



# Standard Test Method for Evaluation of Engine Oils for Roller Follower Wear in Light-Duty Diesel Engine<sup>1</sup>

This standard is issued under the fixed designation D5966; 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

This test method is continually undergoing changes to reflect refinements in procedure, obsolescence of parts or reagents. These changes or updates, as well as general information regarding the test method, are issued as information letters by the ASTM Test Monitoring Center (TMC). Copies of information letters pertaining to the test method may be obtained by contacting the ASTM Test Monitoring Center.<sup>2</sup>

The test method can be used by any properly equipped laboratory, without assistance of anyone not associated with that laboratory. However, TMC provides reference 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 imposes such a requirement, in connection with several military lubricant specifications.

Accordingly, this test method is written for use by laboratories which utilize the TMC services. Laboratories that choose not to use these services may simply ignore those portions of the test procedure which refer to the TMC.

### 1. Scope\*

1.1 This engine lubricant test method is commonly referred to as the Roller Follower Wear Test. Its primary result, roller follower shaft wear in the hydraulic valve lifter assembly, has been correlated with vehicles used in stop-and-go delivery service prior to 1993. It is one of the test methods required to evaluate lubricants intended to satisfy the API CG-4 performance category. This test has also been referred to as the 6.2 L Test.

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 pipe fittings, thermocouple diameters, and NPT screw threads. Also, roller follower wear is measured in mils.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.B0.02 on Heavy Duty Engine Oils.

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<sup>2</sup> ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, PA 15206-4489. This edition incorporated revisions contained in all Information Letters through No. 12-1.

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.*

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<b>D4052</b> Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
<b>D4175</b> Terminology Relating to Petroleum, Petroleum Products, and Lubricants
<b>D4485</b> Specification for Performance of Active API Service Category Engine Oils
<b>D4737</b> Test Method for Calculated Cetane Index by Four Variable Equation
<b>D5185</b> Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
<b>D7422</b> Test Method for Evaluation of Diesel Engine Oils in T-12 Exhaust Gas Recirculation Diesel Engine
<b>E29</b> Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
2.2 American National Standards Institute (ANSI): <sup>4</sup>
<b>MC96.1</b> Temperature Measurement Thermocouples

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

- D86** Test Method for Distillation of Petroleum Products 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)
- D287** Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)
- D445** Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D446** Specifications and Operating Instructions for Glass Capillary Kinematic Viscometers
- D482** Test Method for Ash from Petroleum Products
- 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
- D1319** Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption

## 3. Terminology

### 3.1 Definitions:

3.1.1 *blowby*, *n*—in internal combustion engines, that portion of the combustion products and unburned air/fuel mixture that leaks past piston rings into the engine crankcase during operation.

3.1.2 *BTDC* (*before top dead center*), *n*—used with the degree symbol to indicate the angular position of the crankshaft relative to its position at the point of uppermost travel of the piston in the cylinder.

3.1.3 *calibrate*, *v*—to determine the indication or output of a device (e.g., thermometer, manometer, engine) with respect to that of a standard.

3.1.4 *candidate oil*, *n*—an oil which is intended to have the performance characteristics necessary to satisfy a specification and is tested against that specification. **D4175**

3.1.5 *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 piston rings.

3.1.5.1 *Discussion*—It may contain additives to enhance certain properties. Inhibition of engine rusting, deposit formation, valve train wear, oil oxidation and foaming are examples. **D4175**

3.1.6 *light-duty*, *adj*— in internal combustion engine operation, characterized by average speeds, power output, and internal temperatures that are generally much lower than the potential maximums. **D4485**

<sup>3</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.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

3.1.7 *light-duty engine, n*—in internal combustion engine types, one that is designed to be normally operated at substantially less than its peak output. **D4485**

3.1.8 *lubricant, n*—any material interposed between two surfaces that reduces friction or wear, or both, between them. **D4175**

3.1.9 *lubricating oil, n*—a liquid lubricant, usually comprising several ingredients, including a major portion of base oil and minor portions of various additives. **D4175**

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

3.1.10.1 *Discussion*—Reference oils are used to calibrate testing facilities, to compare the performance of other oils, or to evaluate other materials (such as seals) that interact with oils. **D4175**

3.1.11 *used oil, n*—any oil that has been in a piece of equipment (for example, an engine, gearbox, transformer, or turbine), whether operated or not. **D4175**

3.1.12 *wear, n*—the loss of material from a surface, generally occurring between two surfaces in relative motion, and resulting from mechanical or chemical action, or a combination of both. **D7422**

## 4. Summary of Test Method

4.1 A pre-assembled GM V8 diesel test engine is installed on a test stand and operated for 50 h.

4.2 The test engine operating conditions are generally more extreme than typical service operating conditions. These conditions provide high soot loading and accelerated roller follower shaft wear while maintaining correlation with wear levels found in the field.

