



Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers the manufacture of aviation turbine fuel that consists of conventional and synthetic blending components.

1.2 This specification applies only at the point of batch origination. Aviation turbine fuel manufactured, certified and released to all the requirements of this specification, meets the requirements of Specification D1655 and shall be regarded as Specification D1655 turbine fuel. Once released to this specification (D7566) the requirements of this specification are no longer applicable: any recertification shall be done to D1655. Field blending of synthesized paraffinic kerosine (SPK) with D1655 fuel (which may on the whole or in part have originated as D7566 fuel) shall be considered batch origination in which case all of the requirements of this specification (D7566) apply, however the fuel shall be regarded as D1655 turbine fuel after certification and release.

1.3 This specification defines specific types of aviation turbine fuel that contain synthesized hydrocarbons for civil use in the operation and certification of aircraft and describes fuels found satisfactory for the operation of aircraft and engines. The specification is intended to be used as a standard in describing the quality of aviation turbine fuels and synthetic blending components at the place of manufacture but can be used to describe the quality of aviation turbine fuels for contractual transfer at all points in the distribution system.

1.4 This specification does not include all fuels satisfactory for aviation turbine engines. Certain equipment or conditions of use may permit a wider, or require a narrower, range of characteristics than is shown by this specification.

1.5 While aviation turbine fuels defined by this specification can be used in applications other than aviation turbine engines, requirements for such other applications have not been considered in the development of this specification.

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

1.7 *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:²

D56 Test Method for Flash Point by Tag Closed Cup Tester

D86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D129 Test Method for Sulfur in Petroleum Products (General Bomb Method)

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

D156 Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)

D240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter

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

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)

¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0.06 on Emerging Turbine Fuels.

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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.

- D1298 Test Method for Density, Relative Density (Specific Gravity), 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 Kerosine and Aviation Turbine Fuel
- D1405 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
- D1655 Specification for Aviation Turbine Fuels
- D1740 Test Method for Luminometer Numbers of 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
- D2425 Test Method for Hydrocarbon Types in Middle Distillates by Mass Spectrometry
- 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
- 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
- D3343 Test Method for Estimation of Hydrogen Content of Aviation Fuels
- D3701 Test Method for Hydrogen Content of Aviation Turbine Fuels by Low Resolution Nuclear Magnetic Resonance Spectrometry
- 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
- D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
- 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
- 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
- D4629 Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection
- 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
- D4952 Test Method for Qualitative Analysis for Active Sulfur Species in Fuels and Solvents (Doctor Test)
- D4953 Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)
- D5001 Test Method for Measurement of Lubricity of Aviation Turbine Fuels by the Ball-on-Cylinder Lubricity Evaluator (BOCLE)
- D5006 Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
- D5190 Test Method for Vapor Pressure of Petroleum Products (Automatic Method)
- D5191 Test Method for Vapor Pressure of Petroleum Products (Mini Method)
- D5291 Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants
- D5452 Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration
- 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)
- D6045 Test Method for Color of Petroleum Products by the Automatic Tristimulus Method
- D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6379 Test Method for Determination of Aromatic Hydrocarbon Types in Aviation Fuels and Petroleum Distillates High Performance Liquid Chromatography Method with Refractive Index Detection
- D6469 Guide for Microbial Contamination in Fuels and Fuel Systems
- 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)
- D7359 Test Method for Total Fluorine, Chlorine and Sulfur in Aromatic Hydrocarbons and Their Mixtures by Oxidative Pyrohydrolytic Combustion followed by Ion Chromatography Detection (Combustion Ion Chromatography-CIC)

E29 [Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

2.2 *Energy Institute Standards:*³

IP 225 Copper Content of Aviation Turbine Fuel

IP 227 Silver Corrosion of Aviation Turbine Fuel

IP 540 Determination of the Existent Gum Content of Aviation Turbine Fuel—Jet Evaporation Method

2.3 *ANSI Standard:*⁴

ANSI 863 Report of Test Results

2.4 *Other Standard:*⁵

Defence Standard 91-91 Turbine Fuel, Aviation Kerosine Type, Jet A-1

2.5 *IATA Guidance:*⁶

9680–02 IATA Guidance Material on Microbiological Contamination in Aircraft Fuel Tanks

2.6 *UOP Test Methods:*⁷

UOP 389 Trace Metals in Oils by Wet Ash/ICP-AES

2.7 *U.S. Department of Defense Specifications:*⁸

MIL-PRF-25017 Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble

QDS-25017 Qualified Data Set for MIL-PRF-25017 (Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble)

3. General

3.1 This specification, unless otherwise provided, prescribes the required properties of aviation turbine fuel at the time and place of delivery. batch origination.

