METRIC
MIL-DTL-16884N
22 April 2014
SUPERSEDING
MIL-DTL-16884M
14 August 2012

DETAIL SPECIFICATION

FUEL, NAVAL DISTILLATE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one grade of naval distillate fuel: NATO symbol F-76.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INTERNATIONAL STANDARDIZATION AGREEMENTS

NATO STANAG 1135 - Interchangeability of Fuels, Lubricants and Associated Products Used by the Armed Forces of the North Atlantic Treaty Nations

NATO STANAG 1385 - Guide Specification (Minimum Quality Standards) for Naval Distillate Fuels (F-75 and F-76)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-32490 - Additive, Lubricity Improver, Diesel

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-290 - Packaging and Marking of Petroleum and Related Products

(Copies of these documents are available online at http://quicksearch.dla.mil.)

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D86	-	Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure
ASTM D93	-	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
ASTM D97	-	Standard Test Method for Pour Point of Petroleum Products
ASTM D130	-	Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D189	-	Standard Test Method for Conradson Carbon Residue of Petroleum Products
ASTM D287	-	Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)
ASTM D445	-	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D482	-	Standard Test Method for Ash from Petroleum Products
ASTM D524	-	Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products
ASTM D613	-	Standard Test Method for Cetane Number of Diesel Fuel Oil
ASTM D664	-	Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration
ASTM D974	-	Standard Test Method for Acid and Base Number by Color-Indicator Titration
ASTM D976	-	Standard Test Method for Calculated Cetane Index of Distillate Fuels
ASTM D1141	-	Standard Practice for the Preparation of Substitute Ocean Water
ASTM D1266	-	Standard Test Method for Sulfur in Petroleum Products (Lamp Method)
ASTM D1298	-	Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D1401	-	Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
ASTM D1500	-	Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
ASTM D2274	-	Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)
ASTM D2425	-	Standard Test Method for Hydrocarbon Types in Middle Distillates by Mass Spectrometry
ASTM D2500	-	Standard Test Method for Cloud Point of Petroleum Products
ASTM D2622	-	Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

ASTM D2709 - Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge

ASTM D2887 - Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

ASTM D3120 - Standard Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry

ASTM D3605 - Standard Test Method for Trace Metals in Gas Turbine Fuels by Atomic Absorption and Flame Emission Spectroscopy

ASTM D3828 - Standard Test Methods for Flash Point by Small Scale Closed Cup Tester

ASTM D4052 - Standard Test Method for Density, Relative Density and API Gravity of Liquids by Digital Density Meter

ASTM D4057 - Standard Practice for Manual Sampling of Petroleum and Petroleum Products

ASTM D4176 - Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)

ASTM D4177 - Standard Practice for Automatic Sampling of Petroleum and Petroleum Products

ASTM D4530 - Standard Test Method for Determination of Carbon Residue (Micro Method)

ASTM D4808 - Standard Test Methods for Hydrogen Content of Light Distillates, Middle Distillates, Gas Oils, and Residua by Low-Resolution Nuclear Magnetic Resonance Spectroscopy

ASTM D5291 - Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants

ASTM D5304 - Standard Test Method for Assessing Middle Distillate Fuel Storage Stability by Oxygen Overpressure

ASTM D5452 - Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration

ASTM D5453 - Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

ASTM D5771 - Standard Test Method for Cloud Point of Petroleum Products (Optical Detection Stepped Cooling Method)

ASTM D5772 - Standard Test Method for Cloud Point of Petroleum Products (Linear Cooling Rate Method)

ASTM D5773 - Standard Test Method for Cloud Point of Petroleum Products (Constant Cooling Rate Method)

ASTM D5949 - Standard Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)

ASTM D5950 - Standard Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)

ASTM D5985 - Standard Test Method for Pour Point of Petroleum Products (Rotational Method)

ASTM D6045 - Standard Test Method for Color of Petroleum Products by the Automatic Tristimulus Method

ASTM D6079 - Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)

ASTM D6217 - Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration

ASTM D6450 - Standard Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester

ASTM D6591 - Standard Test Method for Determination of Aromatic Hydrocarbon Types in Middle Distillates – High Performance Liquid Chromatography Method with Refractive Index Detection

ASTM D6890 - Standard Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber

ASTM D7039 - Standard Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry

ASTM D7111 - Standard Test Method for Determination of Trace Elements in Middle Distillate Fuels by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

ASTM D7170 - Standard Test Method for Determination of Derived Cetane Number (DCN) of Diesel Fuel Oils-Fixed Range Injection Period, Constant Volume Combustion Chamber Method

ASTM D7171 - Standard Test Method for Hydrogen Content of Middle Distillate Petroleum Products by Low-Resolution Pulsed Nuclear Magnetic Resonance Spectroscopy

ASTM D7688 - Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFFR) by Visual Observation

ASTM D7777 - Standard Test Method for Density, Relative Density, or API Gravity of Liquid Petroleum by Portable Digital Density Meter

ASTM E29 - Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

(Copies of these documents are available online at www.astm.org.)

