

NOT MEASUREMENT SENSITIVE

VV-F-800E

July 13, 1994

SUPERSEDING

FED. SPEC. VV-F-800D

October 27, 1987

FEDERAL SPECIFICATION

FUEL OIL, DIESEL

This specification was approved by the Assistant Administrator, Office of Federal Supply and Services, General Services Administration, for the use of all Federal Agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers diesel fuel oils suitable for use in compression-ignition engines and gas turbine engines other than aircraft under all climatic conditions (see 6.1). The diesel fuel oils in this specification are intended for use in both off-highway and on-highway equipment except for DF-2/F-54 which is intended for OCONUS.

1.2 Classification. The diesel fuel oils shall be of four grades, as follows:

<u>Military Symbol</u>	<u>NATO Code No.</u>	<u>Description</u>
DL-A	---	Arctic grade
DL-1	---	Winter grade
DL-2	---	Standard grade
DF-2	F-54	OCONUS Diesel Fuel

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions, clarifications) and any pertinent data which may be of use in improving this document should be addressed to: US ARMY BELVOIR RESEARCH, DEVELOPMENT, AND ENGINEERING CENTER, ATTN: SATBE-TSE, 10101 GRIDLEY ROAD STE 104, FT BELVOIR, VA 22060-5818 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter
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Federal Standards:

- FED-STD-313 - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities.
- FED-STD-791 - Lubricants, Liquid Fuels, and Related Products; Methods of Testing.

(Activities outside the Federal Government may obtain copies of Federal specifications, standards, and commercial item descriptions, as outlined under General Information in the Index of Federal Specifications, Standards, and Commercial Item Descriptions. The Index, which includes cumulative bimonthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification, other Federal specifications, and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from General Services Administration Business Service Centers in Boston, MA; New York, NY; Philadelphia, PA; Washington, DC; Atlanta, GA; Chicago, IL; Kansas City, MO; Fort Worth, TX; Houston, TX; Denver, CO; San Francisco, CA; Los Angeles, CA; and Seattle, WA.

(Federal Government activities may obtain copies of Federal standardization documents and the Index of Federal Specifications, Standards, and Commercial Item Descriptions from established distribution points in their agencies.)

Military Specifications:

- MIL-I-25017 - Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble
- MIL-S-53021 - Stabilizer Additive, Diesel Fuel.
- MIL-I-85470 - Fuel System Icing Inhibitor, High Flash Point.

Military Standards:

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-290 - Packaging, Packing, and Marking of Petroleum and Related Products.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the STDZ DCMNT ORDER DESK, BLDG 4D, 700 ROBBINS AVE, PHILADELPHIA PA 19111-5094.)

2.1.2 Other Government Documents

Department of Transportation

Title 40 of the Code of Federal Regulation (40 CFR), Part 80 - Regulation of Fuels and Fuel Additives.

Title 49 of the Code of Federal Regulations (49 CFR), Parts 100-199.

(Applications for copies should be addressed to the Superintendent of Documents, Government Printing office, Washington, D.C.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

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American Society for Testing and Materials (ASTM) Publications:

- D 86 - Distillation of Petroleum Products.
- D 93 - Flash Point by Pensky-Martens Closed Tester.
- D 97 - Pour Point of Petroleum Oils.
- D 129 - Sulfur in Petroleum Products by the Bomb Method.
- D 130 - Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test.
- D 445 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).
- D 482 - Ash from Petroleum Products.
- D 524 - Ramsbottom Carbon Residue of Petroleum Products.
- D 613 - Ignition Quality of Diesel Fuels by the Cetane Method.
- D 974 - Neutralization Number by Color-Indicator Titration.
- D 976 - Calculated Cetane Index of Distillate Fuels.
- D 1298 - Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
- D 1319 - Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorbent.
- D 1552 - Sulfur in Petroleum Products (High-Temperature Method).
- D 2274 - Oxidation Stability of Distillate Fuel Oil (Accelerated Method).
- D 2500 - Cloud Point of Petroleum Oils.
- D 2622 - Sulfur in Petroleum Products (X-Ray Spectrographic Method).
- D 4057 - Manual Sampling of Petroleum and Petroleum Products.
- D 4171 - Standard Specification for Fuel System Icing Inhibitors.
- D 4176 - Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures).
- D 4177 - Automatic Sampling of Petroleum and Petroleum Products.
- D 4294 - Sulfur in Petroleum Products by Nondispersive X-Ray Fluorescence Spectrometry.
- D 4530 - Micro Carbon Residue of Petroleum Products
- D 4737 - Calculated Cetane Index by Four Variable Equation
- D 5006 - Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels.
- D 5304 - Assessing Distillate Fuel Storage Stability by Oxygen Overpressure.
- D 5452 - Particulate Contamination in Aviation Fuels by Laboratory Filtration.

