



Designation: D613 – 24

Standard Test Method for Cetane Number of Diesel Fuel Oil¹

This standard is issued under the fixed designation D613; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of the rating of diesel fuel oil in terms of an arbitrary scale of cetane numbers using a standard single cylinder, four-stroke cycle, variable compression ratio, indirect injected diesel engine.

1.2 The cetane number scale covers the range from zero (0) to 100, but typical testing is in the range of 30 to 65 cetane number.

1.3 The values for operating conditions are stated in SI units and are to be regarded as the standard. The values given in parentheses are the historical inch-pound units for information only. In addition, the engine measurements continue to be in inch-pound units because of the extensive and expensive tooling that has been created for these units.

1.4 *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.* For more specific warning statements, see [Annex A1](#).

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.*

2. Referenced Documents

2.1 ASTM Standards:²

[D975 Specification for Diesel Fuel](#)

[D1193 Specification for Reagent Water](#)

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 [D02.01](#) on Combustion Characteristics.

Current edition approved Feb. 1, 2024. Published February 2024. Originally approved in 1941. Last previous edition approved in 2023 as D613 – 23. DOI: 10.1520/D0613-24.

² 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.

[D2500 Test Method for Cloud Point of Petroleum Products and Liquid Fuels](#)

[D3703 Test Method for Hydroperoxide Number of Aviation Turbine Fuels, Gasoline and Diesel Fuels](#)

[D4057 Practice for Manual Sampling of Petroleum and Petroleum Products](#)

[D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants](#)

[D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products](#)

[D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance](#)

[D6300 Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products, Liquid Fuels, and Lubricants](#)

[D6708 Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material](#)

[E456 Terminology Relating to Quality and Statistics](#)

[E542 Practice for Gravimetric Calibration of Laboratory Volumetric Instruments](#)

[E832 Specification for Laboratory Filter Papers](#)

3. Terminology

3.1 Definitions:

3.1.1 *accepted reference value (ARV), n*—a value that serves as an agreed-upon reference for comparison, and which is derived as: (1) a theoretical or established value, based on scientific principles, or (2) an assigned or certified value, based on experimental work of some national or international organization, or (3) a consensus or certified value, based on collaborative experimental work under the auspices of a scientific or engineering group. **E456**

3.1.1.1 *Discussion*—In the context of this test method, accepted reference value is understood to apply to the cetane number of specific reference materials determined empirically under reproducibility conditions by the National Exchange Group or another recognized exchange testing organization.

3.1.2 *cetane number (CN), n*—a measure of the ignition performance of a diesel fuel oil obtained by comparing it to reference fuels in a standardized engine test. **D4175**

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

3.1.2.1 *Discussion*—In the context of this test method, ignition performance is understood to mean the ignition delay of the fuel as determined in a standard test engine under controlled conditions of fuel flow rate, injection timing, and compression ratio.

3.1.3 *compression ratio (CR)*, *n*—the ratio of the volume of the combustion chamber including the precombustion chamber with the piston at bottom dead center to the comparable volume with the piston at top dead center.

3.1.4 *ignition delay*, *n*—that period of time, expressed in degrees of crank angle rotation, between the start of fuel injection and the start of combustion.

3.1.5 *injection timing (injection advance)*, *n*—that time in the combustion cycle, measured in degrees of crank angle, at which fuel injection into the combustion chamber is initiated.

3.1.6 *quality control (QC) sample*, *n*—for use in quality assurance programs to determine and monitor the precision and stability of a measurement system, a stable and homogeneous material having physical or chemical properties, or both, similar to those of typical samples tested by the analytical measurement system. The material is properly stored to ensure sample integrity, and is available in sufficient quantity for repeated, long term testing. **D6299**

3.1.7 *repeatability conditions*, *n*—conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time. **E456**

3.1.8 *reproducibility conditions*, *n*—conditions where test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment. **E456**

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *cetane meter*, *n*—the electronic apparatus which displays injection advance and ignition delay derived from input pulses of multiple transducers (pickups).

