Designation: D3699 – 13b$^{\varepsilon 1}$

Standard Specification for Kerosine[1]

This standard is issued under the fixed designation D3699; 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.

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

ε[1] NOTE—Subsection X1.1.1 was corrected editorially in February 2015.

1. Scope*

1.1 This specification covers two grades of kerosine suitable for use in critical kerosine burner applications:

1.1.1 *No. 1-K*—A special low-sulfur grade kerosine suitable for use in nonflue-connected kerosine burner appliances and for use in wick-fed illuminating lamps.

1.1.2 *No. 2-K*—A regular grade kerosine suitable for use in flue-connected burner appliances and for use in wick-fed illuminating lamps.

1.2 This specification is intended for use in purchasing, as a reference for industry and governmental standardization, and as a source of technical information.

1.3 This specification, unless otherwise provided by agreement between the purchaser and the supplier, prescribes the required properties of kerosine at the time and place of custody transfer.

NOTE 1—The generation and dissipation of static electricity can create problems in the handling of kerosines. For more information on the subject, see Guide D4865.

1.4 Nothing in this specification shall preclude observance of federal, state, or local regulations which can be more restrictive.

1.5 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]

D56 Test Method for Flash Point by Tag Closed Cup Tester

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

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

D187 Test Method for Burning Quality of Kerosine

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)

D2386 Test Method for Freezing Point of Aviation Fuels

D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

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)

D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester

D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry

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)

D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

D5901 Test Method for Freezing Point of Aviation Fuels (Automated Optical Method) (Withdrawn 2010)[3]

D5972 Test Method for Freezing Point of Aviation Fuels (Automatic Phase Transition Method)

D6469 Guide for Microbial Contamination in Fuels and Fuel Systems

[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.E0 on Burner, Diesel, Non-Aviation Gas Turbine, and Marine 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.

[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**

TABLE 1 Detailed Requirements for Kerosine

Property	ASTM Test Method	Limit[A]
Flash Point °C, min	D56	38
Distillation temperature, °C	D86	
10 % volume recovered, max		205
Final boiling point, max		300
Kinematic viscosity at 40°C, mm^2/s	D445	
min		1.0
max		1.9
Sulfur, % mass	D2622	
No. 1-K, max		0.04
No. 2-K, max		0.30
Mercaptan sulfur, % mass, max[B]	D3227	0.003
Copper strip corrosion rating max, 3 h at 100°C	D130	No. 3
Freezing point, °C, max	D2386	–30
Burn Quality		
Time of Burning	D187	Minimum 16 h continuous after first weighing
Rate of Burning	IP 10	18 to 26 g/h after first weighing
Chimney Appearance	D187	Maximum light white deposit (at end of test)
Flame Characteristics (comparison of properties from beginning and end of test)	D187	Maximum variance of flame width – 6 mm Maximum variance of flame height lowered – 5 mm
Saybolt color, min	D156	+16[C]

[A] To meet special operating conditions, modifications of individual limiting requirements, except sulfur, can be agreed upon among purchaser, seller and manufacturer.
[B] The Mercaptan sulfur determination can be waived if the fuel is considered sweet by Test Method D4952.
[C] Appendixes X1.1 and X1.12 contain additional information on color, red dye, and potential application problems.

D7094 Test Method for Flash Point by Modified Continuously Closed Cup (MCCCFP) Tester
D7220 Test Method for Sulfur in Automotive, Heating, and Jet Fuels by Monochromatic Energy Dispersive X-ray Fluorescence Spectrometry

2.2 *Energy Institute Standard:*[4]
IP 10 Burning Test—24 Hour, Standard Methods for Analysis and Testing of Petroleum and Related Products, Vol 1

2.3 *Other Documents:*[5]
26 CFR Part 48 Diesel Fuel Excise Tax; Dye, Color, and Concentration

3. General Requirements

3.1 Kerosine shall be a refined petroleum distillate consisting of a homogeneous mixture of hydrocarbons essentially free of water, inorganic acidic or basic compounds, and excessive amounts of particulate contaminants. Additive usage can be established by mutual agreement of the supplier and the purchaser.

4. Detailed Requirements

4.1 The kerosine shall conform to the detailed requirements prescribed in Table 1.

4.2 The kerosine shall conform to the following requirements when tested for burning quality as specified:

4.2.1 *Time of Burning*—A minimum of 16 h continuous burning after the first weighing shall be required.

4.2.2 *Rate of Burning*—After the first weighing, the rate of burning shall be 18 to 26 g/h with Test Method IP 10.

