Designation: ~~D396 – 17a~~ D396 – 18

Standard Specification for Fuel Oils[1]

This standard is issued under the fixed designation D396; 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.

1. Scope*

1.1 This specification (see Note 1) covers grades of fuel oil intended for use in various types of fuel-oil-burning equipment under various climatic and operating conditions. These grades are described as follows:

1.1.1 Grades No. 1 S5000, No. 1 S500, No. 1 S15, No. 2 S5000, No. 2 S500, and No. 2 S15 are middle distillate fuels for use in domestic and small industrial burners. Grades No. 1 S5000, No. 1 S500, and No. 1 S15 are particularly adapted to vaporizing type burners or where storage conditions require low pour point fuel.

1.1.2 Grades B6–B20 S5000, B6–B20 S500, and B6–B20 S15 are middle distillate fuel/biodiesel blends for use in domestic and small industrial burners.

1.1.3 Grades No. 4 (Light) and No. 4 are heavy distillate fuels or middle distillate/residual fuel blends used in commercial/industrial burners equipped for this viscosity range.

1.1.4 Grades No. 5 (Light), No. 5 (Heavy), and No. 6 are residual fuels of increasing viscosity and boiling range, used in industrial burners. Preheating is usually required for handling and proper atomization.

NOTE 1—For information on the significance of the terminology and test methods used in this specification, see Appendix X1.
NOTE 2—A more detailed description of the grades of fuel oils is given in X1.3.

1.2 This specification is for the use of purchasing agencies in formulating specifications to be included in contracts for purchases of fuel oils and for the guidance of consumers of fuel oils in the selection of the grades most suitable for their needs.

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

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

1.4.1 Non-SI units are provided in Table 1 and in 7.1.2.1/7.1.2.2 because these are common units used in the industry.

NOTE 3—The generation and dissipation of static electricity can create problems in the handling of distillate burner fuel oils. For more information on the subject, see Guide D4865.

1.5 *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:*[2]

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
D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
D97 Test Method for Pour Point of Petroleum Products
D129 Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method)
D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
D473 Test Method for Sediment in Crude Oils and Fuel Oils by the Extraction Method

[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.

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

TABLE 1 Detailed Requirements for Fuel Oils[A,B]

Property	ASTM Test Method[C]	No. 1 S15[C]	No. 1 S500[C]	No. 1 S5000[C]	No. 2 S15[C]	No. 2 S500[C]	No. 2 S5000[C]	B6–B20 S15[C]	B6–B20 S500[C]	B6–B20 S5000[C]	No. 4 (Light)[C]	No. 4	No. 5 (Light)	No. 5 (Heavy)	No. 6
Flash Point, °C, min	D93 – Proc. A	38	38	38	38	38	38	38	38	38	38	...	...	...	...
	D93 – Proc. B	...	...	...	...	...	...	...	...	...	...	55	55	55	60
Water and sediment, percent by volume, max	D2709	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	...	...	...	...	...
	D95 + D473	...	...	...	...	...	...	...	...	...	(0.50)[D]	(0.50)[D]	(1.00)[D]	(1.00)[D]	(2.00)[D]
Distillation Temperature, °C	D86														
10 % volume recovered, max		215	215	215	...	...	...	...	...	...					
90 % volume recovered, min		...	...	...	282	282	282	282	282	282					
90 % volume recovered, max		288	288	288	338	338	338	343	343	343					
Kinematic viscosity at 40 °C, mm^2/s	D445														
min		1.3	1.3	1.3	1.9	1.9	1.9	1.3	1.3	1.3	1.9	>5.5	...	...	...
max		2.4	2.4	2.4	4.1	4.1	4.1	4.1	4.1	4.1	5.5	24.0[E]			
Kinematic viscosity at 100 °C, mm^2/s	D445														
min		...	...	...	...	...	...	...	...	...	...	...	5.0	9.0	15.0
max		...	...	...	...	...	...	...	...	...	...	...	8.9[E]	14.9[E]	50.0[E]
Ramsbottom carbon residue on 10 % distillation residue percent by mass, max	D524	0.15	0.15	0.15	0.35	0.35	0.35	0.35	0.35	0.35	...	...	...	...	...
Ash, percent by mass, max	D482	...	...	...	...	...	...	...	...	...	0.05	0.10	0.15	0.15	...
Sulfur, percent by mass max[F]	D2622	...	0.05	0.5	...	0.05	0.5	...	0.05	0.5					
	D5453	0.0015	...	...	0.0015	...	...	0.0015	...	...					
Lubricity, HFRR @ 60 °C, micron, max	D6079/D7688	520	520	520	520	520	520	520[K]	520[K]	520[K]					
Copper strip corrosion rating, max, 3 h at a minimum control temperature of 50 °C	D130	No. 3	No. 3	No. 3	No. 3	No. 3	No. 3	No.3	No. 3	No. 3	...	...	...	...	...
Density at 15 °C, kg/m^3	D1298														
min		...	...	...	...	...	...	...	...	...	>876[G]	...	...	...	...
max		850	850	850	876	876	876	876	876	876	...	...	...	...	...
Pour Point °C, max[H]	D97	–18	–18	–18	–6	–6	–6	–6	–6	–6	–6	–6	...	...	[I]
Oxidation Stability, hours, min	EN 15751	...	...	...	...	...	...	6	6	6					
Acid Number, mg KOH/g, max	D664	...	...	...	...	...	...	0.3	0.3	0.3					
Biodiesel Content, percent (V/V)[J]	D7371	...	...	...	...	...	...	6 – 20.	6 – 20.	6 – 20.	...				
Conductivity (pS/m) or Conductivity Units (C.U.), min	D2624/D4308	25[L]	25[L]	25[L]	25[L]	25[L]	25[L]	25[L]	25[L]	25[L]					