(The ASTM Methods listed above are included in Volumes 05.01 through 05.04 of the Annual Book of ASTM Standards and are available individually. Application for copies of all ASTM publications should be addressed to the ASTM, 1916 Race Street, Philadelphia, PA 19103.)

International Maritime Organization (IMO)

International Maritime Dangerous Goods Code (IMDG), Publication 200 89.10.E, Vols. I - IV.

(Application for copies should be addressed to the International Maritime Organization, 4 Albert Embankment, London SE1 7SR)

International Air Transport Association (IATA)**Dangerous Goods Regulations**

(Application for copies should be addressed to the Document Sales Unit, International Civil Aviation Organization, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada H3A 2R2).

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International Civil Aviation Organization (ICAO)

Technical Instructions for the Safe Transport of Dangerous Goods by Air, DOC 9284-AN/905.

(Application for copies should be addressed to the Document Sales Unit, International Civil Aviation Organization, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada H3A 2R2).

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Material. The diesel fuels supplied under this specification shall be refined hydrocarbon distillate fuel oils containing additives in accordance with 3.2. The feed stock from which the diesel fuel is refined shall be crude oils derived from petroleum, tar sands, oil shale, or mixtures thereof.

3.2 Additives. Diesel fuel shall contain Stabilizer additive (3.2.5) and only those additives permitted by 3.2.1 through 3.2.4, as required to meet specification requirements, when the fuel is purchased for the following purposes:

- a. For long term storage (more than six months).
- b. For use in pre-positioned or standby equipment.

Diesel fuel purchased for all other purposes may contain additives in addition to those permitted by 3.2.1 through 3.2.5 without prior approval, provided that the finished fuel meets the requirements of this specification.

3.2.1 Antioxidants. The following antioxidants may be blended separately or in combination into the diesel fuel to retard the formation of gum and other oxidation products:

- a. 2,4-Dimethyl-6-tert-butylphenol.
- b. 2,6-Di-tert-butyl-4-methylphenol.
- c. 2,6-Di-tert-butylphenol.
- d. 2,6-Di-tert-butylphenol (75 weight % min and a mixture of tert-butylphenols and tri-tert-butylphenols (25 weight % max).
- e. 2,4-Di-tert-butylphenol (60 weight % min) and mixed tert-butylphenols (40 weight % max).

The total concentration of antioxidants shall not exceed 24 grams per cubic meter on an active ingredient basis. The addition of antioxidants other than those listed herein may be permitted, provided that prior approval is obtained from the U.S. ARMY MOBILITY TECHNOLOGY CENTER BELVOIR, 5941 Wilson Road, STE 230, ATTN: AMSTA-RBF, Fort Belvoir, VA 22060-5843. Requests for approval shall contain the chemical or trade name of the additive, concentration to be used, and laboratory test data demonstrating the effectiveness of the additive in diesel fuels.

3.2.2 Cetane improvers. Any one or any combination of the following cetane improvers may be added to the diesel fuel to meet the cetane number requirements specified in table 1:

- a. 2-Ethylhexyl nitrate.
- b. Octyl nitrate.

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Concentration of the cetane improvers shall not exceed 0.25 weight percent in grade DL-A, and 0.5 weight percent in grades DL-1 and DL-2.

3.2.3 Corrosion inhibitors. Diesel Fuel DF-2/NATO F-54 shall contain a corrosion inhibitor conforming to MIL-I-25017. The concentration of corrosion inhibitor shall be within the minimum and maximum limits listed in the latest qualified products list (see 6.7).

3.2.4 Fuel system icing inhibitor. Fuel system icing inhibitor conforming to MIL-I-85470 (NATO Code S-1745) or ASTM D 4171 (Type III) may be blended into the diesel fuel to purge small quantities of water from the fuel system. The concentration of icing inhibitor shall not exceed 0.15 volume percent when tested in accordance with FED-STD-791, methods 5340, 5342, or ASTM D 5006.