4.2.3 *Appearance of Chimney at End of Tests*—The chimney shall have no more than a light, white deposit.

4.2.4 *Flame Characteristics at End of Test*—At the end of test, the width of the flame shall not vary by more than 6 mm, and the height of the flame shall not have lowered by more than 5 mm from the respective measurements recorded at the start of the test.

NOTE 2—The significance of ASTM specifications for kerosine is discussed in Appendix X1.

5. Test Methods

5.1 The requirements enumerated in this specification shall be determined in accordance with the following ASTM methods except as noted.

5.1.1 *Flash Point*—Test Method D56, except where other methods are prescribed by law. Test Method D3828 and D7094 may be used as an alternative with the same limits. In case of a dispute, Test Method D56 shall be used as the referee method.

5.1.2 *Distillation*—Distillation shall be determined in accordance with Test Methods D86 or D2887. Results from Test Method D2887 shall be reported as "Predicted D86" results by application of the correlation in Appendix X5 of Test Method D2887 to convert the values. In case of dispute, Test Method D86 shall be used as the referee test method.[6]

5.1.3 *Viscosity*—Test Method D445.

5.1.4 *Sulfur*—Test Method D2622. Test Methods D1266, D4294, or D5453 may also be used. Alternatively, Test Method D7220 may be used if the sulfur result is less than 942 mg/kg or 0.094 mass %. In case of a dispute, Test Method D2622 is the referee sulfur test method for this specification.

[4] Available from Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K.
[5] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1553.

5.1.5 *Mercaptan Sulfur*—Test Method D3227.

5.1.6 *Copper Strip Corrosion*—Test Method D130, 3 h test at 100°C.

5.1.7 *Freezing Point*—Test Method D2386. Automatic Test Methods D5901 and D5972 can be used as alternates with the same limits. In case of a dispute, Test Method D2386 shall be used as referee.

5.1.8 *Burning Quality*—Test Method D187.

5.1.9 *Saybolt Color*—Test Method D156.

6. Keywords

6.1 fuel oil; kerosine; petroleum and petroleum products

APPENDIX

(Nonmandatory Information)

X1. SIGNIFICANCE OF STANDARD SPECIFICATIONS FOR KEROSINE

X1.1 Color—An indication of the overall purity of the product, and is a useful parameter in ensuring the freedom from trace contamination with heavier products which may render the kerosine to be unsuitable for designated critical applications. Kerosine that is subjected to long term storage, excessive heat, or both, particularly in summer storage in above ground tanks, can become unsuitable for use due to degradation and associated loss of Saybolt Color quality. Some contaminants can adversely affect the performance of kerosine, particularly in wick-fed, unvented applications like 1-K space heaters. Detection of these contaminants may require additional testing, such as sulfur content or distillation. Unless gross contamination is present, these tests may not readily identify the presence of contamination.

X1.1.1 *Red Dye*—Kerosine sold exempt from federal motor fuel excise tax sold from terminals may contain the dye Solvent Red 164 at a concentration spectrally equivalent to at least 3.9 lb of the solid dye standard Solvent Red 164 per thousand barrels of kerosine, where required in the United States of America (for example, by 26 CFR Part 48). If clear, undyed fuel is desired for tax-exempt applications, the Internal Revenue Service has provided other options, such as blocked pumps, for consideration. The addition of red dye makes it more difficult to detect contamination by visual inspection. Kerosine subjected to dying must meet the minimum Saybolt Color of +16 prior to the introduction of red dye.

X1.2 *Mercaptan Sulfur*—Mercaptans are limited to preclude undesirable side-reactions and to minimize the unpleasant odor.

X1.3 *Doctor Test*—The doctor test is an indirect indication of Mercaptan levels.

X1.4 *Sulfur*—Limited sulfur content of kerosine may be required for special uses or to meet legal requirements for sulfur dioxide emissions.

X1.5 *Distillation* —An indication of the volatility of a fuel. The maximum 10 % and final boiling point limits specified establish a suitable boiling range to readily vaporize the kerosine in normal applications.

X1.6 *Flash Point*—The flash point of kerosine is used primarily as an index of fire hazards. The minimum permissible flash point is usually regulated by federal, state, or municipal laws and is based on accepted practice in handling and use.

X1.7 *Freezing Point*—The temperature at which crystals of hydrocarbons formed on cooling disappear when the temperature of the fuel is allowed to rise. The waxy crystals may clog the wick in wick-fed systems and can block filter passages in fuel handling systems.

