemical Conversion Coatings on Aluminum Alloys.
MIL-M-45202 - Magnesium Alloy, Anodic Treatment of.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from: STDZN DCMNT ORDER DESK, BLDG 4D, 700 ROBBINS AVE, PHILADELPHIA PA 19111-5094.)

30. REQUIREMENTS

30.1 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.

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A mechanical paint shaker may be used for types I and II, but is not recommended for type III as excessive foaming with waterborne products may occur. Minor viscosity adjustments to type III may be made by adding deionized water (1 megohm/cm or greater). DO NOT USE ORDINARY TAP WATER. Apply the lubricant by brushing, dipping, or spraying to a nominal film thickness of 0.01 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 ±15 °C for one hour (type II and III) or 150 ±15 °C for 1 hour (type I) or 2 hours (type III). 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 30.2 through 30.7 unless otherwise specified in the contract or purchase order.

30.2 Application on aluminum and aluminum alloys. Preclean the surfaces to be coated with Aliphatic Naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, 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 1.

30.3 Application on copper and copper alloys. Preclean the surfaces to be coated with Aliphatic Naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, 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.

30.4 Application on magnesium and magnesium alloys. Preclean the surfaces to be coated with Aliphatic Naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, 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.

30.5 Application on steel. Preclean the surfaces to be coated with aliphatic Naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, but does not harm the surface (i.e. hydrogen embrittlement, etc). Sandblast the surfaces with 180-220 grit aluminum oxide. Phosphate in accordance with DOD-P-16232 (weight should be 11 - 22 g/m²), type M, class 3 or type Z, class 3.

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30.6 Application on stainless steels. Preclean the surfaces to be coated with aliphatic Naphtha conforming to TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, but does not harm the surface (i.e. hydrogen embrittlement, etc). Sandblast the surfaces with 120 grit aluminum oxide. Passivate the surfaces with QQ-P-35, types II, VI, or VII as applicable.

30.7 Application on titanium and titanium alloys. Degrease the surfaces to be coated with aliphatic naphtha meeting the requirements of TT-N-95 or any environmentally safe cleaner that sufficiently cleans surfaces to pass ASTM F 22, but does not harm the surface (i.e. hydrogen embrittlement, etc). Sandblast the surface with 180-220 grit aluminum oxide and alkaline anodize.

30.8 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 which 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.

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.
- The submitter of this form must complete blocks 4, 5, 6, and 7.
- 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.

RECOMMEND A CHANGE:

1. DOCUMENT NUMBER

MIL-L-460100

2. DOCUMENT DATE (YYMMDD)

941202

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.)

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
(if applicable)
(2) DSN

7. DATE SUBMITTED

8. PREPARING ACTIVITY

a. NAME

Carolyn B. Johnson

b. TELEPHONE (Include Area Code)

(1) Commercial (2) DSN

c. ADDRESS (Include Zip Code)

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IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:

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