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Standard Specification for Gasoline-like Test Fuel for Compression-Ignition Engines¹

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1. Scope*

1.1 This specification covers the requirements of test fuels suitable for use in certain gasoline compression-ignition engines and vehicles, which have been specifically designed to operate on the fuel described in this specification. These gasoline-like fuels, which may contain certain gasoline blending components, are henceforth referred to in this specification as “gasoline compression-ignition (GCI) test fuels.”

1.1.1 The GCI test fuels described by this specification are only intended for use by engine and vehicle manufacturers in the continuing development of appropriately designed compression-ignition engines that can take advantage of certain chemical and physical properties of GCI test fuels to achieve higher efficiency and lower emissions (henceforth referred to as “GCI engines”). These GCI test fuels are not intended for use by the general public.

1.1.2 GCI engines include only those engines that directly inject fuel into the combustion chamber, and rely on autoignition of the fuel to initiate combustion part or all the time. Although various combustion strategies may be used depending on the fuel and engine operating condition, the level of fuel stratification is typically decreased in GCI engines under certain operating conditions relative to traditional diesel compression-ignition engines. Engines that use an auxiliary ignition source (such as a spark plug) some but not all of the time could qualify as GCI engines.

1.1.3 The GCI test fuels covered in this specification may contain oxygenates, such as alcohols and ethers. Recommended limits on the type and concentration of specific oxygenates are provided in [Appendix X3](#).

1.2 This specification provides a description of GCI test fuels for automotive engines that are not currently widely available to the general public, but are being developed and require defined standard test fuels. Commercial fuels meeting the same or similar requirements as the GCI test fuels described in this specification could become available to the general public if/when such engines are introduced into com-

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merce; however use of this specification by the general public would require significant modifications. The specification is under continuous review, which can result in revisions based on changes in fuel, automotive requirements, test methods, or a combination thereof. All users of this specification, therefore, should refer to the latest edition.

1.3 Traditional diesel compression-ignition engines and fuel systems are designed for use with fuel, which has a lower volatility, higher flash-point, and higher viscosity than GCI test fuels. Such engines are therefore usually unsuitable for use with GCI test fuels. Certain hardware modifications may be required for the safe use of low flash-point, GCI test fuels.

NOTE 1—If there is any doubt as to the latest edition of Specification D8275, contact ASTM International Headquarters.

1.4 The values stated in SI units are to be regarded as the standard. Any other values given are provided for information only.

1.5 *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.*

1.6 *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

[D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure](#)

[D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test](#)

[D240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter](#)

[D381 Test Method for Gum Content in Fuels by Jet Evaporation](#)

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.

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

- D525** Test Method for Oxidation Stability of Gasoline (Induction Period Method)
- D1266** Test Method for Sulfur in Petroleum Products (Lamp Method)
- D1319** Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
- D2622** Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D2699** Test Method for Research Octane Number of Spark-Ignition Engine Fuel
- D2700** Test Method for Motor Octane Number of Spark-Ignition Engine Fuel
- D3120** Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry
- D3237** Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy
- D3341** Test Method for Lead in Gasoline—Iodine Monochloride Method
- D3606** Test Method for Determination of Benzene and Toluene in Spark Ignition Fuels by Gas Chromatography
- D3831** Test Method for Manganese in Gasoline By Atomic Absorption Spectroscopy
- D4052** Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
- D4057** Practice for Manual Sampling of Petroleum and Petroleum Products
- D4175** Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
- D4176** Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)
- D4177** Practice for Automatic Sampling of Petroleum and Petroleum Products
- D4306** Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
- D4814** Specification for Automotive Spark-Ignition Engine Fuel
- D4815** Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C₁ to C₄ Alcohols in Gasoline by Gas Chromatography
- D4953** Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)
- D5059** Test Methods for Lead and Manganese in Gasoline by X-Ray Fluorescence Spectroscopy
- D5191** Test Method for Vapor Pressure of Petroleum Products and Liquid Fuels (Mini Method)
- D5291** Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants
- D5443** Test Method for Paraffin, Naphthene, and Aromatic Hydrocarbon Type Analysis in Petroleum Distillates Through 200 °C by Multi-Dimensional Gas 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
- D5482** Test Method for Vapor Pressure of Petroleum Products and Liquid Fuels (Mini Method—Atmospheric)
- D5580** Test Method for Determination of Benzene, Toluene, Ethylbenzene, *p/m*-Xylene, *o*-Xylene, C₉ and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography
- D5769** Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry
- D5842** Practice for Sampling and Handling of Fuels for Volatility Measurement
- D5854** Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
- D6079** Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)
- D6378** Test Method for Determination of Vapor Pressure (VP_X) of Petroleum Products, Hydrocarbons, and Hydrocarbon-Oxygenate Mixtures (Triple Expansion Method)
- D7039** Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
- D7220** Test Method for Sulfur in Automotive, Heating, and Jet Fuels by Monochromatic Energy Dispersive X-ray Fluorescence Spectrometry
- D7667** Test Method for Determination of Corrosiveness to Silver by Automotive Spark-Ignition Engine Fuel—Thin Silver Strip Method
- D7671** Test Method for Corrosiveness to Silver by Automotive Spark-Ignition Engine Fuel—Silver Strip Method
- D7757** Test Method for Silicon in Gasoline and Related Products by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. Terminology

3.1 Definitions:

3.1.1 For general terminology, refer to Terminology **D4175**.

3.1.2 *dry vapor pressure equivalent, DVPE, n*—value calculated by a defined correlation equation that is expected to be comparable to the vapor pressure value obtained by Test Method **D4953**, Procedure A.