4. Terminology

4.1 *Definitions:*

4.1.1 *conventional hydrocarbons, n*—hydrocarbons derived from the following conventional sources: crude oil, natural gas liquid condensates, heavy oil, shale oil, and oil sands.

4.2 *Definitions of Terms Specific to This Standard:*

4.2.1

4.2.1 *batch origination, n*—location at which fuel is certified as D7566.

4.2.2 *conventional blending component, n*—blending streams derived from conventional hydrocarbons.

4.2.2

4.2.3 *synthesized hydrocarbons, n*—hydrocarbons derived from alternative sources such as coal, natural gas, biomass, and hydrogenated fats and oils by processes such as gasification, Fischer-Tropsch synthesis, and hydroprocessing.

4.2.3

4.2.4 *synthetic blending component, n*—synthesized hydrocarbons that meet the requirements of Annex A1.

5. Classification

5.1 ~~Two types~~ 5.1 Two grades of aviation turbine fuels are provided, as follows:

5.1.1 *Jet A and Jet A-1*—Relatively high flash point distillates of the kerosine type.

5.2 Jet A and Jet A-1 represent two grades of kerosine fuel that differ in freezing point. Other grades would be suitably identified.

6. Materials and Manufacture

6.1 Aviation turbine fuel, except as otherwise defined in this specification, shall consist of the following blends of components or fuels:

6.1.1 Conventional blending components or Jet A or Jet A-1 fuel certified to Specification D1655; with up to 50 % by volume of the synthetic blending component defined in Annex A1.

6.2 Fuels used in certified engines and aircraft are ultimately approved by the certifying authority subsequent to formal submission of evidence to the authority as part of the type certification program for that aircraft and engine model. Additives to be used as supplements to an approved fuel must also be similarly approved on an individual basis (see X1.2.4).

6.3 *Additives*—May be added to each type of aviation turbine fuel in the amount and of the composition specified in Table 2 or the following list of approved material:⁹

³ Available from Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K., <http://www.energyinst.org.uk>.

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

⁵ Available from Defence Equipment and Support, UK Defence Standardization, Kentigern House, 65 Brown Street, Glasgow, G2 8EX (<http://www.dstan.mod.uk>).

⁶ Available from International Air Transport Association (IATA), Head Office, 800 Place Victoria, PO Box 113, Montreal H4Z 1M1, Quebec, Canada. Executive Office, 33 Route de l'Aéroport, PO Box 416, Beneva, 15 Airport, Switzerland. www.iataonline.com.

⁷ Available from ASTM International, www.astm.org, or contact ASTM Customer Service at service@astm.org.

⁸ Available from the Standardization Document Order Desk, 700 Robbins, Avenue, Building 4D, Philadelphia PA 19111-5094 (<http://assist.daps.dla.mil>).

⁹ Supporting data (Guidelines for Approval or Disapproval of Additives) have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: RR:D02-1125.

TABLE 1 Detailed Requirements of Aviation Turbine Fuels Containing Synthesized Hydrocarbons^A

| Part 1—Basic Requirements | | | |
|--|-----|--|--|
| Property | | Jet A or Jet A-1 | ASTM Test Method ^B |
| COMPOSITION | | | |
| Acidity, total mg KOH/g | Max | 0.10 | D3242 |
| Aromatics: One of the following requirements shall be met: | | | |
| 1. Aromatics, vol % | Max | 25 | D1319 |
| 2. Aromatics, vol % | Max | 26.5 | D6379 |
| Sulfur, mercaptan, ^C mass % | Max | 0.003 | D3227 |
| Sulfur, total mass % | Max | 0.30 | D1266, D2622, D4294, or D5453 |
| VOLATILITY | | | |
| Distillation | | | D2887 ^D or D86 ^E |
| Distillation temperature, °C: | | | |
| 10 % recovered, temperature (T10) | Max | 205 | |
| 50 % recovered, temperature (T50) | | report | |
| 90 % recovered, temperature (T90) | | report | |
| Final boiling point, temperature | Max | 300 | |
| Distillation residue, % | Max | 1.5 | |
| Distillation loss, % | Max | 1.5 | |
| Flash point, °C | Min | 38 ^F | D56 or D3828 ^G |
| Density at 15°C, kg/m ³ | | 775 to 840 | D1298 or D4052 |
| FLUIDITY | | | |
| Freezing point, °C | Max | -40 Jet A ^H -47 Jet A-1 ^H | D5972, D7153, D7154, or D2386 |
| Viscosity -20°C, mm ² /s ^I | Max | 8.0 | D445 |
| COMBUSTION | | | |
| Net heat of combustion, MJ/kg | Min | 42.8 ^J | 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, vol, % | Max | 3.0 | D1840 |
| CORROSION | | | |
| Copper strip, 2 h at 100°C | Max | No. 1 | D130 |
| THERMAL STABILITY | | | |
| 2.5 h at control temperature of 260°C, min | | | D3241 |
| Filter pressure drop, mm Hg | Max | 25 ^K 3 ^L | |
| Tube deposits less than | | No peacock or abnormal color deposits | |
| CONTAMINANTS | | | |
| Existent gum, mg/100 mL | Max | 7 | D381, IP 540 |
| Microseparator, ^M Rating | | | D3948 |
| Without electrical conductivity additive | Min | 85 | |
| With electrical conductivity additive | Min | 70 | |
| ADDITIVES | | | |
| Electrical conductivity, pS/m | | See 6.3 ^N | D2624 |

