



## Standard Specification for ~~Grade 82 Unleaded Aviation Gasoline~~ **Grades UL82 and UL87** **Unleaded Aviation Gasoline<sup>1</sup>**

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### 1. Scope\*

1.1 This specification covers Grades UL82 and UL87 unleaded aviation gasolines, which isare defined by this specification as and are only for use only in engines and associated aircraft that are specifically approved by the engine and aircraft manufacturers, and certified by the National Certifying Agencies to use this fuel. This fuel is not considered suitable for use in other engines and associated aircraft that are certified to use aviation gasolines meeting Specification D910. these fuels. Components containing hetro-atoms (oxygenates) may be present within the limits specified.

1.2 A fuel may be certified to meet this specification by a producer as Grade UL82 or UL87 aviation gasoline only if blended from component(s) approved for use in Grade 82 UL these grades of aviation gasoline by the refiner(s) of such components, because only the refiner(s) can attest to the component source and processing, absence of contamination, and the additives used and their concentrations. Consequently, re-classifying of any other product to Grade UL82 or Grade UL87 aviation gasoline does not meet this specification.

1.3 Appendix X1 contains an explanation for the rationale of the specification. Appendix X2 details the reasons for the individual specification requirements.

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

### 2. Referenced Documents

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

D86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D357 Method of Test for Knock Characteristics of Motor Fuels Below 100 Octane Number by the Motor Method<sup>3</sup>

D381 Test Method for Gum Content in Fuels by Jet Evaporation

D873 Test Method for Oxidation Stability of Aviation Fuels (Potential Residue Method)

D909 Test Method for Supercharge Rating of Spark-Ignition Aviation Gasoline

D910 Specification for Aviation Gasolines

D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)

D1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D2386 Test Method for Freezing Point of Aviation Fuels

D2392 Test Method for Color of Dyed Aviation Gasolines

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

D3231 Test Method for Phosphorus in Gasoline

D3237 Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy

D3338 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0.02 on Aviation Fuels: Gasoline.

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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> Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

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

- [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](#)
- [D4171 Specification for Fuel System Icing Inhibitors](#)
- [D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry](#)
- [D4529 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels](#)
- [D4809 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter \(Precision Method\)](#)
- [D4815 Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C<sub>1</sub> to C<sub>4</sub> 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 in Gasoline by X-Ray Spectroscopy](#)
- [D5190 Test Method for Vapor Pressure of Petroleum Products \(Automatic Method\)](#)
- [D5191 Test Method for Vapor Pressure of Petroleum Products \(Mini Method\)](#)
- [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 \(Mini Method Atmospheric\)](#)
- [D5599 Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection](#)
- [D5845 Test Method for Determination of MTBE, ETBE, TAME, DIPE, Methanol, Ethanol and \*tert\*-Butanol in Gasoline by Infrared Spectroscopy](#)
- [D5983 Specification for Methyl Tertiary-Butyl Ether \(MTBE\) for Downstream Blending for Use in Automotive Spark-Ignition Engine Fuel](#)
- [D6469 Guide for Microbial Contamination in Fuels and Fuel Systems](#)
- [E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)
- [2.2 Military Standard.<sup>4</sup>](#)
- [MIL-PRF-25017F Performance Specification for Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble](#)
- [QPL-25017 Qualified Products List of Products Qualified Under Performance Specification MIL-PRF-25017F](#)

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *aviation gasoline, n*—gasoline possessing specific properties suitable for fueling aircraft powered by reciprocating spark ignition engines.

3.1.1.1 *Discussion*—The principal properties of aviation gasoline include volatility limits, stability, detonation-free performance in the engine for which it is intended, and suitability for low temperature performance.

3.1.2 *oxygenate, n*—an oxygen-containing ashless organic compound, such as an alcohol or ether, which may be used as fuel or fuel supplement.

### 4. Grades

4.1 The specification covers one grade of unleaded aviation gasoline designated Grade 82 UL. Grade 82 UL is the only aviation gasoline defined by this specification and the grade shows the minimum motor octane rating.