4.3 At the end of the test, the performance of the engine oil is determined by measuring the level of wear on the roller follower shafts.

## 5. Significance and Use

5.1 This test method is used to determine the ability of an engine crankcase oil to control wear that can develop in the field under low to moderate engine speeds and heavy engine torques. Side-by-side comparisons of two or more oils in delivery van fleets were used to demonstrate the field performance of various oils. The specific operating conditions of this test method were developed to provide correlation with the field performance of these oils.

5.2 This test method, along with other test methods, defines the minimum performance level of the Category API CG-4 for heavy duty diesel engine lubricants. Passing limits for this category are included in Specification **D4485**.

5.3 The design of the engine used in this test method is not representative of all modern diesel engines. Consider this factor, along with the specific operating conditions used to accelerate wear, when extrapolating test results.

## 6. Apparatus

6.1 A listing and complete description of all apparatus used in the test is found in **Annex A3**. Information concerning procurement of apparatus can be found in **Appendix X1**.

## 7. Reagents

7.1 *Guidelines on Substitution*—No substitutions for the reagents listed in **7.1.1 – 7.1.3** are allowed.

7.1.1 *Cleaning Solvent*, For cleaning parts, use only mineral spirits meeting the requirements of Specification **D235**, Type II, Class C for Aromatic Content (volume fraction (0 to 2) %), Flash Point (61°C, min) and Color (not darker than +25 on the Saybolt Scale or 25 on Pt-Co Scale. (**Warning**—Combustible. Health hazard.) Obtain a Certificate of Analysis for each batch of solvent from the supplier.

7.1.2 *Engine Coolant*—The engine coolant is a solution of demineralized water that has less than 0.03 g/kg dissolved solids and an ethylene glycol based anti-freeze mixed at the following concentration—70 % antifreeze and 30 % water by volume.

7.1.2.1 *Demineralized Water*, is used as a generic term to describe pure water. Deionized or distilled water may also be used as long as the total dissolved solids content is less than 0.03 g/kg.

7.1.3 *Fuel*—Approximately 600 L of either PC-9 or PC-9-HS Reference Diesel Fuel are required for each test.<sup>5</sup> (**Warning**—Combustible. Health hazard. Use adequate safety provisions.)

7.1.3.1 *Fuel Batch Analysis*—Each fuel shipment does not need to be analyzed upon receipt from the supplier. However, laboratories are responsible for periodic checks for contamination. Any analysis results for parameters tested should be within the tolerances shown on Form 20. If any results fall outside the tolerances shown on Form 20, the laboratory should contact the Test Monitoring Center (TMC)<sup>2</sup> for help in resolving the problem.

7.1.3.2 *Fuel Batch Storage*—The fuel should be stored in accordance with all applicable safety and environmental regulations.

7.1.4 *Break-In Oil*—Approximately 8 kg of break-in oil are necessary for new engine break-in. Break-in oil is defined as any SAE 15W-40, API CG-4 quality oil.

7.1.5 *Non-Reference Test Oil*—A minimum of 20 kg of new oil are required to complete the test. A 25 kg sample of new oil is normally provided to allow for inadvertent losses.

7.1.6 *Calibration Test Oil*—A 22 kg sample of reference oil is provided by the TMC for each calibration test.

## 8. Preparation of Apparatus

8.1 *New Engine Preparation*—Paragraphs **8.1.1** through **8.1.7** describe preparations that are only performed on a new engine before conducting the new engine break-in.

8.1.1 *Engine Front Cover Installation*—Install the front cover to the front of the engine block with the gasket supplied and torque all bolts to 40 N·m.

8.1.2 *Oil Sump Drain Location*—Install a drain in the sump as described in **A3.9.3.7**.

8.1.3 *Glow Plug Replacement*—Remove the glow plugs and install 27-in. dry seal NPT socket pressure plugs. Torque the plugs to 20 N·m.

<sup>5</sup> Available from Chevron Phillips, Phillips 66 Co., Marketing Services Center, P.O. Box 968, Borger, TX 79008-0968.