BRITISH STANDARDS INSTITUTE

BS EN 14078 - Liquid petroleum products - Determination of fatty acid methyl ester (FAME) content in middle distillates - Infrared spectrometry method

(Copies of this document are available online at http://shop.bsigroup.com.)

ENERGY INSTITUTE

IP 579 - Liquid petroleum products - Determination of fatty acid methyl ester (FAME) content in middle distillates - Infrared spectrometry Method

(Copies of this document are available online at www.energypublishing.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. Requirements contained herein are not subject to corrections for tolerance of standard test methods. If multiple determinations are made by the inspecting laboratory, average results will be used except for those standard test methods where repeatability data are given. In those cases, the average value derived from the individual results that agree within the repeatability limits given may be used at the discretion of the inspection authority, provided an indication is given of the total number of results obtained and the number falling outside of the repeatability limits. The flash point value is absolute and no value less than 60.0 °C is permissible. For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of ASTM E29.

3.2 Material. The fuel supplied under this specification shall consist of refined hydrocarbon distillate fuel, containing no residual fuel, and may contain only those additives specified in 3.2.2. The fuel shall be derived from conventional material sources, synthesized materials, or mixtures thereof. Conventional material sources are defined as crude oil, natural gas liquid condensates, heavy oil, shale oil, and oil sands. The fuel shall not contain any intentionally blended oxygenated compounds including fatty acid methyl esters (FAME), as specified in 3.2.3.

3.2.1 Synthesized materials. A maximum of 50 volume percent of the finished fuel (see 6.3.4) may consist of Synthesized Paraffinic Diesel (SPD) (see 6.3.9) blend components derived from Hydroprocessed Renewable Diesel (HRD) (see 6.3.6 and 6.3.7) or Fischer-Tropsch (FT) produced SPD. The remainder of the finished fuel must be comprised of conventional source blending components (see 6.3.3). Fischer-Tropsch Hydroprocessed Synthetic Paraffinic Diesel (FT-SPD) (see 6.3.5) and HRD derived blend components shall conform to the requirements in Appendix A. Finished fuel containing synthetic materials shall conform to the properties listed in table I. If the finished fuel containing synthetic materials requires additives, then only the additives in accordance with 3.2.2 shall be used.

3.2.2 Additives. The additives listed herein may be used either singularly or in combination, provided the amounts do not exceed those specified herein. When specified (see 6.2), information concerning the type and dosage rate of each additive used shall be made available when requested by the procuring activity or user. All other additives are prohibited without prior approval from the cognizant activity below:

Cognizant activity for Fuel Additives:

Commander, Naval Sea Systems Command
Ship Integrity and Performance Engineering (SEA 05P2)
1333 Isaac Hull Avenue, SE, Bldg. 197, Washington Navy Yard, DC 20376

3.2.2.1 Metal deactivator. A metal deactivator, N, N-disalicyclidene-1, 2 propanediamine, may be blended into the fuel provided the dosage rate does not exceed 5.8 milligrams of active ingredient per liter of fuel (2.2 grams per 100 U.S. gallons or 2 pounds per 1000 barrels).

3.2.2.2 Lubricity improver additives. Lubricity improver additives may be used to meet the lubricity requirement in table I. The lubricity improver additive shall have an approved formulation in accordance with MIL-PRF-32490 and shall not exceed the maximum dosage rate prescribed by MIL-PRF-32490.

3.2.3 FAME. The recent mandatory and voluntary introduction of FAME (commonly known as biodiesel) in the commercial middle distillate marketplace has resulted in the potential for trace amounts of FAME in F-76 fuel. Fuel supplied under this specification shall not intentionally be blended with FAME. In the event of contamination with FAME, the fuel supplied under this specification shall not contain more than 0.1 volume percent FAME as determined by BS EN 14078 or IP 579.

