



# Standard Specification for Fuel System Icing Inhibitors<sup>1</sup>

This standard is issued under the fixed designation D4171; 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.

## 1. Scope\*

1.1 This specification covers additives for aviation fuels (for example, Specifications D910, D7547, and D1655) used to inhibit ice formation in aircraft fuel systems.

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 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous material that can cause central nervous system, kidney and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's website—<http://www.epa.gov/mercury/faq.htm>—for additional information. Users should be aware that selling mercury and/or mercury containing products into your state or country may be prohibited by law.

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

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- D56 Test Method for Flash Point by Tag Closed Cup Tester
- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D268 Guide for Sampling and Testing Volatile Solvents and Chemical Intermediates for Use in Paint and Related Coatings and Material
- D891 Test Methods for Specific Gravity, Apparent, of Liquid

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.J0.04 on Additives and Electrical Properties.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- Industrial Chemicals
- D910 Specification for Leaded Aviation Gasolines
- D1078 Test Method for Distillation Range of Volatile Organic Liquids
- D1209 Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)
- D1296 Test Method for Odor of Volatile Solvents and Diluents
- D1353 Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products
- D1364 Test Method for Water in Volatile Solvents (Karl Fischer Reagent Titration Method)
- D1476 Test Method for Heptane Miscibility of Lacquer Solvents
- D1613 Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products
- D1655 Specification for Aviation Turbine Fuels
- D1722 Test Method for Water Miscibility of Water-Soluble Solvents
- D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
- D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
- D5006 Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
- D7547 Specification for Hydrocarbon Unleaded Aviation Gasoline
- E1 Specification for ASTM Liquid-in-Glass Thermometers
- E70 Test Method for pH of Aqueous Solutions With the Glass Electrode
- E203 Test Method for Water Using Volumetric Karl Fischer Titration
- E300 Practice for Sampling Industrial Chemicals
- E450 Test Method for Measurement of Color of Low-Colored Clear Liquids Using the Hunterlab Color Difference Meter (Withdrawn 1993)<sup>3</sup>
- E1064 Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

[E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids](#)  
[E2877 Guide for Digital Contact Thermometers](#)

### 3. Classification

3.1 Two types of fuel system icing inhibitors are provided as follows:

3.1.1 *Type I*—Ethylene glycol monomethyl ether is used as an anti-icing additive in both aviation gasoline and aviation turbine fuels.

NOTE 1—Ethylene glycol monomethyl ether (EGME) was previously included in this specification, last appearing in D4171–94. EGME is considered technically satisfactory for this application, but has been generally replaced by DiEGME due to availability, reduced toxicological concerns, and lack of widely available methodology to determine FSII concentration in aviation fuels when a mixture is known to be present, or when the identity of the FSII present in the fuel is not clearly known.

3.2 *Type II*—Anhydrous isopropanol, also described as 99 % grade 2-Propanol or isopropyl alcohol, is used as an anti-icing additive in aviation gasoline. (**Warning**—Isopropanol (2-Propanol) is both flammable and an irritant; use with caution.)

3.3 *Type III*—Diethylene glycol monomethyl ether (DiEGME) is used as an anti-icing additive in both aviation gasoline and aviation turbine fuel. (**Warning**—Diethylene glycol monomethyl ether, (DiEGME). Combustible, toxic material.)

3.3.1 Test Method [D5006](#) can be used to determine the concentration of DiEGME in aviation fuels.

### 4. Properties

4.1 *Type II*—Isopropanol anti-icing additive shall conform to the requirements of [Table 1](#), as manufactured.

4.2 *Type III*—Diethylene glycol monomethyl ether shall conform to the requirements of [Table 2](#), as manufactured.

