

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 3084A

Issued 1-15-76

Revised 1-1-86

Superseding AMS 3084

## SOLID FILM LUBRICANT Space Application, Minimal Outgassing

### 1. SCOPE:

1.1 Form: This specification covers a solid film lubricant in the form of a ready-to-use, sprayable suspension.

1.2 Application: Primarily for use in extreme temperature environments ranging from -185° to +400°C (-300° to +750°F) and in space applications requiring minimal outgassing characteristics.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

#### 2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

AMS 4029 - Aluminum Alloy Sheet and Plate, 4.5Cu - 0.85Si - 0.80Mn - 0.50Mg, (2014 -T6 Sheet, 2014 -T651 Plate)

AMS 5515 - Steel Sheet, Strip, and Plate, Corrosion Resistant, 18Cr - 8.5Ni (SAE 30302), Solution Heat Treated, High Ductility

AMS 6440 - Steel Bars, Forgings, and Tubing, 1.45Cr (0.98 - 1.10C) (SAE 52100) for Bearing Applications

REAFFIRMED

10/91, 5/95

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- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D2510 - Adhesion of Solid Film Lubricants

ASTM D2512 - Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Technique)

ASTM D2625 - Endurance (Wear) Life and Load-Carrying Capacity of Solid Film Lubricants (Falex)

ASTM E595 - Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

- 2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

- 3.1 Material: Shall consist of molybdenum disulfide in a sodium silicate binder at spraying consistency.

- 3.2 Properties: The product shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with specified methods:

- 3.2.1 Curing: The product shall cure to a solid lubricant film by air-drying at  $25^{\circ}\text{C} + 3$  ( $77^{\circ}\text{F} + 5$ ) for 30 - 40 min., heating in an oven at  $80^{\circ}\text{C} + 3$  ( $180^{\circ}\text{F} + 5$ ) for 2 hr + 0.2, further heating in an oven at  $135^{\circ}\text{C} + 3$  ( $275^{\circ}\text{F} + 5$ ) for 6 hr + 0.25, and cooling in air.

- 3.2.2 Film Adhesion: The lubricant film, cured as in 3.2.1, shall not be lifted from the test panel during testing in accordance with ASTM D2510, Procedure B.

- 3.2.3 Thermal Stability: The lubricant film shall not flake, crack, or soften, and shall meet the requirements of 3.2.2, determined in accordance with 4.5.1.

- 3.2.4 Endurance Life: The lubricant film, cured as in 3.2.1 and tested in accordance with ASTM D2625, Procedure A, shall have an average endurance life of at least 100 min. at 1000 lb (4450 N). The endurance life of any single run shall be not less than 80 minutes.

- 3.2.5 Vacuum Performance: The lubricant film, cured as in 3.2.1, shall have maximum average coefficient of friction of 0.14, determined at a reduced pressure of  $10^{-7}$  to  $10^{-10}$  Torr in accordance with 4.5.2.

- 3.2.6 Shock Sensitivity to Liquid Oxygen: The lubricant film, cured as in 3.2.1, shall show no adverse reactions to 20 test drops at 70 ft-lb (95 N·m), determined in accordance with ASTM D2512.

- 3.2.7 Storage Stability: The product shall form a lubricant film conforming to the film adhesion (3.2.2), thermal stability (3.2.3), and endurance life (3.2.4) requirements after six-months storage and application and curing as in 4.5.3.
- 3.2.8 Vacuum Weight Loss: Shall not be greater than 1.0%, determined in accordance with ASTM E595.
- 3.2.9 Volatile Condensable Material: Shall be not greater than 0.1%, determined in accordance with ASTM E595.
- 3.3 Quality: The product, as received by purchaser, shall be homogeneous and shall show no evidence of gelation. The cured lubricant film, examined macroscopically, shall be smooth and uniform in color and shall show no evidence of cracks, scratches, pinholes, blisters, bubbles, runs, sags, foreign matter, grit, rough particles, separation of ingredients, and other imperfections detrimental to usage of the lubricant film.
4. QUALITY ASSURANCE PROVISIONS:
- 4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.
- 4.2 Classification of Tests:
- 4.2.1 Acceptance Tests: Tests to determine conformance to requirements for film adhesion (3.2.2), thermal stability (3.2.3), endurance life (3.2.4), and shock sensitivity (3.2.6) are classified as acceptance tests and shall be performed on each lot.
- 4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of the product to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.
- 4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.
- 4.3 Sampling: Shall be as follows:
- 4.3.1 For Acceptance Tests: Sufficient product shall be taken at random from each lot to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all product produced in a single production run from the same batches of raw materials under the same fixed conditions, or all material subjected to the same unit chemical and physical process intended to make the final product homogeneous, and presented for vendor's inspection at one time. An inspection lot shall not exceed 1000 lb (450 kg) and may be packaged in smaller quantities under the basic lot approval provided lot identification is maintained.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

#### 4.4 Approval:

4.4.1 Sample material shall be approved by purchaser before material for production use is supplied, unless such approval be waived by purchaser. Results of tests on production material shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production material which are essentially the same as those used on the approved sample material. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in material, processing, or both and, when requested, sample material. Production material made by the revised procedure shall not be shipped prior to receipt of reapproval.

