

METRIC
 DOD-L-85645A
 15 October 1988
 SUPERSEDING
 DOD-L-85645
 30 December 1985

MILITARY SPECIFICATION

LUBRICANT, DRY THIN FILM, MOLECULAR BONDED

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 two types of dry thin film lubricants to reduce wear and to prevent galling and seizure of metals.

1.2 Classification. The lubricant shall be of the following types, as specified (see 6.2.b):

- Type I - no binders
- Type II - binders

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 specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

QQ-A-250/5 - Aluminum Alloy, Alclad 2024; Plate and Sheet

MILITARY

MIL-S-5059 - Steel, Corrosion-Resistant (18-8), Plate, Sheet and Strip

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Systems Engineering and Standardization Department (Code 93), Naval Air Engineering Center Lakehurst, NJ 08733-5100, 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

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

DOD-L-85645A

STANDARDS

FEDERAL

FED-STD-313 - Material Safety Data Sheets Preparation and Submission of

MILITARY

MIL-STD-290 - Packaging of Petroleum and Related Products

(Copies of specifications, standards, drawings and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

PUBLICATIONS

CODE OF FEDERAL REGULATIONS

49 CFR - Transportation - Hazardous Materials

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the non-government documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1186 - Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base

ASTM D 2510 - Adhesion of Solid Film Lubricants

ASTM D 2511 - Lubricants, Film, Dry Solid, Thermal Shock, Sensitivity of

ASTM D 2649 - Corrosion Characteristics of Solid Film Lubricants

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

DOD-L-85645A

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z129.1 - American National Standards for the Precautionary Labeling of Hazardous Industrial Chemicals

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

(Non-government standards and other publications are normally available from the organizations which prepare or which 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 specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 First article. When specified, a sample shall be subjected to first article inspection (see 4.3 and 6.3).

3.2 Materials. The material shall consist of tungsten disulfide (WS_2) in a lamellar form, modified as required to meet the requirements of this specification. The material shall have no organic constituents, so as to be compatible in liquid oxygen systems and hard radiation environments. Type I shall bond instantly to the surface of the substrate without the use of heat, binders, or additives. Type II shall contain a suitable binder as required to meet the requirements of this specification. The material shall not contain graphite or powdered metal (see 4.5.7).

3.3 Film appearance and thickness. The bonded dry film lubricant shall appear uniform in color, smooth, free of cracks, scratches, pinholes, blisters, bubbles, runs, sags, foreign matter, grit, rough particles, separation of ingredients, or other surface imperfections (see 4.5.1). The film thickness shall be between 0.00038 and 0.00051 mm for type I and not greater than *0.0035 mm for type II (see 4.5.2)*.

3.4 Thermal stability. The bonded dry film lubricant shall not flake, crack, blister nor soften in a temperature environment ranging from $-200^{\circ}C$ to $+482^{\circ}C$ (see 4.5.3).

3.5 Film adhesion. There shall be no evidence of stripping or lifting of the lubricant coating from the substrate when subjected to the tape test (see 4.5.4).

3.6 Coefficient of friction. The coating shall have a coefficient of friction of no more than 0.030 when tested in accordance with 4.5.5.

3.7 Aluminum corrosion resistance. When subjected to heat and high humidity for at least 500 hours, the bonded dry film lubricant on anodized aluminum panels shall not show discoloration, pitting, formation of white deposits, or other evidence of corrosion (see 4.5.6).

DOD-L-85645A

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. 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 examination and testing requirements shall be classified as follows:

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

4.3 First article inspection. The first article inspection shall consist of review and approval of the test results (see 4.3.2) and performance of all tests or examinations to determine that the first article sample (see 4.3.1) complies with all the requirements of this specification when tested in accordance with the inspection methods specified. Delivery will be deferred pending completion of the first article inspection. If the results of the first article inspection are in accordance with the requirements of this specification, the consistency of production quality will be thereby verified. Failure of the lubricant to pass first article inspection shall constitute failure of the entire lot or batch.

