



Designation: D8147 – 17 (Reapproved 2023)

# Standard Specification for Special-Purpose Test Fuels for Aviation Compression- Ignition Engines<sup>1</sup>

This standard is issued under the fixed designation D8147; 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 is intended to support purchasing agencies when formulating specifications for purchases of aviation distillate fuel under contract.

1.2 This specification defines specialized property requirements to produce special-purpose aviation distillate test fuels that are intended only for engineering and certification testing of aircraft, engines, and aircraft equipment. Use of this specification for engineering and certification testing of aircraft is not mandatory. Its use is at the discretion of the aircraft manufacturer, engine manufacturer, or certification authorities when determining criteria for validation of aircraft equipment design.

1.3 This specification defines special-purpose test fuels that may be used to evaluate the operability, performance and durability of aviation compression-ignition engines when operating with fuels of marginal performance. The aviation distillate test fuels defined in this specification are not intended for general purpose use in aircraft. This specification also lists acceptable additives for aviation distillate special-purpose test fuels.

1.4 Specification D8147 is directed at civil applications, and maintained as such, but may be adopted for military, government, or other specialized uses.

1.5 This specification can be used as a standard in describing the quality of aviation distillate fuel from production to the aircraft. However, this specification does not define the quality assurance testing and procedures necessary to ensure that fuel continues to comply with this specification after batch certification.

1.6 This specification does not include all fuels satisfactory for aviation compression-ignition (CI) engines.

1.7 The values stated in SI units are to be regarded as standard.

<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.J0.02 on Aviation Piston Engine Fuels.

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1.7.1 *Exception*—Other units of measurement are included in this standard.

1.8 *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.*

1.9 *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>

- D56 Test Method for Flash Point by Tag Closed Cup Tester
- D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- D381 Test Method for Gum Content in Fuels by Jet Evaporation
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)
- D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
- D1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
- D1322 Test Method for Smoke Point of Kerosene and Aviation Turbine Fuel

<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.

- D1655 Specification for Aviation Turbine Fuels
- D1840 Test Method for Naphthalene Hydrocarbons in Aviation Turbine Fuels by Ultraviolet Spectrophotometry
- D2276 Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling
- D2386 Test Method for Freezing Point of Aviation Fuels
- D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D2624 Test Methods for Electrical Conductivity of Aviation and Distillate Fuels
- D2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
- D3120 Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry
- D3227 Test Method for (Thiol Mercaptan) Sulfur in Gasoline, Kerosine, Aviation Turbine, and Distillate Fuels (Potentiometric Method)
- D3240 Test Method for Undissolved Water In Aviation Turbine Fuels
- D3241 Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels
- D3242 Test Method for Acidity in Aviation Turbine Fuel
- D3338 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
- D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
- D3948 Test Method for Determining Water Separation Characteristics of Aviation Turbine Fuels by Portable Separometer
- D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
- D4171 Specification for Fuel System Icing Inhibitors
- D4176 Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)
- 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)
- D4952 Test Method for Qualitative Analysis for Active Sulfur Species in Fuels and Solvents (Doctor Test)
- D5006 Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
- D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
- D5972 Test Method for Freezing Point of Aviation Fuels (Automatic Phase Transition Method)
- D6079 Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)
- D6379 Test Method for Determination of Aromatic Hydrocarbon Types in Aviation Fuels and Petroleum Distillates—High Performance Liquid Chromatography Method with Refractive Index Detection
- D6890 Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber
- D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
- D7153 Test Method for Freezing Point of Aviation Fuels (Automatic Laser Method)
- D7154 Test Method for Freezing Point of Aviation Fuels (Automatic Fiber Optical Method)
- D7345 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Micro Distillation Method)
- D7524 Test Method for Determination of Static Dissipater Additives (SDA) in Aviation Turbine Fuel and Middle Distillate Fuels—High Performance Liquid Chromatography (HPLC) Method
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- 2.2 *IP Standards:*<sup>3</sup>
- IP 12 Determination of specific energy
- IP 16 Determination of freezing point of aviation fuels—Manual method
- IP 71 Section 1 Petroleum products—Transparent and opaque liquids—Determination of kinematic viscosity and calculation of dynamic viscosity
- IP 123 Petroleum products—Determination of distillation characteristics at atmospheric pressure
- IP 154 Petroleum products—Corrosiveness to copper—Copper strip test
- IP 156 Petroleum products and related materials—Determination of hydrocarbon types—Fluorescent indicator adsorption method
- IP 160 Crude petroleum and liquid petroleum products—Laboratory determination of density—Hydrometer method
- IP 170 Determination of flash point—Abel closed-cup method
- IP 274 Determination of electrical conductivity of aviation and distillate fuels
- IP 323 Determination of thermal oxidation stability of gas turbine fuels
- IP 336 Petroleum products—Determination of sulfur content—Energy-dispersive X-ray fluorescence spectrometry
- IP 342 Petroleum products—Determination of thiol (mercaptan) sulfur in light and middle distillate fuels—Potentiometric method
- IP 354 Determination of the acid number of aviation fuels—colour-indicator titration method
- IP 365 Crude petroleum and petroleum products—Determination of density—Oscillating U-tube method
- IP 406 Petroleum products—Determination of boiling range distribution by gas chromatography
- IP 435 Determination of the freezing point of aviation