3.3 Physical and chemical requirements. The naval distillate fuel shall conform to the physical and chemical requirements specified in table I. These tests are performed on the finished product. Where more than one test method is allowed for a specific requirement, table I identifies the referee test method first, followed by the notation "(R)".

TABLE I. Physical and chemical requirements.

Characteristic	Requirement		ASTM Test Method
	Minimum	Maximum	
PHYSICAL REQUIREMENTS			
Appearance, at 25 °C or ambient, whichever is higher	Clear, bright, and free of visible particulates		D4176 [1/]
Demulsification, at 25 °C, minutes		10	D1401 [2/]
Density, at 15 °C, kg/m^3	800	876	D1298 (R), D4052, D287, D7777
Distillation: 10% Recovered, °C 50% Recovered, °C 90% Recovered, °C End Point, °C Residue + Loss, volume %	 Report Report	 357 385 3.0	D86 (R) [3/], D2887 [4/]
Cloud Point, °C		-1	D2500 (R), D5771 [5/], D5772 [5/], D5773 [5/]
Color		3	D1500 (R), D6045
Flash Point, °C	60.0		D93 (R) [6/], D6450 [6/], D3828 [6/]
Particulate Contamination, mg/L		10	D6217 (R), D5452 [7/]
Pour Point, °C		-6	D97 (R), D5949, D5950, D5985 [8/]
Viscosity, at 40 °C, mm^2/second	1.7	4.3	D445
CHEMICAL REQUIREMENTS			
Acid Number, mg KOH/g		0.30	D974 (R) [9/], D664
Ash, mass %		0.005	D482
Aromatics, mass %	8.1 [10/]		D6591 (R), D2425
Carbon Residue on 10% bottoms, mass %		0.20	D524 (R) [11/]
		0.14	D189, D4530 [11/]
Corrosion, 3 hours at 100 °C		No. 1	D130
Hydrogen Content, mass %	12.5		D7171 (R), D4808, D5291
Ignition Quality: Cetane Number, or Cetane Index, or Derived Cetane Number	 42 43 42	 	 D613 (R) D976 [12/] D6890, D7170
Storage Stability, total insolubles, mg/100 ml		3.0	D5304 (R) [13/, 14/]
		1.5	D2274 [14/, 15/]
Sulfur Content, mass %		0.0015 [16/]	D5453 (R), D1266, D2622, D3120, D7039
Trace Metals, mg/kg: Calcium Lead Sodium plus Potassium Vanadium	 	 1.0 0.5 1.0 0.5	D7111 (R), D3605 [17/]
Lubricity, at 60 °C, micrometers		460	D6079 (R), D7688
Additive Names and Dosages	Report		

TABLE I. Physical and chemical requirements – Continued.

NOTES:

1/ If the sample has no visible particulates, but is otherwise not "clear and bright" (see 6.3.2) in accordance with ASTM D4176, Procedure 1, then the product shall meet the requirements of ASTM D2709, 0.05-volume percent of water and sediment, maximum. The fuel is acceptable for appearance if the water and sediment content is 0.05 percent volume or less. If the sample fails ASTM D4176, Procedure 1, because it contains visible sediment or particulate matter, but meets the requirements of 10 milligrams per liter (mg/L), maximum, in accordance with ASTM D6217 or ASTM D5452, then the fuel is considered acceptable provided all other physical and chemical requirements are met.

2/ The demulsification test shall be conducted in accordance with ASTM D1401 with the following exceptions:

(a) Synthetic seawater in accordance with ASTM D1141 shall be the emulsifying fluid.

(b) The test temperature shall be 25 °C.

(c) The demulsification time shall be that required for separation into two layers with no visible cuff at the interface. A lacy emulsion or cuff which does not form a band shall be disregarded. The fuel/water/emulsion layer volumes shall be recorded at 1-minute intervals and the demulsification time reported to the nearest minute.

3/ As the end point of the distillation is approached, if either a thermometer reading of 385 °C or a decomposition point is observed, the heating shall be discontinued and the procedure resumed as directed in ASTM D86.

4/ Results from ASTM D2887 shall be reported as "Predicted D86" results by application of the correlation in the Correlation for Jet and Diesel Fuel appendix of ASTM D2887 to convert the values. ASTM D86 shall remain as the referee method. Distillation residue and loss limits provide control of the distillation process during the ASTM D86 test method and do not apply to ASTM D2887.

