Designation: D7592 – 15a

An American National Standard

Standard Specification for Specification for Grade 94 Unleaded Aviation Gasoline Certification and Test Fuel[1]

This standard is issued under the fixed designation D7592; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers formulating specifications for purchases of aviation gasoline under contract and is intended primarily for use by purchasing agencies.

1.2 This specification defines a specific type of aviation gasoline that contains no lead. It does not include all gasolines satisfactory for reciprocating aviation engines. Certain equipment or conditions of use may permit a wider, or require a narrower, range of characteristics than is shown by this specification.

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

1.4 The current purpose for the fuel specified herein is for certification and testing of an engine and engine components.

1.5 The UL94 standard is to be used for engine calibration and FAA certification.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

D323 Test Method for Vapor Pressure of Petroleum Products (Reid Method)

D357 Method of Test for Knock Characteristics of Motor Fuels Below 100 Octane Number by the Motor Method; Replaced by D 2700 (Withdrawn 1969)[3]

D614 Method of Test for Knock Characteristics of Aviation Fuels by the Aviation Method; Replaced by D 2700 (Withdrawn 1970)[3]

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

D910 Specification for Leaded Aviation Gasolines

D1094 Test Method for Water Reaction of Aviation Fuels

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

D1948 Method of Test for Knock Characteristics of Motor Fuels Above 100 Octane Number by the Motor Method; Replaced by D 2700 (Withdrawn 1968)[3]

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

D2699 Test Method for Research Octane Number of Spark-Ignition Engine Fuel

D2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel

D3237 Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy

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

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

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

D4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination

D4529 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels

[1] 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 Spark and Compression Ignition Aviation Engine Fuels.

Current edition approved Oct. 1, 2015. Published October 2015. Originally approved in 2010. Last previous edition approved in 2015 as D7592 – 15. DOI: 10.1520/D7592-15A.

[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.

[3] 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**

D4809 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)
D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D5006 Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
D5059 Test Methods for Lead in Gasoline by X-Ray Spectroscopy
D5191 Test Method for Vapor Pressure of Petroleum Products (Mini Method)
D6227 Specification for Unleaded Aviation Gasoline Containing a Non-hydrocarbon Component
D6469 Guide for Microbial Contamination in Fuels and Fuel Systems
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. Terminology

3.1 *Definitions:*

3.1.1 *unleaded aviation gasoline, n*—gasoline possessing specific properties suitable for fueling aircraft powered by reciprocating spark ignition engines, where lead is not intentionally added for the purpose of enhancing octane performance.

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

4. Classification

4.1 One grade of unleaded aviation gasoline is provided, known as:

Grade UL94

NOTE 1—The above grade is based on its octane number as measured by Test Method D2700 motor method.

5. Materials and Manufacture

5.1 Unleaded 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 synthetic hydrocarbons or aromatic hydrocarbons, or both.

5.2 *Additives*—These may be added to each grade of unleaded aviation gasoline in the amount and of the composition specified in the following list of approved materials.[4] The quantities and types shall be declared by the manufacturer. Additives added after the point of manufacture shall also be declared.

5.2.1 *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.

5.2.1.1 2, 6-ditertiary butyl-4-methylphenol.

5.2.1.2 2, 4-dimethyl-6-tertiary butylphenol.

5.2.1.3 2, 6-ditertiary butylphenol.

5.2.1.4 75 % minimum 2, 6-ditertiary butylphenol plus 25 % maximum mixed *tertiary* and *tritertiary* butylphenols.

5.2.1.5 75 % minimum di- and tri-isopropyl phenols plus 25 % maximum di- and tri-*tertiary* butylphenols.

5.2.1.6 72 % minimum 2,4-dimethyl-6-tertiary butylphenol plus 28 % maximum monomethyl and dimethyl *tertiary* butylphenols.

5.2.1.7 N,N'-di-isopropyl-para-phenylenediamine.

5.2.1.8 N,N'-di-secondary-butyl-para-phenylenediamine.

5.2.2 *Fuel System Icing Inhibitor (FSII)*—One of the following may be used:

5.2.2.1 *Isopropyl Alcohol (IPA, propan-2-ol),* in accordance with the requirements of Specification D4171 (Type II). This may be used in concentrations recommended by the aircraft manufacturer when required by the aircraft owner/operator.

NOTE 2—Addition of isopropyl alcohol (IPA) may reduce knock ratings below minimum specification values in a similar manner to Specification D910 Leaded Aviation Gasoline (see X1.2.3).[5]

5.2.2.2 *Di-Ethylene Glycol Monomethyl Ether (Di-EGME),* conforming to the requirements of Specification D4171 (Type III), may be used in concentrations of 0.10 volume % to 0.15 volume % when required by the aircraft owner/operator.

5.2.2.3 Test Method D5006 may be used to determine the concentration of Di-EGME in aviation fuels.

5.2.3 *Electrical Conductivity Additive*—Stadis 450[6] in concentrations up to 3 mg/L is permitted. When loss of fuel conductivity necessitates retreatment with electrical conductivity additive, further addition is permissible up to a maximum cumulative level of 5 mg/L of Stadis 450.[6]

5.2.4 *Corrosion Inhibitor Additive*—The following corrosion inhibitors may be added to the gasoline in concentrations not to exceed the maximum allowable concentration (MAC) listed for each additive.

