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# Standard Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1R Test Procedure<sup>1</sup>

This standard is issued under the fixed designation D6923; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

Any properly equipped laboratory, without outside assistance, can use the test procedure described in this test method. The ASTM Test Monitoring Center (TMC)<sup>2</sup> provides calibration oils and an assessment of the test results obtained on those oils by the laboratory. By this means, the laboratory will know whether their use of the test method gives results statistically similar to those obtained by other laboratories. Furthermore, various agencies require that a laboratory utilize the TMC services in seeking qualification of oils against specifications. For example, the U.S. Army has such a requirement in some of its engine oil specifications. Accordingly, this test method is written for those laboratories that use the TMC services. Laboratories that choose not to use these services should ignore those portions of the test method that refer to the TMC. Information Letters issued periodically by the TMC may modify this test method.<sup>3</sup> In addition, the TMC may issue supplementary memoranda related to the test method.

### 1. Scope\*

1.1 This test method covers stressing an engine oil under modern high-speed diesel operating conditions and measures the oil's deposit control, lubrication ability, and resistance to oil consumption. It is performed in a laboratory using a standardized high-speed, single-cylinder diesel engine.<sup>4</sup>

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 *Exceptions*—Where there is no direct SI equivalent such as screw threads, national pipe threads/diameters, and tubing size, or where a sole source supplier is specified.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.B0 on Automotive Lubricants.

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<sup>2</sup> ASTM Test Monitoring Center (TMC), 6555 Penn Avenue, Pittsburgh, PA 15206-4489.

<sup>3</sup> Until the next revision of this test method, the ASTM Test Monitoring Center (TMC) will update changes in the test method by means of information letters. Information letters may be obtained from the ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, PA 15206-4489. Attention: Administrator. This edition incorporates revisions in all information Letters through No. 16-1.

<sup>4</sup> Available from Caterpillar Inc., Engine System Technology Development, P.O. Box 610, Mossville, IL 61552-0610.

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 requirements prior to use.* Being an engine test method, this test method does have definite hazards that require safe practices (see [Appendix X2](#) on Safety).

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## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>5</sup>

- D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D97 Test Method for Pour Point of Petroleum Products
- D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- D235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
- D613 Test Method for Cetane Number of Diesel Fuel Oil
- D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D976 Test Method for Calculated Cetane Index of Distillate Fuels
- D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
- D1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
- D2500 Test Method for Cloud Point of Petroleum Products and Liquid Fuels
- D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge
- D3338 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
- D3524 Test Method for Diesel Fuel Diluent in Used Diesel Engine Oils by Gas Chromatography
- D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
- D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
- D4485 Specification for Performance of Active API Service Category Engine Oils
- D4739 Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration
- D4863 Test Method for Determination of Lubricity of Two-Stroke-Cycle Gasoline Engine Lubricants
- D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
- D5302 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Deposit Formation and Wear in a Spark-Ignition Internal Combustion Engine Fueled with

<sup>5</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

1.5 This international standard was developed in accordance with internationally recognized principles on standardization established in the *Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee*.

Gasoline and Operated Under Low-Temperature, Light-Duty Conditions (Withdrawn 2003)<sup>6</sup>

**D5844** Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID) (Withdrawn 2003)<sup>6</sup>

**D5862** Test Method for Evaluation of Engine Oils in Two-Stroke Cycle Turbo-Supercharged 6V92TA Diesel Engine (Withdrawn 2009)<sup>6</sup>

**D5966** Test Method for Evaluation of Engine Oils for Roller Follower Wear in Light-Duty Diesel Engine

**D5967** Test Method for Evaluation of Diesel Engine Oils in T-8 Diesel Engine

**D6202** Test Method for Automotive Engine Oils on the Fuel Economy of Passenger Cars and Light-Duty Trucks in the Sequence VIA Spark Ignition Engine (Withdrawn 2009)<sup>6</sup>