5/ If either ASTM D5771, ASTM D5772, or ASTM D5773 is used, the temperature recorded in each respective test shall be rounded to the next lower integer and reported as the ASTM D2500 equivalent cloud point in accordance with ASTM D5771, ASTM D5772, or ASTM D5773.

6/ The flash point value is absolute and no value less than 60.0 °C is permissible.

7/ If ASTM D5452 is utilized, a minimum 1-liter sample will be used to meet the sample requirement of ASTM D6217.

8/ If either ASTM D5949, ASTM D5950, or ASTM D5985 is used, the results from these tests shall be based on the observations at 3 °C temperature intervals and reported as the ASTM D97 equivalent.

9/ The sample size when using ASTM D974 shall be 20.0±2.0 grams.

10/ Requirement applies only to finished fuels containing synthesized materials as defined in Appendix A.

11/ Fuel must meet the requirements for one of the two test methods. If ASTM D189 or ASTM D4530 is performed in lieu of the referee test method, ASTM D524, the maximum allowable carbon residue shall be 0.14 mass percent.

12/ ASTM D976 is only a valid method when 100 percent of the F-76 is derived from conventional material sources. ASTM D976 is not an acceptable cetane test method for fuels containing synthesized materials as defined in Appendix A.

13/ Only nylon membrane filter media (0.8-micrometer pore size) are acceptable as specified in ASTM D5304. Glass fiber (Type A/E) filter media shall not be used to obtain test results.

14/ Fuel must meet the requirements for one of the two test methods.

15/ If ASTM D2274 is utilized, the test period shall be extended from 16 hours to 40 hours.

16/ Availability of ultra-low sulfur (maximum 0.0015 mass percent) F-76 may be limited in certain regions. A waiver to deliver higher sulfur fuel may be granted on a case-by-case basis. Final authority to approve sulfur content waiver is granted by NAVSEA 05P2.

17/ Results by ASTM D3605 shall be reported in mg/L. Original limits in table I still apply.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as conformance inspection (see 4.4).

4.2 Sampling.

4.2.1 Sampling for bulk lots. Bulk samples for tests shall be taken in accordance with ASTM D4057 for manual sampling and ASTM D4177 for automatic sampling (see 6.3.1).

4.2.2 Sampling for examination of packaged lots. A random sample of packaged containers shall be taken from each lot in accordance with table II. The sample shall be examined in accordance with 4.3 (see 6.3.8).

TABLE II. Sampling for examination of packaged lots.

Lot Size	Sample Size
1-13	All
14-150	13
151-250	32
251-500	50
501-1,200	80
1,201-3,200	125
3,201-10,000	200
10,001-35,000	315
35,001 and over	500

4.3 Examination of the packaged lot. Samples taken in accordance with 4.2.2 shall be examined for compliance with MIL-STD-290 with regard to fill, closure, sealing, leakage, packaging, packing, and marking requirements as specified in 5.1. Any container having one or more defects, or under the required fill volume, shall be rejected (see 6.5).

4.4 Conformance inspection. Each sample selected as specified in 4.2 shall be tested as specified in table I.

4.5 Ozone depleting substances (ODSs). In any of the test methods, the use of any ODS identified as a Class 1 or Class 2 ODS by the Environmental Protection Agency (EPA) is prohibited, as specified (see 6.2). An appropriate non-ODS solvent shall be substituted.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. Naval distillate fuel is intended for use in all naval shipboard boilers, gas turbines, and diesel engines operating at ambient temperatures above -1 °C. Other uses may be specified according to the needs of the Department of Defense. Additives as specified in 3.2.2 are permitted. Gas turbines and diesel engines operating in ambient temperatures that fall consistently below -1 °C should utilize JP-5 fuel in accordance with MIL-DTL-5624.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Date of ordering and date of supply.

b. Title, number, and date of this specification.

c. Type and dosage rate of each additive used (see 3.2.2 and A.4.3).

d. Prohibited ODSs (see 4.5).

e. Packaging requirements (see 5.1).

f. Examination lot acceptance/rejection criteria (see 6.5).

6.3 Definitions.

6.3.1 Bulk lot. A bulk lot should be considered an indefinite quantity of a homogeneous mixture of material offered for acceptance in a single isolated container.

6.3.2 Clear and bright. The terms clear and bright are independent of the natural color of the fuel. Clear means the absence of any cloud, emulsion, or readily visible particulate matter or free water. Bright refers to the shiny appearance of clean, dry fuel.