^A For compliance of test results against the requirements of Table 1, see 7.3.

^B The test methods indicated in this table are referred to in Section 11.

^C The mercaptan sulfur determination may be waived if the fuel is considered sweet by the doctor test described in Test Method D4952.

^D Distillation property criteria are specified in D86 scale units. D2887 results shall be converted to estimated D86 results by application of the correlation in Appendix X5 of D2887 for comparison with the specified property criteria. Distillation residue and loss limits provide control of the distillation process during the D86 test method and do not apply to D2887. Distillation residue and loss shall be reported as "not applicable" (N/A) when reporting D2887 results.

^E D86 distillation of jet fuel is run at Group 4 conditions, except Group 3 condenser temperature is used.

^F A higher minimum flash point specification may be agreed upon between purchaser and supplier.

^G Results obtained by Test Methods D3828 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 will apply.

^H Other freezing points may be agreed upon between supplier and purchaser.

^I 1 mm²/s = 1 cSt.

^J 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.

^K Preferred SI units are 3.3 kPa, max.

^L Tube deposit ratings shall always be reported by the Visual Method.

^M At point of manufacture.

^N If electrical conductivity additive is used, the conductivity shall not exceed 600 pS/m at the point of use of the fuel. When electrical conductivity additive is specified by the purchaser, the conductivity shall be 50 to 600 pS/m under the conditions at point of delivery. (1 pS/m = 1 × 10⁻¹² Ω⁻¹m⁻¹)

TABLE 1 Detailed Requirements of Aviation Turbine Fuels Containing Synthesized Hydrocarbons^A (continued)

| Part 2—Extended Requirements | | | |
|--|--------------------|------------------|--|
| Property | | Jet A or Jet A-1 | ASTM Test Method ^B |
| COMPOSITION | | | |
| Aromatics: One of the following requirements shall be met: | | | |
| 1. Aromatics, vol % | Min ^{O,O} | 8 | D1319 |
| 2. Aromatics, vol % | Min ^{O,O} | 8.4 | D6379 |
| Distillation | | | D2887 ^D or D86 ^E |
| T50-T10, °C | Min ^{P,O} | 15 | |
| T90-T10, °C | Min ^{P,O} | 40 | |
| Lubricity, ^M mm | Max | 0.85 | D5001 |

^O Minimum aromatics contents are based on current experience with the approved synthetic fuels and those levels were established from what is typical for refined jet fuel. Research is ongoing on the actual need for aromatics.

^P These distillation slope limits are based on current experience with the approved synthetic fuels and these values were established from what is typical for refined jet fuel. Research is ongoing on the actual requirements for distillation slope.

^O The minimum aromatics and distillation slope criteria only apply to aviation turbine fuels containing synthesized hydrocarbons produced to this specification and are not applicable to conventional aviation turbine fuels produced to Specification D1655. Some batches of aviation turbine fuels produced to Specification D1655 may not meet the minimum aromatics and distillation slope criteria specified in Table 1 of this specification.

6.3.1 Other additives are permitted under 6.2 and 8.1. These include fuel performance enhancing additives and fuel handling and maintenance additives as found under Table 2. The quantities and types shall be declared by the fuel supplier and agreed to by the purchaser. Only additives approved by the aircraft and engine certifying authority/authorities are permitted in the fuel on which an aircraft is operated.