4.1 The specification covers two grades of unleaded aviation gasoline designated Grade UL82 and Grade UL87.

### 5. General

5.1 This specification, unless otherwise provided, prescribes the required properties of unleaded aviation gasoline at the time and place of delivery.

### 6. Material

6.1 Aviation gasoline, except as otherwise specified in this specification, shall consist of blends of refined hydrocarbons derived from crude petroleum, natural gasoline or blends, thereof, with specific aliphatic ethers, synthetic hydrocarbons, or aromatic hydrocarbons. When applicable, methyl *tertiary* -butyl ether (MTBE) shall conform to the requirements of Specification D5983. Types and quantities of trace alcohols shall meet the requirements of Table 1 and 6.2.4.2.

6.2 Only additives approved by this specification are permitted. In addition to identification dyes, corrosion inhibitors, antioxidants, and metal deactivators, fuel system icing inhibitor additives are permitted under 6.2.4. Permitted additives may be added to aviation gasoline in the amount and of the composition specified in the following list of approved materials. The quantities and types shall be declared by the manufacturer. Additives added after the point of manufacture shall also be declared.

6.2.1 *Antioxidants*—The following oxidation inhibitors may be added to the gasoline separately or in combination in total concentration not to exceed 12 mg of inhibitor (not including weight of solvent) per litre of fuel.

<sup>4</sup> Available from Standardization Document Order Desk, 700 Robbins Ave., Bldg. 4D, Philadelphia, PA 19111-5094 Attn: NPODS.

**TABLE 1 Requirements for Grades UL82 and UL87 Aviation Gasoline<sup>A</sup>**

| Property  | Grade UL82         | Requirement UL87      | ASTM   |
|---|--------------------|-----------------------|--|
| <b>Octane Ratings</b>   |                    |                       |  |
| Knock value, lean mixture   |                    |                       |  |
| Knock value, lean mixture, min  | 82.0               | 87.0                  |  |
| Motor method octane number  |                    |                       |  |
| Motor method octane number, min   |                    | 82.0                  |  |
| Knock value, Research method octane number                              | ...                | 95.0                  |  |
| Color   | purple             |                       |  |
| Color   | purple             | yellow                |  |
| Dye content <sup>C</sup>  |                    |                       |  |
| Blue dye <sup>D</sup> , mg/L, max                                       | 7.5                |                       |  |
| Blue dye, mg/L, max   | 7.5                | ...                   |  |
| Red dye <sup>E</sup> , mg/L, max  | 1.9                |                       |  |
| Red dye, mg/L, max  | 1.9                | ...                   |  |
| Yellow dye, mg/L, max   | ...                | 2.8                   |  |
| <b>Requirements for All Grades</b>                                      |                    |                       |  |
| Distillation temperature, °C (°F) at % evaporated                       |                    |                       | D129   |
| Density at 15°C, kg/m <sup>3</sup>                                      | Report             |                       | D129   |
| Distillation  |                    |                       |  |
| 10 volume %, max  |                    | 70 (158)              |  |
| Fuel Evaporated   |                    |                       |  |
| 50 volume %   |                    | 66 (150)–121 (250)    |  |
| 10 volume % at °C, max  | 70                 |                       |  |
| 90 volume %, max  |                    | 190 (374)             |  |
| 50 volume % at °C, min  | 66                 |                       |  |
| 50 volume % at °C, max  | 121                |                       |  |
| End point, max  |                    | 225 (437)             |  |
| 90 volume % at °C, max  | 190                |                       |  |
| Residue, volume % max   |                    | 2                     |  |
| End point, °C, max  | 225                |                       |  |
| Recovery, volume %, min   | 95.0               |                       |  |
| Distillation recovery, volume %, min                                    |                    | 95                    |  |
| Residue, volume %, max  | 2.0                |                       |  |
| Distillation loss, volume %, max  | 3.0                |                       |  |
| Loss, volume %, max   | 3.0                |                       |  |
| Net heat of combustion, min MJ/kg (BTU/lb)                              |                    | 40.8 (17 540)         | D3338F, D4953, D   |
| Vapor pressure 38°C, kPa, min   | 38                 |                       | D4953, D   |
| Vapor pressure 38°C, kPa, max   | 62 <sup>G</sup>    |                       |  |
| Freezing point, °C (°F), max  | -58 (-72)          | D2386                 |  |
| Freezing point, °C (°F), max  |                    | D2386                 |  |
| Vapor pressure, kPa (psi), max  |                    | 62 (9.0) <sup>H</sup> | D4953, D   |
| Freezing point, °C, max   | -58                |                       | D1266, D   |
| Freezing point, °C, min   |                    | 38 (5.5)              | D54  |
| Sulfur, mass %, max   | 0.07               |                       | D42  |
| Lead content, g/L (g/U)   | 0.013 (0.05)       |                       | D323   |
| Lead content, g/L   | 0.013 <sup>H</sup> |                       | D323   |
| Copper strip corrosion, 3 h at 50°C (122°F), max                        | No. 1              | 0.07                  | D126   |
| Net heat of combustion, MJ/kg   | 40.8               |                       | D3338, D   |
| Corrosion, copper strip (3 h at 50°C)                                   | No. 1              |                       | D429   |
| Corrosion, copper strip (3 h at 50°C)                                   | No. 1              |                       | D130   |
| Potential gum (5-h aging), max, mg/100 mL <sup>J</sup>                  | 6                  |                       |  |
| Potential gum (5-h aging) mg/100 mL <sup>J</sup>                        | 6                  |                       |  |
| Alcohols and ether content <sup>K,L</sup>                               |                    |                       | D4815, D   |
| Total combined methanol and ethanol, mass %, max                        | 2.7                | 0.3                   |  |
| Combined aliphatic ethers, methanol, and ethanol, as mass % oxygen, max | 2.7                |                       | Combined aliphatic ethers, methanol, and ethanol, as mass % oxygen |
|   | 0.3                |                       |  |