[A] It is the intent of these classifications that failure to meet any requirement of a given grade does not automatically place an oil in the next lower grade unless in fact it meets all requirements of the lower grade. However, to meet special operating conditions, modifications of individual limiting requirements may be agreed upon among the purchaser, seller, and manufacturer.

[B] Refer to 7.1.2.1 for Low Temperature guidance for <1000 gal outside or unheated storage containers for the United States.

[C] Under United States regulations, Grades No. 1 S5000, No. 1 S500, No. 1 S15, No. 2 S5000, No. 2 S500, No. 2 S15, B6–B20 S5000, B6–B20 S500, B6–B20 S15, and No. 4 (Light) are required by 40 CFR Part 80 to contain a sufficient amount of the dye Solvent Red 164 so its presence is visually apparent. At or beyond terminal storage tanks, they are required by 26 CFR Part 48 to contain the dye Solvent Red 164 at a concentration spectrally equivalent to at least 3.9 lb of the solid dye standard Solvent Red 26 per thousand barrels of fuel oil.

[D] The amount of water by distillation by Test Method D95 plus the sediment by extraction by Test Method D473 shall not exceed the value shown in the table. For Grade No. 6 fuel oil, the amount of sediment by extraction shall not exceed 0.50 % by mass, and a deduction in quantity shall be made for all water and sediment in excess of 1.0 % by mass.

[E] Where low sulfur fuel oil is required, fuel oil falling in the viscosity range of a lower numbered grade down to and including No. 4 can be supplied by agreement between the purchaser and supplier. The viscosity range of the initial shipment shall be identified and advance notice shall be required when changing from one viscosity range to another. This notice shall be in sufficient time to permit the user to make the necessary adjustments.

[F] Other sulfur limits may apply in selected areas in the United States and in other countries.

[G] This limit ensures a minimum heating value and also prevents misrepresentation and misapplication of this product as Grade No. 2.

[H] Lower or higher pour points can be specified whenever required by conditions of storage or use. When a pour point less than –18 °C is specified, the minimum viscosity at 40 °C for grade No. 2 shall be 1.7 mm^2/s and the minimum 90 % recovered temperature shall be waived.

[I] Where low sulfur fuel oil is required, Grade No. 6 fuel oil will be classified as Low Pour (+15 °C max) or High Pour (no max). Low Pour fuel oil should be used unless tanks and lines are heated.

[J] See subsection 4.3.1.3 on biodiesel content for grades other than B6–B20.

[K] If the fuel oil is qualified under Table 1 of Specification D396 for lubricity, it is not necessary to measure the lubricity of the blend because the lubricity of the individual blend components will be less than 520 µm so the resulting blend will also be less than 520 µm.

[L] The electrical conductivity of the fuel oil is measured at the time and temperature of the fuel at delivery. The 25 pS/m minimum conductivity requirement applies at all instances of high velocity transfer (7 m/s) but sometimes lower velocities, (see 8.1 for detailed requirements) into mobile transport (for example, tanker trucks, rail cars, and barges).

