

MIL-DTL-5624W
28 March 2016
SUPERSEDING
MIL-DTL-5624V
11 July 2013

DETAIL SPECIFICATION
TURBINE FUEL, AVIATION,
GRADES JP-4 AND JP-5

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

1. SCOPE

1.1 Scope. This specification covers two grades of aviation turbine fuel NATO F-40 (JP-4) and NATO F-44 (JP-5) (see 6.1). Synthesized hydrocarbons from new sources require specific guidance that is outside the scope of MIL-DTL-5624. This guidance is found in ASTM D7566.

1.2 Classification. Aviation turbine fuel will be of the following grades, as specified (see 6.2).

<u>Grade</u>	<u>NATO Code No.</u>	<u>Description</u>
JP-4 (Inactive for New Design)	F-40	Wide cut, gasoline type
JP-5	F-44	High flash point, kerosene type

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.

Comments, suggestions, or questions on this document should be addressed to:
Commander, Naval Air Warfare Center, Aircraft Division Lakehurst, Code 4.1.2, Mail Stop
120-3, Route 547, Joint Base MDL, NJ 08733-5100 or emailed to michael.sikora@navy.mil.
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>.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-25017 Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble (NATO S-1747) (Metric)

MIL-DTL-85470 Inhibitor, Icing, Fuel System, High Flash, NATO Code Number S-1745 (Metric)

DEPARTMENT OF DEFENSE STANDARD

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

QUALIFIED PRODUCTS LIST

QPL-25017 Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble (NATO S-1747) (Metric)

(Copies of these documents are available online at <http://quicksearch.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 D56 Standard Test Method for Flash Point by Tag Closed Cup Tester

ASTM D86 Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

ASTM D93 Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

ASTM D129 Standard Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method)

ASTM D130 Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

ASTM D156 Standard Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)

ASTM D323 Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)

ASTM D381 Standard Test Method for Gum Content in Fuels by Jet Evaporation

ASTM D445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D976	Standard Test Method for Calculated Cetane Index of Distillate Fuels
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 D1319	Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
ASTM D1322	Standard Test Method for Smoke Point of Kerosine and Aviation Turbine Fuel
ASTM D1840	Standard Test Method for Naphthalene Hydrocarbons in Aviation Turbine Fuels by Ultraviolet Spectrophotometry
ASTM D2276	Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling
ASTM D2386	Standard Test Method for Freezing Point of Aviation Fuels
ASTM D2622	Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-Ray Fluorescence Spectrometry
ASTM D2624	Standard Test Methods for Electrical Conductivity of Aviation and Distillate Fuels
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 D3227	Standard Test Method for (Thiol Mercaptan) Sulfur in Gasoline, Kerosine, Aviation Turbine, and Distillate Fuels (Potentiometric Method)
ASTM D3241	Standard Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels
ASTM D3242	Standard Test Method for Acidity in Aviation Turbine Fuel
ASTM D3338/ D3338M	Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
ASTM D3701	Standard Test Method for Hydrogen Content of Aviation Turbine Fuels by Low Resolution Nuclear Magnetic Resonance Spectrometry
ASTM D3828	Standard Test Methods for Flash Point by Small Scale Closed Cup Tester
ASTM D3948	Standard Test Method for Determining Water Separation Characteristics of Aviation Turbine Fuels by Portable Separometer

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 D4177	Standard Practice for Automatic Sampling of Petroleum and Petroleum Products
ASTM D4294	Standard Test Method for Sulfur in Petroleum and in Petroleum Products by Energy Dispersive X-Ray Fluorescence Spectrometry
ASTM D4306	Standard Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
ASTM D4529	Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
ASTM D4737	Standard Test Method for Calculated Cetane Index by Four Variable Equation
ASTM D4809	Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)
ASTM D4952	Standard Test Method for Qualitative Analysis for Active Sulfur Species in Fuels and Solvents (Doctor Test)
ASTM D5006	Standard Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
ASTM D5191	Standard Test Method for Vapor Pressure of Petroleum Products (Mini 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 D5972	Standard Test Method for Freezing Point of Aviation Fuels (Automatic Phase Transition Method)
ASTM D6045	Standard Test Method for Color of Petroleum Products by the Automatic Tristimulus Method
ASTM D6379	Standard Test Method for Determination of Aromatic Hydrocarbon Types in Aviation Fuels and Petroleum 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 D7153	Standard Test Method for Freezing Point of Aviation Fuels (Automatic Laser Method)