<sup>A</sup> The requirements stated herein are subject to rounding in accordance with Practice E29 and are not subject to correction for tolerance of the test method.

<sup>B</sup> The test methods indicated in this table are referred to in Section 10.

<sup>C</sup> The maximum dye concentrations shown do not include solvent in dyes supplied in liquid form.

<sup>D</sup> Essentially 1,4-dialkylamino-anthraquinone.

<sup>E</sup> Essentially alkyl derivatives of azobenzene-4-azo-2-naphthol.

<sup>F</sup> Essentially p-diethylaminoazobenzene or 1,3-benzenediol 2,4-bis[(alkylphenyl)azo-].

<sup>G</sup> Fuel with a vapor pressure greater than 62 kPa (9.0 psi) but not exceeding 93 kPa (13.5 psi) is permissible, if the ambient temperature is not more than 29°C (85°F) at the time and place of delivery and all federal and local regulations are met. The vapor pressure of permissible fuel exceeding 62 kPa (9.0 psi) shall be shown on all product transfer documents, including the delivery document to the aircraft.

<sup>H</sup> See X2.10.1 for maximum limits for lead and phosphorus in unleaded gasoline.

<sup>I</sup> Use either Eq 1 or Table 1 in Test Method D4529, or Eq 2 in Test Method D3338. See X2.7.2 for limitations and oxygen corrections required when Test Methods D3338 and D4529 are applied to fuels blended with aliphatic ethers.

<sup>J</sup> Test Method D4809 may be used as an alternative. In case of dispute, Test Method D4809 shall be used.

<sup>K</sup> Fuel with a vapor pressure greater than 62 kPa (9.0 psi) but not exceeding 93 kPa (13.5 psi) is permissible, if the ambient temperature is not more than 29°C (85°F) at the time and place of delivery and all federal and local regulations are met. The vapor pressure of permissible fuel exceeding 62 kPa (9.0 psi) shall be shown on all product transfer documents, including the delivery document to the aircraft.

<sup>L</sup> See X2.10.1 for maximum limits for lead and phosphorus in unleaded gasoline.

