

METRIC

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PERFORMANCE SPECIFICATION

LUBRICANT, SOLID FILM, EXTREME ENVIRONMENT, NATO CODE NUMBER S-1737

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

1. SCOPE

1.1 Scope. This specification covers the requirements for one grade of a solid film lubricant for use at temperatures ranging from -185 to 400 °C. This solid film lubricant is identified by NATO symbol S-1737.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3, Highway 547, Lakehurst, NJ 08733-5100, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 9150

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

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2.2 Government documents.

2.2.1 Specifications. The following specifications 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-250/5 - Aluminum Alloy Alclad 2024, Plate and Sheet.
- TT-N-95 - Naphtha; Aliphatic.

DEPARTMENT OF DEFENSE

- MIL-M-3070 - Mixer, Liquid, Revolving-Shaft and Agitator Types.
- MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.

(Unless otherwise indicated, copies of the above specifications are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM-D2510 - Adhesion of Solid Film Lubricants, Standard Test Method for. (DoD adopted)
- ASTM-D2511 - Thermal Shock Sensitivity of Solid Film Lubricants, Standard Test Method for. (DoD adopted)
- ASTM-D2625 - Endurance (Wear) Life and Load-Carrying Capacity of Solid Film Lubricants (Falex Pin and Vee Method), Standard Test Method for. (DoD adopted)
- ASTM-D4057 - Manual Sampling of Petroleum and Petroleum Products, Standard Practice for. (DoD adopted)
- ASTM-D4177 - Automatic Sampling of Petroleum and Petroleum Products, Standard Practice for. (DoD adopted)

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

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

SAE-AMS5510 - Steel, Corrosion and Heat Resistant, Sheet, Strip, and Plate
18Cr - 10.5Ni-0.40Ti (SAE 30321) Solution Heat Treated.
(DoD adopted)

(Application for copies should be addressed to the Society of Automotive Engineers, Inc.
400 Commonwealth Drive, Warrendale, PA 15096.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1. First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Materials. Component materials used in the manufacture of this lubricant shall consist of lubricating solids in a binder, at spraying consistency. Lubricant compositions furnished under this specification shall contain no organic solvents or binders so as to be compatible with liquid oxygen and radiation.

3.3 Physical and chemical properties.

3.3.1 Film appearance. Film appearance shall be uniform in color, smoothness, and thickness; free of cracks, scratches, pinholes, blisters, bubbles, runs, sags, foreign matter, grit, rough particles, separation of ingredients, or any other surface imperfections (see 4.5.2).

3.3.2 Film thickness. The film thickness shall be not greater than 0.025 mm nor less than 0.035 mm (see 4.5.3).

3.3.3 Film adhesion. The lubricant shall not expose any bare metal surface when tested (see 4.5.4).

3.3.4 Thermal stability. The lubricant shall not flake, crack, or soften when tested (see 4.5.5).

3.3.5 Endurance life. The lubricant endurance life shall be 60 minutes when subjected to a 454-kg applied load (see 4.5.6).

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3.3.6 Storage stability. The lubricant shall show no evidence of gelling and shall conform to the film adhesion requirements of 3.3.3 after 12 months (see 4.5.7).

4. VERIFICATION

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

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

4.2 Inspection conditions. Unless otherwise specified, all inspections shall be performed at a temperature of 25 ± 3 °C.

4.3 First article inspection. First article inspection shall consist of the tests listed in table I.

TABLE I. Inspections.

TEST	PARAGRAPH	FIRST ARTICLE	CONFORMANCE
Film appearance	4.5.2	X	X
Film thickness	4.5.3	X	X
Film adhesion	4.5.4	X	X
Thermal stability	4.5.5	X	--
Endurance life	4.5.6	X	X
Storage stability	4.5.7	X	--

4.3.1 First article samples. The first article samples shall consist of three liters selected at random from the first lot of lubricant processed under a contract or order.

4.4. Conformance inspection. The conformance inspection shall consist of testing the samples of 4.4.1 in accordance with table I.

4.4.1 Conformance samples. The conformance samples shall consist of one can of lubricant taken at random from each lot of packaged lubricant, or; if obtained from a bulk tank, in accordance with ASTM-D4057 or ASTM-D4177. The lot shall be unacceptable if the samples fail to comply with any of the tests specified in table I.

4.5 Tests.

4.5.1 Preparation of test panels. Samples of the lubricant in sprayable form shall be used to prepare bonded film lubricant specimens on test panels in accordance with the following application procedure for the film appearance, film thickness, and film adhesion tests:

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a. The panels shall be made from:

(1) Aluminum alloy in accordance with QQ-A-250/5 and anodized in accordance with MIL-A-8625, type I, measuring 0.4 x 76.2 x 152.4 mm.

(2) Corrosion resistant steel in accordance with SAE-AMS5510, measuring 0.9 x 76.2 x 152.4 mm.

b. The panels shall be pre-cleaned using aliphatic naphtha in accordance with TT-N-95. The stainless steel panels shall be sandblasted with 120 grit steel. The surface of the panel shall be held at a distance of 63.5 mm from the discharge nozzle (orifice opening of 6.35 mm diameter) delivering grit at an air pressure of 550 to 620 kPa. After the panels have been sandblasted, the panels shall be cleaned with a aliphatic naphtha trichloroethane rinse and dried with a stream of dry air that is free of oil. A spray application shall be used to coat the panels with the lubricant for the tests of this specification (see 6.3). Two or three coats may be required to reach the desired dry film thickness of 0.025 to 0.035 mm (see 6.4). Air drying, at a temperature of 25 ± 3 °C for ten minutes, shall be allowed between coats. After the final coat has been applied, the coated panels shall be allowed to air dry for 30 to 35 minutes. The coated panels shall then be heated to 80 ± 1 °C for 120 to 125 minutes followed by 120 to 125 minutes at 150 ± 3 °C. The coated panels shall be allowed to cool to room temperature. At least two coated panels shall be used in each test method requiring test panel specimens.

