Designation: D 3115 – 95 (Reapproved 2000)

An American National Standard

Standard Test Method for Explosive Reactivity of Lubricants with Aerospace Alloys Under High Shear[1]

This standard is issued under the fixed designation D 3115; 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.

1. Scope

1.1 This test method is used to evaluate for explosive reactivity of various lubricants in the presence of aerospace alloys under high shear conditions.

1.2 The values stated in SI units are to be regarded as the standard. In cases where materials, products, or equipment are available in inch-pound units only, SI units are omitted.

1.3 This standard should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire-hazard or fire-risk of materials, products, or assemblies under actual fire conditions. However, results of the test may be used as elements of a fire-hazard assessment or a fire-risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard or fire risk of a particular end use.

1.4 *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:*

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate[2]

B 221 Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes[2]

2.2 *ANSI Standard:*

B 46.1 Surface Texture[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *explosive reactivity*, *n*—occurrence of sparks, smoke, or explosive (audible) sounds during this test.

3.1.2 *lubricants*, *n*—liquid materials used as lubricants or cutting fluids in the presence of aerospace alloys.

4. Summary of Test Method

4.1 A shaped dowel pin made of the test material is rotated at 1760 rpm under a pressure of 689 MPa (1000 psi) for 1 min in a shaped hole (drilled into a block of the test material) containing the test lubricant. Observation for indications of reaction is made.

5. Significance and Use

5.1 Explosive reactivity has resulted when parts made from some light alloys, typically high in aluminum and magnesium, are loaded under shear conditions while in contact with certain lubricants. A typical example is a threaded part, lubricated with a chlorofluorocarbon grease, pulled up normally tight.

6. Apparatus

6.1 *Fluted Ball-End End Mills*,[4] two, 12.7 ± 0.025 mm (0.500 ± 0.001 in.) in diameter with a 6.35 ± 0.025-mm (0.250± 0.001-in.) radius tip, finished to 0.203 to 0.406 µm (8 to 16 µin.) rms.

6.2 *Drill Press*, capable of rotating at 1760 rpm under a 6.89-MPa (1000-psi) load.

6.3 *Drill Chuck*, capacity 12.7-mm (½-in.) end mill.

6.4 *Loading Device*, capable of putting a pressure of 6.89 MPa (1000 psi) on the dowel test pin.

6.5 *Force Gage*, 1112 N (250-lbf) force.[5]

6.6 *Drill Press Vise*, capable of holding the test block in position.

6.7 *Surface Texture Standards*, conforming to American National Standard for Surface Texture (ANSI B46.1).

6.8 *Transparent Safety Shield*.

6.9 *Thermocouple and Potentiometer*, optional, for measuring hole-bottom temperature.

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.11 on Engineering Sciences of High Performance Fluids and Solids. ASTM Committee F-7 on Aerospace Industry Methods maintains a continued interest in this test method and will make use of it in the future.