#### 4.5 Test Methods:

##### 4.5.1 Thermal Stability:

4.5.1.1 Test Panels: Shall be AMS 5515 corrosion-resistant steel with a No. 2D finish, approximately 0.036 x 3 x 6 in. (0.90 x 75 x 150 mm).

4.5.1.2 Precleaning: Vapor degrease the panels in 1,1,1 trichloroethane and abrasively blast clean with 120 mesh (125  $\mu$ m) alumina ( $Al_2O_3$ ). After abrasive cleaning, rinse the panels in 1,1,1 trichloroethane and dry thoroughly in a stream of dry, oil-free air.

4.5.1.3 Application of Lubricant: Spray the panels, using as many coats as required to provide a solid film thickness of 0.0002 - 0.0005 in. (5 - 12.5  $\mu$ m). Cure as in 3.2.1.

4.5.1.4 Exposure: Expose the coated panels to  $400^{\circ}C \pm 5$  ( $750^{\circ}F \pm 10$ ) for  $3 \text{ hr} \pm 0.25$ , followed by  $1 \text{ hr} \pm 0.2$  at  $-185^{\circ}C \pm 15$  ( $-300^{\circ}F \pm 25$ ). Remove panels and allow to reach room temperature.

4.5.1.5 Adhesion Test: Determine adhesion in accordance with 3.2.2.

##### 4.5.2 Vacuum Performance:

4.5.2.1 Test Specimens: Each set of specimens shall consist of the following:

- 4.5.2.1.1 One AMS 4029 aluminum alloy sheet, approximately 0.22 in. (5.5 mm) thick and 3.5 in. (90 mm) square and having a countersunk 0.19-in.  $\pm$  0.01 (4.8-mm  $\pm$  0.2) diameter mounting hole through the center. Spray with the product, using as many coats as required to provide a solid film thickness of 0.0002 - 0.0005 in. (5 - 12.5  $\mu$ m). Cure as in 3.2.1. Burnish the film with metallographic felt.
- 4.5.2.1.2 Three AMS 6440 steel pins having hardness of 60 - 65 HRC and measuring 0.250 in.  $\pm$  0.000, - 0.001 (6.25 mm  $\pm$  0.00, - 0.02) in diameter by 0.75 in.  $\pm$  0.003 (19.0 mm  $\pm$  0.08) long. The pins shall have a 1/2-in. (12.5-mm) spherical radius on one end. Polish the spherical tips using metallographic techniques. Make the final polish with 600 grit alumina, and clean with 1,1,1 trichloroethane.

4.5.2.2 Friction Test Machine: Shall consist of the following:

- 4.5.2.2.1 A movable platform to carry one half of the friction pair. This platform shall be suspended from the frame by four flexible steel ribbons. A shaft shall be attached to one end of the platform and shall pass through a bellows seal in the door of the vacuum chamber to the exterior drive mechanism.
- 4.5.2.2.2 A holder for three pins which are the other half of the friction pair. This holder also supports weights which press the pins against the plate.
- 4.5.2.2.3 Two load beams for measuring the frictional force between pins and plate. Four electrical strain gages shall be bonded to the load beams and wired in a conventional Wheatstone bridge configuration, with wires passing through a seal in the vacuum chamber to amplifier and recorder equipment.
- 4.5.2.3 Procedure: Mount the plate and the pins in the friction test machine and apply a 6.0 lb  $\pm$  0.2 (2.70 kg  $\pm$  0.10) mass to press the pins against the lubricated plate. Close the vacuum chamber and evacuate to a reduced pressure of  $10^{-10}$  torr. Expose the specimen to this reduced pressure for not less than 100 hr and determine the kinetic coefficient of friction at ambient temperature, using a sliding speed of 0.025 in.  $\pm$  0.010 (0.62 mm  $\pm$  0.25) per second. Record the frictional force on a strip chart recorder. The kinetic coefficient of friction is equal to the frictional force divided by the load pressing the pins against the plate. Make a minimum of five friction measurements and determine the average coefficient of friction.

4.5.3 Storage Stability: Store a full, closed, 1-qt (1-L) container of the product at 25°C  $\pm$  2 (77°F  $\pm$  3) for six months. Agitate the closed container in an agitator-type of liquid mixer. Open the container and examine for homogeneity. Apply the lubricant as in 4.5.1.3 and cure as in 3.2.1.