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An American National Standard

Standard Specification for Middle Distillate Fuel Oil—Military Marine Applications[1]

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1. Scope

1.1 This specification covers one grade of 100 % middle distillate fuel oil (no residual contamination), Grade No. 2-LTD, for use in off-road applications requiring long-term storage stability. This grade of middle distillate fuel is similar to Specification D 975, Grade No. 2-D but with additional properties specified to provide storage stability, as well as other properties required by specific end use applications. This grade is intended for off-road applications such as military marine use (non-aviation gas turbine engines, compression ignition/diesel engines, and other non-automotive applications), emergency generators (military or commercial), as well as any other uses that require storage stable middle distillate fuel.

1.2 This specification, unless otherwise provided by agreement between the purchaser and the supplier, prescribes the required properties of middle distillate fuel at the time and place of delivery. Nothing in this specification shall preclude observance of federal, state, or local regulations that may be more restrictive.

1.3 During handling and use of all middle distillate fuels, the generation and dissipation of static electricity can create fire and explosion hazards. For more information on this subject see Guide D 4865.

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

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 56 Test Method for Flash Point by Tag Closed Cup Tester

D 86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D 93 Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester

D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)

D 130 Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)

D 482 Test Method for Ash from Petroleum Products

D 524 Test Method for Ramsbottom Carbon Residue of Petroleum Products

D 613 Test Method for Cetane Number of Diesel Fuel Oil

D 975 Specification for Diesel Fuel Oils

D 976 Test Methods for Calculated Cetane Index of Distillate Fuels

D 1266 Test Method for Sulfur in Petroleum Products (Lamp Method)

D 1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D 1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption

D 1552 Test Method for Sulfur in Petroleum Products (High-Temperature Method)

D 2500 Test Method for Cloud Point of Petroleum Products

D 2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

D 2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge

D 3117 Test Method for Wax Appearance Point of Distillate Fuels

D 3828 Test Methods for Flash Point by Small Scale Closed Cup Tester

D 4057 Practice for Manual 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 4530 Test Method for Determination of Carbon Residue (Micro Method)

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products 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.

D 4737 Test Method for Calculated Cetane Index by Four Variable Equation
D 4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D 5304 Test Method for Assessing Middle Distillate Fuel Storage Stability by Oxygen Overpressure
D 5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Motor Fuels and Oils by Ultraviolet Fluorescence
D 6450 Test Method for Flash Point by Continually Closed Cup (CCCFP) Tester
D 6469 Guide for Microbial Contamination in Fuels and Fuel Systems

2.2 *Government Standards:*[3]

26 CFR Part 48 Manufacturers and Realtors Excise Taxes
40 CFR Part 80 Regulation of Fuels and Fuel Additives

3. Terminology

3.1 *Definitions:*

3.1.1 *long-term storage*, *n*—storage of fuel for longer than 12 months after it is received by the user.

3.1.2 *long-term storage stable middle distillate (LTD)*, *n*—the grade in this specification.

3.1.2.1 *Discussion*—Grade No. 2-LTD is similar to Specification D 975 Grade No. 2-D.

3.1.3 *middle distillate*, *n*—a generic refinery/supplier term that usually denotes a fuel primarily intended for use in compression ignition/diesel engine applications, and also in non-aviation gas turbine engines and other non-automotive applications such as a burner fuel.

3.1.4 *storage stability*, *n*—the resistance of fuel to formation of degradation products when stored at ambient temperatures.

3.2 *Acronyms:*

3.2.1 *CCCFP*, *n*—continually closed cup flash point

3.2.2 *IMO*, *n*—International Maritime Organization

4. Test Methods, Alternate Test Methods, and Significance of Properties

4.1 The requirements listed in Table 1 shall be determined in accordance with the following methods. The referee test methods are listed in Table 1. Where allowed, alternative methods that are not specified in Table 1 are specified in 4.1.1-4.1.11 or in the footnotes to Table 1. Test significance is included in some cases, particularly in the case of storage stability and where additional properties to Specification D 975 have been added to aid the specification user in specific end use applications. Where test significance is not included, it can generally be found in the test methods section and appendix of Specification D 975.

4.1.1 *Ash*—Test Method D 482.

4.1.2 *Carbon Residue*—Test Method D 4530 or D 524. Note that only one of the two methods is required and that the limiting value is different for each test. Both methods use a 10 % distillation bottoms aliquot. In cases of dispute, Test Method D 524 shall be the referee method.

4.1.3 *Cetane Number or Index*—Test Method D 613, D 976, or D 4737. For some marine engine applications, higher minimum values may be required. Use of Test Methods D 976 or D 4737 in place of Test Method D 613 requires a determination using Test Method D 86, a test method not required by this specification, to obtain values necessary to complete the cetane index calculation. In cases of dispute, Test Method D 613 shall be the referee method.

4.1.4 *Cloud Point*—Test Method D 2500. Test Method D 3117 may also be used since the two are closely related. In case of dispute, Test Method D 2500 shall be the referee method.

4.1.5 *Copper Corrosion*—Test Method D 130; 3 h at 50°C.

4.1.6 *Density*—Test Method D 1298. This property is used as an input to Test Methods D 976 and D 4737. A maximum value is also required for water removal in military marine applications.