4.3.1 First article samples. Samples of the bonded lubricant shall be furnished by the supplier in sufficient quantity to make all of the determinations specified herein. Duplicate specimens shall be required for all tests. The test panels and approximate dimensions shall be as specified in 4.4.2. The panels shall be fully coated, except for two of the steel panels which shall have the lubricant applied in a 2.54 cm strip on only one side to enable measurement of film thickness. The first article samples shall be forwarded to the Aircraft and Crew Systems Technology Directorate, Code 60612, Naval Air Development Center, Warminster, PA 18974. The samples shall be plainly identified by securely attached durable tags or labels marked with the following information:

DOD-L-85645A

Sample for first article inspection
 LUBRICANT, DRY THIN FILM, MOLECULAR BONDED
 Specification DOD-L-85645A
 Name of manufacturer
 Product code number
 Date of manufacture
 Contract or purchase order
 Batch number

4.3.2 Certification and test results. When requested by the procuring activity, certification by the manufacturer, accompanied by test results shall be submitted to the first article inspection laboratory (see 4.3.1). The manufacturer shall supply certified test results containing complete test data showing that the samples of the bonded lubricant submitted for first article inspection conforms to the requirements of this specification (see 6.2.e).

4.4 Quality conformance inspection. The quality conformance inspection shall consist of tests of samples from 4.4.2 in accordance with Table I. Samples shall be labeled completely with information specified in 4.3.1.

4.4.1 Lot and batch. A lot shall consist of the material produced by one manufacturer under essentially the same manufacturing conditions. Each batch shall constitute a lot.

4.4.2 Quality conformance samples. Test panel specimens shall be made from aluminum alloy conforming to QQ-A-250/5 and anodized to conform to MIL-A-8625, Type I, measuring approximately .051 x 7.62 x 15.24 cm; and corrosion resistant steel conforming to MIL-S-5059, composition 321, condition-annealed, finish No. 2 dull, measuring approximately .091 x 7.62 x 15.24 cm. 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 film thickness. For application procedure see Appendix.

4.5 Test methods. Unless otherwise specified, all examination and tests shall be performed at a temperature of $25 \pm 3^{\circ}\text{C}$ and at a relative humidity between 45 and 55 percent.

4.5.1 Film appearance. The bonded dry 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, separation of ingredients, and any other surface imperfections.

4.5.2 Film thickness. The thickness of the lubricant coating shall be determined in accordance with ASTM D 1186.

4.5.3 Thermal stability. The bonded dry film lubricant shall be tested for thermal stability in accordance with ASTM D-2511. Condensation shall be removed with clean, dry, compressed air.

DOD-L-85645A

4.5.4 Film adhesion. The bonded dry film lubricant shall be tested for film adhesion in accordance with ASTM D-2510, Procedure B.

4.5.5 Coefficient of friction. The coefficient of friction for the bonded lubricant shall be determined using the inclined plane technique. One surface of a one inch thick stainless steel metal block having a Rockwell hardness of 58-60 HRC shall be coated. The surface of an adjustable inclined plane with the lubricant shall be coated in accordance with the manufacturer's recommended practice. The roughness of these surfaces before coating shall not exceed seven micro inches rms. The block shall be placed on the inclined plane so that the two coated surfaces are in contact with one another. By varying the angle of repose, θ , the angle at which the block begins to slide shall be determined. Using the formula below, the coefficient of friction, f shall be determined.

$$f = \tan \theta \text{ (reference, graphite} = 0.07)$$

4.5.6 Aluminum corrosion resistance. The bonded dry film lubricant shall be tested in accordance with ASTM D-2649 to determine aluminum corrosion resistance.

4.5.7 Graphite and powdered metal. The contractor shall submit to the contracting officer (see 4.3.1) a notarized certification by a responsible official of its management, attesting that no graphite, powdered metal, or organic material is present in the bonded lubricant.