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

turbine fuels by the automatic phase transition method

**IP 436** Determination of aromatic hydrocarbon types in aviation fuels and petroleum distillates— High performance liquid chromatography method with refractive index detection

**IP 498** Determination of ignition delay and derived cetane number (DCN) of middle distillate fuels by combustion in a constant volume chamber

**IP 523** Determination of flash point—Rapid equilibrium closed cup method

**IP 528** Determination for the freezing point of aviation turbine fuels—Automatic fibre optic method

**IP 529** Determination of the freezing point of aviation turbine fuels—Automatic laser method

**IP 540** Determination of the existent gum content of aviation turbine fuel—Jet evaporation method

**IP 598** Petroleum products—Determination of the smoke point of kerosine, manual and automated method

2.3 *ANSI Standard*.<sup>3</sup>

**ANSI 863** Report of Test Results

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *identified incidental materials, n*—chemicals and compositions that have defined upper content limits in an aviation fuel specification but are not approved additives.

### 4. General

4.1 This specification, unless otherwise provided, prescribes the required properties of aviation distillate fuel at the time and place of delivery.

### 5. Materials and Manufacture

5.1 Aviation distillate fuel is a complex mixture predominantly composed of hydrocarbons and varies depending on crude source and manufacturing process. Consequently, it is impossible to define the exact composition of aviation distillate fuels. Therefore, this specification is primarily a performance specification rather than a compositional specification. The specification limits aviation distillate fuels to those made from conventional sources or by specifically approved processes.

5.1.1 Aviation distillate fuel, except as otherwise specified in this specification, shall consist predominantly of refined hydrocarbons (see **Note 1**) derived from conventional sources including crude oil, natural gas liquid condensates, heavy oil, shale oil, and oil sands. The use of middle distillate fuel blends containing components from other sources is permitted.

**NOTE 1**—Conventionally refined aviation distillate fuel contains trace levels of materials that are not hydrocarbons, including oxygenates, organosulfur, and nitrogenous compounds.

5.2 *Additives*—Additives approved for use in **D1655** jet fuel are approved for aviation distillate fuels and are shown in **Table 2**. They may be used within the concentration limits shown in the table subject to any restrictions described in the table footnotes.

[ASTM D8147-17\(2023\)](https://standards.iteh.ai/catalog/standards/sist/bfac0127-4975-4b29-b4c7-88282fb17bb3/astm-d8147-172023)

<https://standards.iteh.ai/catalog/standards/sist/bfac0127-4975-4b29-b4c7-88282fb17bb3/astm-d8147-172023>