6.3.1.1 Biocidal additives are available for controlled usage. Where such an additive is used in the fuel, the approval status of the additive and associated conditions shall be checked for the specific aircraft and engines to be operated.

6.3.1.2 *Fuel System Icing Inhibitor* :

(1) *Diethylene Glycol Monomethyl Ether (DiEGME)*, conforming to the requirements of Specification D4171, Type III, may be used in concentrations of 0.10 to 0.15 volume %.

(2) Test Method D5006 may be used to determine the concentration of DiEGME in aviation fuels.

6.4 Guidance material is presented in ~~Appendix X2~~ ~~Appendix X3~~ concerning the need to control processing additives in jet fuel production.

7. Detailed Requirements

7.1 The aviation turbine fuel shall conform to the requirements prescribed in Table 1 Part 1 and Table 1 Part 2 unless otherwise noted in Annex A1.

7.2 The additional requirements of Part 2 of Table 1 apply only for each batch of fuel intentionally containing a synthetic blending component. The additional requirements of Part 2 of Table 1 are not mandated if conventionally-derived jet fuel is mixed with the residue of a D7566 semi-synthetic aviation turbine fuel in refinery equipment from a previous batch of certified final blended product, for example in a tank heel.

7.3 Test results shall not exceed the maximum or be less than the minimum values specified in Table 1, Table A1.1, and Table A1.2. No allowance shall be made for the precision of the test methods. To determine conformance to the specification requirement, a test result may be rounded to the same number of significant figures as in Table 1, Table A1.1, and Table A1.2 using Practice E29. Where multiple determinations are made, the average result, rounded in accordance with Practice E29, shall be used.

8. Workmanship, Finish and Appearance

8.1 The aviation turbine fuel specified in this specification shall be visually free of undissolved water, sediment, and suspended matter. The odor of the fuel shall not be nauseating or irritating. If the fuel has an odor similar to that of “rotten egg,” please refer to X1.12.5 for further discussion. No substance of known dangerous toxicity under usual conditions of handling and use shall be present, except as permitted in this specification.

9. Sampling

9.1 Because of the importance of proper sampling procedures in establishing fuel quality, use the appropriate procedures in Practice D4057 to obtain a representative sample from the batch of fuel for specification compliance testing. This requirement is met by producing fuel as a discrete batch then testing it for specification compliance. This requirement is not satisfied by averaging online analysis results.

9.2 A number of jet fuel properties, including thermal stability, water separation, electrical conductivity, and others, are very sensitive to trace contamination, which can originate from sample containers. For recommended sample containers, refer to Practice D4306.

10. Report

10.1 The type and number of reports to ensure conformance with the requirements of this specification shall be mutually agreed upon by the seller and the purchaser of the aviation turbine fuel.

TABLE 2 Detailed Requirements for Additives in Aviation Turbine Fuels

| Additive | Dosage |
|--|--|
| Fuel Performance Enhancing Additives | |
| Antioxidants ^{A,B} One of the following: 2,6 ditertiary-butyl phenol 2,6 ditertiary-butyl-4-methyl phenol 2,4 dimethyl-6-tertiary-butyl-phenol 75 % minimum, 2,6 ditertiary-butyl phenol plus 25 % maximum mixed tertiary and tritertiary butyl-phenols 55 % minimum 2,4 dimethyl-6-tertiary-butyl phenol plus 15 % minimum 2,6 ditertiary-butyl-4-methyl phenol, remainder as monomethyl and dimethyl tertiary-butyl phenols 72 % minimum 2,4 dimethyl-6-tertiary-butyl phenol plus 28 % maximum monomethyl and dimethyl-tertiary-butyl-phenols | 24.0 mg/L max ^C |
| Metal Deactivator ^A N,N-disalicylidene-1,2-propane diamine On initial blending After field reblending cumulative concentration | 2.0 mg/L max ^{C,D} 5.7 mg/L max |
| Fuel System Icing Inhibitor ^E Diethylene Glycol Monomethyl Ether (see Specification D4171) | 0.10 vol % min 0.15 vol % max |
| Fuel Handling and Maintenance Additives | |
| Electrical Conductivity Improver ^F Stadis 450 ^G On initial blending After field reblending, cumulative concentration If the additive concentration is unknown at time of retreatment, additional concentration is restricted to 2 mg/L max | 3 mg/L max 5 mg/L max |
| Leak Detection Additive Tracer A (LDTA-A) ^H | 1 mg/kg max |
| Biocidal Additives ^{E,I,J} Biobor JF Kathon FP1.5 Corrosion Inhibitor/Lubricity Improvers ^K One of the following: Apoelle PRI-19 HiTEC 580 Octel DCI-4A Nalco 5403 | 23 mg/L max 23 mg/L max 23 mg/L max 23 mg/L max |

^A The active ingredient of the additive must meet the composition specified.