ASTM D7154	Standard Test Method for Freezing Point of Aviation Fuels (Automatic Fiber Optical Method)
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 D7224	Standard Test Method for Determining Water Separation Characteristics of Kerosine-Type Aviation Turbine Fuels Containing Additives by Portable Separometer
ASTM D7345	Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Micro Distillation Method)
ASTM D7566	Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons
ASTM D7619	Standard Test Method for Sizing and Counting Particles in Light and Middle Distillate Fuels, by Automatic Particle Counter
ASTM D7777	Standard Test Method for Density, Relative Density, or API Gravity of Liquid Petroleum by Portable Digital Density Meter
ASTM D7797	Standard Test Method for Determination of the Fatty Acid Methyl Esters Content of Aviation Turbine Fuel Using Flow Analysis by Fourier Transform Infrared Spectroscopy-Rapid Screening Method
ASTM E29	Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

(Copies of these documents are available from <http://www.astm.org/>.)

ENERGY INSTITUTE

IP 540	Determination of the Existent Gum Content of Aviation Turbine Fuel - Jet Evaporation Method
IP 564	Determination of the Level of Cleanliness of Aviation Turbine Fuel -- Laboratory Automatic Particle Counter Method
IP 565	Determination of the Level of Cleanliness of Aviation Turbine Fuel -- Portable Automatic Particle Counter Method
IP 577	Determination of the Level of Cleanliness of Aviation Turbine Fuel-- Automatic Particle Counter Method Using Light Extinction
IP 583	Determination of the Fatty Acid Methyl Esters Content of Aviation Turbine Fuel Using Flow Analysis by Fourier Transform Infrared Spectroscopy - Rapid Screening Method
IP 585	Determination of Fatty Acid Methyl Esters (FAME), Derived From Bio-Diesel Fuel, in Aviation Turbine Fuel - GC-MS with Selective Ion Monitoring/Scan Detection Method
IP 590	Determination of Fatty Acid Methyl Esters (FAME) in Aviation Turbine Fuel - HPLC Evaporative Light Scattering Detector Method

IP 599

Determination of Fatty Acid Methyl Esters (FAME) in Aviation Turbine Fuel - Gas Chromatography Using Heart-Cut and Refocusing

(Copies of these documents are available from <http://www.energyinst.org/home>.)

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 Materials. Aviation turbine fuel is a complex mixture composed of hydrocarbons and varies depending on crude source and manufacturing process. The fuels supplied under this specification shall be refined hydrocarbon distillate fuel oils, which contain additives in accordance with 3.3. Unless the feedstock from which the fuel is refined is as specified in 3.1.1 or 3.1.2, the feedstock shall be crude oils derived from petroleum, oil sands, oil shale, or mixtures thereof.

3.1.1 Synthesized Paraffinic Kerosenes (applies to Grade JP-5 fuel only). A maximum of 50 percent volume of the finished fuel may consist of Synthesized Paraffinic Kerosene (SPK) blend components derived from Fischer Tropsch (FT) produced SPK or Hydroprocessed Esters and Fatty Acids (HEFA). FT-SPK blend components shall conform to the requirements in ASTM D7566 Annex A1. SPK blend components derived from HEFA shall conform to requirements in ASTM D7566 Annex A2. Finished fuel shall conform to the properties listed in Tables I and III. Finished fuel shall contain additives in accordance with 3.3 through 3.3.6.

3.1.2 Synthesized Iso-Paraffins From Hydroprocessed Fermented Sugars (applies to Grade JP-5 fuel only). A maximum of 10 percent volume of the finished fuel may consist of Synthesized Iso-Paraffins (SIP) blend components derived from Hydroprocessed Fermented Sugars. SIP blend components shall conform to the requirements in ASTM D7566 Annex A3. Finished fuel shall conform to the properties listed in Tables I and III. Finished fuel shall contain additives in accordance with 3.3 through 3.3.6.

3.2 Finished fuel. Finished fuels shall meet the requirements of this specification. The requirements of Table III apply if the finished fuel contains synthesized hydrocarbons.

3.3 Additives. If specified in the acquisition documents (see 6.2), information concerning the type and amount of each additive used shall be reported.

3.3.1 Antioxidants. Immediately after processing (i.e., during the rundown into feed/batch tank) and before the fuel is exposed to the atmosphere, an approved antioxidant shall be added to all JP-5 fuel and to JP-4 fuel that contains blending stocks that have been hydrogen-treated to prevent the formation of gums and peroxides after manufacture. JP-4 fuel that does not contain hydrogen-treated blending stocks may have the antioxidant added. The concentration of antioxidant to be added shall be as follows:

- a. For JP-5 and hydrogen-treated JP-4: Not less than 17.2 mg nor more than 24.0 mg of active ingredient per liter of fuel (6.0 to 8.4 lbs/1000 barrels).
- b. For JP-4 fuel not hydrogen-treated, if added, not more than 24.0 mg of active ingredient per liter of fuel (8.4 lbs/1000 barrels).