**TABLE 1 Detailed Requirements of Aviation Distillate Fuels**

Grades	ID 7.9	ID 7.0	ID 6.3	900 WSD	Test Methods
Property	Aviation Distillate Fuels				Test Methods
Ignition Delay, ms	min	7.9	7.0	6.3	Report D6890/IP 498
LUBRICITY					
Wear Scar Diameter, $\mu\text{m}$	min	Report	Report	Report	900 D6079
Requirements for All Grades					
Property	Aviation Distillate Fuels				Test Methods
<b>COMBUSTION</b>					
Net heat of combustion, MJ/kg	min	42.8 <sup>A</sup>		D4529, D3338, or D4809	
One of the following requirements shall be met:					
(1) Smoke point, mm, or	min	25		D1322	
(2) Smoke point, mm, and	min	18		D1322	
Naphthalenes, percent by volume	max	3.0		D1840	
<b>VOLATILITY</b>					
Distillation temperature, °C					D86, <sup>B</sup> D2887/IP 406, <sup>C</sup> D7345, <sup>D</sup> IP 123 <sup>B</sup>
10 % recovered, temperature	max	205			
50 % recovered, temperature					report
90 % recovered, temperature					report
Final boiling point, temperature	max	300			
Distillation residue, %	max	1.5			
Distillation loss, %	max	1.5			
Flash point, °C	min	38 <sup>E</sup>		D56, D93, <sup>F</sup> D3828, <sup>F</sup> IP 170 <sup>F</sup> or IP 523 <sup>F</sup>	
Density at 15 °C, kg/m <sup>3</sup>					D1298/IP 160 or D4052 or IP 365
<b>FLUIDITY</b>					
Freezing point, °C <sup>G</sup>	max	−40		D5972/IP 435, D7153/IP 529, D7154/IP 528, or D2386/IP 16	
Viscosity −20 °C, mm <sup>2</sup> /s <sup>H</sup>	max	8.0		D445/IP 71, Section 1 or D7042 <sup>I</sup>	
<b>COMPOSITION</b>					
Acidity, total mg KOH/g	max	0.10		D3242/IP 354	
(1) Aromatics, percent by volume	max	25.0		D1319 or IP 156	
(2) Aromatics, percent by volume	max	26.5		D6379/IP 436	
Sulfur, mercaptan, <sup>J</sup> percent by mass	max	0.003		D3227/IP 342	
Sulfur, total percent by mass	max	0.30		D1266, D2622, D4294, D5453, or IP 336	
<b>CORROSION</b>					
Copper strip, 2 h at 100 °C	max	No. 1		D130/IP 154	
<b>THERMAL STABILITY</b>					
(2.5 h at control temperature of 260 °C min)					
Filter pressure drop, mm Hg	max	25		D3241 <sup>K</sup> /IP 323 <sup>K</sup>	
Tube rating: One of the following requirements shall be met: <sup>L</sup>					
(1) Annex A1 VTR, VTR Color Code	Less than	3 (no peacock or abnormal color deposits)			
(2) Annex A2 ITR or Annex 3 ETR, nm average over area of 2.5 mm <sup>2</sup>	max	85			
<b>CONTAMINANTS</b>					
Existent gum, mg/100 mL	max	7		D381, IP 540	
Microseparator, Rating					
Without electrical conductivity additive	min	85		D3948	
With electrical conductivity additive	min	70			
<b>ADDITIVES</b>					
Electrical conductivity, pS/m	See 5.2				D2624/IP 274

<sup>A</sup> For all grades use either Eq 1 or Table 1 in Test Method D4529 or Eq 2 in Test Method D3338. Calculate and report the net heat of combustion corrected for the sulfur content when using Test Method D4529 and D3338 empirical test methods. Test Method D4809 can be used as an alternative. In case of dispute, Test Method D4809 shall be used.

<sup>B</sup> D86 and IP 123 distillation of jet fuel is run at Group 4 conditions, except Group 3 condenser temperature is used.

<sup>C</sup> D2887/IP 406 results shall be converted to estimated D86 or IP 123 results by application of the correlation in Appendix X4 on Correlation for Jet and Diesel Fuel in Test Method D2887 or Annex G of IP 406. Distillation residue and loss limits provide control of the distillation process during the use of Test Method D86, and they do not apply to Test Method D2887/IP 406. Distillation residue and loss shall be reported as "not applicable" (N/A) when reporting D2887 results.

<sup>D</sup> Results from Test Method D7345 shall be corrected for relative bias as described in Test Method D7345.

<sup>E</sup> A higher minimum flash point specification can be agreed upon between purchaser and supplier.

<sup>F</sup> Aviation turbine fuel results obtained by Test Method D93 can be up to 1 °C higher than those obtained by Test Method D56. Results obtained by Test Methods D3828, IP 170, and IP 523 can be up to 2 °C lower than those obtained by Test Method D56, which is the preferred method. In case of dispute, Test Method D56 shall apply.

<sup>G</sup> Other freezing points can be agreed upon between supplier and purchaser.

<sup>H</sup> 1 mm<sup>2</sup>/s = 1 cSt.

<sup>I</sup> Test Method D7042 results shall be converted to bias-corrected kinematic viscosity results by the application of the correction described in Test Method D7042 for jet fuel at −20 °C (currently subsection 15.4.4).

<sup>J</sup> The mercaptan sulfur determination may be waived if the fuel is considered sweet by the doctor test described in Test Method D4952.