



AEROSPACE INFORMATION REPORT

AIR1794™

REV. B

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Superseding AIR1794A

Ball-On-Cylinder (BOC)
Aircraft Turbine Fuel Lubricity Tester

RATIONALE

ASTM D5001 is a more contemporary standard for fuel lubricity testing that is currently preferred by the Industry. The AE-5B Committee, therefore, decided to reference ASTM D5001 as the preferred method in ARP1794 and then stabilize ARP1794. Revision A of ARP1794, containing the reference to ASTM D5001, has been published, and the next step is to stabilize the standard.

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1. SCOPE

- 1.1 This metric SAE Aerospace Information Report (AIR) details a ball-on-cylinder (BOC) test device and specifies a method of rating the relative lubricity of aviation turbine fuel samples. The BOC produces a wear scar on a stationary steel ball by forcing it with a fixed load against a fuel wetted steel test ring in a controlled atmosphere. The test ring is rotated at a fixed speed so its surface is wetted by a momentary exposure to the fluid under test. The size of the wear scar is a measure of the test fluid lubricity and provides a basis for predicting friction or wear problems.

1.2 Field of Application

To rate the lubricity of turbine fuels for the low lubricity pump endurance test or to determine fuel lubricity.

NOTE: This document, ARP1797, and AIR4027 are complementary documents on the subject of aircraft turbine fuel low lubricity.

1.3 Background

In recent years an increasing amount of lower grade crude oil has been used in the production of aircraft turbine fuel. Hydrogen refining techniques remove the sulfur and polar constituents of the crude oil. Some high quality hydro-refined fuel products have very poor lubricating properties. These low lubricity fuels have caused friction and wear problems in aircraft components. The BOC tester will be increasingly essential to monitor fuel lubricity for fuel system component development tests, production screening tests and field use.

2. REFERENCES

2.1 Applicable Documents

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP1797 Aircraft and Aircraft Engine Fuel Pump Low Lubricity Fluid Endurance Test

AIR4027 Aircraft Turbine Engine Fuel Low Lubricity Information Report

SAE 8720 Steel

2.1.2 Military Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, <http://quicksearch.dla.mil/>.

MIL-PRF-25017 Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D329 Acetone

ASTM D770 Isopropyl Alcohol

ASTM D1016 Iso-octane

ASTM D4306 Practice for Sampling Aviation Fuel for Tests Affected by Trace Contamination

ASTM D5001 Standard Test Method for Measurement of Lubricity of Aviation Turbine Fuels by the Ball-on-Cylinder Lubricity Evaluator (BOCLE)

2.1.4 ANSI Publications

Copies of these documents are available online at <http://webstore.ansi.org>.

ANSI B3.12 Metal Balls

2.1.5 AISI Publications

Available from American Iron and Steel Institute, 25 Massachusetts Avenue, NW, Suite 800, Washington, DC 20001, Tel: 202-452-7100, www.steel.org.

AISI E52100 Chromium Alloy Steel

2.2 Definitions, Symbols, and Abbreviations

LUBRICITY: Property of the fluid, measured by the wear scar in millimeters, produced on a stationary ball from contact with the fuel wetted rotating cylinder operating under closely controlled conditions.

CYLINDER: Falex ring and mandrel assembly.

BOC: Common acronym for versions of the Fuery ball-on-cylinder machine, is also known as BOCM, BOCLE (ball-on-cylinder lubricity evaluator), and more recently BORLE (ball-on-ring lubricity evaluator).

RH: Relative humidity of air.

WSD: Wear scar "diameter," in millimeters, which is the dimensional average of the major and minor axes of the ball wear scar ellipse.

WEAR TRACK: The width of the wear mark in millimeters on the test ring.

3. TEST REQUIREMENTS

3.1 Apparatus

(Reference Figures 1 and 2.)

3.1.1 Ball-On-Cylinder Fuel Lubricity Tester

The BOC fuel lubricity tester is shown in Figures 1 and 2. The original BOC tester was designed by Exxon Research and Engineering Company of Linden, NJ. It was based on the "Fuery Ball-On-Cylinder Test Machine." A derivative of the Exxon design was made by Woodward Governor Company, Aircraft Engineering Department, Rockford, IL. This version beefed up the ball vise, the beam and support, eliminated a problem ridden "friction" measuring feature, provided spring-loaded bearings and larger diameter mandrel axle. A number of BOC testers have been made from nonproprietary Woodward drawings. A version of this design is commercially available in a complete system as p/n BOC-100 from Inter-Av, San Antonio, TX. A recent configuration change has been the adoption of a case hardened steel test ring on a mandrel in place of the test "cylinder." This change has been made to provide better accuracy and repeatability.

3.1.2 Constant Temperature Control

The temperature of flowing water through the BOC reservoir base shall be $25\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$.

3.1.3 Hygrometer

The hygrometer shall be capable of measuring the RH of purge air to $\pm 0.2\%$ at a flow rate of 0.03 to 0.22 m³/h.

3.1.4 Microscope

The microscope shall have a capability up to 100X with an ocular containing a scaled reticule 0 to 1 mm in graduations of 0.1 and 0.01 mm or cross hairs and a mechanical stage with the same resolution.

3.1.5 Ultrasonic Cleaner

There shall be an ultrasonic cleaner with a timer and a minimum 2 L stainless steel tank.

3.1.6 Frequency (Speed) Counter

The frequency counter shall be capable of reading $\pm 1\text{ Hz}$ (rpm).

3.2 Materials