



Designation: D8048 – 21a^{ε1}

Standard Test Method for Evaluation of Diesel Engine Oils in T-13 Diesel Engine¹

This standard is issued under the fixed designation D8048; 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.

^{ε1} NOTE—Editorially updated TMC governance information in June 2022.

INTRODUCTION

This test method is written for use by laboratories that use the portions of the test method that refer to ASTM Test Monitoring Center (TMC)² services (see [Annex A1](#) – [Annex A4](#)).

The TMC provides reference oils, and engineering and statistical services to laboratories that desire to produce test results that are statistically similar to those produced by laboratories previously calibrated by the TMC.

In general, the Test Purchaser decides if a calibrated test stand is to be used. Organizations such as the American Chemistry Council require that a laboratory utilize the TMC services as part of their test registration process. In addition, the American Petroleum Institute and the Gear Lubricant Review Committee of the Lubricant Review Institute (SAE International) require that a laboratory use the TMC services in seeking qualification of oils against their specifications.

The advantage of using the TMC services to calibrate test stands is that the test laboratory (and hence the Test Purchaser) has an assurance that the test stand was operating at the proper level of test severity. It should also be borne in mind that results obtained in a non-calibrated test stand may not be the same as those obtained in a test stand participating in the ASTM TMC services process.

Laboratories that choose not to use the TMC services may simply disregard these portions.

ASTM International policy is to encourage the development of test procedures based on generic equipment. It is recognized that there are occasions where critical/sole-source equipment has been approved by the technical committee (surveillance panel/task force) and is required by the test procedure. The technical committee that oversees the test procedure is encouraged to clearly identify if the part is considered critical in the test procedure. If a part is deemed to be critical, ASTM encourages alternative suppliers to be given the opportunity for consideration of supplying the critical part/component providing they meet the approval process set forth by the technical committee.

An alternative supplier can start the process by initiating contact with the technical committee (current chairs shown on ASTM TMC website). The supplier should advise on the details of the part that is intended to be supplied. The technical committee will review the request and determine feasibility of an alternative supplier for the requested replacement critical part. In the event that a replacement critical part has been identified and proven equivalent the sole-source supplier footnote shall be removed from the test procedure.

1. Scope*

1.1 This test method covers an engine test procedure for evaluating diesel engine oils for oxidation performance char-

acteristics in an engine equipped with exhaust gas recirculation and running on ultra-low sulfur diesel fuel.² This test method is commonly referred to as the Volvo T-13.

¹ 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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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, 203 Armstrong Drive, Freeport, PA 16229, Attention: Director. This edition incorporates revisions in all Information Letters through No. 21-1.

*A Summary of Changes section appears at the end of this standard

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 *Exception*—Where there is no direct SI equivalent, such as the units for screw threads, National Pipe Threads/diameters, tubing size, and single source supply equipment specifications.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* See **Annex A10** for specific safety precautions.

1.4 *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.*

2. Referenced Documents

2.1 ASTM Standards:³

- 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)
- 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 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
 - D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry
 - D4485 Specification for Performance of Active API Service Category Engine Oils
 - D4739 Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration
 - D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
 - D5186 Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels By Supercritical Fluid Chromatography
 - D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
 - D5967 Test Method for Evaluation of Diesel Engine Oils in T-8 Diesel Engine
 - D6079 Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)
 - D7039 Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatized Wavelength Dispersive X-ray Fluorescence Spectrometry
 - E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
 - E178 Practice for Dealing With Outlying Observations
- 2.2 *National Archives and Records Administration:*⁴
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.
 - 3.1.1.1 *Discussion*—This is coded reference oil that is submitted by a source independent from the test facility. **D4175**
 - 3.1.2 *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.
 - 3.1.3 *calibrate, v*—to determine the indication or output of a device (for example, thermometer, manometer, and engine) with respect to that of a standard.

