



Standard Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1P Test Procedure¹

This standard is issued under the fixed designation D 6681; 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.

INTRODUCTION

Any properly equipped laboratory without outside assistance can use the test method described in this standard. However, the ASTM Test Monitoring Center (TMC)² 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 method.³ In addition, the TMC may issue supplementary memoranda related to the test method.

1. Scope

1.1 This test method covers and is required to evaluate the performance of engine oils intended to satisfy certain American Petroleum Institute (API) C service categories (included in Specification D 4485). It is performed in a laboratory using a standardized high-speed, single-cylinder diesel engine.⁴ Piston and ring groove deposit-forming tendency and oil consumption is measured. The piston, the rings, and the liner are also examined for distress and the rings for mobility.

~~1.2 All measurements made in accordance with this standard shall use the SI system of units.~~

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

1.3 *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.* Being an engine test method, this standard does have definite hazards that require safe practices (see Appendix X2 on Safety).

1.4 The following is the Table of Contents:

	Section
Scope	1
Referenced Documents	2
Terminology	3
Summary of Test Method	4
Significance and Use	5
Apparatus and Installation	6
Intake Air System	6.2.1
Exhaust System	6.2.2
Fuel System	6.2.3
Oil Consumption System	6.2.4
Engine Oil System	6.2.5
Oil Heating System	6.2.5.1

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 Automotive Lubricants—Heavy Duty Engine Oils.

Current edition approved Nov. 1, 2005; Oct. 15, 2008. Published December 2005; November 2008. Originally approved in 2001. Last previous edition approved in 2004 as D 6681-04.5.

² ASTM Test Monitoring Center (TMC), 6555 Penn Ave., Pittsburgh, PA 15206-4489.

³ This edition incorporates revisions contained in all information letters through 05-1-07-1. Users of this test method shall contact the ASTM Test Monitoring Center to obtain the most recent information letters.

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

	Section
Oil Sample Valve	6.2.5.2
Engine Coolant System	6.2.6
Engine Instrumentation	6.2.7
Reagents and Materials	7
Oil Samples	8
Preparation of Apparatus	9
General Engine Assembly Practices	9.1
Complete Engine Inspection	9.2
Copper Components	9.3
Engine Lubricant System Flush	9.4
Engine Piston Cooling Jets	9.5
Engine Measurements and Inspections	9.6
Cylinder Head	9.7
Valve Guide Bushings	9.8
Fuel Injector	9.9
Piston and Rings	9.10
Cylinder Liner	9.11
Compression Ratio	9.12
Engine Timing	9.13
Engine Coolant System Cleaning Procedure	9.14
Calibration and Standardization	10
Test Cell Instrumentation	10.1
Instrumentation Standards	10.2
Coolant Flow	10.3
Re-calibration Requirements	10.4
Fuel Injectors	10.5
Air Flow	10.6
Intake Air Barrel	10.7
Fuel Filter	10.8
Oil Scale Flow Rates	10.9
Calibration of Test Stands	10.10
Extending Test Stand Calibration Period	10.11
Test Run Numbering	10.13
Humidity Calibration Requirements	10.14
Calibration of Piston Deposit Raters	10.15
Procedure	11
Engine Break-in Procedure	11.1
Cool-down Procedure	11.2
Warm-up Procedure	11.3
Shutdowns and Lost Time	11.4
Periodic Measurements	11.5
Engine Control Systems	11.6
Engine Coolant	11.6.1
Engine Fuel System	11.6.2
Engine Oil Temperature	11.6.3
Exhaust Pressure	11.6.4
Intake Air	11.6.5
Post-Test Procedures	11.7
Piston Ring Side Clearances	11.7.1
Piston Ratings	11.7.2
Referee Ratings	11.7.3
Ring End Gap Increase	11.7.4
Cylinder Liner Wear	11.7.5
Cylinder Liner Bore Polish	11.7.6
Photographs	11.7.7
Calculation and Interpretation of Results	12
Test Validity	12.1
Calculations	12.2
Quality Index	12.2.1
Oil Consumption	12.2.2
Report	13
Forms and Data Dictionary	13.1
Test Validity	13.2
Report Specifics	13.3
Precision and Bias	14
Precision	14.1
Bias	14.1.4
Keywords	15
Annexes	
Engine and Parts Warranty	Annex A1
Instrument Locations, Measurements, and Calculations	Annex A2
Cooling System Arrangement	Annex A3
Intake Air Mass Flow Sensor Installation	Annex A4
Fuel System Design and Required Components	Annex A5
Oil System	Annex A6
Exhaust and Intake Barrel Piping	Annex A7
Humidity Probe Installation (Location)	Annex A8

iTeh Standards
(<https://standards.itih.ai>)
Document Preview

ASTM D6681-08

<https://standards.itih.ai/catalog/standards/astm/579559b7-024b-4834-8f77-b546af20855b/astm-d6681-08>

Return Goods Authorization (Claim Form)
 Engine Assembly Information
 Flushing Instructions and Apparatus
 Warm-up, Cool-down and Testing Conditions
 Piston and Liner Rating Modifications
 Additional Report Forms
 Test Report Forms

Section
 Annex A9
 Annex A10
 Annex A11
 Annex A12
 Annex A13
 Annex A14
 Annex A15

