Designation: D6975 – 04 (Reapproved 2010)

# Standard Test Method for Cummins M11 EGR Test[1]

This standard is issued under the fixed designation D6975; 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 commonly referred to as the Cummins M11 Exhaust Gas Recirculation Test (EGR). The test method defines a heavy-duty diesel engine test procedure conducted under high soot conditions to evaluate oil performance with regard to valve train wear, sludge deposits, and oil filter plugging[2] in an EGR environment.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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.* See Annex A1 for general safety precautions.

1.4 *Table of Contents*:



[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.B0.02 on Heavy Duty Engine Oils.

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[2] The ASTM Test Monitoring Center will update changes in this test method by means of Information Letters. Information letters may be obtained from the ASTM Test Monitoring Center, 6555 Penn Avenue, Pittsburgh, PA 15206-4489, Attention: Administrator. This edition incorporates revisions contained in all information letters through 03-1.

## 2. Referenced Documents

2.1 *ASTM Standards:*[3]

D86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D97 Test Method for Pour Point of Petroleum Products

D129 Test Method for Sulfur in Petroleum Products (General Bomb Method)

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

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)

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

D2274 Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)

D2500 Test Method for Cloud Point of Petroleum Products

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

D2896 Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration

D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

D4485 Specification for Performance of Engine Oils

D4737 Test Method for Calculated Cetane Index by Four Variable Equation

D4739 Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration

D5185 Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in 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 Gasoline and Operated Under Low-Temperature, Light-Duty Conditions[4]

D5844 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID)[4]

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

D6483 Test Method for Evaluation of Diesel Engine Oils in T-9 Diesel Engine[4]

D6557 Test Method for Evaluation of Rust Preventive Characteristics of Automotive Engine Oils

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

E344 Terminology Relating to Thermometry and Hydrometry

[3] 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.

[4] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

2.2 *Coordinating Research Council (CRC):*[5]

CRC Manual No. 20

2.3 *National Archives and Records Administration:*[6]

Code of Federal Regulations Title 40 Part 86.310-79

## 3. Terminology

3.1 *Definitions:*

3.1.1 *blind reference oil*, *n*—a reference oil, the identity of which is unknown by the test facility. **D5844**

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

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

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

3.1.5 *heavy-duty engine*, *adj—in internal combustion engines*, one that is designed to allow operation continuously at or close to its peak output. **D4485**

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

3.1.7 *non-standard test*, *n*—a test that is not conducted in conformance with the requirements in the standard test method; such as running in a non-calibrated test stand or using different test equipment, applying different equipment assembly procedures, or using modified operating conditions. **D5844**

3.1.8 *reference oil*, *n*—an oil of known performance characteristics used as a basis for comparison. **D4485**

3.1.9 *sludge*, *n—in internal combustion engines*, a deposit, principally composed of insoluble resins and oxidation products from fuel combustion and the lubricant, that does not drain from engine parts but can be removed by wiping with a cloth. **D5302**

3.1.10 *test oil*, *n*—any oil subjected to evaluation in an established procedure. **D6557**

3.1.11 *wear*, *n*—the loss of material from, or relocation of material on, a surface. **D5302**

3.1.11.1 *Discussion*—Wear generally occurs between two surfaces moving relative to each other, and is the result of mechanical or chemical action or by a combination of mechanical and chemical actions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *crosshead*, *n*—an overhead component, located between the rocker arm and each intake valve and exhaust valve pair, that transfers rocker arm travel to the opening and closing of each valve pair.

3.2.1.1 *Discussion*—Each cylinder has two crossheads, one for each pair of intake valves and exhaust valves.

3.2.2 *de-rate protocols*, *n*—protocols in the engine control module that cause the engine to reduce power output when certain operating parameters are exceeded.

3.2.3 *exhaust gas recirculation (EGR)*, *n*—a method by which a portion of the engine exhaust is returned to the combustion chambers through the intake system.

3.2.4 *overhead*, *n—in internal combustion engines*, the components of the valve train located in or above the cylinder head.

3.2.5 *overfuel*, *v*—to cause the fuel flow to exceed the standard production setting.

3.2.6 *valve train*, *n—in internal combustion engines*, the series of components, such as valves, crossheads, rocker arms, push rods, and camshaft, that open and close the intake and exhaust valves.

## 4. Summary of Test Method

4.1 This test method uses a Cummins M11 400 diesel engine with a specially modified engine block. Test operation includes a 25-min warm-up, a 2-h break-in, and 300 h in six 50-h stages. During stages A, C, and E, the engine is operated with retarded fuel injection timing and is overfueled to generate excess soot. During stages B, D, and F, the engine is operated at conditions to induce valve train wear.

4.2 Prior to each test, the engine is cleaned and assembled with new cylinder liners, pistons, piston rings, and overhead valve train components. All aspects of the assembly are specified.

4.3 A forced oil drain, an oil sample, and an oil addition, equivalent to an oil consumption of 0.23 g/kW-h, is performed at the end of each 25-h period.

4.4 The test stand is equipped with the appropriate instrumentation to control engine speed, fuel flow, and other operating parameters.

4.5 Oil performance is determined by assessing crosshead wear at 8.5 mass % soot, sludge deposits, and oil filter plugging.

## 5. Significance and Use

5.1 This test method was developed to assess the performance of an engine oil to control engine wear and deposits under heavy-duty operating conditions selected to accelerate soot generation, valve train wear, and deposit formation in a turbocharged, aftercooled four-stroke-cycle diesel engine equipped with exhaust gas recirculation hardware.

5.2 This test method may be used for engine oil specification acceptance when all details of this test method are in compliance. Applicable engine oil service categories are included in Specification D4485.

5.3 The design of the engine used in this test method is representative of many, but not all, modern diesel engines. This factor, along with the accelerated operating conditions, needs to be considered when extrapolating test results.

## 6. Apparatus

6.1 *Test Engine Configuration*:

6.1.1 *Test Engine*—The Cummins M11 400 is an in-line six-cylinder heavy-duty diesel engine with 11 L of displacement and is turbocharged and aftercooled. The engine has an

[5] Available from the Coordinating Research Council, Inc., 219 Perimeter Parkway, Atlanta, GA 30346.

[6] Available from Superintendent of Documents, Attn: New Orders, P.O. Box 371954, Pittsburgh, PA 15250-7954.