3.3.1.1 Formulations. 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 min 2,6-di-tert-butylphenol
25 percent max tert-butylphenols and tri-tert-butylphenols
- e. 72 percent min 6-tert-butyl-2,4-dimethylphenol
28 percent max tert-butyl-methylphenols and tert-butyl-dimethylphenols
- f. 55 percent min 2,4-dimethyl-6-tert-butylphenol and
15 percent min 2,6-di-tert-butyl-4-methylphenol and
30 percent max mixed methyl and dimethyl tert-butylphenols

3.3.2 Metal deactivator. Metal deactivator additive shall not be used in JP-4 or JP-5 unless specified in the acquisition documents (see 6.2). A metal deactivator may be used if approved by the procuring activity and the user. If JP-5 is to be used by the Navy, written consent for the use of metal deactivator shall also be obtained from NAVAIR 4.4.5 (see 6.7). If approved, the metal deactivator, N,N'-disalicylidene-1,2-propanediamine, shall be blended into the fuel. The concentration of active material used on initial batching of the fuel at the refinery shall not exceed 2.0 mg/L. Cumulative addition of metal deactivator when redoping the fuel shall not exceed 5.7 mg/L.

3.3.3 Corrosion inhibitor/lubricity improver. A corrosion inhibitor/lubricity improver in accordance with MIL-PRF-25017 shall be blended into the JP-4 and JP-5. The amount added shall be equal to or greater than the minimum effective concentration and shall not exceed the maximum allowable concentration for an approved source as specified on QPL-25017. The point of injection of the corrosion inhibitor/lubricity improver shall be as specified in the acquisition documents (see 6.2).

3.3.4 Fuel system icing inhibitor. A fuel system icing inhibitor in accordance with MIL-DTL-85470 shall be used for JP-4 and JP-5. The point of injection of the additive shall be as specified in the acquisition documents (see 6.2).

3.3.5 Static dissipater additive. An approved static dissipater additive shall be blended into JP-4 fuel in sufficient concentration to increase the conductivity of the fuel to within the range specified in Table I, at the point of injection. The point of injection shall be as specified in the acquisition documents (see 6.2). The following static dissipater additive is approved: Stadis® 450 marketed by Innospec Fuel Specialties LLC. Static dissipater additive shall not be used in JP-5 unless written consent has been obtained from NAVAIR 4.4.5 (see 6.7).

3.3.6 Premixing of additives. Additives shall not be premixed with other additives before injection into the fuel so as to prevent possible reactions among the concentrated forms of different additives.

3.4 Finished fuel chemical and physical property requirements. The chemical and physical properties of all finished fuels shall meet the requirements specified in Table I when tested in accordance with the specified test methods. The micro-separometer rating of a finished fuel depends on the additives present (see Table II).

TABLE I. Chemical and physical property requirements and test methods.

Property	GRADE JP-4	GRADE JP-5	ASTM or IP Test Method
Color, Saybolt	Report	Report	D156 ^{1/} or D6045
Total acid number, mg KOH/g, max	-----	0.015	D3242
Aromatics, vol percent, max	25.0	25.0	D1319 ^{1/}
	26.5 ^{2/}	26.5 ^{2/}	D6379
Sulfur, Mercaptan, mass percent, max or Doctor test ^{3/}	0.003	0.002	D3227 ^{1/}
	Negative	Negative	D4952
Sulfur, total, mass percent, max	0.30	0.20	D129, D1266, D2622, D3120, D4294 ^{1/} or D5453
Distillation temperature, °C Initial boiling point 10 percent recovered, temp 20 percent recovered, temp 50 percent recovered, temp 90 percent recovered, temp End point, max temp Residue, vol %, max (for D86) Loss, vol %, max (for D86)	Report Report 90, min 145, max 110, min 190, max 245, max Report 1.5 1.5	Report 205, max Report Report 300, max 1.5 1.5	D86 ^{1/4/} , D7345 or D2887 ^{5/}
Flash point, °C, min	-----	60.0 ^{6/}	D56, D93 ^{1/} , or D3828
Density, at 15° C kg/L, min (API max) kg/L, max (API min)	0.751 (57.0) 0.802 (45.0)	0.788 (48.0) 0.845 (36.0)	D1298, D4052 ^{1/} , or D7777
Vapor pressure, at 37.8° C, kPa minimum maximum	14 21	----- -----	D323, or D5191 ^{1/7/}

TABLE I. Chemical and physical property requirements and test methods – Continued.