^B Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D02:1125.

^C Active ingredient (not including weight of solvent).

^D If copper contamination is suspected, initial treatment may exceed 2.0 mg/L but cumulative total must be below 5.7 mg/L.

^E Quantity must be declared by the fuel supplier and agreed to by the purchaser.

^F If electrical conductivity improver is used, the conductivity shall not exceed 600 pS/m at the point of use of the fuel. When electrical conductivity additive is specified by the purchaser, the conductivity shall be 50 to 600 pS/m under the conditions at point of delivery. (1 pS/m = $1 \times 10^{-12} \Omega^{-1}m^{-1}$)

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

^H Tracer A (LDTA-A) is a registered trademark of Tracer Research Corp., 3755 N. Business Center Dr., Tucson, AZ 85705.

^I Biocidal additives are available for controlled usage. Where such an additive is used in the fuel, the approval status of the additive and associated conditions must be checked for the specific aircraft and engines to be operated.

^J Refer to the Aircraft Maintenance Manual (AMM) to determine if either biocide is approved for use and for their appropriate use and dosage.

^K More information concerning minimum treat rates of corrosion inhibitor/lubricity improver additives is contained in X1.10.2.

10.2 A suggested form for reporting inspection data on aviation turbine fuels is given in ~~Appendix X3~~ Appendix X4.

11. Test Methods

11.1 Determine the requirements enumerated in this specification in accordance with the following ASTM test methods.

11.1.1 *Density*—Test Method D1298 or D4052.

11.1.2 *Distillation*—Test Method D86. For Jet A and Jet A-1, Test Method D2887 may be used as an alternate. Results from Test Method D2887 shall be reported as estimated D86 results by application of the correlation in Appendix X5 of D2887. In case of dispute, Test Method D86 shall be the referee method (see X1.6.1.1).

11.1.3 *Flash Point*—Test Method D56 or D3828.

11.1.4 *Freezing Point*—Test Method D5972, D7153, D7154, or D2386. Any of these test methods may be used to certify and

recertify jet fuel. However, Test Method D2386 is the referee method. An interlaboratory study (RR: D02-1572¹⁰) that evaluated the ability of freezing point methods to detect jet fuel contamination by diesel fuel determined that Test Methods D5972 and D7153 provided significantly more consistent detection of freeze point changes caused by contamination than Test Methods D2386 and D7154. It is recommended to certify and recertify jet fuel using either Test Method D5972 or Test Method D7153, or both, on the basis of the reproducibility and cross-contamination detection reported in RR:D02-1572.¹⁰ The cause of freezing point results outside specification limits by automated methods should be investigated, but such results do not disqualify the fuel from aviation use if the results from the referee method (Test Method D2386) are within the specification limit.

11.1.5 *Viscosity*—Test Method D445.

11.1.6 *Net Heat of Combustion*—Test Method D4529, D3338, or D4809.

11.1.7 *Corrosion (Copper Strip)*—Test Method D130.

11.1.8 *Total Acidity*—Test Method D3242.

11.1.9 *Sulfur*—Test Method D1266, D2622, D4294, or D5453.

11.1.10 *Mercaptan Sulfur*—Test Method D3227.

11.1.11 *Microseparator*—Test Method D3948.

11.1.12 *Existent Gum*—Test Method D381 or IP 540. Test Method D381, using steam jet operating conditions, shall be the referee test method.

11.1.13 *Thermal Stability*—Test Method D3241.

11.1.14 *Aromatics*—Test Method D1319 or D6379. Test Method D1319 shall be the referee test method.

11.1.15 *Smoke Point*—Test Method D1322.

11.1.16 *Naphthalene Content*—Test Method D1840.

11.1.17 *Electrical Conductivity*—Test Method D2624.

