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Standard Specification for Commercial Boiler Fuels With Used Lubricating Oils[1]

This standard is issued under the fixed designation D6823; 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 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 D6448 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 United States federal requirements imposed on used oil generators, transporters and transfer facilities, reprocessors, marketers, and burners, see 40 CFR Part 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 D4865.

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

1.4.1 *Exception*—Table 1 and Table X1.1 include inch-pound values in parentheses for information only.

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
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)
D240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter
D396 Specification for Fuel Oils
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
D482 Test Method for Ash from Petroleum Products
D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
D974 Test Method for Acid and Base Number by Color-Indicator Titration
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

[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.P0 on Recycled Products.

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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.

TABLE 1 Detailed Requirements for Non-Industrial Burner Fuels from Used Lubricating Oils

Properties	Test Method[A]	Limits[B]			
		RFC4	RFC5L	RFC5H	RFC6
Physical					
Viscosity at 100 °C mm^2/s[C]	D445				
min	. . .	. . .	5.0	9.0	15.0
max	. . .	<5.0	8.9	14.9	50.0
Flash point, °C (°F), min	D93, Procedure B	38 (100)	55 (130)	55 (130)	60 (140)
Water and sediment,[D] % volume max	D1796	1.0	1.0	2.0	2.0
Pour point, °C (°F), max	D97	-6 (21)	[E]	[E]	[E]
Density, kg/m^3 at 15 °C[F]	D1298	Report	Report	Report	Report
Chemical					
Acid no., mg KOH/g, max	D664	0.15	0.15	0.30	0.30
Ash, % mass, max[G]	D482	0.2	0.3	0.3	Report
Sulfur, % mass[H]	D129	Report	Report	Report	Report
Performance					
Gross heating value, MJ/kg (BTU/gal),[I] min	D240	40.0 (130 000)	41.5 (135 000)	41.5 (135 000)	43.0 (140 000)
Contaminants[J]					
Arsenic, ppm, max.	[K]		5		
Cadmium, ppm, max	[K]		2		
Chromium, ppm, max	D5185[K]		10		
Lead, ppm, max	D5185[K]		100		
Total halogens, ppm, max	D5384[K]		1000		
PCBs, ppm, max	D6160		50[L]		

[A] See Section 8 for details and additional test methods.
[B] Units given in parentheses are for informational purposes only.
[C] 1 cSt = 1 mm^2/s.
[D] Solids content shall not exceed 0.5 %. Filtration may be required to obtain appropriate particle size for use. A deduction in quantity shall be made for all water and sediment in excess of 1.0 % by mass for Grades RFC5H and RFC6.
[E] Buyer and seller to agree.
[F] Density in kg/L at 15 °C multiplied by 1000 = kg/m^3.
[G] Buyer and seller may agree on a higher ash content.
[H] Local jurisdictions may limit the sulfur content in burner fuels.
[I] Assumes 7.5 lb/US gal.
[J] These are US EPA current limits (40 CFR Part 279 and 40 CFR Part 761). If state or local requirements for used oil are more stringent, the burner fuel offered shall comply with the more stringent requirements.
[K] US EPA SW-846 6010. Where Test Method D5185 is listed, Test Method D5185 will be the referee test method.
[L] In the United States, current unrestricted use IAW 40 CFR Part 279 is <2 ppm. PCBs are permitted in qualified incinerators as defined in 40 CFR Part 761. US EPA prohibits blending down oils of >50 ppm to <50 ppm and oils <50 ppm to less than 2 ppm.

D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)
D1796 Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)
D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
D2983 Test Method for Low-Temperature Viscosity of Automatic Transmission Fluids, Hydraulic Fluids, and Lubricants using a Rotational Viscometer
D3228 Test Method for Total Nitrogen in Lubricating Oils and Fuel Oils by Modified Kjeldahl Method
D3245 Test Method for Pumpability of Industrial Fuel Oils (Withdrawn 2010)[3]
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
D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
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
D4629 Test Method for Trace Nitrogen in Liquid Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection
D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D4868 Test Method for Estimation of Net and Gross Heat of Combustion of Hydrocarbon Burner and Diesel Fuels
D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
D5291 Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants
D5384 Test Methods for Chlorine in Used Petroleum Products (Field Test Kit Method)

[3] The last approved version of this historical standard is referenced on www.astm.org.

