



Designation: D4176 – 04 (Reapproved 2019)

# Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)<sup>1</sup>

This standard is issued under the fixed designation D4176; 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.

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

## 1. Scope

1.1 This test method covers two procedures for estimating the presence of suspended free water and solid particulate contamination in distillate fuels having distillation end points below 400 °C and an ASTM color of 5 or less.

1.1.1 Both procedures can be used as field tests at storage temperatures, or as laboratory tests at controlled temperatures.

1.1.2 Procedure 1 provides a rapid pass/fail method for contamination. Procedure 2 provides a gross numerical rating of haze appearance.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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:*<sup>2</sup>

[D1500 Test Method for ASTM Color of Petroleum Products \(ASTM Color Scale\)](#)

[D1744 Test Method for Determination of Water in Liquid](#)

[Petroleum Products by Karl Fischer Reagent \(Withdrawn 2016\)](#)<sup>3</sup>

[D2276 Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling](#)

[D2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge](#)

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

[D4860 Test Method for Free Water and Particulate Contamination in Middle Distillate Fuels \(Clear and Bright Numerical Rating\)](#)

2.2 *ASTM Adjuncts:*

[Distillate Fuel Bar Chart](#)<sup>4</sup>

[Distillate Fuel Haze Rating Standard](#)<sup>5</sup>

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *clear-and-bright* (also termed *clean-and-bright*)—a condition in which the fuel is free of haze or cloudiness.

3.1.2 *free water*—water in excess of that soluble in the fuel at the temperature of the test, and appearing in the fuel as a haze or cloudiness, or as droplets.

3.1.3 *particulates*—small solid or semisolid particles, sometimes referred to as silt or sediment, that may or may not be suspended in the fuel as a result of contamination by air-blown dusts, corrosion by-products, fuel instability, or protective-coating deterioration.

## 4. Summary of Test Method

4.1 In Procedure 1 approximately 900 mL of fuel is placed into a clear, glass, 1 L jar and is examined visually for clarity. The sample is then swirled and examined for visual sediment or water drops below the vortex.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the responsibility of Subcommittee D02.14 on Stability, Cleanliness and Compatibility of Liquid Fuels.

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<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

<sup>4</sup> Available from ASTM International Headquarters. Order Adjunct No. [ADJD417601](#). Original adjunct produced in 1991.

<sup>5</sup> Available from ASTM International Headquarters. Order Adjunct No. [ADJD417602](#). Original adjunct produced in 1991.

4.2 In Procedure 2 approximately 900 mL of fuel is placed into a clear, glass, 1 L jar and is examined visually for clarity. Fuel clarity is rated by placing a standard bar chart behind the sample and comparing its visual appearance with the standard haze rating photos. The sample is then swirled and examined for visual sediment or water drops below the vortex.

4.3 When field testing, both Procedures 1 and 2 are performed immediately after sampling and at storage temperature conditions.

4.4 When lab testing, both Procedures 1 and 2 are performed after the sample has equilibrated at the test temperature of interest.

## 5. Significance and Use

5.1 It has long been the practice to include in fuel specifications a requirement that the fuel be *clear and bright and free of visible particulate matter* (see **Note 1**). However, there has been no standard method for making this determination so that practices have differed. This test method provides standard procedures for the test.

**NOTE 1**—*Clean and bright* is sometimes used in place of *clear and bright*. The meaning is identical.

5.2 Procedure 1 provides a rapid pass/fail method for contamination in a distillate fuel. Procedure 2 provides a gross numerical rating of haze appearance, primarily as a communication tool. Other test methods, including Test Methods **D1744**, **D2276**, **D2709**, and **D4860**, permit quantitative determinations of contaminants. No relationship has been established between Procedure 2 and various quantitative methods.

5.3 Limited laboratory evaluations of samples that have failed this *clear and bright* test indicate that an experienced tester can detect as little as 40 ppm of free water in the fuel.

## 6. Interferences

6.1 When a fuel is tested at low temperatures at or below the cloud point temperature of the fuel, small amounts of solid wax particles may be confused with a water-induced haze or cloudiness.

6.2 If an attempt is made to use the test with fuels darker than a color rating of 5 in Test Method **D1500**, the presence of free water or particulate could be obscured and missed by the viewer.

## 7. Apparatus

7.1 *Cylindrical Container*, clear-glass, capable of holding 1.0 L  $\pm$  0.1 L of fuel and having a diameter of 100 mm  $\pm$  10 mm.

7.2 *Paper Card (Bar Chart)*, <sup>4</sup> laminated in clear plastic, having five parallel lines of different widths and meeting the following description:

7.2.1 *Characteristics of Card Stock*, white paper 120 mm by 180 mm long.

7.2.2 *Line Color, Width, and Spacing*, five black lines of increasing widths, commencing with a line 0.6 mm wide, the second line 1.6 mm wide, and each succeeding line 1.6 mm wider to a maximum of 6.4 mm.

7.2.3 The lines shall be numbered from 1 through 5, with the thinnest line being No. 1.

7.3 A series of standard photographs<sup>5</sup> of the bar chart through samples of differing haze levels, numbered from 1 through 6. Photograph No. 1 is the clearest, while No. 6 represents the densest haze.

7.4 The differences between these haze levels are arbitrary and are not intended to represent equivalent increases in suspended water content or particulates. It is essential, therefore, that only the proper approved photos be used.

7.5 *Temperature Sensing Device (TSD)*, capable of monitoring the observed test temperature to within an accuracy of  $\pm 0.5$  °C ( $\pm 1$  °F) for use in laboratory tests that require measurements to be made at a specific temperature.

7.6 *Temperature-Controlled Bath*, of suitable dimensions and capable of controlling the sample container temperature within  $\pm 0.5$  °C ( $\pm 1$  °F) of the desired temperature for laboratory tests that require measurements to be made at a specific temperature.

## 8. Sampling

8.1 Sampling shall be consistent with the procedures of Practice **D4057**.

8.2 Draw the sample directly into the sample container using the following procedure:

8.2.1 Be sure the sampling valve is free of loose solid contaminants. If rust or other loose encrustations are present, remove with a cloth; then flush the sampling valve prior to taking the actual sample.

8.2.2 Rinse a clean test container thoroughly with the fuel being sampled. (**Warning**—Flammable. See Annex **A1.1**.)

8.2.3 Draw approximately 900 mL of fuel into the container as rapidly as possible. Use a full flush rather than permitting the fuel sample to trickle out.

## 9. Sample Preparation

9.1 *Field Testing*—Both Procedures 1 and 2 are to be performed immediately after drawing the sample. Record the approximate sample storage temperature and the approximate ambient temperature at which the test is performed.

9.2 *Laboratory Testing*:

9.2.1 Do not subsample or transfer the sample to a secondary container. Perform the test with the sample drawn in the original sample container.

9.2.2 Replace the sample container's closure with an air tight closure through which a calibrated temperature sensing device is immersed in the sample. Allow the sample container to equilibrate in a temperature-controlled bath, bringing it to desired test temperature within the allowed tolerance. Periodically agitate the sample in a manner sufficient to homogenize the bulk of the sample (water droplets and particulates, if present, do not need to be evenly dispersed).

9.2.3 Remove the sample container from the temperature-controlled bath, wipe dry with an absorbent material (if a liquid bath is used), and perform the desired procedure(s) with minimal delay after removal. Remove the temperature sensing device after recording the sample test temperature.