5. PACKAGING

5.1 Packaging requirements. This section is not applicable to this specification.

6. NOTES

6.1 Intended use. The lubricant is intended for use on aluminum, aluminum alloys, copper and copper alloys, steel and stainless steel, titanium, and chromium and nickel bearing surfaces and over all platings. Test data generated by this specification is specific to aluminum and stainless steel. The user should investigate the integrity of the lubricant for protecting other metal surfaces. The lubricant is useful under the following conditions:

- a. Worn surfaces originally coated with lubricant conforming to DOD-L-85645.
- b. For rotary and sliding motion applications such as ball, roller, sleeve and spherical bearings, fasteners, tracks, hinges, threads, cams, gears, shafts, pins, sleeves, bushings, gauges, rails, springs, saws, knives, punches, draw forming dies, cutter and tooling for release of molded plastic.
- c. With conventional lubricants or where conventional lubricants cannot be used because of anticipated temperature extremes of -200°C to $+482^{\circ}\text{C}$, $+1316^{\circ}\text{C}$ @ vacuum, or with liquid oxygen, hard radiation or electrical items, or where other lubricants may be easily contaminated with dirt, dust or difficult to apply and retain.

DOD-L-85645A

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

- a. Sliding and rolling loads in excess of 2.45×10^6 kPa.
- b. Finishes in excess of 125 rms (roughness microfinish surfaces).
- c. Abrasive environments that will wear substrate.

6.2 Ordering data. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Type
- c. Quantity
- d. If first article inspection is required (see 3.1 and 6.3).
- e. Submittal of test results (see 4.3.2)

6.3 First article. When a first article inspection is required, the item should be a sample coated with lubricant from the first lot. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Material safety data sheets. Material safety data sheets on toxicity shall be prepared in accordance with FED-STD-313 and submitted when required by the procuring activity.

6.5 Subject term (key word) listing.

Air-dried
Lubricant
Metals, dry lubricant for
Non cured dry lubricant
Dry lubricant
Dry thin film lubricant
Oven-cured
Tungsten disulfide
Tungsten disulfide dry lubricant

DOD-L-85645A

Custodian:
Navy - AS
Air Force - 11
Army - ME

Preparing activity:
Navy - AS
(Project No. 9150-1003)

Review activity:
DLA - GS
Army - SM

User:
Army - AR

DOD-L-85645A

TABLE I. Quality conformance inspections.

Inspection	Requirement Paragraph	Inspection Paragraph
Thermal stability	3.4	4.5.3
Film adhesion	3.5	4.5.4
Coefficient of friction	3.6	4.5.5
Aluminum corrosion resistance	3.7	4.5.6

DOD-L-85645A

APPENDIX

INSTRUCTIONS FOR APPLYING LUBRICANT, DRY THIN FILM,
MOLECULAR BONDED

10. SCOPE

10.1 Scope. This appendix covers the application of the dry film lubricant when it is applied over various metal surfaces. This appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS

20.1 Government documents. The following documents form a part of this Appendix to the extent specified herein.

SPECIFICATION

MILITARY

MIL-T-81533 1,1,1-Trichloroethane

FEDERAL

O-T-634 Trichloroethylene, Technical

TT-N-95 Naphtha, Aliphatic

(Copies of specifications, standards, drawings and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

30. REQUIREMENTS

30.1 Inspection. All parts, prior to being degreased, shall be free of all foreign matter. Assemblies with plastic or other non metallic components shall be degreased only when authorized by the contract or applicable drawing. Parts that are excessively soiled or contaminated shall undergo a preliminary cleaning in a steam bath, or soak in a detergent type cleaner providing such treatment is authorized by the contract or applicable drawing.

30.2 Cleaning. Removal of oils, greases, waxes and other foreign matter from surfaces of parts or test specimens shall be cleaned by vaporized chlorinated solvent trichloroethylene in accordance with O-T-634, type II, or 1,1,1-Trichloroethane in accordance with MIL-T-81533 except with titanium and titanium alloys which will be treated with aliphatic naphtha in accordance with TT-N-95. The surface shall be air blasted with a suitable mesh powder that can provide a uniform clean surface. The blast shall not exceed 690 kPa and will be directed in such a manner as to not change the surface dimensional tolerances.