

METRIC

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11 July 2013
SUPERSEDING
MIL-DTL-5624U
05 January 2004

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, Code 4L8000B120-3, Highway 547, Lakehurst, 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.

INTERNATIONAL STANDARDIZATION AGREEMENTS

- STANAG 1135 Interchangeability of Fuels, Lubricants, and Associated Products Used by the Armed Forces of the North Atlantic Treaty Nations
- STANAG 3747 Guide Specifications (Minimum Quality Standards) for Aviation Turbine Fuels (F-24, F-27, F-34, F-35, F-40, and F-44)

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 STANDARDS

- 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 <https://assist.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 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 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 at Atmospheric Pressure
- ASTM D93 Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

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|------------|---|
| ASTM D129 | Standard Test Methods 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 D1094 | Standard Test Method for Water Reaction of Aviation Fuels |
| ASTM D1266 | Standard Test Method for Sulfur in Petroleum Products (Lamp Method) |
| ASTM D1298 | Standard Practice 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 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 |

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|------------|---|
| ASTM D3338 | Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels |
| ASTM D3343 | Standard Test Method for Estimation of Hydrogen Content 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 D4953 | Standard Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method) |
| ASTM D5001 | Standard Test Method for Measurement of Lubricity of Aviation Turbine Fuels by the Ball-on-Cylinder Lubricity Evaluator (BOCLE) |
| 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 D5452 | Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration |

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|------------|---|
| ASTM D5453 | Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oils 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 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 Kerosene - Type Aviation Turbine Fuels Containing Additives by Portable Separometer |
| ASTM D7566 | Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons |
| 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 or from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

ENERGY INSTITUTE

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|--------|--|
| IP 540 | Determination of the Existant 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 |

(Copies of these documents are available online at <http://www.energyinst.org/> or from the Energy Institute, 61 New Cavendish Street, London, WIG 7AR, UK.)

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. The fuels supplied under this specification shall be refined hydrocarbon distillate fuel oils, which contain additives in accordance with 3.3. The feedstock from which the fuel is refined shall be crude oils derived from petroleum, oil sands, oil shale, synthesized hydrocarbons, or mixtures thereof.

3.1.1 Synthesized Hydrocarbons (applies to Grade JP-5 fuel only). A maximum of 50 volume percent of the finished fuel may consist of Synthesized Paraffinic Kerosene (SPK) blend components derived from Hydroprocessed Esters and Fatty Acid (HEFA) or Fischer Tropsch (FT) produced SPK. FT-SPK blend components shall conform to the requirements in ASTM D7566 Annex A1 with the exceptions as noted in Table I of this specification. SPK blend components derived from HEFA shall conform to requirements in ASTM D7566 Annex A2 with the exceptions as noted in Table I of this specification. Finished fuel containing synthesized hydrocarbons shall conform to the properties listed in Tables II and IV. Finished fuel containing synthesized hydrocarbons shall contain additives in accordance with 3.3 through 3.3.6. The U.S. Army is currently in the process of qualifying their respective aircraft, ground vehicles, and equipment to use fuel containing SPK. Fuels containing synthetic blending components shall not be used in Army aircraft, ground vehicles, and equipment without approval from the following cognizant activities.

Cognizant activities for the U.S. Army:

U.S. Army Ground: Fuels and Lubricants Technology Team,
RDECOM-TARDEC, RDTA-SIE-ES-FPT-FLT, Building 210,
6501 E. 11 Mile Road, Warren, MI 48397-5000.

U.S. Army Aviation: U.S. Army RDECOM,
Attn: RDMR-AEP, Building 4488,
Room C-211, Redstone Arsenal, AL 35898-5000.

TABLE I. Requirements for Synthesized Paraffinic Kerosene blend components for JP-5 Fuel – exceptions to ASTM D7566, annexes A1 and A2, Tables A1.1, A1.2, A2.1, and A2.2 detailed requirements.

Note: Values in this table take precedence over any conflicting values in ASTM D7566.

| Property | FT-SPK or HEFA-SPK | ASTM Test Method |
|---|--------------------|--|
| Flash Point, ° C, min | 60.0 | D56, D93 ^{1/2} , or D3828 |
| Density at 15° C kg/L, min (API max) | 0.750 (57.2) | D1298 or D4052 ^{1/} |
| kg/L, max (API min) | 0.770 (52.3) | |
| Freezing Point, ° C, max | -46 | D2386 ^{1/} , D5972, D7153, or D7154 |
| Derived Cetane Number, min | 40 | D6890 ^{1/} or D7170 |

1/ Referee Test Method.