3.2.5 Stabilizer additive. Diesel fuel stabilizer additive conforming to MIL-S-53021 may be blended into the diesel fuel when additional protection against deterioration and microbiological growth is required (see 3.2). Additives conforming to MIL-S-53021 perform the following functions: antioxidant, biocide, corrosion inhibitor, dispersant, and metal deactivator. The treatment rates for stabilizer additives shall be as shown in the latest qualified products list (see 6.6).

TABLE 1. Physical and chemical requirements.

Properties	Values			
	Grade DL-A	Grade DL-1	Standard Grade	
			DL-2	NATO F-54
Density, kg/L @ 15 °C	Report	Report	Report	0.815 to 0.860
Flash point, °C min.	38	38	52	56 ^{1/}
Cloud point, °C max.	-51	^{2/}	^{2/}	^{2/}
Pour point, °C max.	Report	Report	Report	^{2/}
Kinematic viscosity, cSt				
@ 20 °C	-	-	-	1.8 to 9.5
@ 40 °C	1.1 to 2.4	1.3 to 2.9	1.9 to 4.4	
Distillation, °C				
50 % evaporated	Report	Report	Report	Report
90 % evaporated, max.	288	288	338	357
End point, max.	300	330	370	370
Residue, vol. %, max.	3	3	3	3
Carbon residue on 10 % bottoms, mass %, max. ^{4/}	0.1	0.15	0.35	0.2
Sulfur, mass %, max.	0.05 ^{5/}	0.05 ^{5/}	0.05 ^{5/}	0.30 ^{5/}
Copper strip corrosion, 3 hrs. @50°C max. rating	3	3	3	1
Scuffing Load Wear, g, min ^{2/}	3300	3300	3300	--
Ash, %, max.	0.01	0.01	0.01	0.02
Accelerated stability, total insolubles, mg/100 mL, max.	1.5	1.5	1.5	1.5
Neutralization number, TAN, max.	0.05	--	--	0.1
Particulate contamination, mg/L, max.	10	10	10	10
Cetane number, min. ^{5/}	40	40	40	45
Clean Air Act (CAA) ^{5/}				

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Cetane Index, min.	<u>2/</u>	<u>2/</u>	<u>2/</u>	--
or Aromaticity, vol %, max.	35	35	35	--

- 1/ Diesel fuel DF-2 intended for the Central European Pipeline System shall have a minimum value of 58°C.
- 2/ As specified by the procuring activity based on guidance in appendix A. Diesel fuel DF-2 for Europe and S. Korea shall have maximum limit of -13 °C.
- 3/ As specified by the procuring activity (see 6.2). Diesel fuel DF-2 for Europe and S. Korea shall have a maximum limit of -18 °C.
- 4/ See appendix B. If the fuel contains cetane improvers, the test must be performed and reported on both the base fuel blend and treated fuel. However, limits apply only to the base fuel.
- 5/ Applies to all diesel fuel used in the U.S. including Alaska, Hawaii, and U.S. territories and possessions.
- 6/ Not for use in U.S., Alaska, Hawaii, or U.S. territories and possessions.
- 7/ The 3300g min is applicable to a single test result. For an average of two test results, the minimum limit is 3000g, and for a three result average the minimum limit is 2800g.
- 8/ If calculated cetane index is used in lieu of Cetane Number, then the minimum Cetane Index shall be 43 for grades DL-A, DL-1, and Standard DL-2.
- 9/ The Cetane Index test method to meet the CAA is ASTM D 976. The minimum Cetane Index to meet only CAA (if you meet Cetane Number using ASTM D 613) is 40 min., otherwise the minimum for Cetane Index is 43 min. as in footnote 8.

3.3 Physical and chemical requirements. The finished diesel fuels shall conform to the requirements specified in table 2, 3.4, and 3.5 (see 6.4).

TABLE 2. Test methods.