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 Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

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

3.1.5 *exhaust gas recirculation (EGR)*, *n*—the mixing of exhaust gas with intake air to reduce the formation of nitrogen oxides (NO_x). **D4175**

3.1.6 *heavy-duty*, *adj*—in internal combustion engine operation, characterized by average speeds, power output and internal temperatures that are close to the potential maximums. **D4175**

3.1.7 *heavy-duty engine*, *n*—in internal combustion engine types, one that is designed to allow operation continuously at or close to its peak output.

3.1.8 *non-reference oil*, *n*—any oil other than a reference oil; such as a research formulation, commercial oil, or candidate oil. **D4175**

3.1.9 *non-standard test*, *n*—a test that is not conducted in conformance with the requirements in the standard test method; such as running on an uncalibrated test stand, using different test equipment, applying different equipment assembly procedures, or using modified operating conditions. **D4175**

3.1.10 *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.

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

3.1.11.1 *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**

3.1.12 *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. **D4175**

3.1.13 *standard test*, *n*—a test on a calibrated test stand, using the prescribed equipment in accordance with the requirements in the test method, and conducted in accordance with the specified operating conditions.

3.1.14 *test parameter*, *n*—a specified component, property, or condition of a test procedure.

3.1.14.1 *Discussion*—Examples of *components* are fuel, lubricant, reagent, cleaner, and sealer; of *properties* are density, temperature, humidity, pressure, and viscosity; and of *conditions* are flow rate, time, speed, volume, length, and power. **D4175**

3.1.15 *varnish*, *n*—in internal combustion engines, a hard, dry, generally lustrous deposit that can be removed by solvents but not by wiping with a cloth. **D4175**

3.1.16 *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. **D4175**

4. Summary of Test Method

4.1 The test operation involves use of a Volvo/Mack D13/MP8 diesel engine with Exhaust Gas Recirculation (EGR). A warm-up and a 1 h break-in are followed by a single-phase test consisting of 360 h at 1500 r/min and fuel flow of 68.0 kg/h.

4.2 Take oil samples periodically and analyze for viscosity increase, oxidation, and wear metals content.

4.3 Rebuild the engine prior to each test. Disassemble, solvent-clean, measure, and rebuild the engine power section using all new pistons, rings, cylinder liners, and connecting rod bearings, in strict accordance with furnished specifications.

4.4 Solvent-clean the engine crankcase and replace worn or defective parts.

4.5 Equip the test stand with appropriate accessories for controlling speed, fuel flow, and various engine operating conditions.

5. Significance and Use

5.1 This test method was developed to evaluate the oxidation resistance performance of engine oils in turbocharged and intercooled four-cycle diesel engines equipped with EGR and running on ultra-low sulfur diesel fuel. Obtain results from used oil analysis and component measurements before and after test.

5.2 The test method may be used for engine oil specification acceptance when all details of the procedure are followed.

6. Apparatus

6.1 General Description:

6.1.1 The test engine is a Volvo/Mack D13/MP8, electronically controlled fuel injection with six electronic unit injectors. It is an open-chamber, in-line, six-cylinder, four-stroke, turbocharged, charge air-cooled, and compression ignition engine.

6.1.2 The ambient laboratory atmosphere shall be relatively free of dirt and other contaminants as required by good laboratory standards. Filtering air, controlling temperature, and controlling humidity in the engine buildup area helps prevent accumulation of dirt and other contaminants on engine parts and aids in measuring and selecting parts for assembly.

6.2 Test Engine:

6.2.1 *Volvo T-13 Test Engine*—The engine is available from TEI. A list of test parts to be replaced for each test is shown in **Table A6.1**. Use test parts on a first-in/first-out basis. A complete engine parts list is available from the TMC website.

6.2.1.1 The engine should be mounted with the flywheel perpendicular to the floor and tilted 4° toward the intake manifold side of the engine.

6.2.2 Engine Cooling System:

6.2.2.1 Use a new Volvo or Mack branded coolant filter, without additives, every test, to limit scaling in the cooling system. Pressurize the system at the expansion tank to 103 kPa. Use the coolant described in **7.3.1**.

6.2.2.2 Remove the thermostat and replace it with a sleeve (P/N 21474103) and seal (P/N 1549651).