2/ 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.

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

3.3 Additives. If specified in the contract or purchase order (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 lb/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 lb/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 contract or purchase order (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 contract or purchase order (see 6.2).

3.3.4 Fuel system icing inhibitor. A fuel system icing inhibitor in accordance with MIL-DTL-85470 shall be used. The point of injection of the additive for JP-4 and JP-5 shall be as specified in the contract or purchase order (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 II, at the point of injection. The point of injection shall be as specified in the contract or purchase order (see 6.2). The following static dissipater additive is approved: Stadis® 450 marketed by Innospec Fuel Specialties LLC (formerly Octel Starreon LLC), Newark, DE 19702. 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 II when tested in accordance with the specified test methods.

TABLE II. 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 | 0.015 | D3242 |
| Aromatics, vol percent, max | 25.0 | 25.0 | D1319 |
| Sulfur, Mercaptan, mass percent, max or Doctor test | 0.002 Negative | 0.002 Negative | D3227 D4952 |
| Sulfur, total, mass percent, max | 0.40 | 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 100, min 125, min Report 270, max 1.5 1.5 | Report 205, max Report Report Report 300, max 1.5 1.5 | D86 ^{1,2/} or D2887 ^{3/} |
| Flash point, ° C, min | ----- | 60.0 ^{4/} | 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 (100° F), kPa minimum maximum | 14 21 | ----- ----- | D323, D4953, or D5191 ^{1,5/} |

TABLE II. 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 | -58 | -46 | D2386 ^{1/} , D5972 ^{6/} , D7153, or D7154 |
| Viscosity, at -20° C, max, mm ² /s | ----- | 8.5 | D445 |
| Net Heat of combustion, MJ/kg, min | 42.8 | 42.6 | D3338, D4529, or D4809 ^{1/} |
| Calculated Cetane Index ⁷ | ----- | Report | D976 or D4737 |
| Hydrogen content, mass percent, min | 13.5 | 13.4 | D3701 ^{8/} or D7171 ^{1/} |
| Smoke point, mm, min | 20.0 | 19.0 | D1322 |
| Copper strip corrosion, 2 hr at 100° C, max | No. 1 | No. 1 | D130 |
| Thermal stability: | | | |
| Change in pres. drop, mm of Hg,max | 25 | 25 | D3241 ^{9/} |
| Tube deposit code, less than | 3 ^{10/} | 3 ^{10/} | |
| Existent gum, mg/100 mL, max | 7.0 | 7.0 | D381 ^{1/} or IP 540 ^{11/} |
| Particulate matter, mg/L, max | 1.0 | 1.0 | D2276 or D5452 ^{1/12/} |
| Filtration time, minutes, max | 10 | 15 ^{13/} | 12/ |
| Water reaction interface rating, max | lb | ----- | D1094 |
| Micro Separometer rating, min | 14/ | 14/ | D3948 or D7224 ^{1/} |
| Fuel system icing inhibitor | | | |
| volume percent min | 0.10 | 0.10 | D5006 ^{15/} |
| volume percent max | 0.15 | 0.15 | |
| Fuel electrical conductivity, pS/m allowable range | 150 to 600 ^{16/} | ----- | D2624 |
| Particulate counting, cumulative channel counts ^{17/} | | | |
| ≥ 4 µm | ----- | Report | |
| ≥ 6 µm | ----- | Report | IP 564, IP 565, or IP 577 |
| ≥ 14 µm | ----- | Report | |
| ≥ 21 µm | ----- | Report | |
| ≥ 25 µm | ----- | Report | |
| ≥ 30 µm | ----- | Report | |

^{1/} Referee Test Method.^{2/} A condenser temperature of 0 to 5° C shall be used for the distillation of JP-5 fuel. For JP-4, group 3 test conditions shall be used.