4.5.2 Film appearance test. The bonded solid film lubricant specimens shall be examined visually at a magnification of 12X for surface imperfections (see 3.3.1).

4.5.3 Film thickness test. Film thickness shall be determined by a magnagauge or by the difference in thickness as measured between an unlubricated anodized aluminum panel and the same panel coated with the dry film lubricant. To ensure measurements in the same portion of the panel, a template shall be made the same size as the panel with a total of four 9.5 mm holes, centered 38 mm in from each 76.2 mm edge and 15.9 mm in from each 152.4 mm edge. Using a precision micrometer with a 0.0025 mm graduation, the thickness shall be measured at each opening in the template with the template in position on the uncoated panel. After the dry film has been applied to the panel and cured, the thickness shall be re-measured at the same positions. The difference in the readings represents the film thickness of the lubricant. The film thickness shall be not greater than 0.025 mm nor less than 0.035 mm.

4.5.4 Film adhesion test. Four bonded anodized aluminum panels (see 4.5.1) shall be tested in accordance with ASTM-D2510. A uniform powdery deposit clinging to the tape shall not be objectionable.

4.5.5 Thermal stability test. The thermal stability test shall be run over a temperature range of -185 to 400 °C in accordance with ASTM-D2511.

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4.5.6 Endurance life test. The lubricant shall be subjected to an endurance test in accordance with ASTM-D2625. The cure schedule shall be as follows:

- a. Air dry for 30 minutes at room temperature (25 ± 3 °C),
- b. Heat for two hours at 80 ± 1 °C, and
- c. Heat for two hours at 150 ± 3 °C.

The test pin shall be uncoated and fabricated from a molybdenum alloy (0.5Ti 0.08Zr) having a Rockwell hardness B95 to B99 and a surface finish of 8 to 12 root-mean-square (rms). The V-blocks may be phosphated or grit blasted with 120 grit steel to produce a surface roughness of 50 to 60 rms.

4.5.7 Storage stability test. A full one-liter container shall be stored for 12 months at 25 ± 3 °C. At the conclusion of the storage period, the container of lubricant shall be subjected to mechanical agitation using an apparatus similar to MIL-M-3070, Type II, size as required, for five minutes. The lubricant shall then be applied (see 4.5.2) and tested for film adhesion, thermal stability, and endurance life.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The lubricant covered by this specification is intended primarily for use in liquid oxygen systems, space vehicles, bearing assemblies, and other equipment where the environments of extreme temperature and nuclear radiation preclude the use of commercial lubricants and organic solid film lubricant. It is intended to reduce wear and to prevent galling and seizing of metal surfaces. Do not use the lubricant on materials that may be adversely affected by exposure to the specific cure temperature of 150 °C. The lubricant should not be used with oils or greases, unless field use indicates otherwise.

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6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- c. Whether first article is required (see 3.1).
- d. Packaging requirements (see 5.1).

6.3 Composition and application. The composition and application of the lubricant under this specification should be optional with the manufacturer, but should be restricted by the requirements of this specification.

6.4 Film thickness by spray application. Spray application (two coats) produces a film thickness in the range of 0.025 to 0.035 mm. This thickness may be reduced by burnishing the cured film. A burnishing technique is as follows:

- a. Vapor degrease grade 0 steel wool.
- b. Don clean, white, lint-free cotton gloves, and rub the solid film lubricant surface gently and uniformly with the steel wool. A micrometer or other measuring technique should be used to determine film thickness.
- c. Remove loose film particles and steel wool with a jet of air which is oil and water-free.
- d. Continue the burnishing technique until the desired film thickness is achieved.

6.5 International standardization agreement. Certain provisions of this specification (see 1.1) are the subject of international standardization agreement AIR-STD-15/1, and STANAG-1135. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices to change the agreement or make other appropriate accommodations.

6.6 Subject term (keyword) list.

Liquid oxygen systems
Nuclear radiation
Space vehicles

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

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CONCLUDING MATERIAL

Custodians:

Army – AV
Navy – AS
Air Force - 11

Preparing activity

Navy – AS
(Project 9150-1219)

Review activities:

Army - AT
Navy - OS
Air Force - 68
DLA - GS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.
NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-81329D

2. DOCUMENT DATE (YYMMDD)
980918

3. DOCUMENT TITLE

LUBRICANT, SOLID FILM, EXTREME ENVIRONMENT, NATO CODE NUMBER S-1737

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (*Last, First, Middle Initial*)

b. ORGANIZATION

c. ADDRESS (*Include Zip Code*)

d. TELEPHONE
(*Include Area Code*)
(1) Commercial:

7. DATE SUBMITTED
(YYMMDD)

(2) DSN:
(*If Applicable*)

8. PREPARING ACTIVITY

a. NAME
COMMANDER
NAVAL AIR WARFARE CENTER
AIRCRAFT DIVISION

b. TELEPHONE NUMBER (*Include Area Code*)
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