DCI-4A	MAC = 24.0 g/m^3
DCI-6A	MAC = 15.0 g/m^3
HITEC 580	MAC = 22.5 g/m^3
NALCO 5403	MAC = 22.5 g/m^3
NALCO 5405	MAC = 11.0 g/m^3
UNICOR J	MAC = 22.5 g/m^3
SPEC-AID 8Q22	MAC = 24.0 g/m^3
TOLAD 351	MAC = 24.0 g/m^3
TOLAD 4410	MAC = 22.5 g/m^3

6. Detailed Requirements

6.1 The unleaded aviation gasoline shall conform to the requirements prescribed in Table 1.

6.2 Test results shall not exceed the maximum or be less than the minimum values specified in Table 1. No allowance shall be made for the precision of the test methods. To determine the conformance to the specification requirement, a test result may be rounded to the same number of significant figures as in Table 1 using Practice E29. Where multiple

[4] Supporting data (guidelines for the approval or disapproval of additives) have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1125.

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1256.

[6] Stadis 450 is a registered trademark marketed by Innospec, Inc., Innospec Manufacturing Park, Oil Sites Road, Ellesmere Port, Cheshire, CH65 4EY, UK.

TABLE 1 Detailed Requirements for Unleaded Aviation Gasoline[A]

Octane Ratings		Grade 94	ASTM Test Method[B]
Knock value, Motor Octane Number[C]	min	94.0	D2700
Knock value, Research Octane Number[C]	min	Report	D2699
Identifying Color		colorless	
Density at 15 °C, kg/m^3		Report	D1298 or D4052
Distillation			D86
Initial boiling point, °C		Report	
Fuel Evaporated			
10 volume % at °C	max	75	
40 volume % at °C	min	75	
50 volume % at °C	max	105	
90 volume % at °C	max	135	
Final boiling point, °C	max	170[D]	D86
Sum of 10 % + 50 % evaporated temperatures, °C	min	135	
Recovery volume %	min	97	
Residue volume %	max	1.5	
Loss volume %	max	1.5	
Vapor pressure, 38 °C, kPa	min	38.0	D323 or D5191[E]
	max	49.0	
Freezing point,°C	max	-58[F]	D2386
Sulfur, mass %	max	0.05	D2622
Net heat of combustion, MJ/kg[G]	min	43.5	D4529 or D3338
Corrosion, copper strip, 2 h at 100 °C	max	No. 1	D130
Oxidation stability(5 h aging)[H]			D873
Potential gum, mg/100 mL	max	6	
Water reaction			D1094
Volume change, mL	max	±2	
Electrical conductivity, pS/m	max	450[I]	D2624
Tetraethyl Lead, g Pb/L	max	0.0130	D3237 or D5059

[A] For compliance of test results against the requirements of Table 1, see 6.2.
[B] The test methods indicated in this table are referred to in Section 10.
[C] Knock ratings shall be reported to the nearest 0.1 octane number.
[D] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1801. Contact ASTM Customer Service at service@astm.org.
[E] Test Method D5191 shall be the referee vapor pressure method.
[F] If no crystals have appeared on cooling to –58 °C, the freezing point may be reported as less than –58 °C.
[G] For all grades use either Eq 1 or Table 1 in Test Method D4529 or Eq 2 in Test Method D3338. Test Method D4809 may be used as an alternative. In case of dispute, Test Method D4809 shall be used.
[H] If mutually agreed upon between the purchaser and the supplier, a 16 h aging gum requirement may be specified instead of the 5 h aging gum test; in such case the gum content shall not exceed 10 mg/100 mL. In such fuel the permissible antioxidant shall not exceed 24 mg/L.
[I] Applies only when an electrical conductivity additive is used; when a customer specifies fuel containing conductivity additive, the following conductivity limits shall apply under the condition at point of use:
Minimum 50 pS/m.
Maximum 450 pS/m.
The supplier shall report the amount of additive added.

determinations are made, the average result, rounded according to Practice E29, shall be used.

7. Workmanship, Finish, and Appearance

7.1 The unleaded aviation gasoline specified in this specification shall be free from undissolved water, sediment, and suspended matter. The odor of the fuel shall not be nauseating or irritating. No substances of known dangerous toxicity under usual conditions of handling and use shall be present.

8. Sampling

8.1 Because of the importance of proper sampling procedures in establishing fuel quality, use the appropriate procedures in Practice D4057 or Practice D4177.

8.1.1 Although automatic sampling following Practice D4177 may be useful in certain situations, initial refinery specification compliance testing shall be performed on a sample taken following procedures in Practice D4057.

8.2 A number of unleaded aviation gasoline properties, including copper corrosion, electrical conductivity, and others are very sensitive to trace contamination which can originate from sample containers. For recommended sample containers, refer to Practice D4306.

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 unleaded 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 *Knock Value*—MON (Test Method D2700) and RON (Test Method D2699).