- 3/ 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.
- 4/ 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.
- 5/ When using ASTM D5191 for vapor pressure determination of JP-4, the quality control checks, section 10, 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 and 14 kPa and the second control sample shall have a vapor pressure between 21 and 23 kPa.
- 6/ 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.
- 7/ 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.
- 8/ ASTM D3343, ASTM D3701, or ASTM D7171 may be used to measure hydrogen content of JP-4, but when measuring hydrogen content of JP-5, only ASTM D3701 and ASTM D7171 shall be used.
- 9/ See 4.3.2.1 for ASTM D3241 test conditions and procedures.
- 10/ If the visual rating of the heater tube shows peacock (P) or Abnormal (A) type deposits, the fuel sample is not acceptable.
- 11/ 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.
- 12/ 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.
- 13/ The flow reducer ring of Appendix A of this specification, A.3.c, is not required for JP-5.
- 14/ The minimum microseparometer rating using a Micro-Separometer (MSEP) shall be as specified in Table III.

TABLE III. 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 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.

^{15/} For refractometers with dual scales, the DiEGME scale shall be used.

^{16/} The conductivity shall be in the range of 150 to 600 pS/m at ambient fuel temperature or 29.4° C, whichever is lower.

^{17/} To assist in the data collection process, the results should be reported to NAVAIR 4.4.5.1, ryan.turgeon@navy.mil, or NAVAIRSYSCOM, AIR 4.4.5.1, BLDG 2360, PSEF, 22229 Elmer Road, Patuxent River, MD 20670-1534.

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 IV, when tested in accordance with the specified test methods.

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

| Property | JP-5 | ASTM Test Method |
|-----------------------|------|--|
| Aromatics, vol %, min | 8.0 | D1319 |
| Distillation | | D86 ^{1/} or D2887 ^{2/} |
| T50-T10, ° C, min | 15 | |
| T90-T10, ° C, min | 40 | |
| Lubricity, mm, max | 0.85 | D5001 |

^{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.

3.6 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.

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 and ASTM D4177 or both, 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 II using the specified test methods. If the finished fuel contains synthesized hydrocarbons, the finished fuel shall also meet the limiting values in Table IV 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 II for all finished fuels. For finished fuels containing synthesized hydrocarbons, tests shall also be conducted in accordance with Table IV. Requirements contained in Table II and IV 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 Table II and IV. 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. The heater tube shall be rated visually (see Annex A1 of ASTM D3241).

4.3.2.1.1 Test conditions.

- a. Minimum heater tube temperature at maximum point: 260° C
- b. Fuel system pressure: 3.45 MPa (500 psig)
- c. Fuel flow rate: 3.0 mL/minute
- d. Test duration: 150 minutes

4.3.2.1.2 ASTM D3241 procedure.

- a. Record the differential pressure in mm Hg at 150 minutes, or time to differential pressure of 25 mm Hg, whichever comes first.
- b. Record the heater tube deposit code rating at the end of the test.

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 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 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 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313. 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. Synthetic Paraffinic Kerosene produced by hydroprocessing plant, algal oils or animal fats.

6.6.6 Hydroprocessed or Hydrotreated Renewable Jet (HRJ). Terminology used to identify HEFA SPKs.

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

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

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

6.7 NAVAIR approval. To obtain written consent contact NAVAIRSYSCOM, AIR 4.4.5.1, BLDG 2360, PSEF, 22229 Elmer Road, Patuxent River, MD 20670-1534.

6.8 Subject term (key word) listing.

- Antioxidants
- Corrosion inhibitor
- Flash point
- Freezing point
- Hydroprocessed Esters and Fatty Acids (HEFA)
- Hydroprocessed / Hydrotreated Renewable Jet (HRJ)
- Hydrocarbon distillate fuel
- Hydrogen content
- Icing inhibitor
- Lubricity improver
- Static dissipater additive
- Synthesized Paraffinic Kerosene (SPK)

6.9 International standardization agreement implementation. This specification implements NATO STANAG 1135, and NATO STANAG 3747. 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>.

6.10 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.

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. 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 reducing washer: The flow reducer washer shall only be used with JP-4 fuel. A 47-mm diameter paper flow reducer ring with dimensions to give a filtering area of 4.8 cm^2 . (Millipore Corporation Part No. XX10 04710 or equivalent).
- 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 $90 \pm 5^\circ \text{ C}$.
- g. Forceps: Flat-bladed with unserrated, nonpointed 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 $90^{\circ}\text{ C} \pm 5^{\circ}\text{ C}$ 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° 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 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 $90^{\circ} \pm 5^{\circ}$ 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 9130-2012-001)

Review activities:

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

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>.