6.3.3 Conventional source blending component. Blending streams derived from the following conventional sources: crude oil, petroleum, oil sands, oil shale, natural gas liquid condensates, or mixtures thereof.

6.3.4 Finished fuel. Fuel conforming to the requirements of section 3 and containing a maximum of 50 volume percent synthetic materials.

6.3.5 Fischer-Tropsch hydroprocessed synthetic paraffinic diesel (FT-SPD). SPD synthesized by FT processing. FT-SPD may also be referred to as paraffinic middle distillate (PMD).

6.3.6 Hydroprocessed. Conventional chemical processing in which hydrogen is reacted with organic compounds in the presence of a catalyst to remove impurities such as oxygen, sulfur, nitrogen; to saturate unsaturated hydrocarbons; or to alter the molecular structure of the hydrocarbon molecules.

6.3.7 Hydroprocessed or hydrotreated renewable diesel (HRD). SPD produced from mono-, di-, and triglycerides, free fatty acids, and fatty acid esters from plant, algal oils, or animal fats (for example, fatty acid methyl esters) that have been hydroprocessed to remove essentially all oxygen. HRD may also be referred to as hydroprocessed esters and fatty acids synthetic paraffinic diesel (HEFA-SPD) or PMD.

6.3.8 Packaged lot. A packaged lot should be considered an indefinite number of 208-liter (55-gallon) drums or smaller unit containers of identical size and type, offered for acceptance, and filled with a homogeneous mixture of material from one isolated container; or filled with a homogeneous mixture of material manufactured in a single plant run (not exceeding 24 hours) through the same processing equipment, with no change in ingredient material.

6.3.9 Synthesized paraffinic diesel (SPD). Middle distillate blending component consisting of n-paraffins, iso-paraffins, and cycloparaffins that meet the requirements of Appendix A. Hydrocarbons shall be derived from alternative sources such as coal, natural gas, biomass, and hydrogenated fats and oils by processes such as FT synthesis and hydroprocessing.

6.4 NAVSEA approval and direction. Deviation from specified materials, procedures, and requirements, and selection of specific alternative materials and procedures require NAVSEA approval or direction. Requests should include supporting documentation.

6.5 Recommended examination lot acceptance/rejection criteria. If, as a result of the examination of the packaged lot, the number of defective or under-filled containers exceeds the reject limit number of table III, the lot represented by the sample should be rejected as specified (see 6.2).

TABLE III. Lot acceptance/rejection criteria.

Lot Size	Sample Size	Reject Limit
1-13	All	Any
14-150	13	1
151-250	32	2
251-500	50	3
501-1,200	80	4
1,201-3,200	125	6
3,201-10,000	200	11
10,001-35,000	315	15
35,001 and over	500	22

NOTES:

1. All defective items should be replaced with acceptable items prior to lot acceptance.
2. Inspect sample size until reject criteria are reached.
3. Rejected lots may be screened and resubmitted for inspection and retest.

6.6 Subject term (key word) listing.

Boiler

Diesel engine

Diesel fuel

Fischer-Tropsch Hydroprocessed Synthetic Paraffinic Diesel (FT-SPD)

Gas turbine engine

Hydroprocessed Esters and Fatty Acids (HEFA)

Hydroprocessed/Hydrotreated Renewable Diesel (HRD)

Lubricity

Marine diesel

Marine gas oil

Metal deactivator

Paraffinic Middle Distillate (PMD)

Refined hydrocarbon distillate fuel

Synthesized Paraffinic Diesel (SPD)

6.7 International standardization agreement implementation. This specification implements NATO STANAG 1135, Interchangeability of Fuels, Lubricants and Associated Products Used by the Armed Forces of the North Atlantic Treaty Nations, and NATO STANAG 1385, Guide Specification for Naval Distillate Fuels (F-75 and F-76). When amendment, revision, or cancellation of this specification is proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at https://assist.dla.mil.

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

HYDROPROCESSED SYNTHESIZED PARAFFINIC DIESEL (SPD)

A.1 SCOPE

A.1.1 Scope. This appendix defines hydroprocessed Synthesized Paraffinic Diesel (SPD) for use as a synthetic blending component in marine diesel fuels. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in Appendix A of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Appendix A of this specification, whether or not they are listed.