Various Examples for Reference Purposes
 Safety

Appendixes

Appendix X1
 Appendix X2

2. Referenced Documents

2.1 ASTM Standards:⁵

- D 86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure
- D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D 97 Test Method for Pour Point of Petroleum Products
- ~~D 130 Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test~~ 130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- D 235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the and Calculation of Dynamic Viscosity)
- D 482 Test Method for Ash from Petroleum Products
- D 524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
- D 613 Test Method for Cetane Number of Diesel Fuel Oil
- D 664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D 1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
- D 2274 Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)
- D 2425 Test Method for Hydrocarbon Types in Middle Distillates by Mass Spectrometry
- D 2500 Test Method for Cloud Point of Petroleum Products
- D 2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D 2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge
- D 3227 Test Method for (Thiol Mercaptan) Sulfur in Gasoline, Kerosine, Aviation Turbine, and Distillate Fuels (Potentiometric Method)
- D 3524 Test Method for Diesel Fuel Diluent in Used Diesel Engine Oils by Gas Chromatography
- D 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants
- D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter
- D 4485 Specification for Performance of Engine Oils
- D 4739 Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration
- D 4863 Test Method for Determination of Lubricity of Two-Stroke-Cycle Gasoline Engine Lubricants
- D 5185 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)
- D 5302 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
- D 5844 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID)
- D 5862 Test Method for Evaluation of Engine Oils in the Two-Stroke Cycle Turbo-Supercharged 6V92TA Diesel Engine
- D 6202 Test Method for Automotive Engine Oils on the Fuel Economy of Passenger Cars and Light-Duty Trucks in the Sequence VIA Spark-Ignition Engine
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E 344 Terminology Relating to Thermometry and Hydrometry
- G 40 Terminology Relating to Wear and Erosion

2.2 SAE Standard:

SAE J183 Engine Oil Performance and Engine Service Classification⁶

2.3 API Standard:

API 1509 Engine Service Classification and Guide to Crankcase Oil Selection⁷

⁵ 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.

⁶ Available from the Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

⁷ Available from the American Petroleum Institute, 1220 L Street NW, Washington DC, 20005.

3. Terminology

3.1 Definitions:

3.1.1 *additive*, *n*—a material added to another, usually in a small amount, to impart or enhance desirable properties or to suppress undesirable properties. **D 4175**

3.1.2 *automotive*, *adj*—descriptive of equipment associated with self-propelled machinery, usually vehicles driven by internal combustion engines. **D 4485**

3.1.3 *blind reference oil*, *n*—~~a~~a reference oil, the identity of which is unknown by the test facility. **D 5844**

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

3.1.4 *blowby*, *n*—in internal combustion engine, the combustion products and unburned air-and-fuel mixture that enter the crankcase. **D 5302**

3.1.5 *calibrate*, *v*—to determine the indication or output of a measuring device with respect to that of a standard. **E 344**

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. **Sub. B Glossary²**

3.1.6.1 *Discussion*—In several automotive lubricant standard test methods, the ASTM Test Monitoring Center provides testing guidance and determines acceptability.

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. **D 5844**

3.1.7.1 *Discussion*—These oils are mainly submitted for testing as *candidates* to satisfy a specified performance; hence the designation of the term.

3.1.8 *debris*, *n*—in internal combustion engines, solid contaminant materials unintentionally introduced into the engine or resulting from wear. **D 5862**

3.1.9 *dispersant*, *n*—in engine oil, an additive that reduces deposits on oil-wetted engine surfaces primarily through suspension of particles. **D 4175**

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. **D 5862**

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.

3.1.11 *heavy-duty*, *adj*—in internal combustion engine operation, characterized by average speeds, power output, and internal temperatures that are generally close to the potential maximums. **D 4485**

3.1.12 *lubricant*, *n*—any material interposed between two surfaces that reduces the friction or wear, or both, between them. **D 5862**

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. **Sub. B Glossary²**

3.1.14 *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 a combination thereof. **Sub. B Glossary²**

3.1.15 *non-reference oil*, *n*—any oil other than a reference oil; such as a research formulation, commercial oil, or candidate oil. **D 5844**

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. **D 6202**

3.1.17 *reference oil*, *n*—an oil of known performance characteristics, used as a basis for comparison. **D 5844**

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.

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. **G 40**

3.1.19 *scuff*, *scuffing*, *n*—in lubrication, damage caused by instantaneous localized welding between surfaces in relative motion that~~which~~ does not result in immobilization of the parts. **D 4863**

3.1.20 *sponsor*, *n*—of an ASTM test method, an organization that is responsible for ensuring supply of the apparatus used in the test procedure portion of the test method. **Sub. B Glossary²**

3.1.20.1 *Discussion*—In some instances, such as a test method for chemical analysis, an ASTM working group can be the sponsor of the test method. In other instances, a company with a self-interest may or may not be the developer of the test procedure used within the method, but is the sponsor of the test method.

3.1.21 *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. **D 4175**

3.1.22 *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. **D 5302**

3.1.23 *wear*, *n*—the loss of material from, or relocation of material on, a surface. **D 5302**

3.1.23.1 *Discussion*—Wear generally occurs between two surfaces moving relative to each other, and is the result of mechanical