Test	Test Method No.
Density	ASTM D 1298
Flash point	ASTM D 93
Cloud point	ASTM D 2500
Pour point	ASTM D 97
Kinematic viscosity	ASTM D 445
Distillation	ASTM D 86
Carbon residue <u>1/</u>	ASTM D 524, D 4530
Sulfur <u>2/</u>	ASTM D 129, D 1552, D 2622, or D 4294
Copper strip corrosion	ASTM D 130
Scuffing Load Wear Test	Appendix C
Ash	ASTM D 482
Accelerated stability	ASTM D 2274, D 5304
Neutralization	ASTM D 974
Particulate contamination	ASTM D 5452
Aromaticity	ASTM D 1319
Cetane number <u>3/</u>	ASTM D 613
Cetane Index	ASTM D 976, D 4737
Fuel system icing inhibitor	FED-STD-791, methods 5340, 5342 or D 5006
Workmanship	ASTM D 4176, procedure 1 or 2

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- 1/ See Appendix B.
- 2/ For Standard DL-2 fuel in the U.S (including Alaska, Hawaii, and U.S. territories and possessions) use only ASTM D 2622. For NATO F-54, ASTM D 1552 is the preferred method but ASTM D 129, D 2622, or D 4294 may be used as an alternate.
- 3/ ASTM D 613 is the preferred method of determining cetane quality. When cetane number by ASTM D 613 is not available, ASTM D 976 or D 4737 may be used as alternate. If a calculated cetane index is used in lieu of cetane number, the minimum shall be 43 for grades DL-A, DL-1, and Standard DL-2. ASTM D 976 or D 4737 shall not be permitted as alternate for NATO F-54 Military Diesel Fuel. ASTM D 976 shall be use to meet cetane index under the Clean Air Act requirement

3.4 Material Safety Data Sheets(MSDS). The contractor shall provide an MSDS which complies with all the requirements for a hazardous as prescribed in FED-STD-313 when fuel is packaged in drums or cans. A MSDS is not required for bulk deliveries (see 6.5).

3.5 Workmanship. The finished diesel fuel shall be visually free from undissolved water, sediment, and suspended matter; and shall be clear and bright when tested in accordance with ASTM D 4176, procedure 1 or 2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Component and material inspection. The contractor is responsible for insuring that components and materials are manufactured, examined, and tested in accordance with referenced specifications and standards, as applicable.

4.2 Lot.

4.2.1 Bulk lot. An indefinite quantity of a homogeneous blend of diesel fuel of one grade offered for acceptance in a single isolated container; or manufactured in a single plant run (not exceeding 24 hours) through the same blending or processing equipment, with no change in ingredient material.

4.2.2 Packaged lot. An indefinite number of 55-gallon drums or other unit containers of identical size and type, offered for acceptance, and filled with a homogeneous blend of diesel fuel of one grade from one isolated container; or filled with a homogeneous blend of diesel fuel of one grade manufactured in a single plant run (not exceeding 24 hours) through the same blending or processing equipment, with no change in ingredient material.

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4.3 Sampling.

4.3.1 Sampling for the inspection of filled containers. Take a random sample of filled containers from each lot in accordance with MIL-STD-105, at inspection level II. Presence of one or more defects shall be cause for rejection.

4.3.2 Sampling for tests. Take samples for tests in accordance with ASTM D 4057 or D 4177. Test the samples in accordance with 4.6.

4.4 Inspection. Perform inspection in accordance with FED-STD-791, method 9601.

4.4.1 Examination of the preparation for delivery. Examine samples taken in accordance with 4.3.1 for compliance with MIL-STD-290 with regard to fill, closure, sealing, leakage, packaging, packing, and marking requirements. Reject any container having one or more defects or under the required fill. Reject the lot represented by the sample if the number of defective or underfilled containers exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105. Packaged Lot (see 4.2.2) only requires one MSDS. Reject packaged lot if a MSDS is not in accordance with FED-STD-313.

4.5 Classification of tests. All tests are quality conformance tests.

4.6 Test methods. Perform tests in accordance with the applicable methods listed in table 2 and Appendices B and C.

5. PREPARATION FOR DELIVERY

5.1 Packaging, packing, and marking. Unless otherwise specified in the contract or order (see 6.2), packaging, packing, and marking shall be in accordance with MIL-STD-290.