Property	GRADE JP-4	GRADE JP-5	ASTM or IP Test Method
Freezing point, °C, max	–50	–46	D2386 ^{1/} , D5972 ^{8/} , D7153, or D7154
Viscosity, at –20 °C, max, mm ² /s	-----	7.0	D445
Net Heat of combustion, MJ/kg, min	42.8	42.6	D3338/D3338M, D4529, or D4809 ^{1/}
Calculated Cetane Index ^{9/}	-----	Report	D976 or D4737
Hydrogen content, mass percent, min	-----	13.4	D3701, D5291, or D7171 ^{1/}
Smoke point, mm, min or Smoke point, mm, min and naphthalene, vol %, max	25.0	25.0	D1322
	18.0	18.0	D1322
	3.0	3.0	D1840
Copper strip corrosion, 2 hr at 100 °C, max	No. 1	No. 1	D130
Thermal stability: change in pres. drop, mm of Hg, max and tube deposit code, less than or average deposit thickness, nm, over area of 2.5 mm ² , max	25	25	D3241 ^{10/}
	3 ^{11/}	3 ^{11/}	D3241 Annex A1
	-----	85	D3241 Annex A2 or A3 ^{1/}
Existent gum, mg/100 mL, max	7	7	D381 ^{1/} or IP 540 ^{12/}
Micro-Separometer rating, min	13 [/]	13 [/]	D3948 or D7224 ^{1/}
Fuel system icing inhibitor: volume percent min volume percent max	0.10	0.08	D5006 ^{14/}
	0.15	0.11	
Fuel electrical conductivity: allowable range, pS/m	150 to 600 ^{15/}	-----	D2624

^{1/} Referee Test Method.^{2/} When using D6379 results, the higher maximum total aromatics limit shall apply.^{3/} If the Doctor Test results in a failure ('positive' result), then mercaptan sulfur content shall be determined by the referee test method ASTM D3227.^{4/} A condenser temperature of 0 °C to 5 °C shall be used for the distillation of JP-5 fuel. For JP-4, group 3 test conditions shall be used.^{5/} ASTM D2887 shall be used for JP-5 fuel only. Distillation property criteria are specified in ASTM D86 scale units. ASTM D2887 results shall be converted to estimated ASTM D86 results by application of the correlation in Appendix X4 of ASTM D2887 for comparison

- with the specified property criteria. Distillation residue and loss limits provide control of the distillation process during the ASTM D86 test method and do not apply to ASTM D2887.
- 6/ ASTM D3828 may give results up to 1.7 °C below the ASTM D93 results. ASTM D56 may give results up to 1 °C below the ASTM D93 results.
- 7/ When using ASTM D5191 for vapor pressure determination of JP-4, the quality control checks, section 12, shall be performed each day using two control samples as the reference pure materials. The first control sample shall have a vapor pressure between 7 kPa and 14 kPa and the second control sample shall have a vapor pressure between 21 kPa and 23 kPa.
- 8/ For JP-4, ASTM D5972 may produce a higher freezing point result than that determined by ASTM D2386. In case of dispute, ASTM D2386 shall be the referee test method.
- 9/ Mid-boiling temperatures may be obtained by either ASTM D86 or ASTM D2887 to perform the Cetane Index calculation. If ASTM D86 values are used, they shall be corrected to standard barometric pressure.
- 10/ See 4.3.2.1 for ASTM D3241 test conditions and procedures.
- 11/ If the visual rating of the heater tube shows peacock (P) or Abnormal (A) type deposits, the fuel sample is not acceptable.
- 12/ The preferred vaporizing medium for aviation turbine fuel is steam, however, the existent gum test IP 540 may be performed using air as the vaporizing medium. If air is used instead of steam, it shall be recorded. In case of a failure with air, the sample shall be retested using steam. Test Method ASTM D381, using steam jet operating conditions, shall be the referee test method.
- 13/ The minimum microseparometer rating using a Micro-Separometer (MSEP) shall be as specified in Table II.
- 14/ See Note 2 in ASTM D5006.
- 15/ The conductivity shall be in the range of 150 pS/m to 600 pS/m at ambient fuel temperature or 29.4 °C, whichever is lower.

TABLE II. Micro-separometer rating.

Product	Additives*	MSEP Rating, min
JP-4 and JP-5	Antioxidant (AO)*, Metal Deactivator (MDA)*	90
JP-4 and JP-5	AO*, MDA*, and Fuel System Icing Inhibitor (FSII)	85
JP-4 and JP-5	AO*, MDA*, and Corrosion Inhibitor/Lubricity Improver (CI/LI)	80
JP-4 and JP-5	AO*, MDA*, CI/LI, and FSII	70

*Even though the presence or absence of these additives does not change these limits, samples submitted for specification conformance testing shall contain the same additives present in the refinery batch. Regardless of which minimum the refiner elects to meet, the refiner shall report the MSEP rating on a laboratory hand blend of the fuel with all additives required by the specification.