X1.8 *Viscosity* —The measure of internal resistance to flow, and an indication of flowability and lubricity.

X1.9 *Burning Quality*—An indication of the kerosine performance in critical applications. The inherent burning quality potential of the bulk fuel, as determined by conventional parameters such as smoke point, luminometer number, or hydrogen content, cannot always be fully realized due to the adverse overriding effect of trace quantities of certain sulfur, oxygen, or nitrogen compounds that can be present in some kerosines. Thus, the burning quality of kerosine must be evaluated by designation of a suitable bench-type burning test.

X1.9.1 Burning tests are essentially performance tests and are a direct method for determining the quality of the kerosines for the specific purpose for which they are intended. However, it is not possible to make tests in all kinds of commercial equipment, or under all the combinations of such factors as location, time, temperature, humidity, air currents, and cleanliness. These difficulties are partially overcome by selecting equipment for the burning test that is known to be severe (Test Method D187), and by extending the test beyond the typical time interval between cleanings of the lamp in its usual service.

X1.9.2 The most important features in Test Method D187 are the shape and size of the flame. Changes in flame size or shape are generally caused by changes in the portion of the wick adjacent to the flame. Some wick crusts are *bushy* and increase flame size; others tend to enclose the surface of the wick and cause flame shrinkage. The worst type of deposit is an irregular one, sometimes localized as mushroom formations, that produces a distorted flame and usually causes smoking, which is quite objectionable to the user.

X1.9.3 The condition of the chimney at the end of the burning test is also important. Illuminating kerosine should not

cause objectionable smoke deposit on the chimney. An appreciable black sooty deposit is obviously objectionable, but the operator must always assure himself that it is not caused by drafts or improper testing techniques. A heavy whitish deposit nearly always forms when a new chimney is put into service.

X1.10 *Corrosion* —An indication of the tendency to corrode copper and copper-alloy components that may be present in the kerosine handling and burner systems.

X1.11 *Microbial Contamination*—Refer to Guide D6469 for a discussion of this form of contamination.

X1.12 Potential Application Concerns

X1.12.1 *Red Dye*—It is recommended that 1-K kerosine used in unvented, wick-fed applications like space heaters be clear and undyed. Red dye can mask the presence of contaminants like diesel. Some of these contaminants may adversely affect the performance of unvented, wick-fed space heaters. Elevated sulfur content, higher aromatics, and olefin content, associated with diesel contamination, are known to increase performance problems with wick-fed, unvented applications and can be detrimental to health. Additionally, insufficient health testing on red-dyed 1-K for use in unvented, wick-fed applications, like 1-K space heaters, has also resulted in a recommendation for the exclusion of red-dyed 1-K usage at this time. Once additional testing is conducted, a review will be made and reconsideration given to red-dyed 1-K.

X1.12.2 *Other Additives and Potential Blending Components*—Through field experiences and laboratory data, it has been demonstrated that certain additives or non-kerosine blending components, or both, can negatively impact burn quality performance in unvented, wick-fed space heaters. Negative performances have been observed in wick-fed applications when 1–K kerosine contains nitrate-containing cetane improvers at 500 wppm or higher, contains certain lubricity additives at 5000 wppm or higher, and when biodiesel is blended at 20 vol% or higher. The listing of these materials and their respective treat/blend rates is not intended to imply that lower levels of these materials, or other additives, or non-kerosine blending components, or a combination thereof, are acceptable in wick-fed applications. It is recommended that kerosine used in wick-fed applications be free of additives and blending components that can alter burning quality in a negative manner.

SUMMARY OF CHANGES

Subcommittee D02.E0 has identified the location of selected changes to this standard since the last issue (D3699 – 13a) that may impact the use of this standard. (Approved Nov. 15, 2013.)

(1) An alternative test method (D7094) for the determination of flash point was added to Sections 2 and 5.1.1.

Subcommittee D02.E0 has identified the location of selected changes to this standard since the last issue (D3699 – 13) that may impact the use of this standard. (Approved June 15, 2013.)

(1) Modified Table 1 to replace Test Method D1266 with Test Method D2622 as the sulfur method listed in the table.
(2) Modified 5.1.4, Sulfur, to list Test Method D2622 as the referee and make Test Method D1266 as an alternative sulfur test method.

Subcommittee D02.E0 has identified the location of selected changes to this standard since the last issue (D3699 – 08) that may impact the use of this standard. (Approved May 1, 2013.)

(1) An alternative test method (D7220) for the determination of sulfur was added to Section 2 and 5.1.4.