METRIC

MIL-PRF-16884K
14 November 2002

SUPERSEDING
MIL-F-16884J
31 May 1995

PERFORMANCE 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 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 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).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

DOD-A-24682	- Additive, Fuel Oil Stabilizer.
MIL-DTL-5624	- Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP-5/JP-8 ST.
NATO-STANAG-1135	- Interchangeability of Fuels, Lubricants and Associated Products used by the Armed Forces of the North Atlantic Treaty Nations.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 9140

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

STANDARDS

DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

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 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).

ASTM INTERNATIONAL

D86 - Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure.
D93 - Standard Test Method for Flash Point by Pensky-Martens Closed Cup Tester.
D97 - Standard Test Method for Pour Point of Petroleum Products.
D129 - Standard Test Method for Sulfur in Petroleum Products (General Bomb Method).
D130 - Standard Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test.
D189 - Standard Test Method for Conradson Carbon Residue of Petroleum Products.
D287 - Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method).
D445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).
D482 - Standard Test Method for Ash from Petroleum Products.
D524 - Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products.
D613 - Standard Test Method for Cetane Number of Diesel Fuel Oil.
D664 - Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration.
D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
D976 - Standard Test Methods for Calculated Cetane Index of Distillate Fuels.
D1141 - Standard Practice for Substitute Ocean Water.
D1298 - Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
D1401 - Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids.
D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
D1552 - Standard Test Method for Sulfur in Petroleum Products (High-Temperature Method).

D2274 - Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method).
D2500 - Standard Test Method for Cloud Point of Petroleum ~~Oils~~ Products.
D2622 - Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-Ray Fluorescence Spectrometry.
D2709 - Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge.
D3605 - Standard Test Method for Trace Metals in Gas Turbine Fuels by Atomic Absorption and Flame Emission Spectroscopy.
D4052 - Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter.
D4057 - Standard Practice for Manual Sampling of Petroleum and Petroleum Products.
D4176 - Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures).
D4177 - Standard Practice for Automatic Sampling of Petroleum and Petroleum Products.
D4294 - Standard Test Method for Sulfur in Petroleum Products by Energy Dispersive X-Ray Fluorescence Spectroscopy.
D4530 - Standard Test Method for Determination of Carbon Residue (Micro Method).
D4539 - Standard Test Method for Filterability of Diesel Fuels by Low-Temperature Flow Test (LTFT).
D4808 - Standard Test Methods for Hydrogen Content of Light Distillates, Middle Distillates, Gas Oils, and Residua by Low-Resolution Nuclear Magnetic Resonance Spectroscopy.
D5291 - Standard Test methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants.
D5304 - Standard Test Method for Assessing Distillate Fuel ~~for~~ Storage Stability by Oxygen Overpressure.
D5452 - Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration.
D5771 - Standard Test Method for Cloud Point of Petroleum Products (Optical Detection Stepped Cooling Method).
D5772 - Standard Test Method for Cloud Point of Petroleum Products (Linear Cooling Rate Method).
D5773 - Standard Test Method for Cloud Point of Petroleum Products (Constant Cooling Rate Method).
D5949 - Standard Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method.
D5950 - Standard Test Method for Pour Point of Petroleum Products (Automatic Tilt Method).
D6045 - Standard Test Method for Color of Petroleum Products by the Automatic Tristimulus Method.
D6217 - Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration.
D6371 - Standard Test Method for Cold Filter Plugging Point of Diesel and Heating Fuels.
E29 - Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.

(All ASTM Specifications listed above are DoD adopted. Application for copies should be addressed to the ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, or www.astm.org.)

INSTITUTE OF PETROLEUM (IP)

IP 309 - Determination of Cold Filter Plugging Point of Distillate Fuels.

(Application for copies should be addressed to Institute of Petroleum, 61 New Cavendish Street, LONDON, W1M 8AR, United Kingdom)

2.4 Order of precedence. 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, supercedes 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 or results obtained and the number falling outside of the repeatability limits. 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 be a refined hydrocarbon distillate fuel with no residual fuel and may contain only those additives specified in 3.2.1 unless otherwise stated.

3.2.1 Additives. The additives listed herein may be used either singly or in combination provided the amounts do not exceed those specified herein. Information concerning the type and amount of each additive used shall be made available when requested by the procuring activity or user.

