



Standard Specification for Commercial Boiler Fuels With Used Lubricating Oils¹

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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 four grades of fuel oil made of at least 25 % used lubricating oils. The four grades of fuel are intended for use in various types of fuel-oil-burning industrial equipment and commercial boilers under various climatic and operating conditions. These fuels are not intended for use in residential heaters.

1.1.1 Grades RFC4, RFC5L, RFC5H and RFC6 are used lubricating oil blends of increasing viscosity, with or without middle distillate or residual fuel oil, or both, that are intended for use in industrial burners and commercial boilers equipped to handle these types of fuels. This specification is for applications where Specification D 6448 would not meet the performance or other requirements of the burner or boiler in question.

NOTE 1—For information on the significance of the terminology and test methods used in this specification, see Appendix X1.

1.2 This specification is for use in contracts for the purchase of fuel oils derived from used lubricating oil and for the guidance of consumers of such fuels. This specification does not address the frequency with which any particular test must be run.

1.3 Nothing in this specification shall preclude observance of national or local regulations which can be more restrictive. In some jurisdictions, used oil is considered a hazardous waste and fuels derived from used oil are required to meet certain criteria before use as a fuel.

NOTE 2—For U.S. federal requirements imposed on used oil generators, transporters and transfer facilities, reprocessors, marketers, and burners, see U.S. Federal Code 40 CFR 279.

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.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.P0 on Recycled Petroleum Products.

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2. Referenced Documents

2.1 ASTM Standards:

- D 56 Test Method for Flash Point by Tag Closed Tester²
- 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 Products²
- D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)²
- D 240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter²
- D 396 Specification for Fuel Oils²
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (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 664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration²
- D 974 Test Method for Acid and Base Number by Color-Indicator Titration²
- D 1266 Test Method for Sulfur in Petroleum Products (Lamp Method)²
- D 1298 Test Method 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 1796 Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)²
- D 2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry²
- D 2983 Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer²
- D 3228 Test Method for Total Nitrogen in Lubricating Oils and Fuel Oils by Modified Kjeldahl Method²

² Annual Book of ASTM Standards, Vol 05.01.

- 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 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants³
- D 4177 Practice for Automatic Sampling of Petroleum and Petroleum Products³
- D 4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy-Dispersive X-ray Fluorescence Spectrometry³
- D 4629 Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection³
- D 4865 Guide for the Generation and Dissipation of Static Electricity in Petroleum Fuel Systems³
- D 4868 Test Method for Estimation of Net and Gross Heat of Combustion of Burner and Diesel Fuels³
- D 5185 Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)³
- D 5291 Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants³
- D 5384 Test Methods for Chlorine in Used Petroleum Products (Field Test Kit Method)⁴
- D 5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products⁴
- D 6160 Test Method for Determination of Polychlorinated Biphenyls (PCBs) in Waste Materials by Gas Chromatography⁴
- D 6448 Specification for Industrial Burner Fuels from Used Lubricating Oils⁵
- D 6450 Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester⁵
- 2.2 *ISO Standard*.⁶
- ISO 8217** Petroleum Products—Fuel (Class F)—Specifications for Marine Fuels
- 2.3 *Government Standards*:
- U.S. Federal Code CFR 761.3** ⁷
- U.S. Federal Code 40 CFR 279** Standards for the Management of Used Oil⁷

USEPA SW-846 ⁸

3. Terminology

3.1 Definitions:

3.1.1 *burner fuel oil, n*—any petroleum liquid suitable for the generation of heat by combustion in a furnace or firebox as a vapor or a spray, or a combination of both.

3.1.1.1 *Discussion*—Different grades are characterized primarily by viscosity ranges.

3.1.2 *reclaiming, n*—the use of cleaning methods during recycling primarily to remove insoluble contaminants, thus making the oil suitable for further use. The methods may include settling, heating, dehydration, filtration, and centrifuging.

3.1.3 *recycling, n—in petroleum technology*, the acquisition of oil that has become unsuitable for its intended use, and processing it in order to regain useful materials.

3.1.4 *re-refining, n*—the use of refining processes during recycling to produce high quality base stocks for lubricants or other petroleum products. Re-refining may include distillation, hydrotreating, or treatments employing acid, caustic, solvent, clay, or both, or other chemicals, or a combination thereof.

3.1.5 *used oil, n—in petroleum product recycling*, oil whose characteristics have changed since being originally manufactured, and which is suitable for recycling.

3.1.6 *waste oil, n—in petroleum technology*, oil having characteristics making it unsuitable either for further use or for economic recycling.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *commercial boiler, n*—indirect heating units which transfer thermal energy to water or other fluids or gases for use in heating and having a heat input between 0.3 to 10×10^6 BTU/h.

3.2.2 *industrial burner, n*—a device which produces heat for industrial use through the combustion of liquid hydrocarbon fuels.

3.2.2.1 *Discussion*—Industrial burners are typically designed for one of two applications: (1) *industrial furnaces*—integral components of manufacturing processes that provide direct heating; for example, in aggregate, cement, lime, or phosphate kilns; coke ovens; or blast, smelting, melting, refining, or drying ovens and (2) *industrial boilers*—large indirect heating units which transfer thermal energy to water or other fluids or gases for use in heating in industrial settings and in manufacturing processes. These boilers can be classified as utility/large industrial boilers with a heat input greater than 100×10^6 BTU/h or small industrial boilers with a heat input of between 10 to 100×10^6 BTU/h.

3.2.3 *reprocessing, n—in petroleum product recycling*, the preparation of used oil to be suitable as a fuel.

3.2.3.1 *Discussion*—Reprocessing includes procedures such as settling, filtration, blending, distillation, or chemical treatment.