3.1.3 *gasoline, n*—volatile mixture of liquid hydrocarbons, generally containing small amounts of additives, suitable for use as a fuel in spark-ignition, internal combustion engines.

3.1.4 *gasoline-oxygenate blend, n*—fuel consisting primarily of gasoline along with a substantial amount (more than 0.35 % by mass oxygen) of one or more oxygenates.

3.1.5 *octane sensitivity, n*—the mathematical difference between research octane number (RON) and motor octane number (MON) (octane sensitivity = RON – MON).

3.1.5.1 *Discussion*—The terms octane sensitivity and octane number sensitivity are used synonymously.

3.1.6 *oxygenate, n*—a molecule composed solely of carbon, hydrogen, and oxygen.

3.1.6.1 *Discussion*—The fuel described in this standard may contain oxygenates, such as alcohol and ethers.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *gasoline compression-ignition test fuel, n*—a homogeneous, volatile mixture of liquid hydrocarbons with or without oxygenates, generally containing small amounts of additives, suitable for use as a fuel in certain gasoline compression-ignition engines and vehicles.

3.2.2 *gasoline compression-ignition engine, n*—a type of internal combustion engine in which gasoline or gasoline-like fuel is directly injected into the combustion chamber, and which uses a compression-ignition process to initiate combustion under some operating conditions.

4. Performance Requirements

4.1 The fuel shall conform to the requirements of [Table 1](#). The significance of each of the properties of this specification is shown in [Appendix X2](#).

4.1.1 The reader is advised to review other applicable national, state, provincial, or local requirements.

4.1.2 The following applies to all specified limits in this specification: For purposes of determining conformance with this specification, an observed value or a calculated value shall be rounded “to the nearest unit” in the right-most significant digit used in expressing the specification limit, in accordance with the rounding method of [Practice E29](#). All digits associated with property limits in this specification are significant unless otherwise noted.

4.2 Seasonal and regional volatility classes are not specified as the limits in this specification are provided for research and development purposes only, and are not meant for use by the general public.

4.3 Additional recommended property limits for GCI test fuel formulation are provided in [Table X3.1](#). These property requirements are provided as guidance for continued research and development purposes. Those properties which are subsequently shown to be required for GCI vehicle performance will be included in [Table 1](#) in future versions of this specification.

5. Workmanship

5.1 The GCI test fuel shall be visually free of undissolved water, sediment, and suspended matter; it shall be clear and

bright at the fuel temperature at the point-of-custody transfer or at a lower temperature agreed upon by the purchaser and seller.

5.1.1 Test Method [D4176](#) can be helpful for evaluating the product.

5.1.2 *Avoiding Water Haze and Phase Separation*—GCI test fuel should not contain a separate water or water-alcohol phase at the time it is introduced into a vehicle or equipment fuel tank or under the conditions the fuel is used. Water that is dissolved in fuel at the point of use does not generally cause engine problems. However, if excess water is present in gasoline compression-ignition fuel, a separate phase, either “free water” or a water-alcohol mixture, can form. Either condition can lead to engine damage, or the engine failing to start or operate properly. A separated water-rich phase can be observed as a haze, water droplets or a distinct lower layer. This lower aqueous phase can be corrosive to many metals and the engine cannot operate on it. Similarly, the upper hydrocarbon phase may no longer meet volatility properties. See [Appendix X8](#) in [Specification D4814](#) for additional information on water haze and phase separation.

5.1.2.1 GCI test fuel should be resistant to phase separation or undissolved matter at the lowest temperatures to which it is likely to be subjected, dependent on the time and place of its intended use.

NOTE 2—Solubility is temperature dependent. As this fuel cools, water or water-alcohol and some high molecular weight additives can become insoluble.

5.2 The GCI test fuel shall also be free of any adulterant or contaminant that can render the fuel unacceptable for its commonly used applications.

5.2.1 Manufacturers and blenders of GCI test fuel shall avoid blending stocks (for example, purchased used toluene solvents or improperly recycled ethanol) contaminated by silicon-containing materials. Silicon contamination can lead to fouled vehicle components requiring parts replacement and repairs. Test Method [D7757](#) is a procedure for determining silicon content but no specification limits have been established for silicon.

TABLE 1 GCI Test Fuel Specifications

Property	Limit	ASTM Test Method
Lead content, g/L, max	0.013	D3237 or D5059
Sulfur, mg/kg, max	10.	D1266 , D2622 , D3120 , D5453 , D7039 or D7220
Manganese content, mg/L, max	0.25	D3831
Copper strip corrosion, max (3 h at a minimum control temperature of 50 °C)	No. 1	D130
Silver strip corrosion, max (2 h at a minimum control temperature of 50 °C)	No. 1	D7667 or D7671
Solvent-washed gum content, mg/100 mL, max	5	D381
Oxidation stability, minutes, min	240.	D525
Vapor pressure, at 37.8 °C, kPa		D4953 , D5191 , D5482 , or D6378
min	44	
max	103	
Distillation Temperature, °C, at percent evaporated		D86
Initial boiling point,		
min	30.	
max	160.	
End point, max	360.	
Distillation residue, % by volume, max	2	D86