D482 Test Method for Ash from Petroleum Products
D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
D975 Specification for Diesel Fuel Oils
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
D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)
D2500 Test Method for Cloud Point of Petroleum Products and Liquid 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
D2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge
D2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
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
D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
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
D4308 Test Method for Electrical Conductivity of Liquid Hydrocarbons by Precision Meter
D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
D5842 Practice for Sampling and Handling of Fuels for Volatility Measurement
D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
D5949 Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)
D5950 Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)
D5985 Test Method for Pour Point of Petroleum Products (Rotational Method)
D6079 Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)
D6469 Guide for Microbial Contamination in Fuels and Fuel Systems
D6749 Test Method for Pour Point of Petroleum Products (Automatic Air Pressure Method)
D6751 Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels
D6892 Test Method for Pour Point of Petroleum Products (Robotic Tilt Method)
D7039 Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
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
D7344 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Mini Method)
D7345 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Micro Distillation Method)
D7346 Test Method for No Flow Point and Pour Point of Petroleum Products and Liquid Fuels
D7371 Test Method for Determination of Biodiesel (Fatty Acid Methyl Esters) Content in Diesel Fuel Oil Using Mid Infrared Spectroscopy (FTIR-ATR-PLS Method)
D7688 Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR) by Visual Observation
D7861 Test Method for Determination of Fatty Acid Methyl Esters (FAME) in Diesel Fuel by Linear Variable Filter (LVF) Array Based Mid-Infrared Spectroscopy
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *Other Documents:*
26 CFR Part 48 Diesel Fuel Excise Tax; Dye Color and Concentration[3]
40 CFR Part 80 Regulation of Fuel and Fuel Additives[3]
EN 14078 Determination of Fatty Acid Methyl Ester (FAME) Content in Middle Distillates — Infrared Spectrometry Method[4]
EN 15751 Automotive Fuels—Fatty Acid Methyl Ester (FAME) Fuel and Blends with Diesel Fuel—Determination of Oxidation Stability by Accelerated Oxidation Method[4]

3. Terminology

3.1 *Definitions:*
3.1.1 *additive, n—in fuel oils*, a substance added to fuel oil at a blend level not greater than 1 % by volume of the finished fuel.

[3] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.
[4] Available from the National CEN members listed on the CEN website (www.cenorm.be) or from the CEN/TC 19 Secretariat (astm@nen.nl).

3.1.1.1 *Discussion—*

Additives are generally included in finished fuel oil to enhance performance properties (for example, stability, pour point, and so forth)

3.1.1.2 *Discussion—*

Additives that contain hydrocarbon oil blended with other substances may exclude the hydrocarbon oil portion for determination of the volume percent of the finished fuel.

3.1.1.3 *Discussion—*

Triglycerides (for example, vegetable oils, animal fats, greases, and so forth) have been found to cause fouling of fuel oil burning equipment, and triglycerides are therefore not allowed as additives or components of additives.

3.1.2 *alternative blendstock, n—in fuel oils*, a non-hydrocarbon oil substance added to fuel oil at blend levels greater than 1 % by volume of the finished fuel.

3.1.2.1 *Discussion—*

An alternative blendstock should normally have an industry consensus standard or an annex in this specification that defines its physical and chemical properties.

3.1.2.2 *Discussion—*

See Appendix X3 for guidance regarding new materials for No. 1 and No. 2 grades of fuel oils.

3.1.3 *biodiesel, n*—fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100.

3.1.4 *biodiesel blend (BXX), n*—blend of biodiesel fuel with fuel oils.

3.1.4.1 *Discussion—*

In the abbreviation BXX, the XX represents the volume percentage of biodiesel fuel in the blend.

3.1.5 *hydrocarbon oil, n*—a homogeneous mixture with elemental composition primarily of carbon and hydrogen that may also contain sulfur, oxygen, or nitrogen from residual impurities and contaminants associated with the fuel's raw materials and manufacturing processes and excluding added oxygenated materials.

3.1.5.1 *Discussion—*

Neither macro nor micro emulsions are included in this definition since neither are homogeneous mixtures.

3.1.5.2 *Discussion—*

Examples of excluded oxygenated materials are alcohols, esters, ethers, and triglycerides.

3.1.5.3 *Discussion—*

The hydrocarbon oil may be manufactured from a variety of raw materials, for example, petroleum (crude oil), oil sands, natural gas, coal, and biomass. Appendix X3 discusses some matters for consideration regarding the use of fuel oils from feedstocks other than petroleum.