3.3 For definitions of other terms used in this specification, refer to Terminology D 4175.

⁸ Available from United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460 (www.epa.gov).

³ Annual Book of ASTM Standards, Vol 05.02.

⁴ Annual Book of ASTM Standards, Vol 05.03.

⁵ Annual Book of ASTM Standards, Vol 05.04.

⁶ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁷ National Archives and Records Administration, Code of Federal Regulations. Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401 (www.access.gpo.gov).

4. Significance and Use

4.1 The intention of this specification is to cover fuel oil used in industrial equipment and commercial boilers as stated in the Scope section. The use of used lube oil in marine and industrial diesel engines is a contentious issue. A major marine fuel oil specification is **ISO 8217**. Fuel oils manufactured against this standard may also meet the requirements of **ISO 8217** and can be used in marine diesel engine operations provided compliance to **ISO 8217** is demonstrated.

5. Classification

5.1 There are four grades of burner fuel containing recycled lubricating oils covered by this specification. These grades may or may not correlate directly with similar grades in other ASTM standards. The RFC designation identifies them as recycled fuel oil, commercial boilers. The usage descriptions of each grade may not describe all the uses, but are included as general information. The four grades are described as follows:

5.1.1 *Grade RFC4*—Primarily a blend of used lubricating oils and middle distillate or a reprocessed distillate product derived from used oil. It is intended for use in pressure atomizing industrial burners or commercial boilers with no pre-heating. This grade of recycled oil fuel is used in many medium capacity industrial burners and commercial boilers where ease of handling justifies the higher cost over the heavier used oil fuels.

5.1.2 *Grade RFC5L*—A blend of a used lubricating oil or a reprocessed product from used oil and middle distillate or residual fuel of intermediate viscosity heavier than RFC4. It is intended for use both in pressure-atomizing industrial burners and commercial boilers not requiring higher cost middle distillates and in burners and commercial boilers equipped to atomize fuel oils of higher viscosity with or without pre-heating. Its permissible viscosity range allows it to be pumped and atomized at relatively low-storage temperatures.

5.1.3 *Grade RFC5H*—A used lubricating oil and residual blend fuel, heavier than Grade RFC5L. It is intended for use in industrial burners and commercial boilers equipped with devices that atomize fuel oil of higher viscosity. Preheating may be necessary in some types of equipment for burning and in colder climates for handling.

5.1.4 *Grade RFC6*—A high-viscosity used lubricating oil and fuel heavier than Grade RFC5H. It is intended for use in large industrial heaters and boilers and may require preheating in the storage tank to permit pumping. Additional preheating at the burner may be necessary to permit satisfactory atomization. The extra equipment and maintenance required to handle this fuel usually preclude its use in small installations.

6. General Requirements

6.1 The fuel oils specified herein shall contain a minimum of 25 % volume of used lubricating oil-derived products, the balance being a Specification **D 396** fuel oil or suitable refinery stocks.

6.2 The fuel oils shall be homogeneous fluids consisting primarily of hydrocarbons. RFC shall remain homogeneous and uniform in storage and shall not separate by gravity or aging into layers in normal operating conditions.

NOTE 4—Prolonged storage or equipment down time may necessitate circulation of the fuel oil in-tank to prevent such separation.

6.3 The fuel oil shall not contain excessive amounts of organic or inorganic acids, or both, and shall be free of solid or fibrous matter that could cause system handling or maintenance problems. The buyer and seller should agree on any requirements for particle size.

NOTE 5—The fuels defined by this specification are appropriate for burners capable of handling and combusting fuels with potentially higher metals and ash content.

7. Detailed Requirements

7.1 *Grade RFC4*—The requirements for this type of fuel are presented in **Table 1** and include fuels in the viscosity range below 5 mm²/s (cSt) at 100°C according to Test Method **D 445**.

7.2 *Grade RFC5L*—The requirements for this type of fuel are presented in **Table 1** and include fuels in the viscosity range 5.0 to 8.9 mm²/s (cSt) at 100°C according to Test Method **D 445**.

7.3 *Grade RFC5H*—The requirements for this type of fuel are presented in **Table 1** and include fuels in the viscosity range 9.0 to 14.9 mm²/s (cSt) at 100°C according to Test Method **D 445**.

7.4 *Grade RFC6*—The requirements for this type of fuel are presented in **Table 1** and include fuels in the viscosity range 15.0 to 50.0 mm²/s (cSt) at 100°C according to Test Method **D 445**.

NOTE 6—Refer to **X1.3**. Viscosity measurements may be provided/agreed to other than the above listed temperatures.

NOTE 7—In the U.S., fuel must also meet U.S. Environmental Protection Agency (USEPA) on-specification parameters for recycled used oil fuels as defined under 40 CFR Part 279.11.

7.5 The properties listed in this specification are those of greatest significance in obtaining acceptable performance of the burner. Only referee test methods are shown in **Table 1**. (See Section **8** for alternate test methods and **Appendix X1** for significance of test requirements.)

7.5.1 *Ash Content*—Specific burners/boilers may be able to handle higher ash contents without increasing maintenance. Buyer/seller may agree on an alternate ash content based on specific equipment capabilities.

7.6 A representative sample shall be obtained for testing. Practices **D 4057**, **D 4177**, or other comparable sampling standards should be followed. In case of dispute, Practice **D 4057** shall be the referee practice. A minimum sample size of about 1 L (1 US qt) is recommended for each sample taken (before compositing). Sample handling and mixing shall comply with Practice **D 5854**.

7.7 Testing frequency and any modifications of limiting requirements to meet special operating conditions shall be agreed upon by both the buyer and the seller.

NOTE 8—It is possible that one or more of the parameters listed in **Table 1** may be used as an indicator of when more extensive testing is required.

8. Test Methods

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