3.2.1.1 Stabilizer additives. Fuel oil stabilizer additive, conforming to DOD-A-24682 and listed on the current QPL-24682, may be added to improve the storage stability performance of the fuel as listed in Table I. Such stabilizer additives are not intended for use in fuel acquired for immediate shipboard use. These additives may be blended into the distillate fuel at a dosage of up to 100 milligrams per liter (37.9 grams/100 U.S. gallons, or 35 pounds/1,000 barrels) for additional protection against deterioration.

3.2.1.2 Metal deactivator. A metal deactivator, N, N-disalicyclidene-1, 2 propanediamine, may be blended into the fuel in an amount not to exceed 5.8 milligrams of active ingredient per liter of fuel (2.2 grams/100 U.S. gallons, or 2 lb/1,000 barrels).

3.2.1.3 Ignition improver. The following additives may be used to raise the ignition quality of the fuel as required to meet the performance requirements of this specification:

Amyl nitrate (mixed primary nitrates)
Hexyl nitrate (N-hexyl nitrate)
Cyclohexyl nitrate
N-octyl nitrate
2-ethylhexyl nitrate

3.3 Physical and chemical requirements. The Naval distillate fuel shall conform to the physical and chemical requirements specified in Table I. Where more than one test method is allowed for a specific requirement, Table I lists the referee test method first and follows it with the notation "(R)".

TABLE I. Physical and chemical requirements.

PHYSICAL REQUIREMENTS		
Characteristic	Requirement	Test Method (all ASTM standards except IP 309)
Appearance, @ 25°C or ambient whichever is higher	Clear, bright and free of visible particulates	D4176 (1)
Demulsification, @ 25°C, minutes (max)	10	D 1401 (2)
Density, @15°C, kg/m^3 (max)	876	D1298 (R), D4052, D287
Distillation: 10 % Point, °C 50 % Point, °C 90 % Point, °C (max) End Point, °C (max) Residue + Loss, % vol. (max)	 Record Record 357 385 3.0	D86 *(3)*
Cloud Point, °C (max)	-1	D2500 (R), D5771, D5772, D5773 (4), D6371 (5), IP 309 (5), D4539 (6)
Color, (max)	3	D1500(R), D6045
Flash Point, °C (min)	60	D93 (7)
Particulate Contamination, mg/liter (max)	10	D6217 (R), D5452 (8)
Pour Point, °C (max)	-6	D97 (R), D5949, D5950, (9)
Viscosity, @ 40°C, mm^2/second	1.7 – 4.3	D445
Acid Number, mg KOH/g (max)	0.30	D974 (R), D664
Ash, wt. %(max)	0.005	D482
Carbon Residue on 10% bottoms, wt. % (max)	0.20 0.14	D524 (R) (10) D189, D4530 (10)
Corrosion, @ 100°C (max)	No. 1	D130
Hydrogen Content, wt. % (min)	12.5	D4808 (R), D5291
Ignition Quality: Cetane Number, (min) Cetane Index, (min)	 42 43	 D613 (R) (11) D976 (11)

PHYSICAL REQUIREMENTS		
Characteristic	Requirement	Test Method (all ASTM standards except IP 309)
Storage Stability, total insolubles, mg/100ml (max)	1.5	D5304 (R), D2274 (12)
Sulfur Content, wt. % (max)	1.0	D4294 (R), D129, D1552, D2622
Trace Metals, ppm (max):		
Calcium	1.0	
Lead	0.5	D3605 (13)
Sodium plus Potassium	1.0	
Vanadium	0.5	
Additive Names and Dosages	Record	

Notes:

(1) If the sample has no visible particulates, but is otherwise not "clear and bright" per ASTM D4176, procedure 1, then the product must meet the requirements of ASTM D2709, 0.05-percent volume 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, maximum, in accordance with ASTM D5452 or ASTM D6217 then the fuel is considered acceptable provided all other 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 one-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) If either ASTM D5571, D5572, or D5573 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, D5772 or D5773.