12. Keywords

12.1 aviation turbine fuel; avtur; Jet A; Jet A-1; jet fuel; synthesized hydrocarbons; synthesized paraffinic kerosene; synthetic blending component; turbine fuel

ANNEX

(Mandatory Information)

A1. HYDROPROCESSED SYNTHESIZED PARAFFINIC KEROSENE

A1.1 Scope

A1.1.1 This annex defines hydroprocessed synthesized paraffinic kerosene (SPK) for use as a synthetic blending component in aviation turbine fuels for use in civil aircraft and engines. The specifications in this annex can be used for contractual exchange of synthetic blending components.

A1.1.2 The synthetic blending components defined in this annex are not satisfactory for aviation turbine engines unless blended with conventional fuel or conventional blending components in accordance with the limitations described in 6.1.1.

A1.1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

A1.2 General

A1.2.1 All requirements of the main body of this specification apply except as detailed in this annex.

A1.3 Terminology

A1.3.1 *Definitions of Terms Specific to This Annex:*

A1.3.1.1 *synthesized paraffinic kerosene (SPK), n*—a synthetic blending component that is comprised essentially of iso-paraffins, normal paraffins and cycloparaffins.

Discussion—Trace materials are permitted provided they are components that normally occur in hydroprocessed jet fuel including but not limited to trace organics, nitrogen compounds, water, dissolved air etc.

A1.3.1.2 *hydroprocessed, n*—a conventional chemical process in which hydrogen is reacted with organic compounds in the presence of a catalyst to remove impurities such as oxygen, sulfur, nitrogen, to saturate unsaturated hydrocarbons, or to alter the molecular structure of the hydrocarbon molecules.

A1.4 Materials and Manufacture

A1.4.1 Synthetic blend components shall be comprised of hydroprocessed synthesized paraffinic kerosene.

A1.4.2 The following types of hydroprocessed SPK are acceptable synthetic blending components for aviation turbine fuel:

¹⁰ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: RR:D02-1572.

A1.4.2.1 Fischer-Tropsch hydroprocessed SPK (FT-SPK).¹¹ FT-SPK blending components shall be wholly derived from synthesis gas via the Fischer-Tropsch (FT) process using Iron or Cobalt catalyst. Subsequent processing of the product shall include hydrotreating, hydrocracking or hydroisomerization and is expected to include, but not be limited to, a combination of other conventional refinery processes such as polymerization, isomerization and fractionation.

A1.5 Detailed Batch Requirements

A1.5.1 Each batch of synthetic blending component shall conform to the requirements prescribed in Table A1.1.

A1.5.2 *Test Methods*—Determine the requirements enumerated in this annex in accordance with the following ASTM test methods.

A1.5.2.1 *Density*—Test Method D1298 or D4052.

A1.5.2.2 *Distillation*—Test Method D2887. Results from Test Method D2887 shall be reported as estimated D86 results by application of the correlation in Appendix X5 of D2887.

A1.5.2.3 *Flash Point*—Test Method D56 or D3828.

A1.5.2.4 *Freezing Point*—Test Method D5972, D7153, D7154, or D2386. Any of these test methods may be used to certify and recertify jet fuel. However, Test Method D2386 is the referee method. An interlaboratory study (RR: D02–1572¹⁰) that evaluated the ability of freezing point methods to detect jet fuel contamination by diesel fuel determined that Test Methods D5972 and D7153 provided significantly more consistent detection of freeze point changes caused by contamination than Test Methods D2386 and D7154. It is recommended to certify and recertify jet fuel using either Test Method D5972 or Test Method D7153, or both, on the basis of the reproducibility and cross-contamination detection reported in RR:D02-1572.¹⁰ The cause of freezing point results outside specification limits by automated methods should be investigated, but such results do not disqualify the fuel from aviation use if the results from the referee method (Test Method D2386) are within the specification limit.

A1.5.2.5 *Total Acidity*—Test Method D3242.

A1.5.2.6 *Thermal Stability*—Test Method D3241.

A1.6 Other Detailed Requirements

A1.6.1 The hydroprocessed SPK blend component shall meet the requirements of Table A1.2. It is not necessary to analyze each batch of hydroprocessed SPK for compliance with Table A1.2 once it is demonstrated that the process scheme is adequately controlled to support the expectation that these requirements are always met. At a minimum, significant changes in production operations shall be cause for recertifying that these limits continue to be met.

A1.6.2 *Test Methods*—Determine the requirements enumerated in this annex in accordance with the following ASTM test methods.

A1.6.2.1 *Cycloparaffins*—Test Method D2425.

A1.6.2.2 *Aromatics*—Test Method D2425.

A1.6.2.3 *Paraffins*—Test Method D2425.

A1.6.2.4 *Carbon and Hydrogen*—Test Method D5291.

