



Designation: **D2649 – 04 (Reapproved 2009) D2649 – 04 (Reapproved 2014)**

Standard Test Method for Corrosion Characteristics of Solid Film Lubricants¹

This standard is issued under the fixed designation D2649; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method² covers the evaluation of the corrosion characteristics of dry solid film lubricants under conditions of high humidity.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:³

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B308/B308M Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

D235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)

D1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting

D1748 Test Method for Rust Protection by Metal Preservatives in the Humidity Cabinet

D4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants

2.2 U. S. Military Specifications:⁴

Mil-PRF-3043 Resin-Coating, Permanent (for Internal Engine Parts)

2.3 Government Standard:⁵

P-D-680 Dry Cleaning and Degreasing Solvent

3. Terminology

3.1 Definitions:

3.1.1 *lubricant, n*—any material interposed between two surfaces that reduces the friction or wear between them (see Test Method **D4175**).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *dry solid film lubricant, n*—on an aluminum surface, one consisting of friction-reducing powders bonded in tight matrix to the surface of the metal.

4. Summary of Test Method

4.1 An aluminum panel having solid film deposited on one surface is contacted under load with the surface of an unlubricated panel. The specimen is subjected to 95 ± 3 % relative humidity at 49°C (120°F) for a period of 500 h. After this period, the surface of the unlubricated panel is examined for evidence of corrosion.

¹ This test method is under the jurisdiction of ASTM Committee **D02** on Petroleum Products—Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee **D02.L0.05** on Solid Lubricants.

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² Reference may be made to Military Specification MIL-L-8937 (ASG), Jan. 22, 1963, and Method 3814 of Federal Test Method Standard No. 791.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁵ Available from Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

5. Significance and Use

5.1 Surfaces are examined for signs of corrosion. Any sign of corrosion is an indication of potential field failure.

6. Apparatus

6.1 *Bolt and Nut*, Finished hex bolt, $\frac{3}{8}$ -24, minimum 19-mm ($\frac{3}{4}$ -in.) long and finished hex nut, $\frac{3}{8}$ -24. Bolt and nut shall be made of corrosion-resistant aluminum or stainless steel. Two (2) nuts and two (2) bolts are required.

6.2 *Channel*, made of aluminum alloy 6061-T6, conforming to Specification **B308/B308M**, 76-mm (3-in.) wide, 36-mm (1.41-in.) high, cut to 178-mm (7-in.) long. Holes for the bolts to pass through are drilled on the centerline of the channel ~~25 mm~~ 25 mm (1 in.) from each end. Two (2) channels are required.

6.3 *Humidity Environmental Test Chamber*, capable of producing $95 \pm 3\%$ relative humidity, $49 \pm 1^\circ\text{C}$ ($120 \pm 2^\circ\text{F}$), and conforming to Test Method **D1748**, Annex A1 on Humidity Cabinet Apparatus.

6.4 *Torque Wrench*, with capacity of 2.8 N·m (25 lb·in.).

6.5 *Micrometer*, reading 0 to ~~25 ± 0.002~~ 25 ± 0.002 mm (0 to ~~1 ± 0.0001~~ 1 ± 0.0001 in.) with a spherical anvil.

6.6 *Forced-Circulation Oven*, capable of maintaining a temperature of ~~$66 \pm 3^\circ\text{C}$ ($150 \pm 5^\circ\text{F}$) and $149 \pm 5.5^\circ\text{C}$ ($300 \pm 10^\circ\text{F}$)~~ $66 \pm 3^\circ\text{C}$ ($150 \pm 5^\circ\text{F}$) and $149 \pm 5.5^\circ\text{C}$ ($300 \pm 10^\circ\text{F}$).

7. Reagents and Materials

7.1 *Panels*, made of aluminum alloy 2024, conforming to Specification **B209**, 76 by 152 by 0.5 mm (3 by 6 by 0.020 in.) thick, anodized in accordance with Practices **D1730**, Type C, Method 2.

NOTE 1—Other metals and alloys, with other methods of surface pretreatment, may be used in this test method for special purpose. Such deviations shall become a part of the report, **10.1**.

7.2 *Dry Cleaning Solvent*, conforming to Specification **D235** or Federal Specification P-D-680.

7.3 *Resin Coating*, permanent (for internal engine parts), conforming to Military Specification Mil-PRF-3043.

8. Sampling, Test Specimens, and Test Units

8.1 Be certain there is sufficient quantity of solid film lubricant mixture to perform the test.

8.2 Prepare the apparatus and specimens as follows:

8.2.1 Liquid degrease the aluminum channel, nuts, bolts, and test panels with hydrocarbon dry cleaning solvent (see **7.2**).

8.2.2 Deposit a film of resin coating on the surface of the aluminum channel and cure in accordance with the manufacturer's specification.

8.2.3 Apply solid film lubricant to the surface of the panel by spraying or equivalent method to produce a dry film thickness between 0.005 and 0.013 mm (0.0002 and ~~0.0005 in.~~) 0.0005 in.

8.2.4 In most cases, curing will be according to the particular manufacturer's specifications. If such instructions are not provided, cure the film by air drying for 6 h at $26.7 \pm 3^\circ\text{C}$ ($80 \pm 5^\circ\text{F}$) ~~$26.7 \pm 3^\circ\text{C}$ ($80 \pm 5^\circ\text{F}$)~~ or by air drying for 30 min at 26.7°C followed by 1 h in an air-circulating oven at ~~$149 \pm 5.5^\circ\text{C}$ ($300 \pm 10^\circ\text{F}$)~~ $149 \pm 5.5^\circ\text{C}$ ($300 \pm 10^\circ\text{F}$).

8.2.5 Measure the dry film thickness using a micrometer.

9. Procedure

9.1 Arrange the panels (see **Fig. 1**) by placing a coated panel against an uncoated panel at a 90° angle to each other; place them between the aluminum channel, insert the bolts, and tighten the nut and bolt combination to a constant load of ~~$2.8 \text{ N}\cdot\text{m}$ (25 lb·in.)~~ $2.8 \text{ N}\cdot\text{m}$ (25 lb·in.) using a torque wrench. Discard any nuts or bolts that show evidence of corrosion that might lessen the effect of the tightening torque.

9.2 Run a blank assembly with uncoated panels concomitantly with each set of samples as a check on the whole process of panel preparation.

9.3 If it is planned to make inspections prior to the completion of the normal 500-h period, prepare additional assemblies so that no reassembly will be required.

9.4 Place the assembly in a preheated oven at ~~$65.6 \pm 4^\circ\text{C}$ ($150 \pm 8^\circ\text{F}$) for 2 h~~ $65.6 \pm 4^\circ\text{C}$ ($150 \pm 8^\circ\text{F}$) for 2 h.

9.5 Remove the assembly after 2 h and immediately place the assembly into the humidity cabinet at ~~$49 \pm 3^\circ\text{C}$ ($120 \pm 5^\circ\text{F}$)~~ $95 \pm 3^\circ\text{C}$ ($120 \pm 5^\circ\text{F}$), $95 \pm 3\%$ relative humidity.

NOTE 2—Assemblies may be placed in the cabinet in any suitable way to avoid interference with each other and drippage of condensate. Hanging from the rotor is permissible but not specifically recommended.

9.6 Disassemble and inspect the coated and uncoated contact surfaces at 500 h unless some other test period is specifically required.