3.5 Additional requirements for finished fuels containing synthesized hydrocarbons (JP-5 only). Finished fuels containing synthesized hydrocarbons shall meet the additional requirements specified in Table III, when tested in accordance with the specified test methods.

TABLE III. Additional requirements of JP-5 containing synthesized hydrocarbons.

Property	JP-5	ASTM Test Method
Aromatics, vol %, min	8.0	D1319 ^{1/}
	8.4	D6379
Distillation		D86 ^{1/} or D2887 ^{2/}
T50–T10, °C, min	15	
T90–T10, °C, min	40	
Derived Cetane Number, min	40	D6890 ^{1/} or D7170
Viscosity at –40 °C, max, mm ² /s ^{3/}	12	D445

^{1/} Referee Test Method.

^{2/} ASTM D2887 results shall be converted to estimated ASTM D86 results by application of the correlation in Appendix X4 of ASTM D2887 for comparison with the specified property criteria.

^{3/} Requirement only applies to fuel containing SIP specified in 3.1.2.

3.6 Workmanship. At the time of Government acceptance, the finished fuel shall be clear and bright and visually free from undissolved water, sediment, or suspended matter. In case of dispute, the fuel shall be clear and bright at 21 °C and shall contain no more than 1.0 mg/L of particulate matter.

3.7 Incidental contaminants. At the time of Government acceptance, the concentration of incidental contaminants in the finished fuel shall not exceed the limits in Table IV.

TABLE IV. Incidental contaminants.

Material	GRADE JP-4	GRADE JP-5	ASTM or IP Test Method
Particulate matter (gravimetric), mg/L, max ^{1/}	1.0	1.0	ASTM D2276 or ASTM D5452 ^{2/}
Filtration time, minutes, max ^{1/}	10	15	
Particle counting individual channel counts ^{3/}			IP 564, IP 565, IP 577, or ASTM D7619 ^{2/}
≥ 4 μm (c) ^{4/}	----	Report	
≥ 6 μm (c)	----	Report	
≥ 14 μm (c)	----	Report	
≥ 21 μm (c)	----	Report	
≥ 25 μm (c)	----	Report	
≥ 30 μm (c)	----	Report	
Fatty Acid Methyl Ester ^{5/} (FAME), mg/kg, max		50	ASTM D7797, IP 583, IP 585 ^{2/} , IP 590, or IP 599

^{1/} A minimum sample size of 3.785 liters (1 gallon) shall be filtered. Filtration time shall be determined in accordance with the procedure in Appendix A of this specification. The procedure in Appendix A may also be used for the determination of particulate matter as an alternate to ASTM D2276 or ASTM D5452.

^{2/} Referee Test Method.

^{3/} See 6.8.

^{4/} The notation (c), used with particle sizes, denotes that the apparatus has been calibrated.

^{5/} For a definition of FAME, see 6.6.8. The recent mandatory and voluntary introduction of FAME in the commercial middle distillate marketplace has resulted in the potential for trace amounts of FAME in JP-5 fuel. Fuel supplied under this specification shall not intentionally be blended with FAME. Where a risk exists for incidental FAME contamination, the supplier shall ensure this limit is not exceeded prior to product availability. Fatty acid methyl esters that fail to meet the biodiesel quality standards are not permitted in aviation turbine fuel.

3.8 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

4. VERIFICATION

4.1 Conformance inspection. Conformance inspection shall consist of all examinations, inspections and tests of this specification.

4.1.1 Inspection lot. For conformance inspection, individual lots shall be examined, inspected, and tested as specified herein to ensure individual lots meet all the requirements specified in section 3.

4.1.2 Sampling plans.

4.1.2.1 Sampling for conformance inspection. Each bulk or packaged lot (see 6.6) of material shall be sampled in accordance with ASTM D4057 or ASTM D4177, except where individual test procedures contain specific sampling instructions.

4.1.2.1.1 Sample containers. Examine the sample container for conformance to ASTM D4306 recommended sample containers (see 6.5).

4.1.2.2 Sampling for examination of filled containers for delivery. A random sample of filled containers shall be selected from each lot. The samples shall be examined in accordance with 4.3.1.3.

4.2 Inspection conditions. The finished fuel shall meet the limiting values in Table I using the specified test methods. If the finished fuel contains synthesized hydrocarbons, the finished fuel shall also meet the limiting values in Table III using the specified test methods.