TABLE 1 Detailed Requirements for Middle Distillate Fuel Oil—Military Marine Applications[A,B]

Property	Referee Test Method[C]	Grade No. 2-LTD
Ash, mass %, max.	D 482	0.01
One of the following shall be met:		
Carbon residue, 10 % distillation residue, mass %, max.	D 524	0.20
(Ramsbottom or Micro)	D 4530	0.14
One of the following shall be met:		
Cetane no., min.	D 613	40[D]
Cetane index, min.	D 976	40[D]
Cetane index, min.	D 4737	42[D]
Cloud point, °C, max.	D 2500	-1
Copper corrosion rating, max. at 50°C for 3 h	D 130	No. 3
Density, kg/m^3, max.	D 1298	876
Flash point, °C, min.	D 93	60
Storage stability, mg/100 mL, max.	D 5304[E]	3.0
Sulfur, mass %, max.	D 129[F]	0.50[F]
Viscosity (kinematic), mm^2/S at 40°C	D 445	
Min.		1.9
Max.		4.1
Water and Sediment, vol %, max.	D 2709	0.05
Middle distillate (no residual contamination)	N/A	100 %

[A] For sale in the United States, U.S. Regulation 26 CFR Part 48 requires that fuel greater than 0.05 mass % sulfur that is sold for tax exempt purposes must be dyed by Solvent Red 164 at a concentration spectrally equivalent to 3.9 lb per thousand barrels of the solid dye standard Solvent Red 26 at or beyond the terminal storage tanks or the tax must be collected.

For sale in the United States, U.S. Regulation 40 CFR Part 80 requires that fuel greater than 0.05 mass % sulfur must be dyed by Solvent Red 164 so its presence is visually apparent. At or beyond terminal storage tanks, such fuel is required by 26 CFR Part 48 to contain the dye Solvent Red 164 at a concentration spectrally equivalent to 3.9 lb per thousand barrels of the solid dye standard Solvent Red 26.

For sale in the United States, U.S. Regulation 40 CFR Part 80 requires that one of the following properties must be met: *(1)* cetane index, min of 40 by Test Methods D 976 or *(2)* aromatics vol %, max of 35 by Test Method D 1319.

[B] Modifications of individual limiting requirements may be agreed upon among purchaser, seller, and fuel manufacturer.

[C] Alternate test methods are indicated in Section 4. Where multiple methods are listed, the first method listed shall be the referee method.

[D] Certain marine engine and other applications may require higher cetane number/index minima and will be set by agreement between seller and buyer.

[E] Only nylon membrane filter media (0.8 µm pore size) are acceptable as specified in Test Method D 5304. Do not use glass fiber (Type A/E) filter media to obtain test results.

[F] Where allowed by law, this sulfur maximum level is 1.0 mass %. Test Method D 129 is the referee method for sulfur level greater than 0.1 mass %. Test Method D 2622 is the referee method for sulfur levels less than or equal to 0.1 mass %.

[3] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

4.1.7 *Flash Point*—Test Methods D 93, except where other methods are prescribed by law. Test Method D 6450 and D 3828 may be used as an alternative provided that data is available to show correspondence with Test Methods D 93 values. Test Method D 56 may be used as an alternate 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. Test Method D 56 will give slightly lower values. In cases of dispute, Test Methods D 93 shall be the referee method.

4.1.8 *Storage Stability*—Test Method D 5304.

4.1.8.1 Most middle distillate fuels meeting Specification D 975 Grade No. 2-D have good to excellent storage stability for 12 months or longer at ambient temperature. Test Method D 5304 requires the use of nylon membrane filters, 0.8-µm pore size, to give an assessment of storage stability at ambient temperature for greater than 12 months. See Test Method D 5304, Appendix X1 (X1.1.2), for details.

4.1.8.2 After a storage stable fuel is purchased, it is the responsibility of the buyer/user to ensure continued stability by maintaining storage tanks free of water and microbial growth, by avoiding extreme temperature changes, by maintaining appropriate tank wall conditions, by avoiding copper or zinc contamination or exposure, and by minimizing multiple supplier mixing in a given tank.

4.1.9 *Sulfur*—Table 2 shows the referee test methods for sulfur, the alternate sulfur test methods, and the range over which each test method applies.

4.1.10 *Viscosity*—Test Method D 445.

4.1.11 *Water and Sediment*—Test Method D 2709.

4.2 *Sampling*—Sampling shall be in accordance with Practice D 4057 or as prescribed by agreement between seller and buyer.

TABLE 2 Sulfur

Sulfur Test Method	Range, mass %
D 129 (referee)[A]	0.1 to 1.0[B]
D 2622 (referee)[C]	0.0003 to 1.0[B]
D 1266[D]	0.01 to 0.4
D 1552[D]	0.06 to 1.0[B]
D 4294[D]	0.0150 to 1.0[B]
D 5453[D]	0.00010 to 0.8000

[A] For fuel sulfur greater than 0.1 mass %.
[B] Test method upper range limit exceeds 1.0 mass %, the maximum allowed in this specification; see Table 1, Footnote F.
[C] For fuel sulfur less than or equal to 0.1 mass %.
[D] Alternate test method.

4.3 *Guides/Other Information*—For information on microbial growth in middle distillate fuel, see Guide D 6469. For information on safety and fire hazards, see Guide D 4865. For information on fuel lubricity issues, see Specification D 975, Appendix X3.

5. Workmanship

5.1 The fuel shall be visually free of undissolved water, sediment, and suspended matter.

6. Requirements

6.1 The specified product is primarily defined by its properties as listed in Table 1.

7. Keywords

7.1 compression ignition; diesel; diesel fuel oil; emergency generator; marine; middle distillate; middle distillate fuel oil; non-aviation gas turbine; petroleum products; stable; storage stability