



## Standard Specification for Commercial Boiler Fuels With Used Lubricating Oils<sup>1</sup>

This standard is issued under the fixed designation D 6823; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*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.~~ United States federal requirements imposed on used oil generators, transporters and transfer facilities, reprocessors, marketers, and burners, see ~~U.S. Federal Code~~ 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 D 4865.

~~1.4~~

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.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- D 56 Test Method for Flash Point by Tag Closed Cup Tester
- D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D 95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
- D 97 Test Method for Pour Point of Petroleum Products
- D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)
- D 240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter
- D 396 Specification for Fuel Oils
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids ~~(the~~(and Calculation of Dynamic Viscosity)
- D 473 Test Method for Sediment in Crude Oils and Fuel Oils by the Extraction Method
- D 482 Test Method for Ash from Petroleum Products
- D 664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D 974 Test Method for Acid and Base Number by Color-Indicator Titration
- D 1266 Test Method for Sulfur in Petroleum Products (Lamp Method)

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* Vol 05.01, 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 Non-Industrial Burner Fuels-F from Used Lubricating Oils**

Properties	Test Method <sup>A</sup>	Proposed Limits <sup>B</sup>			
		RFC4	RFC5L	RFC5H	RFC6
<b>Physical</b>					
Viscosity at 100°C mm <sup>2</sup> /s <sup>C</sup>	D 445				
—min	—	—	5.0	9.0	15.0
min	—	—	5.0	9.0	15.0
—max	—	<5.0	8.9	14.9	50.0
max	—	<5.0	8.9	14.9	50.0
Flash point, °C (°F), min	D 93D	38 (100)	55 (130)	55 (130)	60 (140)
Flash point, °C (°F), min	D 93, Procedure B	38 (100)	55 (130)	55 (130)	60 (140)
Water and sediment, <sup>E</sup> % volume max	D 1796	1.0	1.0	2.0	2.0
Water and sediment, <sup>D</sup> % volume max	D 1796	1.0	1.0	2.0	2.0
Pour point, °C (°F), max	D 97	-6 (21)	—	—	—
Pour point, °C (°F), max	D 97	-6 (21)	<sup>E</sup>	<sup>E</sup>	<sup>E</sup>
Density, kg/m <sup>3</sup> at 15°C <sup>G</sup>	D 1298	Report	Report	Report	Report
Density, kg/m <sup>3</sup> at 15°C <sup>F</sup>	D 1298	Report	Report	Report	Report
<b>Chemical</b>					
Acid no., mg KOH/g, max	D 664 <sup>H</sup> /D 974	0.15	0.15	0.30	0.30
Acid no., mg KOH/g, max	D 664	0.15	0.15	0.30	0.30
Ash, % mass, max <sup>I</sup>	D 482	0.2	0.3	0.3	Report
Ash, % mass, max <sup>G</sup>	D 482	0.2	0.3	0.3	Report
Sulphur, % mass <sup>J</sup>	D 129	Report	Report	Report	Report
Sulfur, % mass <sup>H</sup>	D 129	Report	Report	Report	Report
<b>Performance</b>					
Gross heating value, MJ/kg (BTU/gal), <sup>K</sup> min	D 240	40.0 (130 000)	41.5 (135 000)	41.5 (135 000)	43.0 (140 000)
Gross heating value, MJ/kg (BTU/gal), <sup>K</sup> min	D 240	40.0 (130 000)	41.5 (135 000)	41.5 (135 000)	43.0 (140 000)
<b>Contaminants<sup>L</sup></b>					
<b>Contaminants<sup>J</sup></b>					
Arsenic, ppm, max	<sup>M</sup>			5	
Arsenic, ppm, max	<sup>K</sup>			5	
Cadmium, ppm, max	<sup>M</sup>			2	
Cadmium, ppm, max	<sup>K</sup>			2	
Chromium, ppm, max	D 5185 <sup>M</sup>			10	
Chromium, ppm, max	D 5185 <sup>K</sup>			10	
Lead, ppm, max	D 5185 <sup>M</sup>			100	
Lead, ppm, max	D 5185 <sup>K</sup>			100	
Total halogens, ppm, max	D 5384 <sup>M</sup>			1000	
Total halogens, ppm, max	D 5384 <sup>K</sup>			1000	
PCBs, ppm, max	D 6160			50 <sup>N</sup>	
PCBs, ppm, max	D 6160			50 <sup>L</sup>	

<sup>A</sup> See Section 8 for details and additional test methods.

<sup>B</sup> Units given in parentheses are for informational purposes only.