4.3 Methods of inspection.

4.3.1 Examination of product.

4.3.1.1 Visual inspection. Samples selected in accordance with 4.1.1 shall be visually examined for compliance with 3.6.

4.3.1.2 Examination of empty containers. Prior to filling, each empty unit container shall be visually inspected for cleanliness and prepared for proper usage in accordance with ASTM D4057.

4.3.1.3 Examination of filled containers. Samples taken as specified in 4.1.2 shall be examined for conformance to MIL-STD-290 with regard to fill, closure, sealing, leakage, packaging, packing, and markings.

4.3.2 Chemical and physical tests. Tests to determine conformance to chemical and physical requirements shall be conducted in accordance with Table I for all finished fuels. For finished fuels containing synthesized hydrocarbons, tests shall also be conducted in accordance with Table III. Requirements contained in Tables I and III are not subject to corrections for test tolerances. If multiple determinations are made, results falling within any specified repeatability and reproducibility tolerances shall be averaged to determine conformance to Tables I and III. The following applies to all specified limits in this standard: For purposes of determining conformance with this specification, 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.

4.3.2.1 Thermal stability. The thermal stability test shall be conducted using ASTM D3241 at a test temperature of 260 °C. The heater tube shall be rated in accordance with Annex A1 (Visual Tube Rater), Annex A2 (Interferometric Tube Rater) or Annex A3 (Ellipsometric Tube Rater).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the acquisition documents (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 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 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. The JP-4 and JP-5 fuels covered by this specification are intended for use in aircraft turbine engines. These fuels require military unique additives that are necessary in military weapon systems. This requirement is unique to military aircraft, engine designs, and missions. Additionally, JP-5 is a military-unique fuel because it is required to have a substantially higher flash point than commercial aviation turbine fuels for shipboard safety. It is stored in large quantities on aircraft carriers and other vessels. The flash point is for safety in these military-unique applications.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification
- b. Grade of fuel required (see 1.2)
- c. Information concerning the type and amount of each additive used (see 3.3)
- d. Location and injection method of the corrosion inhibitor/lubricity improver (see 3.3.3)
- e. Location and injection method of the fuel system icing inhibitor (see 3.3.4)
- f. Location and injection method of the static dissipater additive for JP-4 only (see 3.3.5)
- g. Quantity required and size containers desired
- h. Level of packaging and packing required (see 5.1)

6.3 Conversion of metric units. Units of measure have been converted to the International System of Units (SI) (metric) in accordance with IEEE/ASTM SI 10. If test results are obtained in units other than metric or there is a requirement to report dual units, ASTM SI 10 should be used to convert the units.

6.4 Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed 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. During transition to Globally Harmonized System (GHS) safety data sheets, refer to OSHA guidance.

6.5 Sample containers. A number of jet fuel properties are very sensitive to trace contamination from sample containers.

6.6 Definitions.

6.6.1 Bulk lot. A bulk lot consists of an indefinite quantity of a homogeneous mixture of material offered for acceptance in a single isolated container or manufactured in a single plant run through the same processing equipment, with no change in ingredient material.

6.6.2 Packaged lot. A packaged lot consists of an indefinite number of 208-liter (55-gallon) drums or smaller unit packages of identical size and type, offered for acceptance, and filled from the isolated tank containing a homogeneous mixture of material, or filled with a homogeneous mixture of material run through the same processing equipment, with no change in ingredient material.

6.6.3 Homogeneous product. A homogeneous product is defined as a product where samples taken at various levels of the batch tank are tested for the defining homogeneous characteristics and all values obtained meet the repeatability precision requirements for that test method.

6.6.4 Synthesized Paraffinic Kerosene (SPK). Kerosene consisting of n-paraffins, iso-paraffins, and cycloparaffins.

6.6.5 Hydroprocessed Esters and Fatty Acids (HEFA) SPKs. Synthesized Paraffinic Kerosene produced by hydroprocessing plant, algal oils, or animal fats.

6.6.6 Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene (FT-SPK). SPK produced from one or more precursors synthesized by Fischer-Tropsch processing.

6.6.7 Conventional blending component. Blending streams derived from the following conventional sources: crude oil, petroleum, oil sands, oil shale, or mixtures thereof.

6.6.8 Fatty Acid Methyl Ester (FAME). FAME is synonymous with biodiesel meeting the requirements of ASTM D6751 or EN 14214. Per ASTM D6751, "biodiesel is a fuel comprised of fatty acids derived from vegetable oils or animal fats, designated B100."

6.6.9 Finished fuel. Final blend of a complex mixture of hydrocarbons, with additives, provided for specification acceptance.