D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
D6160 Test Method for Determination of Polychlorinated Biphenyls (PCBs) in Waste Materials by Gas Chromatography
D6448 Specification for Industrial Burner Fuels from Used Lubricating Oils
D6450 Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester
D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

2.2 *ISO Standard:*[4]
ISO 8217 Petroleum Products–Fuel (Class F)–Specifications for Marine Fuels

2.3 *U.S. Code of Federal Regulations:*[5]
40 CFR Part 761 Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
40 CFR Part 279 Standards for the Management of Used Oil

2.4 *US EPA Standards:*[6]
SW-846 Test Methods for Evaluating Solid Wastes Physical/Chemical Methods
SW-846 5050 Bomb Preparation Method for Solid Waste
SW-846 6010 Inductively Coupled Plasma-Atomic Emission Spectrometry
SW-846 9056A Determination of Inorganic Anions by Ion Chromatography
SW-846 9075 Test Method for Total Chlorine in New and Used Petroleum Products by X-Ray Fluorescence Spectrometry (XRF)
SW-846 9076 Test Method for Total Chlorine in New and Used Petroleum Products by Oxidative Combustion and Microcoulometry
SW-846 9077 Test Methods for Total Chlorine in New and Used Petroleum Products (Field Test Kit Methods)

3. Terminology

3.1 For definitions of other terms used in this specification, refer to Terminology D4175.

3.2 *Definitions:*

3.2.1 *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.

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

3.2.2 *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.

3.2.3 *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.

3.2.4 *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.

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

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

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *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.

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

3.3.2.1 *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.

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

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

3.4 *Acronyms:*

3.4.1 *ISO*—International Organization for Standardization.

3.4.2 *RCRA*—Resource Conservation and Recovery Act (United States).

3.4.3 *US EPA*—United States Environmental Protection Agency.

3.5 *Abbreviations:*

3.5.1 *CFR*—Code of Federal Regulations.

3.5.2 *IAW*—in accordance with.

3.5.3 *RFC4*—recycled fuel, commercial boilers, grade number 4.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.
[5] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401 (www.gpoaccess.gov).
[6] Available from Environmental Protection Agency, Ariel Rios Bldg., 1200 Pennsylvania Ave., N.W., Washington, DC 20460 (www.epa.gov). Downloadable files available at http://www.epa.gov/epawaste/hazard/testmethods/sw846/index.htm.

3.5.4 *RFC5L*—recycled fuel, commercial boilers, grade number 5 light.

3.5.5 *RFC5H*—recycled fuel, commercial boilers, grade number 5 heavy.

3.5.6 *RFC6*—recycled fuel, commercial boilers, grade number 6.

3.5.7 *SW*—solid waste, SW-846 is US EPA Office of Solid Waste's official compendium of analytical and sampling methods for use in complying with the RCRA regulations.

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 preheating. 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 D396 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 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. The buyer and seller should agree on any requirements for long-term homogeneity.

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 high metals and higher ash content than Specification D396 fuels.

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 mm^2/s (cSt) at 100 °C according to Test Method D445.

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 mm^2/s to 8.9 mm^2/s (cSt) at 100 °C according to Test Method D445.

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 mm^2/s to 14.9 mm^2/s (cSt) at 100 °C according to Test Method D445.

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 mm^2/s to 50.0 mm^2/s (cSt) at 100 °C according to Test Method D445.

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., RFC must also meet US EPA on-specification parameters for recycled used oil fuels as defined under 40 CFR Part 279, 40 CFR Part 761, and air quality regulations for particulate matter.

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 D4057, D4177, or other comparable sampling standards should be followed. In case of dispute, Practice D4057 shall be the referee practice. A minimum sample size of about 1 L is recommended for each sample taken (before compositing). Sample handling and mixing shall comply with Practice D5854.