<sup>C</sup> 1 cSt = 1 mm<sup>2</sup>/s.

<sup>D</sup> 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 mass % for Grades RFC5H and RFC6.

<sup>E</sup> 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 mass % for Grades RFC5H and RFC6.

<sup>F</sup> Buyer and seller to agree.

<sup>G</sup> Density in kg/L at 15°C multiplied by 1000 = kg/m<sup>3</sup>.

<sup>H</sup> Referee method.

<sup>I</sup> Buyer and seller may agree on a higher ash content.

<sup>J</sup> Local jurisdictions may limit the sulphur content in burner fuels.

<sup>K</sup> Assumes 7.5 lb/US gal.

<sup>L</sup> These are US EPA current limits (40 CFR Part 279). Copies of 40 CFR Federal Regulations may be obtained from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20460 (www.access.gpo.gov). If state or local requirements for used oil are more stringent, the burner fuel offered shall comply with the more stringent requirements.

<sup>M</sup> Test Method US EPA SW-846- 6010. Where Test Method D 5185 is listed, Test Method D 5185 will be the referee test method. EPA Test Methods may be obtained from the United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460 (www.epa.gov).

<sup>N</sup> 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 761.3. US EPA prohibits blending down oils of >50 ppm to <50 ppm and oils <50 ppm to less than 2 ppm.

- D 1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
- D 1552 Test Method for Sulfur in Petroleum Products (High-Temperature Method)
- D 1796 Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)
- D 2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D 2983 Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer
- D 3228 Test Method for Total Nitrogen in Lubricating Oils and Fuel Oils by Modified Kjeldahl Method
- D 3245 Test Method for Pumpability of Industrial Fuel Oils
- D 3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
- D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter
- D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants  
 D 4177 Practice for Automatic Sampling of Petroleum and Petroleum Products  
 D 4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy- Dispersive X-ray Fluorescence Spectrometry  
 D 4629 Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection  
 D 4865 Guide for the Generation and Dissipation of Static Electricity in Petroleum Fuel Systems  
 D 4868 Test Method for Estimation of Net and Gross Heat of Combustion of Burner and Diesel Fuels  
 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)  
 D 5291 Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants  
 D 5384 Test Methods for Chlorine in Used Petroleum Products (Field Test Kit Method)  
 D 5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products  
 D 6160 Test Method for Determination of Polychlorinated Biphenyls (PCBs) in Waste Materials by Gas Chromatography  
 D 6448 Specification for Industrial Burner Fuels from Used Lubricating Oils  
 D 6450 ~~Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester<sup>5</sup>~~ Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester  
 D 7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

### 2.2 ISO Standard:<sup>3</sup>

ISO 8217 Petroleum Products—Fuel (Class F)—Specifications for Marine Fuels

### 2.3 Government Standards—U.S. Code of Federal Regulations:<sup>4</sup>

~~U.S. Federal Code CFR 761.3-40 CFR Part 761 Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions~~

~~U.S. Federal Code 40 CFR 279 Standards for the Management of Used Oil<sup>7</sup>~~

~~USEPA SW-846 40 CFR Part 279 Standards for the Management of Used Oil~~

### 2.4 US EPA Standards:<sup>5</sup>

~~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)~~ 3-08

## 3. Terminology

3-1

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

### 3.2 Definitions:

3.1-1

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.

3.1-1-1

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

3.1-2

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.

3.1-3

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.

<sup>3</sup> Annual Book of ASTM Standards, Vol 05.02.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>4</sup> Annual Book of ASTM Standards, Vol 05.03.

<sup>4</sup> Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401 ([www.gpoaccess.gov](http://www.gpoaccess.gov)).

<sup>5</sup> Annual Book of ASTM Standards, Vol 05.04.

<sup>5</sup> Available from Environmental Protection Agency, Ariel Rios Bldg., 1200 Pennsylvania Ave., N.W., Washington, DC 20460 ([www.epa.gov](http://www.epa.gov)). Downloadable files available at <http://www.epa.gov/epawaste/hazard/testmethods/sw846/index.htm>.

### 3.1.4

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.

### 3.1.5

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.

### 3.1.6

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

### 3.2

#### 3.3 *Definitions of Terms Specific to This Standard:*

#### 3.2.1

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  $10 \times 10^6$  BTU/h.

#### 3.2.2

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

#### 3.2.2.1

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  $100 \times 10^6$  BTU/h or small industrial boilers with a heat input of between  $10$  to  $100 \times 10^6$  BTU/h.

#### 3.2.3

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

#### 3.2.3.1

3.3.3.1 *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 D4175.

#### 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.

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.