6.6.10 Synthesized Iso-Paraffins (SIP). A synthesized blending component consisting of nearly all iso-paraffins.

6.7 NAVAIR approval. To obtain written consent contact NAVAIRSYSCOM, AIR 4.4.5, BLDG 2360, PSEF, 22229 Elmer Road, Patuxent River, MD 20670-1534.

6.8 Particle counting. To assist in the data collection process, the results should be reported to NAVAIRSYSCOM, AIR 4.4.5.1, BLDG 2360, PSEF, 22229 Elmer Road, Patuxent River, MD 20670-1534.

6.9 Subject term (key word) listing.

- Antioxidants
- Corrosion inhibitor
- Flash point
- Freezing point
- Hydroprocessed Esters and Fatty Acids (HEFA)
- Hydrocarbon distillate
- Hydrogen content
- Icing inhibitor
- Lubricity improver
- Static dissipater additive
- Synthesized Iso-Paraffins (SIP)
- Synthesized Paraffinic Kerosene (SPK)

6.10 International standardization agreement implementation. This specification is an implementing document to NATO STANAG 1135 "Interchangeability of Fuels, Lubricants and Associated Products Used by the Armed Forces of the North Atlantic Treaty Nations," NATO AFLP 3747 "Guide Specifications (Minimum Quality Standards) for Aviation Turbine Fuels (F-24, F-27, F-34, F-35, F-37, F-40 and F-44)," and ASIC AIR STD FG 4024 "Interchangeability Chart of Standardised Aviation Fuels, Lubricants, and Associated Products." 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>.

6.11 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.

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APPENDIX A

METHOD FOR DETERMINATION OF
FILTRATION TIME AND TOTAL SOLIDS (PARTICULATE)

A.1 SCOPE

A.1.1 Scope. This method describes a procedure to determine singularly or simultaneously the filterability characteristics and solids contamination of jet fuel. The purpose is to detect and prevent contaminants in jet fuel, which can plug and cause rupture of ground filtration equipment, thereby affecting flight reliability/safety of aircraft. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 METHODS

A.2.1 Summary of method. An amount of 3.785 liters (1 gallon) of jet fuel is filtered through a membrane filter in the laboratory. The time required to filter this volume is measured in minutes and solids content is determined gravimetrically.

A.3 APPARATUS

- a. Membrane filter: White, plain 47 mm diameter, nominal pore size 0.8 micron. The membrane filter shall conform to the ASTM D5452 requirements.
- b. Filtration apparatus: The apparatus, constructed of stainless steel, consists of a funnel and funnel base with a filter support such that a membrane filter can be securely held between the sealing surface of the funnel and the funnel base (see ASTM D5452, Figure 1).
- c. Flow reducer washer: A 47-mm diameter paper flow reducer ring having a 4.8 cm² filtering area (Millipore Corporation Part No. XX10 04710 or equivalent as approved by the qualifying activity). The flow reducer washer shall only be used with JP-4 fuel.
- d. Vacuum flask: A minimum of 4 liters.
- e. Vacuum system: That develops in excess of 67.5 kPa (20 in. of mercury) vacuum.
- f. Oven: Of the static type (without fan assisted circulation) controlling to 90 °C ±5 °C.
- g. Forceps: Flat-bladed with non-serrated, non-pointed tips.
- h. Dispenser, rinsing solvent (petroleum ether): Containing a 0.45 micron membrane filter in the delivery line. If the solvent has been pre-filtered using a 0.45 micron filter then an inline filter is not required.
- i. Glass Petri dish: Approximately 125 mm in diameter with removable cover.
- j. Analytical balance: Single or double pan, the precision standard deviation of which shall be 0.07 mg or better.

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A.4 PREPARATION

A.4.1 Preparation of apparatus and sample containers. All components of the filtration apparatus (except the vacuum flask), sample containers, and their caps shall be cleaned as described in ASTM D5452. All metal parts of the filtration apparatus are to be electrically bonded and grounded, including the fuel sample container. See ASTM D5452 for other safety precautions.

A.5 SAMPLING

A.5.1 Sample. Obtain a representative 3.785 liters (1 gallon) sample as directed in ASTM D5452. When sampling from a flowing stream is not possible, an all-level sample or an average sample in accordance with ASTM D4057 and/or ASTM D4177 shall be permitted. The 3.785 liter sample container shall be an interior epoxy-coated metal can, a brown glass bottle, or a clear glass bottle protected by suitable means from exposure to light.

A.6 PROCEDURE

A.6.1 Test procedure.