5.2 Transportation of fuels. The transportation of fuels under this specification shall be in accordance with the following documents:

- | | |
|-----------------------------|---|
| a. Continental U.S. | <ul style="list-style-type: none"> - 40 CFR, Part 80 - Regulation of Fuels and Fuel Additives - 49 CFR, Parts 100-199 |
| b. Outside Continental U.S. | <ul style="list-style-type: none"> - International Maritime Dangerous Goods Code (IMDG), Publication 200 89.10.E, Vols I-IV - IATA Dangerous Goods Regulations - ICAO Technical instructions for the Safe Transport of Dangerous Goods by Air, DOC 9284-AN/905 |

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

6.1.1 Military symbol DL-A. Arctic-grade low-sulfur diesel fuel oil is intended for use in high-speed automotive-type diesel engines, gas turbine engines other than aircraft, and pot-type burner space-heaters, in areas where ambient temperatures lower than -32 °C generally occur, and where it is impractical to maintain dual storage capabilities. This grade of diesel fuel should not be used for slow-speed stationary engine applications.

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6.1.2 Military symbol DL-1. Winter-grade low-sulfur diesel fuel oil is intended for use in high-speed automotive diesel engines and gas turbine engines other than aircraft, in areas in which ambient temperatures as low as -32 °C may occur (see appendix A). This grade of diesel fuel may be used for medium-speed stationary engine applications, where fuel heating facilities are not available.

6.1.3 Military symbol DL-2. Regular-grade low-sulfur diesel fuel oil is intended for use in all automotive high-speed/medium-speed engine applications and gas turbine engines other than aircraft, in temperate climates according to guidelines in appendix A.

6.1.4 Military symbol DF-2. Regular-grade diesel fuel oil is intended for OCONUS use only in all automotive high-speed/medium-speed engine applications and gas turbine engines other than aircraft, in temperate climates according to guidelines in table 4-appendix A.

6.1.5 Use of diesel fuel oil in space heaters. Diesel fuel oil should not be burned in space heaters which are not vented to the outside to prevent personnel from being overcome by sulfur dioxide and other combustion products.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of the specification.
- b. Grade designation (military symbol; see 1.2).
- c. *Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).*
- d. Expected Storage time: Long or Short (see 3.2)
- e. Size and type container required (see 5.1).
- f. Quantity of diesel fuel required. The unit of purchase is the U.S. gallon (231 cubic inches at 60°F (15.6°C)).
- g. Level of packaging and level of packing required (see 5.1).
- h. Cloud point for DL-1 and DL-2 (see appendix A).
- i. Pour point for NATO F-54 DF-2 (see note 3, table 1).

6.3 Standardization agreements. Certain provisions of this specification are the subject of international standardization agreements (NATO STANAGs 1135, 2754, and 2845). When amendment, revision, or cancellation of this specification is proposed which would affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental standardization offices, if required.

6.4 NATO and non-NATO applications of grade DL-2. The requirements for NATO F-54 grade diesel fuel DF-2 specified in table I are intended primarily for the acquisition of military diesel fuel in accordance with the STANAGs cited in 6.3. In non-NATO areas overseas, standard DL-2 or NATO F-54 may also be used for military applications. If fuel meeting standard DL-2 or NATO F-54 requirements is not commercially available in non-NATO areas overseas, the contracting officer may permit limited waivers of the requirements in table 1 on a case by case basis to ensure adequate fuel availability.

6.5 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.6 Stabilizer additive. Diesel fuel stabilizer additive conforming to MIL-S-53021 is not intended for routine use in all diesel fuels, but should be used only in situations where protection against deterioration and microbiological growth is required. Typical applications are fuel supplies for designated high-priority missions, marginally stable fuel scheduled for consumption during extremely hot weather which tends to accelerate deterioration, and equipment undergoing depot rebuild.

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However, the following applications must use the stabilizer additive (see 3.2) due to expected long periods of inactivity:

- a. Pre-positioned fuel
- b. Prepositioned equipment stored fully-fueled
- c. Equipment undergoing depot or interim storage
- d. National Guard and Reserve equipment, which may be inactive for long periods of time.

Treatment rates for the stabilizer additive varies according to whether is a single or dual package system, or formulation technology. However, treatment rates are shown in QPL-53021.

6.7 Corrosion inhibitors. The minimum and maximum concentration limits for each corrosion inhibitor are shown on QPL-25017.