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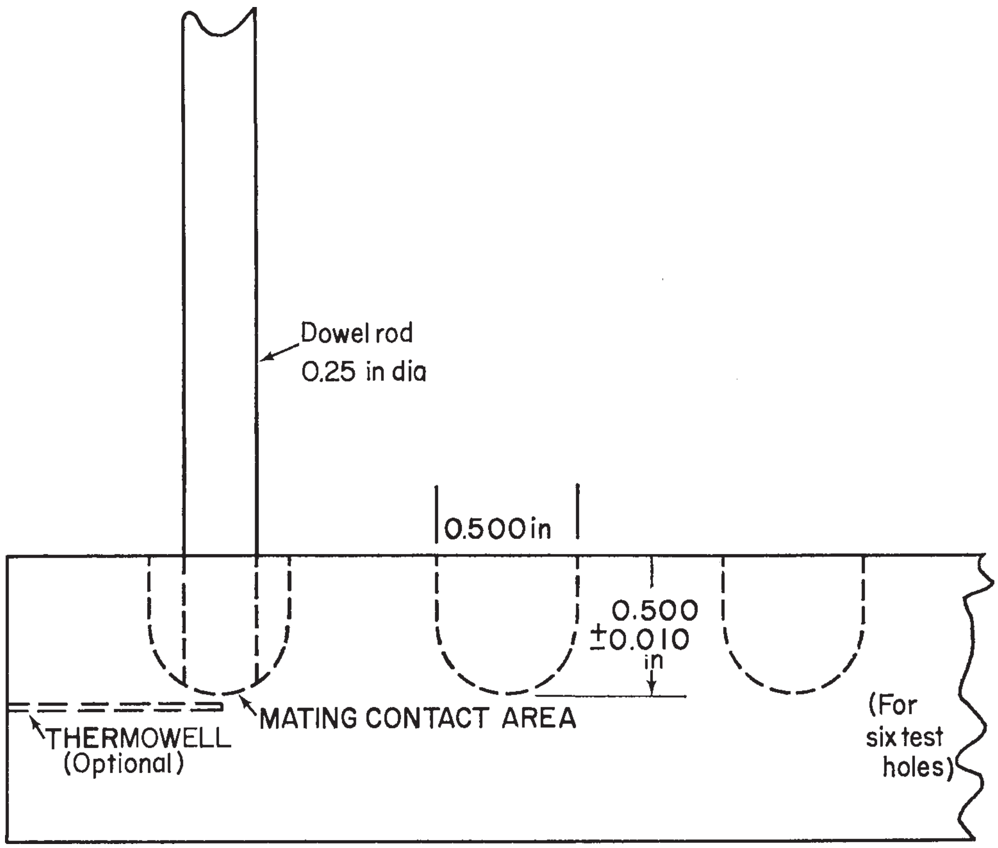
[2] *Annual Book of ASTM Standards*, Vol 02.02.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Carbide tipped ball-end end mills are available and may be used when working with metals harder than aluminum.

[5] A gage manufactured by AMETEK, Inc., Testing Equipment Div., Box 288, Lansdale, PA 19446, has proven satisfactory.



mm	in
0.254	0.010
6.35	0.250
12.7	0.500

FIG. 1 Block, Drilled for Tests

6.10 *Desiccator*, maintained at 50 ± 5 % relative humidity. Water saturated with $Ca(NO_3)_2 \cdot 4H_2O$ at 294 K (70°F) is satisfactory.

7. Materials

7.1 *Blocks*, of the appropriate alloy, 25.4 mm (1 in.) thick by 38 mm (1.5 in.) wide by 165 mm (6.5 in.) long. Unless otherwise specified, use metal conforming to Specification B 209, Grade 2024-T4.

7.2 *Dowel Pins*, of the appropriate alloy, 6.35 ± 0.025 mm (0.250 ± 0.001 in.) in diameter by 76 ± 2.5 mm (3.0 ± 0.1 in.) long and the end having a hemispherical surface with a 6.35 ± 0.025 mm (0.250 ± 0.01-in.) radius and an 0.203 to 0.406 µm (8 to 16-µin.) finish. Unless otherwise specified, use metal conforming to Specification B 221, Grade 2024-T4.

NOTE 1—Both ends of each dowel pin may be so prepared and each considered a *new* test pin under 9.8 provided that the dimensions are maintained as required.

7.3 *Acetone*, reagent grade.[6]

7.4 *Test Lubricant*, sufficient for at least one test series (that is, 6 mL).

8. Test Specimen

8.1 Prepare the block, as shown in Fig. 1, by drilling six holes with the 12.7 mm (0.500-in.) ball-end end mill to a depth of 12.7 mm ± 0.254 mm (0.500 ± 0.100 in.) measured to the tip of the hole. The hole centers shall not be less than 12.7 mm (0.500 in.) from the edge of the block or another hole. The ball end mill will create the correct surface finish in the hole when driven at 500 to 600 rpm with no lubricant.