A.2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

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ASTM D1298	-	Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D2425	-	Standard Test Method for Hydrocarbon Types in Middle Distillates by Mass Spectrometry
ASTM D2500	-	Standard Test Method for Cloud Point of Petroleum Products
ASTM D2622	-	Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
ASTM D3241	-	Standard Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels
ASTM D3828	-	Standard Test Methods for Flash Point by Small Scale Closed Cup Tester

ASTM D4052 - Standard Test Method for Density, Relative Density and API Gravity of Liquids by Digital Density Meter

ASTM D4530 - Standard Test Method for Determination of Carbon Residue (Micro Method)

ASTM D4629 - Standard Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection

ASTM D4808 - Standard Test Methods for Hydrogen Content of Light Distillates, Middle Distillates, Gas Oils, and Residua by Low-Resolution Nuclear Magnetic Resonance Spectroscopy

ASTM D4809 - Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)

ASTM D5291 - Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants

ASTM D5452 - Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration

ASTM D5453 - Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

ASTM D5771 - Standard Test Method for Cloud Point of Petroleum Products (Optical Detection Stepped Cooling Method)

ASTM D5772 - Standard Test Method for Cloud Point of Petroleum Products (Linear Cooling Rate Method)

ASTM D5773 - Standard Test Method for Cloud Point of Petroleum Products (Constant Cooling Rate Method)

ASTM D6217 - Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration

ASTM D6304 - Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration

ASTM D6890 - Standard Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber

ASTM D7111 - Standard Test Method for Determination of Trace Elements in Middle Distillate Fuels by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

ASTM D7170 - Standard Test Method for Determination of Derived Cetane Number (DCN) of Diesel Fuel Oils—Fixed Range Injection Period, Constant Volume Combustion Chamber Method

ASTM D7171 - Standard Test Method for Hydrogen Content of Middle Distillate Petroleum Products by Low-Resolution Pulsed Nuclear Magnetic Resonance Spectroscopy

ASTM D7261 - Standard Test Method for Determining Water Separation Characteristics of Diesel Fuels by Portable Separometer

(Copies of these documents are available online at www.astm.org.)

A.3 MATERIALS AND MANUFACTURE

A.3.1 Synthetic paraffinic materials. SPDs shall be derived from Fischer-Tropsch (FT) or Hydroprocessed Renewable Diesel (HRD) methods. FT-SPD blending components shall be wholly derived from synthesis gas via the FT process using iron or cobalt catalyst. HRD blend components shall be comprised of hydrocarbon fuel obtained from hydrogenation and deoxygenation of fatty acid esters and free fatty acids. Subsequent processing of the product shall include hydrotreating, hydrocracking, or hydroisomerization and is expected to include, but not be limited to, a combination of other conventional refinery processes such as polymerization, isomerization, and fractionation.

A.4 DETAILED BATCH REQUIREMENTS

A.4.1 Batch requirements. Each batch of synthetic blending component shall conform to the requirements prescribed in table A-I.

A.4.2 Hydroprocessed SPD batch. The hydroprocessed SPD blend component shall meet the requirements of table A-I. It is not necessary to analyze each batch of hydroprocessed SPD for compliance with table A-II once it is demonstrated that the process scheme is adequately controlled to support the expectation that these requirements are always met. At a minimum, batches shall be required to meet the specifications of table A-II when new production facilities or schemes are established, or when significant changes to existing production operations are implemented, such as the introduction of a new feedstock material.

TABLE A-I. Detailed batch requirements; hydroprocessed SPD.

Characteristic	Requirement		ASTM Method
	Minimum	Maximum	
Acid Number, mg KOH/g		0.08	D974 (R), D664
Carbon Residue on 10% bottoms, mass %		0.20	D524 (R) [1/]
		0.14	D189 [1/], D4530 [1/]
Cloud Point, °C		-1	D2500 (R), D5771, D5772, D5773
Corrosion, 3 hours at 100 °C		No. 1	D130
Density, at 15 °C, kg/m^3	770	805	D1298 (R), D4052, D287
Derived Cetane Number	42	80	D6890, D7170
Distillation:			D86
Initial Boiling Point, °C	Report		
10% Recovered, °C	191	290	
50% Recovered, °C	Report		
90% Recovered, °C	290	357	
Final Boiling Point, °C	300	385	
T50-T10, °C	Report		
T90-T10, °C	20		
Residue + Loss, volume %		3.0	
Flash Point, °C	60.0		D93 (R) [2/], D3828
Heating Value, MJ/kg	43.5		D4809
Hydrogen Content, mass %	14.5		D7171 (R), D4808, D5291
Kinematic Viscosity, at 40 °C, mm^2/s	1.7	4.3	D445
DSEP	85		D7261
Particulate Contamination, mg/L		1.0	D6217 (R), D5452
Thermal Stability:			D3241 [3/]
Change in Pressure Drop, mm of Hg		25	
Tube Deposit Code, less than		3 [4/]	
Total Water, mg/kg		100	D6304