6.8 Subject term (key word) listing.

Diesel fuel
 Low Sulfur
 Fuel oil, diesel, Arctic grade
 Fuel oil, diesel, regular grade
 Fuel oil, diesel, winter grade

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

MILITARY INTEREST:

Custodians:

Army - ME
 Navy - SH
 Air Force - 68

Review activities:

Army - AT, MI
 Navy - YD

User activities:

Army - AR
 Navy - MC

CIVIL AGENCY COORDINATING ACTIVITIES:

GSA - FSS
 DOT - NHT
 HHS - FEC, NIH

Preparing Activity:

Army - ME

Project 9140-0135

Orders for this publication are to be placed with General Services Administration, acting as an agent for the Superintendent of Documents. See section 2 of this specification to obtain extra copies and other documents referenced herein.

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TENTH PERCENTILE MINIMUM AMBIENT TEMPERATURE FOR DEFINING
SATISFACTORY LOW TEMPERATURE PROPERTIES OF DIESEL FUEL

10. SCOPE

10.1 Scope. This appendix is mandatory. It covers a method to assess the low temperature operability limit for automotive diesel fuel.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. METHODOLOGY

30.1 Minimum daily temperatures compiled from weather stations were statistically evaluated to determine the probability for various temperature occurrences. A method of reporting this probability is with the use of percentiles which evaluate the compiled distribution and report the temperatures corresponding to their probabilities of occurrence. To predict limiting low ambient temperatures, the 10th percentile minimum temperature values have been selected as a realistic guide. By definition, the 10th percentile minimum temperature predicts a 10 percent chance that the daily minimum will be lower than the predicted value, or a 90 percent chance that the daily minimum will be no lower than the predicted value.

40. APPLICATION

40.1 The 10th percentile minimum temperature values for the United States and OCONUS areas are tabulated and presented in table 3 and 4. Satisfactory operation should be achieved in most cases if the cloud point is specified at or below the 10th percentile minimum temperature. This guidance is of general nature as some equipment design, use of flow improvers, fuel properties, and type of operating conditions may allow higher or require lower cloud point fuels.

TABLE 3. United States 10th percentile minimum temperatures, °C.

State	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Alabama	13	4	-3	-6	-7	-3	-2
Alaska: <u>1/</u>							
Northern	-7	-25	-37	-45	-49	-47	-43
Southern	-1	-11	-13	-18	-32	-32	-29
South East	1	-4	-11	-16	-19	-13	-12
Arizona:							
N 34° LAT	1	-4	-12	-14	-17	-16	-12
S 34° LAT	13	7	0	-2	-4	-3	-1
Arkansas	9	2	-4	-7	-11	-7	-3
California: <u>2/</u>							
N and S Coast	6	4	0	-2	-2	-1	-1
Interior and SE	6	1	-6	-8	-11	-7	-6
Colorado:							
E 105° LONG	4	-2	-12	-14	-19	-15	-12
W 105° LONG	-3	-8	-18	-25	-30	-24	-16
Connecticut	4	-1	-7	-16	-17	-16	-9
Delaware	8	2	-3	-10	-11	-10	-6
Florida	17	7	1	-1	-3	-1	4
Georgia	12	3	-2	-6	-7	-6	-2
Idaho	2	-4	-13	-18	-21	-18	-13
Illinois	5	-1	-9	-19	-21	-18	-11
Indiana	6	-1	-7	-16	-18	-16	-9
Iowa	4	-2	-13	-23	-26	-22	-16

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APPENDIX ATABLE 3. United States 10th percentile minimum temperatures, °C. (continued)