8.1.1 If it is desired to determine the temperature attained during the test, a thermowell shall be cross-drilled to a point directly under the hole tip ±0.127 mm (±0.005 in.) with a metal thickness between holes of 0.127 ± 0.025 mm (0.005 ± 0.001 in.), using a No. 80 0.343 mm (0.135 in.) drill. A bare-tipped thermocouple made from iron and constantan wires of No. 40 B & S gage (0.0114 mm (0.00315-in.) shall be inserted to full depth and tack-welded by discharging a condenser from the thermocouple to the hole bottom. An electrolytic condenser of 300 µF charged to 45 V has proved satisfactory with many metals, but some experimentation is necessary with aluminum alloys. The temperature is only a relative indication of the frictional heat generated.

[6] "Reagent Chemicals," American Chemical Society Specifications, American Chemical Society, Washington, DC.

TABLE 1 Typical Report

Sample No. Date X/Y/69 Dowel 2024-T4 Block 2024-T4 Lubricant Grease XYZ (Lot No.) Received X/Z/69

Run	Sparks	Bangs	Smoke	Residue	Reaction Time, s	Remarks
1	3	1	black	darkened	19	
2	0	0	white	unchanged	no reaction	
3	1	1 (weak)	gray	darkened	50	
4	5	0	gray	slightly dark	60	
5	2	2 (weak-1)	black	darkened	30	
6	1	1	black	darkened	20	

8.2 Wash the specimens with acetone by dipping and airdrying and store them in a desiccator at 50 ± 5 % relative humidity, unless the room meets this requirement and is fume-free. Do not use until at least 24 h after cleaning.

9. Procedure

9.1 Place a dowel pin in the drill chuck and secure.

9.2 Adjust the drill press to run at 1760 rpm.

9.3 Adjust the load with the force gage to be 233 ± 2 N (52.5 ± 0.5 lbf) which is equivalent to 6.89 MPa (1000 psi).

9.4 Position block in vise so that it will be at 1.57± 0.09 rad (90 ± 5°) to the axis of the dowel pin, and locate the vise on the drill press table in such a way that the hole and dowel axes will be self-aligning.

9.5 Place 0.7 ± 0.1 mL of sample in the first hole, using a 5-mL hypodermic syringe or equivalent.

9.5.1 Unless otherwise required, the test specimens and sample shall be at room temperature; that is, 295 to 301 K (72 to 82°F).

9.6 Lower the dowel pin to the bottom of the hole.

9.7 Apply the load to the dowel pin.

9.8 Position the safety shield.

9.9 Start the motor on the drill press and run the test under load for 60 ± 5 s, or until reaction is evident, and stop while still loaded.

9.10 During the test period, observe the hole for sparks, smoke, and explosive (audible) sounds.

9.11 After terminating the run, release the load and examine the residue for changes in appearance. Record the results.

9.12 Repeat 9.5-9.8 to a total of six runs, using a new hole and dowel-end for each test.

10. Report

10.1 Report the materials used for the dowel pin and block and the identification of the lubricant being tested.

10.2 Report the number and type of reactions for each run of the series. Table 1 illustrates a typical report.

11. Precision and Bias

11.1 *Precision*—The precision of this test method as determined by the statistical examination of interlaboratory test results involving five laboratories and nine samples is as follows:

11.1.1 *Repeatability*—Duplicate results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method exceed more than one reaction per set of six runs only in one case in twenty.

11.1.2 *Reproducibility*—The difference between independent results obtained by different operators working in different laboratories on identical test material would, in the long run, exceed a difference of 108 % of the mean number of reactions only in one case in twenty.

11.2 *Bias*—No statement is made about the bias of this test method since the results cannot be compared to any form of a standard value.

12. Keywords

12.1 aerospace alloys; explosive reactivity; lubricants; reactivity; shear