



Standard Test Method for Determining the Tribological Behavior and the Relative Lifetime of a Fluid Lubricant using the Spiral Orbit Tribometer¹

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1. Scope

1.1 This test method covers the quantitative determination of the friction coefficient and the lifetime of oils and greases, when tested on a standard specimen under specified conditions of preparation, speed, Hertzian stress, materials, temperature, and atmosphere, by means of the Spiral Orbit Tribometer (SOT). This test method is intended primarily as an evaluation of the lifetimes of fluid lubricants under vacuum and ambient conditions.

1.2 This standard may involve hazardous materials, operations, and equipment. *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

D1193 Specification for Reagent Water

F22 Test Method for Hydrophobic Surface Films by the Water-Break Test

F2215 Specification for Balls, Bearings, Ferrous and Non-ferrous for Use in Bearings, Valves, and Bearing Applications

G115 Guide for Measuring and Reporting Friction Coefficients

2.2 Anti Friction Bearing Manufacturers Association Standards³

ANSI ABMA ISO 3290 (AFBMA Standard 10 Balls)

¹ This test method is under the jurisdiction of ASTM Committee F34 on Rolling Element Bearings and is the direct responsibility of Subcommittee F34.02 on Tribology.

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² 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.

³ Available from American Bearing Manufacturers Association (ABMA), 8221 Old Courthouse Road, Suite 207 Vienna, Virginia 22182.

3. Terminology

3.1 Definitions:

3.1.1 *coefficient of friction*—the dimensionless ratio of the friction force between two bodies to the normal force pressing these bodies together.

3.1.2 *fixed plate*—stationary, horizontal flat plate, typically through which a force (the “load”) is applied to the ball.

3.1.3 *friction coefficient limit*—maximum value that the friction coefficient is permitted to attain.

3.1.4 *guide plate*—physical element that deflects the ball to its original orbit radius.

3.1.5 *lubricant total amount*—mass of lubricant deposited on the entire ball surface at the beginning of the test.

3.1.6 *normalized lifetime*—number of ball orbits performed until the friction coefficient limit is reached divided by the lubricant total amount initially deposited on the ball.

3.1.7 *rotary plate*—flat plate rotating at a constant rate selected for the test.

3.1.8 *scrub zone*—Region of the ball's orbit in which the ball is in contact with the guide plate.

3.1.9 *spiral orbit*—track traced by the ball on the fixed and rotating plates of the Spiral Orbit Tribometer. The track has a spiral shape.

4. Summary of Test Method

4.1 A lubricated ball is clamped between two parallel plates. One of the plates rotates up to 210 rpm, causing the ball to roll in a near-circular orbit, but is actually an opening spiral. A clamping force, the “load”, provides a chosen mean Hertz stress (typically 1.5 GPa). The system is targeted to operate in the boundary lubrication regime due to the combination of the high load, the moderate speed, and the small amount of lubricant (approximately 50 μg). The ball rolls and pivots in a spiral orbit and is maintained in the orbit by the guide plate. The ball slides on the rotating plate when it contacts the guide plate. The measured force exerted by the ball on the guide plate is used to determine the friction coefficient. The tribometer runs until the coefficient of friction rises to values much larger than the initial, steady value. At this point the initial charge of