### 5. Sampling

5.1 The material shall be sampled in accordance with Practice [E300](#).

**TABLE 1 Detailed Requirements for Isopropanol (99 % Grade) (Type II) FSII**

| Property                           | Requirement   | ASTM Test Method                              |
|------------------------------------|---|---|
| Acidity, max, mg KOH/g             | 0.019   | <a href="#">D1613</a>                         |
| Relative density:                  |   |   |
| 20 °C/20 °C                        | 0.785 to 0.787  | <a href="#">D268</a>                          |
| 25 °C/25 °C                        | 0.782 to 0.784  | <a href="#">D268</a>                          |
| Color, platinum-cobalt, max        | 10  | <a href="#">D1209</a> or <a href="#">E450</a> |
| Distillation range, max, °C        | 1.5 (including 82.3 °C)   | <a href="#">D1078</a>                         |
| Nonvolatile matter, max, mg/100 mL | 5   | <a href="#">D1353</a>                         |
| Odor                               | characteristic, nonresidual   | <a href="#">D1296</a>                         |
| Water, max, mass %                 | 0.2   | <a href="#">D1364</a>                         |
| Heptane miscibility at 20 °C       | miscible without turbidity with 19 vol heptane (99 % Grade)         | <a href="#">D1476</a>                         |
| Water miscibility at 25 °C         | miscible without turbidity when diluted with 10 vol distilled water | <a href="#">D1722</a>                         |

**TABLE 2 Detailed Requirements for Fuel System Icing Inhibitors (Type III)**

| Property                                    | Requirement       |   |
|---|-------------------|---|
|   | DiEGME (Type III) | ASTM Test Method  |
| Acid number, max, mg KOH/g                  | 0.09              | <a href="#">D1613</a>   |
| Color, platinum-cobalt, max                 | 10                | <a href="#">D1209</a> or <a href="#">E450</a>                           |
| Purity, min, mass %                         | 99.0              | <a href="#">Annex A1</a>  |
| pH of 25 % solution in water (25 °C ± 2 °C) | 5.5–7.5           | <a href="#">E70</a> <sup>A</sup>  |
| Relative density, 20 °C/20 °C               | 1.020–1.025       | <a href="#">D891</a> (Method A or B) or <a href="#">D4052</a>           |
| Water, max, mass %                          |                   | <a href="#">D1364</a> , <a href="#">E1064</a> , or <a href="#">E203</a> |
| Point of manufacture                        | 0.10              |   |
| Point of use                                | 0.8               |   |
| Flash point, min, °C                        | 85 °C             | <a href="#">D93</a> , <a href="#">D56</a> , or <a href="#">D3828</a>    |
| Antioxidant, mg/kg                          | 50–150            | <sup>B</sup>  |

<sup>A</sup> Pipette 25 mL of the inhibitor into a 100 mL volumetric flask and filled with freshly boiled and cooled distilled water having a pH of 6.5 to 7.5. Measure the pH value with a pH meter calibrated in accordance with Test Method [E70](#).

<sup>B</sup> Acceptable antioxidants are: 2,6-ditertiary-butyl-4-methylphenol, 2,4-dimethyl-6-tertiary-butyl phenol, 2,6-ditertiary-butyl phenol, and 75 % min 2,6-ditertiary-butyl phenol plus 25 % max tertiary and tritertiary butyl phenols.

### 6. Test Methods

6.1 Determine the properties enumerated in this specification in accordance with the following ASTM methods:

6.1.1 *Relative Density*—Determine the relative density (that is, specific gravity) at 20 °C or 25 °C with respect to water by a method accurate to the third decimal place. See Section 5 of Test Method [D268](#), Test Method [D4052](#), or Method A or B of Test Methods [D891](#).

6.1.2 *Color*—Test Method [D1209](#) or [E450](#).

6.1.3 *Distillation Range*—Test Method [D1078](#) using ASTM Solvents Distillation Thermometers (40C with a range from 72 °C to 126 °C for isopropanol) conforming to the requirements of Specification [E1](#) or any other temperature measuring device that cover the temperature range of interest, such as thermocouples, thermistors, or resistance temperature detectors (RTDs). An instrument meeting Guide [E2877](#) or Specification [E2251](#) may be used in preference to 40C if the instrument provides equivalent or better accuracy and precision.

6.1.4 *Nonvolatile Matter*—Test Method [D1353](#).

6.1.5 *Odor*—Test Method [D1296](#).

6.1.6 *Water*—Test Method [D1364](#), [E1064](#), or [E203](#).

6.1.7 *Heptane Miscibility*—Test Method [D1476](#).

6.1.8 *Acidity*—Test Method [D1613](#).

6.1.9 *Water Miscibility*—Test Method [D1722](#).

6.1.10 *Flash Point*—Test Methods [D56](#), [D93](#), or [D3828](#).

### 7. Keywords

7.1 additives; aircraft fuel systems; aviation fuels; fuel system icing inhibitors; ice formation