- a. Using forceps, place a new membrane (test) filter in a clean petri dish. Place the petri dish with the lid slightly ajar in a $90\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ oven for 30 minutes. Remove the petri dish from the oven and place it near the balance with the lid slightly ajar, but still protecting the filter from airborne contamination, for 30 minutes.
- b. Weigh the test filter. A filter weighing in excess of 90 mg shall not be used in the test.
- c. Place a flow reducing washer (required only for JP-4 fuel filtration time testing) on top of the funnel base. Then place a test filter on top of the reducing washer and secure the funnel to the funnel base.
- d. Immediately prior to filtering the fuel, shake the sample to obtain a homogenous mix and ensure that fuel temperature does not exceed $30\text{ }^{\circ}\text{C}$. Clean the exterior or top portion of the sample container to ensure no contaminants are introduced. Any free water present in the fuel sample will invalidate the filtration time results by giving an excessive filtration time rating.
- e. With the vacuum off, pour approximately 200 mL of fuel into the funnel.
- f. Turn vacuum on and record starting time. Continue filtration of the 3.785-liter sample, periodically shaking the sample container to maintain a homogenous mix. Record the vacuum (kPa or inches of mercury) 1 minute after start and again immediately prior to completion of filtration. Throughout filtration, maintain a sufficient quantity of fuel in the funnel so the membrane filter is always covered.
- g. Record the filtration time in minutes expressed to the nearest whole number. If filtration of the 3.785 liters is not completed within 30 minutes, the test shall be stopped and the volume of the fuel filtered shall be measured. In these cases, report the filtration time as “greater than 30 minutes” and the total volume of fuel filtered.

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h. Record the vacuum in kPa (in. of mercury) as determined from the average of the two readings taken in A.6.1.f.

i. After recording the filtration time, shut off the vacuum and rinse the sample container with approximately 100 mL of filtered petroleum ether and dispense into the filtration funnel. Turn on the vacuum and filter the 100 mL rinse. Turn off the vacuum and wash the inside of the funnel with approximately 50 mL of filtered petroleum ether. Turn on the vacuum and filter. Repeat the funnel rinse with another 50 mL of petroleum ether but allow the rinse to soak the filter for approximately 30 seconds before turning on the vacuum to filter the rinse. With the vacuum on, carefully remove the top funnel and rinse the periphery of the membrane filter by directing a gentle stream of petroleum ether from the solvent dispenser from the edge of the membrane toward the center, taking care not to wash contaminants off the filter. Maintain vacuum after final rinse for a few seconds to remove the excess petroleum ether from the filter.

j. Using forceps, carefully remove the test filter from the funnel base and flow reducing washer (if present) and place in a clean Petri dish. Dry in the oven at 90 °C ±5 °C for 30 minutes with the cover on the Petri dish slightly ajar. Remove the petri dish from the oven and place it near the balance with the lid slightly ajar, but still protecting the filter from airborne contamination, for 30 minutes. If more than one sample is processed, cooling time may have to be increased. Reweigh the filter.

k. Record the total solids content in mg/liter by using the following formula:

$$\frac{\text{Weight gain of filter in mg}}{3.785 \text{ L}} = \text{mg/L}$$

l. Should the sample exceed the 30-minute filtration time and a portion of the fuel is not filtered, the solids content in mg/liter shall be reported as follows: Determine the volume of fuel filtered by subtracting the mL of fuel remaining from 3785 mL.

$$\frac{\text{Weight gain of filter in mg}}{\text{mL of fuel filtered} \times 0.001} = \text{mg/L}$$

A.7 LIMITS

A.7.1 Filtration time:

(1) The maximum allowable filtration time shall be 10 minutes for grade JP-4 and 15 minutes for grade JP-5.

(2) The vacuum shall exceed 67.5 kPa (20 inches of mercury) throughout the test; i.e., the differential pressure across the filter should exceed 67.5 kPa (20 inches of mercury).

(3) The fuel temperature shall be between 18 °C and 30 °C.

A.7.2 Total solids: Maximum allowable particulate matter is 1.0 mg/liter.

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A.8 NOTES

A.8.1 If it is desired to determine the filtration time and not the total solids content, perform the test by omitting weighing steps and A.6.1k calculation.

A.8.2 If it is desired to determine the total solids content and not the filtration time, use of the insert ring may be omitted. When a reducing ring is not used, then total solids shall be determined as per ASTM D5452 and the use of a control filter shall be required.

CONCLUDING MATERIAL

Custodians:

Army - AT
Navy - AS
Air Force - 68
DLA - PS

Preparing activity:

Navy - AS

(Project 9130-2016-001)

Review activities:

Army - AR, AV
Navy - SH
Air Force - 11, 84, 99

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>.