State	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Kansas	4	-2	-11	-15	-19	-14	-13
Kentucky	7	1	-6	-13	-14	-11	-6
Louisiana	14	5	-1	-3	-4	-2	1
Maine	1	-3	-10	-23	-26	-26	-18
Maryland	8	2	-3	-10	-12	-10	-4
Massachusetts	3	-2	-7	-16	-18	-17	-10
Michigan	1	-2	-11	-20	-23	-23	-18
Minnesota	-1	-4	-18	-30	-34	-31	-24
Mississippi	13	3	-3	-6	-6	-4	-1
Missouri	8	1	-7	-14	-16	-13	-8
Montana	-1	-7	-18	-24	-30	-24	-21
Nebraska	3	-3	-13	-18	-22	-19	-13
Nevada:							
N 38° LAT	-2	-7	-14	-18	-22	-18	-13
S 38° LAT	14	8	0	-3	-4	-2	1
New Hampshire	1	-3	-8	-18	-21	-21	-12
New Jersey	8	2	-3	-11	-12	-11	-6
New Mexico	5	-2	-11	-14	-17	-14	-11
New York	1	-3	-8	-21	-24	-24	-16
North Carolina	6	-1	-7	-10	-11	-9	-5
North Dakota	1	-4	-20	-27	-31	-29	-22
Ohio	4	-1	-7	-16	-17	-15	-9
Oklahoma	9	1	-8	-12	-13	-8	-7
Oregon:							
E 122° LONG	-1	-6	-11	-14	-19	-21	-9
W 122° LONG	4	0	-4	-5	-7	-4	-3
Pennsylvania	0	-3	-8	-19	-20	-21	-15
Rhode Island	6	1	-3	-12	-13	-13	-7
South Carolina	13	5	-1	-5	-5	-3	-2
South Dakota	3	-4	-14	-24	-27	-24	-18
Tennessee	7	1	-5	-9	-11	-9	-4
Texas:							
N 31° LAT	9	3	-6	-9	-13	-9	-7
S 31° LAT	16	9	2	-2	-3	-1	2
Utah	4	-2	-11	-14	-18	-14	-8
Vermont	3	-3	-8	-20	-23	-24	-15
Virginia	8	2	-3	-9	-11	-9	-4
Washington:							
E 122° LONG	2	-2	-8	-11	-18	-11	-8
W 122° LONG	3	0	-3	-3	-7	-4	-3
West Virginia	3	-3	-8	-15	-16	-14	-9
Wisconsin	2	-3	-14	-24	-28	-24	-18
Wyoming	1	-4	-15	-18	-26	-19	-16

1/ Details of state division are as indicated:

- * Northern Region: Area north of the 62° LAT.
- * Southern Region: Area bordered on the north by the 62° LAT, bordered on the east by the 141° LONG., and bordered on the south by the 56° LAT.
- * Southeastern Coast Islands: Area bordered on the north by Canada, bordered on the east and Aleutian west by the 141° LONG., and the remaining area bordered on the north by the 56° LAT.

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APPENDIX A2/ Details of state division by county as indicated:

- California, North Coast - Alameda, Contra Costa, Del Norte, Humboldt, Lake, Marin, Mendocino, Monterey, Napa, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, Trinity
- California, Interior - Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Fresno, Glenn, Kern (except that portion lying east of the Los Angeles County Aqueduct), Kings, Lassen, Madera, Mariposa, Merced, Modoc, Nevada, Placer, Plumas, Sacramento, San Joaquin, Shasta, Sierra, Siskiyou, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Yolo, Yuba
- California, South Coast - Los Angeles (except that portion north of the San Gabriel Mountain range and east of the Los Angeles County Aqueduct), Orange, San Diego, San Luis Obispo, Santa Barbara, Ventura
- California, Southeast - Imperial, Inyo, Kern (that portion lying east of the Los Angeles County Aqueduct), Los Angeles (that portion north of the San Gabriel Mountain range and east of the Los Angeles County Aqueduct), Mono, Riverside, San Bernardino

TABLE 4. OCONUS 10th percentile minimum temperatures, °C.

Country	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Austria	-1	-5	-12	-10	-9	-6	-1
Belgium	0	-3	-9	-7	-6	-6	-3
Denmark	-1	-3	-6	-7	-7	-7	-3
France	0	-2	-9	-9	-5	-5	-1
Germany	-2	-5	-13	-13	-12	-9	-5
Greece	5	0	-3	-3	-2	-1	3
Iceland	-1	-5	-7	-9	-7	-7	-4
Italy	1	-3	-6	-8	-7	-3	-1
Korea	1	-6	-13	-20	-15	-7	-1
Luxembourg	1	-3	-7	-7	-6	-4	-2
Netherlands	0	-2	-8	-8	-6	-5	-2
Norway	-6	-14	-16	-18	-18	-16	-6
Portugal	8	4	1	1	1	1	5
Turkey	-1	-6	-10	-16	-16	-6	-1
United Kingdom	0	-4	-4	-4	-6	-4	-4

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APPENDIX B

DETECTION OF NITRATE-TYPE IGNITION IMPROVERS IN DIESEL FUEL

10. SCOPE

10.1 **Scope.** This appendix is mandatory. The method of test covers the determination of organic nitrate ester-type cetane improver additives used in diesel fuel. It is intended as a screening test for those diesel fuel inspection test procedures that are affected by the presence of cetane improvers; namely, ASTM D 524 and ASTM D 976.