A1.6.2.5 *Nitrogen*—Test Method D4629.

A1.6.2.6 *Water*—Test Method D6304.

A1.6.2.7 *Sulfur*—Test Methods D5453 or D2622. Either of these test methods can be used to certify and recertify jet fuel. However, Test Method D5453 is the referee method.

A1.6.2.8 *Metals*—Test Method UOP 389.

A1.6.2.9 *Halogens*—Test Method D7359.

¹¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0.06 on Emerging Turbine Fuels.

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TABLE A1.1 Detailed Batch Requirements; Hydroprocessed SPK^A

| Property | | Hydroprocessed SPK | ASTM Test Method ^B |
|---------------------------------------|-----|--------------------|-------------------------------|
| COMPOSITION | | | |
| Acidity, total mg KOH/g | Max | 0.015 | D3242 |
| VOLATILITY | | | |
| Simulated Distillation | | | D2887 ^C |
| Distillation temperature, °C: | | | |
| 10 % recovered, temperature (T10) | Max | 205 | |
| 50 % recovered, temperature (T50) | | report | |
| 90 % recovered, temperature (T90) | | report | |
| Final boiling point, temperature | Max | 300 | |
| T90-T10, °C | Min | 22 | |
| Flash point, °C | Min | 38 ^D | D56 or D3828 ^E |
| Density at 15°C, kg/m ³ | | 730 to 770 | D1298 or D4052 |
| Freezing point, °C | Max | -40 | D5972, D7153, D7154, or D2386 |
| 2.5 h at control temperature | | | |
| Temperature, °C | Min | 325 ^F | D3241 |
| Filter pressure drop, mm Hg | Max | 25 ^G | |
| Tube deposit rating less than | | 3 ^H | |
| No peacock or abnormal color deposits | | | |
| ADDITIVES | | | |
| Antioxidants, mg/L ^I | Min | 17 | |
| | Max | 24 | |

^A For compliance of test results against the requirements of Table A1.1, see 7.3.

^B The test methods indicated in this table are referred to in A1.5.2.

^C Distillation property criteria are specified in D86 scale units. D2887 results shall be converted to estimated D86 results by application of the correlation in Appendix X5 of D2887 for comparison with the specified property criteria. Distillation residue and loss limits provide control of the distillation process during the D86 test method and do not apply to D2887. Distillation residue and loss shall be reported as "not applicable" (N/A) when reporting D2887 results.

^D A higher or lower minimum flash point specification may be agreed upon between purchaser and supplier. When the agreed flash point is less than 38°C then the product shall not be known as SPK or as kerosene, but may be used as an Annex A1 blending component at the point of manufacture.

^E Results obtained by Test Methods D3828 may 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 will apply.

^F Control temperature of 325°C is specified to provide a recurring, batch-by-batch verification of process stability and compositional consistency.

^G Preferred SI units are 3.3 kPa, max.

^H Tube deposit ratings shall always be reported by the Visual Method.

^I Antioxidant shall be added to the bulk product prior to movements or operations that will significantly expose the product to air and in such a way as to ensure adequate mixing. This shall be done as soon as practicable after hydroprocessing or fractionation to prevent peroxidation and gum formation after manufacture. In-line injection and tank blenders are considered acceptable methods for ensuring adequate mixing.

<https://standards.iteh.ai/catalog/standards/sist/b63e16b6-c320-4ee6-af88-ccaa8ab08c56/astm-d7566-10a>

TABLE A1.2 Other Detailed Requirements; Hydroprocessed SPK^A

| Property | | Hydroprocessed SPK | ASTM Test Method ^B |
|--|-----|--------------------|-------------------------------|
| Hydrocarbon Composition | | | |
| Cycloparaffins, mass % | Max | 15 ^C | D2425 |
| Aromatics, mass % | Max | 0.5 | D2425 |
| Paraffins, mass % | | report | D2425 |
| Carbon and Hydrogen, mass% | Min | 99.5 | D5291 |
| Non-hydrocarbon Composition | | | |
| Nitrogen, mg/kg | Max | 2 | D4629 |
| Water, mg/kg | Max | 75 | D6304 |
| Sulfur, mg/kg | Max | 15 | D5453 |
| Sulfur, mass % | Max | 0.0015 | D2622 |
| Sulfur, mg/kg | Max | 15 | D2622 |
| Metals | | | |
| (Al, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Pd, Pt, Sn, Sr, Ti, V, Zn), mg/kg | Max | 0.1 per metal | UOP 389 |
| (Al, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Pd, Pt, Sn, Sr, Ti, V, Zn), mg/kg | Max | 0.1 per metal | UOP 389 |
| Halogens, mg/kg | Max | 1 | D7359 |

^A For compliance of test results against the requirements of Table A1.2, see 7.3.