(5) This method may be used as a substitute if the test procedure is modified as follows: apply vacuum to the sample for the first time when the fuel sample temperature reaches −1 °C. If the time

required for the 20 ml of fuel to be filtered through the wire mesh filter exceeds 60 seconds, record the test as a failure. If the time required for the 20-ml sample to flow through the filter is 60 seconds or less, record the test result as a pass. Do not repeat application of vacuum at successively lower temperatures. This is a modification of the requirement of ASTM D6371 (IP method 309) that vacuum be applied to the test specimen immediately after the test jar is inserted into the cooling jacket or, at a minimum, when the fuel is a least 5 °C above its cloud point.

(6) Low Temperature Flow Test of ASTM D4539 may be used as a substitute method on the condition that the "specified test temperature" approach provided therein is used: start the test (apply the test vacuum to the test specimen for the first time) when the fuel sample temperature reaches -1 °C. Do not repeat application of vacuum at successive lower temperatures.

(7) The flash point value is absolute and no value less than 60 °C is permissible.

(8) If ASTM D5452 is utilized, a one-liter minimum sample is required.

(9) If either ASTM D5949 or D5950 is used, the results from these tests should be based on the observations at 3 °C temperature intervals and reported as the ASTM D97 equivalent.

(10) If ASTM D189 or ASTM D4530 is performed in lieu of ASTM D524, the maximum allowable carbon residue shall be 0.14 percent. When the finished fuel contains a cetane improver, the carbon residue requirement specified in Table I shall apply to the base fuel without the cetane improver.

(11) The minimum allowable Cetane Number of the finished product shall be 42 when tested in accordance with ASTM D613. Alternatively, the Cetane Index of the base fuel without cetane-improving additives, shall be a minimum of 43 when tested in accordance with ASTM D976.

(12) This test is performed on the finished product. If ASTM D2274 is utilized, the test period shall be extended from 16 hours to 40 hours.

(13) Any quantitative spectroscopic method may be employed if correlation to ASTM D3605 is demonstrated to the satisfaction of the inspection authority.

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 6.3.2).

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 6.6).

4.4 Conformance inspection. Each sample selected as specified in 4.2 and 4.3 shall be tested as specified in Table I.

4.5 Ozone Depleting Substances (ODS). In any of the test methods, the use of any ODS as outlined in EPA Class 1 and Class 2 Ozone Depleting Substances is prohibited. 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 actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. 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 (30°F). Other uses may be specified according to the needs of the Department of Defense. The use of a fuel stabilizer additive conforming to DOD-A-24682 and listed in the current version of QPL-24682 is permitted. Other additives as specified in 3.2.1 are also 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 the specification.
(c) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).
(d) Packaging requirements (see 5.1).
(e) Unit container quantity (see 5.2).
(f) Ozone depleting substances are prohibited.

6.3 Definitions.

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

6.3.2 Packaged lot. Packaged lot shall 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.

6.4 International standardization agreement. Certain provisions of this specification are the subject of international agreement, NATO-STANAG-1135. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices to change the agreement or make other appropriate accommodations. In addition, this specification complies with NATO-STANAG-1385, guide specification for Naval Distillate Fuel.

6.5 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.

6.6 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 shall be rejected.

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 shall 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.

6.7 Subject term (key word) listing.

Diesel
Distillate Fuel
Fuel
Gas turbine
Ignition improver
Marine diesel
Marine gas oil
Metal deactivator
Naval distillate
Refined hydrocarbon distillate fuel
Stabilizer additive

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.

Custodians:
Army - CR4
Navy - SH
Air Force - 68

Review activities:
Navy - CG, MC, SA, YD
DLA - GS, PS

Preparing activity:
Navy-SH
(Project 9140-1144)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4,5,6, and 7 and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-16884K	2. DOCUMENT DATE *(YYYYMMDD)*

3. DOCUMENT TITLE: FUEL, NAVAL DISTILLATE

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER		
a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN *(if applicable)*	7. DATE SUBMITTED *(YYYYMMDD)*

8. PREPARING ACTIVITY	
a. NAME SEA O5Q	b. TELEPHONE *(Include Area Code)* (1) Commercial (202) 781-3731 (2) DSN 326-3731
c. ADDRESS *(Include Zip Code)* Commander Naval Sea Systems Command ATTN: SEA 05Q 1333 Isaac Hull Ave., SE, Stop 5160 Washington Navy Yard DC 20376-5160	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888

DD Form 1426, FEB 1999 (EG) PREVIOUS EDITION IS OBSOLETE WHS/DIDR, Feb 99