3.2.1.1 *Discussion*—In the context of this test method, three generations of apparatus have been approved for use as cetane meters. These are (year of introduction is parenthesis) the Mark II Ignition Delay Meter (1974), the Dual Digital Cetane Meter (1990), and the XCP Cetane Panel (2014).

3.2.2 *check fuels*, *n*—for quality control testing, a diesel fuel oil of selected characteristics having a cetane number accepted reference value determined in accordance with Practice **D6299** requirements for check standards derived from interlaboratory exchange programs.

3.2.2.1 *Discussion*—When evaluating the interlaboratory data to establish the ARV, outlier identification and rejection criteria shall be applied at the 5 % significance level prior to computing the average result.

3.2.3 *combustion pickup*, *n*—pressure transducer exposed to cylinder pressure to indicate the start of combustion.

3.2.4 *handwheel reading*, *n*—an arbitrary numerical value, related to compression ratio, obtained from a micrometer scale that indicates the position of the variable compression plug in the precombustion chamber of the engine.

3.2.5 *injector opening pressure*, *n*—the fuel pressure that overcomes the resistance of the spring which normally holds the nozzle pintle closed, and thus forces the pintle to lift and release an injection spray from the nozzle.

3.2.6 *injector pickup*, *n*—transducer to detect motion of the injector pintle, thereby indicating the beginning of injection.

3.2.7 *primary reference fuels (PRF)*, *n*—hexadecane (HXD), heptamethylnonane (HMN), pentamethylheptane (PMH), and volumetrically proportioned binary mixtures of HXD with either HMN or PMH, which now define the cetane number scale.

3.2.7.1 *Discussion*—In the context of this test method, the arbitrary cetane number scale was originally defined as the volume percent of hexadecane in a blend with 1-methylnaphthalene (AMN) where HXD had an assigned value of 100 and AMN an assigned value of zero (0). A change from 1-methylnaphthalene to heptamethylnonane as the low cetane ingredient was made in 1962 to utilize a material of better storage stability and availability. Heptamethylnonane was determined to have a cetane number accepted reference value (CN_{ARV}) of 15 based on engine testing by the ASTM Diesel National Exchange Group.³ A change to add a second low cetane ingredient, pentamethylheptane (PMH), as an alternative to HMN was made in 2018 to utilize a material of higher purity and better availability. Pentamethylheptane was determined to have a cetane number accepted reference value (CN_{ARV}) of 16.3 based on engine testing by the ASTM Diesel National Exchange Group.⁴

3.2.7.2 *Discussion*—In the context of this test method, the Diesel National Exchange Group of Subcommittee D02.01⁵ is composed of petroleum industry, governmental, and independent laboratories. It conducts regular monthly exchange sample analyses to generate precision data for this engine test standard and determines the CN_{ARV} of reference materials used by all laboratories.

3.2.8 *reference pickups*, *n*—transducers or optical sensors mounted over the flywheel of the engine, triggered by a flywheel indicator, used to establish a top-dead-center (tdc) reference and a time base for calibration of the cetane meter.

3.2.9 *repeatability conditions NEG*, *n*—replicate testing conditions employed by the National Exchange Group in which a single operator tests two specimens taken from a single sample container with at least one other sample being tested between the two specimens.

3.2.10 *secondary reference fuels (SRF)*, *n*—volumetrically proportioned blends of two selected, numbered, and paired hydrocarbon mixtures designated *T Fuel* (high cetane) and *U Fuel* (low cetane) that have been rated by the ASTM Diesel National Exchange Group using primary reference fuels to

³ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1092. Contact ASTM Customer Service at service@astm.org.

⁴ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1885. Contact ASTM Customer Service at service@astm.org.

⁵ Bylaws governing ASTM Subcommittee D02.01 on Combustion Characteristics are available from the subcommittee or from ASTM International.