^B The test methods indicated in this table are referred to in A1.6.2.

^C Maximum cycloparaffin composition is based on current experience with the approved synthetic fuels and is within the range of what is typical for refined jet fuel.

APPENDIXES

(Nonmandatory Information)

X1. PERFORMANCE CHARACTERISTICS OF AVIATION TURBINE FUELS

X1.1 Introduction

X1.1.1 This appendix describes the performance characteristics of aviation turbine fuels. A more detailed discussion of the individual test methods and their significance is found in ASTM Manual No. 1.¹² Additional information on aviation turbine fuel and its properties is found in ASTM's MNL 37, *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing*¹³ and the *Handbook of Aviation Fuel Properties*.¹⁴

X1.2 Significance and Use

X1.2.1 Specification D7566 defines two grades of jet fuel for civil use. Limiting values for the two grades of fuel covered are placed on fuel properties believed to be related to the performance of the aircraft and engines in which they are most commonly used.

X1.2.2 The safe and economical operation of aircraft requires fuel that is essentially clean and dry and free of any contamination prior to use. It is possible to measure a number of jet fuel characteristics related to quality.

X1.2.3 The significance of standard tests for fuel properties may be summarized for convenience in terms of the technical relationships with performance characteristics as shown in Table X1.1.

X1.2.4 The acceptability of additives for use is determined by the engine and aircraft type certificate holder and must be approved by his certifying authority. In the United States of America, the certifying authority is the Federal Aviation Administration.

X1.3 Thermal Stability

X1.3.1 Stability to oxidation and polymerization at the operating temperatures encountered in certain jet aircraft is an important performance requirement. The thermal stability measurements are related to the amount of deposits formed in the engine fuel system on heating the fuel in a jet aircraft. Commercial jet fuels should be thermally stable at a fuel temperature as high as 163°C (325°F). Such fuels have been demonstrated to have inherent storage stability.

X1.3.2 In 1973, Test Method D3241 replaced Method of Test D1660, known as the ASTM Coker, for the determination of oxidative thermal stability. (See CRC Report 450, dated 1969 and revised in 1972. See also Bert and Painter's SAE paper

¹² *Manual on Significance of Tests for Petroleum Products*, MNL 1, ASTM International, 2003.

¹³ MNL 37, *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing*, Eds., Totten, George E., Westbrook, Steven R., and Shah, Rajesh J., ASTM International, W. Conshohocken, PA, 2003.

¹⁴ *Handbook of Aviation Fuel Properties*, Third Edition, CRC Report 635, Coordinating Research Council, Atlanta, GA, 2004.

TABLE X1.1 Performance Characteristics of Aviation Turbine Fuels

| Performance Characteristics | Test Method | Sections |
|--|--|-----------|
| Engine fuel system deposits and coke | Thermal stability | X1.3 |
| | Smoke point | X1.4.2.1 |
| Combustion properties | Aromatics | X1.4.2.2 |
| | Percent naphthalenes | X1.4.2.3 |
| | Density | X1.5.1 |
| Fuel metering and aircraft range | Net heat of combustion | X1.5.2 |
| | Distillation | X1.6.1 |
| Fuel atomization | Viscosity | X1.6.2 |
| | Freezing point | X1.7.1 |
| Fluidity at low temperature | Mercaptan sulfur | X1.8.1 |
| | Sulfur | X1.8.2 |
| Compatibility with elastomer and the metals in the fuel system and turbine | Copper strip corrosion | X1.8.3 |
| | Acidity | X1.8.4 |
| | Existent gum | X1.9.1 |
| | Flash point | X1.11.1 |
| Fuel storage stability | Static Electricity | X1.11.2 |
| | Water separation characteristics | X1.13.2 |
| Fuel handling | Free water and particulate contamination | X1.12.3 |
| | Particulate matter | X1.12.4 |
| | Membrane color ratings | X1.12.4.1 |
| | Undissolved water | X1.12.2 |
| | Fuel lubricity | X1.10 |
| | Additives | X1.15.1 |
| | Sample containers | X1.15.3 |
| Fuel lubricating ability (lubricity) | | |
| Miscellaneous | | |