3.1.6 *S(numerical specification maximum), n*—indicates the maximum sulfur content in µg/g (ppm by mass) allowed by this specification in a fuel.

3.1.6.1 *Discussion—*

Of the fourteen fuel oil grades specified in this specification, nine have important distinguishing maximum sulfur regulatory requirements: Grades No. 1 S5000, No. 1 S500, No. 1 S15; No. 2 S5000, No. 2 S500, and No. 2 S15; B6-B20 S5000, B6-B20 S500, and B6-B20 S15. The remaining grades are distinguished from these grades by other major properties in addition to sulfur (unregulated maximum), and therefore are not included in this designation system.

4. General Requirements

4.1 The grades of fuel oil specified herein shall be hydrocarbon oils, except as provided in 4.3, free from inorganic acid, and free from excessive amounts of solid or fibrous foreign matter. The inclusion of additives to enhance performance properties, if required, is allowed.

NOTE 4—Additives are generally included in finished fuel oil to improve performance properties (stability, pour point, and so forth).

4.2 All grades containing residual components shall remain uniform in normal storage and not separate by gravity into light and heavy oil components outside the viscosity limits for the grade.

4.3 *Alternative Blendstocks:*

4.3.1 *Fuels Blended with Biodiesel*—The detailed requirements for fuels blended with biodiesel shall be as follows:

4.3.1.1 *Biodiesel for Blending*—If biodiesel is a component of any fuel oil, the biodiesel shall meet the requirements of Specification D6751.

4.3.1.2 The remainder of the fuel oil shall be fuel oil conforming to Specification D396 Grades No. 1 or No. 2 of any sulfur level specified, with the exception that fuel oil whose sulfur level falls outside of Specification D396 may be blended with biodiesel meeting Specification D6751, provided the finished mixture meets this specification.

4.3.1.3 Fuel oil containing up to 5 % by volume biodiesel shall meet the requirements for the appropriate grade No. 1 or No. 2 fuel as listed in Table 1.

4.3.1.4 Fuel oil containing 6 % to 20 % by volume biodiesel shall meet the requirements for the appropriate grade B6 to B20 as listed in Table 1.

4.3.1.5 Test Methods D7371, D7861, and EN 14078 may be used for determination of the percent by volume biodiesel in a biodiesel blend. In cases of dispute, Test Method D7371 shall be the referee test method. See Practice E29 for guidance on significant digits.

4.3.1.6 Fuel oils containing more than 20 % by volume biodiesel component are not included in this specification.

4.3.1.7 Biodiesel blends with Grades 4, 5, or 6 are not covered by this specification.

5. Detailed Requirements

5.1 The various grades of fuel oil shall conform to the limiting requirements shown in Table 1. A representative sample shall be taken for testing in accordance with Practice D4057.

5.2 Modifications of limiting requirements to meet special operating conditions agreed upon between the purchaser, the seller, and the supplier shall fall within limits specified for each grade, except as stated in supplementary footnotes for Table 1.

6. Sampling, Containers, and Sample Handling

6.1 The reader is strongly advised to review all intended test methods prior to sampling in order to understand the importance and effects of sampling technique, proper containers, and special handling required for each test method.

6.2 Correct sampling procedures are critical to obtaining a sample representative of the fuel oil to be tested. Refer to X1.4 for recommendations. The recommended procedures or practices provide techniques useful in the proper sampling or handling of fuels oils.

7. Test Methods

7.1 The requirements enumerated in this specification shall be determined in accordance with the following ASTM test methods,[5] except as may be required under 7.1.1.

7.1.1 *Flash Point*—Test Method D93 (Procedure A) for Grades No. 1 S5000, No. 1 S500, No. 2 S5000, No. 2 S500, and No. 4 (Light), and Test Method D93 (Procedure B) for Grades No. 4, No. 5 (Light), No. 5 (Heavy), and No. 6, except where other methods are prescribed by law. For Grades No. 1 S5000, No. 1 S500, No. 2 S5000, No. 2 S500, and No. 4 (Light), Test Methods D3828 and D7094 may be used as an alternative with the same limits. For Grades No. 1, No. 1 Low Sulfur, No. 2, and No. 2 Low Sulfur, Test Method D56 may be used as an alternative with the same limits, provided the flash point is below 93 °C and the viscosity is below 5.5 mm^2/s at 40 °C. This test method will give slightly lower values. In cases of dispute, Test Method D93, with the appropriate procedure, shall be used as the referee method.