NOTES:

[1/] Fuel must meet the requirements for one of the three test methods. If ASTM D189 or ASTM D4530 is performed in lieu of the referee test method, ASTM D524, the maximum allowable carbon residue shall be 0.14 mass percent.

[2/] ASTM D3828 may give results up to 1.7 °C below the ASTM D93 results.

[3/] See A.4.5.1 and A.4.5.2 for ASTM D3241 test conditions and procedures.

[4/] If the visual rating of the heater tube shows Peacock (P) or Abnormal (A) type deposits, the fuel sample is not acceptable.

TABLE A-II. Other detailed requirements; hydroprocessed SPD.

Characteristic	Requirement		ASTM Method
	Minimum	Maximum	
Hydrocarbon Composition			
Cycloparaffins, mass %		15 [1/]	D2425
Aromatics, mass %		0.5	D2425
Paraffins (normal and iso), mass %	Report		D2425
Carbon and Hydrogen, mass %	99.5		D5291
Non-Hydrocarbon Composition			
Nitrogen, mg/kg		10	D4629
Sulfur, mg/kg		15	D5453, D2622
Metals [2/] (Al, Ca, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, P, Pb, Pd, Pt, Sn, Sr, Ti, V, Zn), mg/kg		0.1 per metal	D7111
Alkali Metals and Metalloids [2/] (B, Na, K, Si, Li), mg/kg		1 total	D7111

NOTES:

[1/] Maximum cycloparaffin composition is based on current experience with the approved synthetic fuels and is within the range of what is typical for refined diesel fuel.

[2/] All detected metals below the detection limits shall be considered as 0 µg/kg. Only the metals whose measured values are higher than their respective detection limits shall be considered as legitimate values for calculation.

A.4.3 Additives. When specified (see 6.2), information concerning the type and dosage rate of each additive used shall be made available.

A.4.4 Antioxidants. Antioxidant shall be added as soon as practicable after hydroprocessing or fractionation synthesizing and prior to the product or component being passed into storage to prevent peroxidation and gum formation after manufacture. Not less than 17.2 mg/L or more than 24.0 mg/L of active ingredient shall be used. The following antioxidant formulations are approved:

a. 2,6-di-tert-butyl-4-methylphenol

b. 6-tert-butyl-2,4-dimethylphenol

c. 2,6-di-tert-butylphenol

d. 75 percent minimum 2,6-di-tert-butylphenol
25 percent maximum tert-butylphenols and tri-tert-butylphenols

e. 72 percent minimum 6-tert-butyl-2,4-dimethylphenol
28 percent maximum tert-butyl-methylphenols and tert-butyl-dimethylphenols

f. 55 percent minimum 2,4-dimethyl-6-tert-butylphenol and
15 percent minimum 2,6-di-tert-butyl-4-methylphenol and
30 percent maximum mixed methyl and dimethyl tert-butylphenols

A.4.5 Thermal stability. The thermal stability test shall be conducted using ASTM D3241 (Thermal Oxidation Stability of Aviation Fuels Test). The heater tube shall be rated visually (see Test Method for Visual Rating of ASTM D3241 Heater Tubes Annex of ASTM D3241).

A.4.5.1 Test conditions.

a. Minimum heater tube temperature at maximum point: 325 °C

b. Fuel system pressure: 3.45 MPa (500 psig)

c. Fuel flow rate: 3.0 mL/minute

d. Test duration: 150 minutes

A.4.5.2 ASTM D3241 procedure.

a. The differential pressure in mm Hg at 150 minutes or time to differential pressure of 25 mm Hg, whichever comes first, shall be recorded.

b. The heater tube deposit code rating shall be recorded at the end of the test.

Custodians:

Army – CR4
Navy – SH
Air Force – 68

Preparing activity:

Navy – SH
(Project 9140-2013-002)

Review activities:

Army – AT
Navy – CG, MC, SA
DLA – GS, PS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.