<sup>M</sup> Test Method D381 existent gum test can provide a means of detecting deteriorated quality or contamination, or both, with heavier products following distribution from

- 6.2.1.1 2,6-ditertiary-butyl-phenol.
- 6.2.1.2 2,6-ditertiary-butyl-4-methyl-phenol.
- 6.2.1.3 2,4-dimethyl-6-tertiary-butyl-phenol.
- 6.2.1.4 2,6-ditertiary-butyl-phenol, 75 % minimum.  
Tertiary and tritertiary-butyl-phenols, 25 % maximum.
- 6.2.1.5 2,4-dimethyl-6-tertiary-butyl-phenol, 55 % minimum; 4-methyl-2,6-ditertiary-butyl phenol 15 % minimum; the remainder as a mixture of monomethyl and dimethyl-tertiary-butyl-phenols.
- 6.2.1.6 2,4-dimethyl-6-tertiary-butyl-phenol, 72 % minimum.  
Mixture of tertiary-butyl-methyl-phenols and tertiary-butyl-dimethyl-phenols, 28 % maximum.
- 6.2.1.7 2,6-ditertiary-butyl-4-methyl-phenol, 35 % minimum.  
Mixed methyl, ethyl, and dimethyl tertiary-butyl-phenols, 65 % maximum.
- 6.2.1.8 2,4-di-tertiary butyl-phenol, 60 % minimum.  
Mixed tertiary-butyl-phenol, 40 % maximum.
- 6.2.1.9 Butylated ethyl-phenols, 55 % minimum.  
Butylated methyl and dimethyl-phenols, 45 % maximum.
- 6.2.1.10 Mixture of a di- and tri-isopropyl-phenols, 75 % minimum.  
Mixture of di- and tri-tertiary butyl-phenols, 25 % maximum.
- 6.2.1.11 N,N' di-secondary butyl-para phenylene diamine.
- 6.2.1.12 N,N' di-isopropyl-para-phenylene-diamine.
- 6.2.1.13 N-secondary butyl, N'-phenyl ortho-phenylenediamine.
- 6.2.2 *Metal Deactivators*—A metal deactivator, N,N'-disalicylidene-1,2-propane diamine may be added to the gasoline in an amount not to exceed 3.0 mg/L.
- 6.2.3 *Corrosion Inhibitors*—Corrosion inhibitors that conform to MIL-PRF-25017F may be added to the gasoline in amounts not exceeding the maximum allowable concentrations listed in the latest revision of QPL-25017.
- 6.2.4 *Fuel System Icing Inhibitor* :
  - 6.2.4.1 Diethylene glycol monomethyl ether, conforming to the requirements of Specification D4171 (Type III), may be used in concentrations of 0.10 to 0.15 volume %.
  - 6.2.4.2 Isopropyl alcohol conforming to the requirements of Specification D4171 (Type II) may be used in concentrations recommended by the aircraft manufacturers when required by the aircraft owner operator.

## 7. Detailed Requirements

7.1 The aviation gasoline shall conform to the requirements in Table 1.

## 8. Workmanship

8.1 The finished fuel shall be visually free of water, sediment, and suspended matter.

NOTE 1—See Practice D4057 for appropriate sampling procedures.

## 9. Reports

9.1 The type and number of reports to ensure conformance with the requirements of this specification shall be mutually agreed to by the purchaser and the supplier of the aviation gasoline.

## 10. Test Methods

10.1 The requirements enumerated in this specification shall be determined in accordance with the following ASTM test methods:

- 10.1.1 *Research Octane*—Test Method D2699.
- 10.1.2 *Motor Octane*—Test Method D2700.
- ~~10.1.2~~
- 10.1.3 *Color*—Test Method D2392.
- ~~10.1.3~~
- 10.1.4 *Distillation*—Test Method D86.
- ~~10.1.4~~
- 10.1.5 *Net Heat of Combustion*—Test Method D3338, D4529, or D4809.
- ~~10.1.5~~
- 10.1.6 *Freezing Point*—Test Method D2386.
- ~~10.1.6~~
- 10.1.7 *Vapor Pressure*—Test Method D4953, D5190, D5191 or D5482.
- ~~10.1.7~~
- 10.1.8 *Lead Content*—Test Method D3237 or D5059 (Test Method C).
- ~~10.1.8~~