7.1.2 *Pour Point*—Test Method D97. For all grades, the automatic Test Methods D5949, D5950, D5985, D6749, D6892, and D7346 may be used as alternatives with the same limits. In case of dispute, Test Method D97 shall be used as the referee method. Alternative test methods that indicate flow point properties can be used for low sulfur residual fuels by agreement between purchaser and supplier.

7.1.2.1 The maximum Pour Point limits specified in Table 1 should be adequate under most circumstances for shipment and use of Fuel Oil from April through September and in operations year round where larger storage tanks (>1000 gal) are in use and appropriate consideration has been given to operating conditions as described in X2.1.2.

7.1.2.2 Table 2 lists 10th percentile ambient temperatures as guidance for smaller Fuel Oil storage conditions (<1000 gal in outside or unheated storage) in the United States (see X2.1.3, Current Practices). Appropriate low temperature operability properties should be agreed upon between the fuel supplier and purchaser for the intended use and expected ambient temperatures. The 10th percentile ambient temperatures are divided by month (October through March) and by state or by specific portion of a state. Smaller storage containers are commonly used and stored outside in home heating oil applications (275 gal and 550 gal outside storage tanks are typical).

7.1.2.3 The low temperature recommendations discussed in X2.1.3 may be met by Test Method D2500 Cloud Point (or an approved alternative test method) or by Test Method D97 Pour Point (or an approved alternative test method). If Pour Point is used then the difference between the Cloud Point and the Low Temperature guidance found in Table 2 should not exceed 10 °C.

7.1.3 *Water and Sediment*—The water and sediment in Grade No. 1 S500, No. 1 S5000, No. 2 S500, and No. 2 S5000 shall be determined in accordance with Test Method D2709 and in Grade Nos. 4, 5, and 6 by Test Method D95 and Test Method D473. A density of 1.0 kg/L shall be used for the Test Method D95 water.

7.1.4 *Carbon Residue*—Test Method D524.

7.1.5 *Ash*—Test Method D482.

7.1.6 *Distillation*—Distillation of Grade No. ~~1 and No. 2 oils~~ 1, No. 2, and B6–B20 shall be determined in accordance with Test Methods D86, D2887~~or, D2887~~D7344, or D7345.[6] Results from Test Method D2887 shall be reported as "Predicted D86" results by application of the correlation in Appendix X4 Test Method D2887 to convert the values. Results from Test Method D7344 shall be reported as "Predicted D86" results by application of the corrections described in Test Method D7344 to improve agreement with D86 values. Results from Test Method D7345 shall be reported as "Predicted D86" results by application of the corrections described in Test Method D7345 to improve agreement with D86 values. In case of dispute, Test Method D86 shall be used as the referee test method.

7.1.7 *Viscosity*—Viscosity shall be determined in accordance with Test Method D445. Bias-corrected values from Test Method D7042 may be used as alternative results for Test Method D445 on Grades No. 1 and No. 2 with the same limits. Section 15 of Test Method D7042 contains bias-correction information. In case of dispute, Test Method D445 shall be used as the referee method.

7.1.8 *Density*—Test Method D1298. Test Method D4052 can be used as an alternative with the same limits. In case of dispute, Test Method D1298 shall be used as the referee method.

7.1.9 *Corrosion*—Test Method D130, 3 h test at a minimum control temperature of 50 °C.

7.1.10 *Sulfur*—Test Methods D2622 for all grades except S15 and D5453 for S15 grades. See Table 3 for alternative test methods for sulfur and the corresponding fuel grades.

7.1.11 *Lubricity*—Test Methods D6079 or D7688. Test Method D6079 shall be the referee method.

7.1.12 *Conductivity*—Both conductivity test methods, Test Methods D2624 and D4308 are allowed for all grades of No. 1 and No. 2 fuels. There is no conductivity requirement for No. 4, No. 5, or No. 6 grades.

[5] For information on the precision of the ASTM test methods for fuel oils refer to "An Evaluation of Methods for Determination of Sulfur in Fuel Oils" by A. R. Crawford, Esso Mathematics and Systems Inc. and G. V. Dyroff, Esso Research and Engineering Co., 1969. This document is available from the Publications Section, API Library, American Petroleum Institute, 1220 L St., NW, Washington, DC 20005.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1553. Contact ASTM Customer Service at service@astm.org.