**D6594** Test Method for Evaluation of Corrosiveness of Diesel Engine Oil at 135 °C

**D6681** Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1P Test Procedure

**E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

**E344** Terminology Relating to Thermometry and Hydrometry

**G40** Terminology Relating to Wear and Erosion

2.2 *Other ASTM Document:*

**ASTM Deposit Rating Manual 20** (formerly CRC Manual 20)<sup>7</sup>

2.3 *SAE Standard:*

**SAE J183** Engine Oil Performance and Engine Service Classification<sup>8</sup>

2.4 *API Standard:*

**API 1509** Engine Service Classification and Guide to Crankcase Oil Selection<sup>9</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *additive, n*—a material added to another, usually in small amounts, to impart or enhance desirable properties or to suppress undesirable properties. **D4175**

3.1.2 *automotive, adj*—descriptive of equipment associated with self-propelled machinery, usually vehicles driven by internal combustion engines. **D4485**

3.1.3 *blind reference oil, n*—a reference oil, the identity of which is unknown by the test facility.

3.1.3.1 *Discussion*—This is a coded reference oil, which is submitted by a source independent from the test facility. **D5844**

3.1.4 *blowby, n—in internal combustion engines*, the combustion products and unburned air-and-fuel mixture that enter the crankcase. **D5302**

<sup>6</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>7</sup> For Stock #TMCML20, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM International Customer Service at [service@astm.org](mailto:service@astm.org).

<sup>8</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

<sup>9</sup> Available from The American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005.

3.1.5 *calibrate, v*—to determine the indication or output of a measuring device with respect to that of a standard. **E344**

3.1.6 *calibrated test stand, n*—a test stand on which the testing of reference material(s), conducted as specified in the standard, provided acceptable test results.

3.1.6.1 *Discussion*—In several automotive lubricant standard test methods, the TMC<sup>2</sup> provides testing guidance and determines acceptability. **D6681**

3.1.7 *candidate oil, n*—an oil which is intended to have the performance characteristics necessary to satisfy a specification and is to be tested against that specification. **D5844**

3.1.8 *debris, n—in internal combustion engines*, solid contaminant materials unintentionally introduced into the engine or resulting from wear. **D5862**

3.1.9 *dispersant, n—in engine oil*, an additive that reduces deposits on oil-wetted surfaces primarily through suspension of particles. **D4175**

3.1.10 *engine oil, n*—a liquid that reduces friction or wear, or both, between the moving parts within an engine; removes heat, particularly from the underside of pistons; and serves as a combustion gas sealant for the piston rings.

3.1.10.1 *Discussion*—It may contain additives to enhance certain properties. Inhibition of engine rusting, deposit formation, valve train wear, oil oxidation and foaming are examples. **D5862**

3.1.11 *heavy-duty, adj—in internal combustion engine operation*, characterized by average speeds, power output and internal temperatures that are close to the potential maximums. **D4485**

3.1.12 *lubricant, n*—any material interposed between two surfaces that reduces the friction or wear, or both, between them. **D5862**

3.1.13 *lubricating oil, n*—a liquid lubricant, usually comprising several ingredients, including a major portion of base oil and minor portions of various additives. **D5966**

3.1.14 *non-reference oil, n*—any oil other than a reference oil; such as a research formulation, commercial oil or candidate oil. **D5844**

3.1.15 *oxidation, n—of engine oil*, the reaction of the oil with an electron acceptor, generally oxygen, that can produce deleterious acidic or resinous materials often manifested as sludge formation, varnish formation, viscosity increase, or corrosion, or combination thereof. **D6681**

3.1.16 *purchaser, n—of an ASTM test*, person or organization that pays for the conduct of an ASTM test method on a specified product. **D6202**

3.1.17 *reference oil, n*—an oil of known performance characteristics, used as a basis for comparison.

3.1.17.1 *Discussion*—Reference oils are used to calibrate testing facilities, to compare the performance of other oils, or to evaluate other material (such as seals) that interact with oils. **D5844**

3.1.18 *scoring, n—in tribology*, a severe form of wear characterized by the formation of extensive grooves and scratches in the direction of sliding. **G40**