



Standard Specification for Fuel Oils¹

This standard is issued under the fixed designation D 396; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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

1. Scope

1.1 This specification (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 1 and 2 are distillate fuels for use in domestic and small industrial burners. Grade 1 is particularly adapted to vaporizing type burners or where storage conditions require low pour point fuel.

1.1.2 Grades 4 (Light) and 4 are heavy distillate fuels or distillate/residual fuel blends used in commercial/industrial burners equipped for this viscosity range.

1.1.3 Grades 5 (Light), 5 (Heavy), and 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 All values are stated in SI units and are regarded as standard.

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 D 4865.

2. Referenced Documents

2.1 ASTM Standards:

- D 56 Test Method for Flash Point by Tag Closed Tester²
- D 86 Test Method for Distillation of Petroleum Products²

¹ This specification is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.E on Burner, Diesel, Non-aviation Gas Turbine, and Marine Fuels.

Current edition approved Apr. 10, 1998. Published September 1998. Originally published as D 396 – 34 T. Last previous edition D 396 – 96.

² Annual Book of ASTM Standards, Vol 05.01.

- D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester²
- D 95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation²
- D 97 Test Method for Pour Point of Petroleum Oils²
- D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)²
- D 130 Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test²
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)²
- D 473 Test Method for Sediment in Crude Oils and Fuel Oils by the Extraction Method²
- D 482 Test Method for Ash from Petroleum Products²
- D 524 Test Method for Ramsbottom Carbon Residue of Petroleum Products²
- D 1266 Test Method for Sulfur in Petroleum Products (Lamp Method)²
- D 1298 Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method²
- D 1552 Test Method for Sulfur in Petroleum Products (High-Temperature Method)²
- D 2622 Test Method for Sulfur in Petroleum Products by X-Ray Spectrometry³
- D 2709 Test Method for Water and Sediment in Distillate Fuels by Centrifuge³
- D 3245 Test Method for Pumpability of Industrial Fuel Oils³
- D 3828 Test Methods for Flash Point by Small Scale Closed Tester³
- D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter³
- D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products³
- D 4294 Test Method for Sulfur in Petroleum Products by Energy-Dispersive X-Ray Fluorescence Spectrometry³
- D 4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems⁴
- D 5949 Test Method for Pour Point of Petroleum Products

³ Annual Book of ASTM Standards, Vol 05.02.

⁴ Annual Book of ASTM Standards, Vol 05.03.

- (Automatic Pressure Pulsing Method)⁴
- D 5950 Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)⁴
- D 5985 Test Method for Pour Point of Petroleum Products (Rotational Method)⁴
- 2.2 Other Documents:⁵
- 26 CFR Part 48 Diesel Fuel Excise Tax; Dye Color and Concentration
- 40 Part 80 Regulation of Fuel and Fuel Additives

3. General Requirements

3.1 The grades of fuel oil specified herein shall be homogeneous hydrocarbon oils, free from inorganic acid, and free from excessive amounts of solid or fibrous foreign matter.

3.2 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. Detailed Requirements

4.1 The various grades of fuel oil shall conform to the

⁵ Available from Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

limiting requirements shown in Table 1. A representative sample shall be taken for testing in accordance with Practice D 4057.

4.2 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.

5. Test Methods

5.1 The requirements enumerated in this specification shall be determined in accordance with the following ASTM test methods,⁶ except as may be required under 5.1.1.

5.1.1 *Flash Point*—Test Method D 93, except where other methods are prescribed by law. For all grades, Test Method D 3828 may be used as an alternate with the same limits. For Grades No. 1 and No. 2, Test Method D 56 may be used as an alternate with the same limits, provided the flash point is below

⁶ 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 & 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., N.W., Washington, DC 20005.

TABLE 1 Detailed Requirements for Fuel Oils^A

Property	ASTM Test Method ^B	No. 1 ^C	No. 2 ^C	Grade No. 4 (Light) ^C	No. 4	No. 5 (Light)	No. 5 (Heavy)	No. 6
Flash Point °C, min	D 93	38	38	38	55	55	55	60
Water and sediment, % vol, max	D 2709	0.05	0.05	...	...	...	...	...
	D 95 + D 473	...	...	(0.50) ^D	(0.50) ^D	(1.00) ^D	(1.00) ^D	(2.00) ^D
Distillation temperature °C	D 86	...	...	...	...	...	...	...
10 % volume recovered, max		215	...	...	...	...	...	...
90 % volume recovered, min		...	282	...	...	...	...	...
max		288	338	...	...	...	...	...
Kinematic viscosity at 40°C, mm ² /s	D 445	...	...	...	...	...	...	...
min		1.3	1.9	1.9	>5.5	...	...	...
max		2.1	3.4	5.5	24.0 ^E	...	...	...
Kinematic viscosity at 100°C, mm ² /s	D 445	...	...	...	...	5.0	9.0	15.0
min		...	...	...	...	8.9 ^E	14.9 ^E	50.0 ^E
max		...	...	...	...	...	...	...
Ramsbottom carbon residue on 10 % distillation residue % mass, max	D 524	0.15	0.35	...	...	...	...	...
Ash, % mass, max	D 482	...	...	0.05	0.10	0.15	0.15	...
Sulfur, % mass max ^F	D 129	0.50	0.50	...	...	...	...	...
Copper strip corrosion rating, max, 3 h at 50°C	D 130	No. 3	No. 3	...	...	...	...	...
Density at 15°C, kg/m ³	D 1298	...	...	...	...	...	...	...
min		...	...	>876 ^G	...	...	...	...
max		850	876	...	...	...	...	...
Pour Point °C, max ^H	D 97	-18	-6	-6	-6	...	...	...

^AIt 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.

^BThe test methods indicated are the approved referee methods. Other acceptable methods are indicated in Section 2 and 5.1.

^CUnder United States regulations, Grades No. 1, No. 2, 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 3.9 lbs per thousand barrels of the solid dye standard SolventRed 26.

^DThe amount of water by distillation by Test Method D 95 plus the sediment by extraction by Test Method D 473 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 mass %, and a deduction in quantity shall be made for all water and sediment in excess of 1.0 mass %.

^EWhere 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.

^FOther sulfur limits may apply in selected areas in the United States and in other countries.

^GThis limit assures a minimum heating value and also prevents misrepresentation and misapplication of this product as Grade No. 2.

^HLower 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 mm²/s and the minimum 90 % recovered temperature shall be waived.

^IWhere 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.