20. **APPLICABLE DOCUMENTS.** This section is not applicable to this appendix.

30. SUMMARY

30.1 A diesel fuel sample is saponified in a potassium hydroxide-*n*-butanol mixture and then filtered through a glass fiber filter disk. The material remaining on the disc is treated with diphenylamine reagent after drying. The presence of a nitrate ester cetane improver is revealed by the formation of a blue ring or blue-black spot due to oxidation of diphenylamine to intense blue quinoidal compounds by the nitrate salt. No color change confirms the absence of a cetane improver.

40. APPARATUS

40.1 Reaction bottle - Screw-cap bottle, 29.6 mL (1 fl. oz.) capacity, wide mouth, flint glass, with screw cap lined with tin or tetrafluoroethylene (TFE) resin.

40.2 Glass fiber filter paper - 37 mm diameter, Grade 934 AH (H. Reeve Angel, Inc., Clifton, N.J., or equivalent).

40.3 Pipette - 10 mL capacity, fitted with a pipetting bulb. Several types and makes of pipetting bulbs and assemblies are available. One of the following is suggested: Fisher Cat. No. 13-681, Pipet Filler, Fisher Safety, or equal; Fisher Cat. No. 13-681-50, Pipet Filler, or equal; Fisher Cat No. 13-682, Pipet Adapter, Fisher, or equal.

40.4 Graduated cylinders - 10 mL and 25 mL capacity.

40.5 Suction flask with a suitable holder to accommodate a 60 mL glass-fitted crucible.

40.6 Crucible - 60 mL capacity, glass-fritted, medium porosity.

40.7 Oven suitable for drying filter discs at 110 °C.

50. REAGENTS

50.1 Saponification mixture (1N) - Prepared by mixing 6.5 g potassium hydroxide (KOH, ACS grade) with 100 mL absolute *n*-butanol (ACS grade) and heating to dissolve the KOH. After the solution cools, the mixture is filtered through the glass fiber filter paper.

50.2 Diphenylamine (1 percent solution) - Prepared by dissolving 0.250 g diphenylamine (ACS indicator grade) in 25 mL sulfuric acid (sp. gr. 1.834).

50.3 Toluene (ACS reagent grade).

NOTE: Toluene is flammable and toxic. Avoid breathing vapors or contact with skin.

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60. PROCEDURE

60.1 Pipette 10 mL of sample into the reaction bottle and add 5 mL of toluene followed by 10 mL of the saponification mixture.

NOTE: Oral pipetting techniques should not be used because of the toxicity of the substances involved. A pipeting bulb or assembly similar to one of those described in 40.3 should be used.

60.2 Affix cap to the reaction bottle tightly and, after mixing the contents, place it in an oven maintained at 110 ± 5 °C for 4 hours.

60.3 Remove the reaction bottle from the oven and allow to cool to 25 ± 3 °C.

60.4 Filter the contents of the reaction bottle through the 60 mL glass-fritted crucible fitted with the glass filter disc.

60.5 Wash the reaction bottle with 25 mL of toluene and transfer it to the glass-fritted crucible.

60.6 Carefully remove the glass fiber filter disc and dry it in oven at 110 ± 5 °C for 15 minutes.

60.7 Remove the filter disc and cool it to 25 ± 3 °C.

60.8 Add 3 drops of diphenylamine solution to the center of the disc and observe whether a blue or blue-black color forms.

70. REPORT

70.1 The presence of organic nitrate ester-type cetane improvers will be reported if the formation of a blue color occurs. Reference samples of diesel fuels containing 0.5 percent by volume of any one of the approved cetane improvers (amyl nitrate, cyclohexyl nitrate, hexyl nitrate, isopropyl nitrate, 2-ethylhexyl nitrate, and octyl nitrate) give an intense blue to blue-black color throughout the reagent spot whereas those samples containing only 0.1 percent by volume produce a blue ring at the outer boundary of the reagent. If a positive reaction occurs (i.e., a blue or blue-black coloration), the carbon residue determination (ASTM D 524) must be performed on a neat or base fuel blend.