INCH – POUND

MIL-DTL-25576E
14 April 2006

SUPERSEDING
MIL-DTL-25576D
20 May 2005

DETAIL SPECIFICATION

PROPELLANT, ROCKET GRADE KEROSENE

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

Comments, suggestions, or questions on this document should be addressed to DET 3, WR-ALC/AFTT, 2430 C Street, Bldg 70, Area B, Wright-Patterson AFB OH 45433-7632 or e-mailed to AFPET.AFTT@wpafb.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

AMSC N/A FSC 9130

1. SCOPE

1.1 Scope. This specification covers two grades of rocket propellant kerosene for use in rocket engines.

1.2 Classification. Rocket propellant kerosene will be of the following designated grades:

RP-1 – Normal production, total sulfur content of 30 mg/Kg (max), suitable for most uses.

RP-2 – Processed RP-1, total sulfur content of 100 µg/Kg (max).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in 3, 4, or 5 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, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS, INC. (ASTM)

ASTM D 86	Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure (DoD Adopted)
ASTM D 93	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester (DoD Adopted)
ASTM D 130	Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test (DoD Adopted)
ASTM D 240	Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (DoD Adopted)
ASTM D 381	Standard Test Method for Gum Content in Fuels by Jet Evaporation (DoD Adopted)
ASTM D 445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity) (DoD Adopted)
ASTM D 1094	Standard Test Method for Water Reaction of Aviation Fuels (DoD Adopted)
ASTM D 1298	Standard t Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer method (DoD Adopted)
ASTM D 1319	Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption (DoD Adopted)
ASTM D 2386	Standard Test Method for Freezing Point of Aviation Fuels (D0D Adopted)

ASTM D 3227	Standard Test Method for (Thiol Mercaptan) Sulfur in Gasoline, Kerosine, Aviation Turbine, and Distillate Fuels (Potentiometric Method) (DoD Adopted)
ASTM D 3241	Standard Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels (JFTOT Procedure) (DoD Adopted)
ASTM D 3343	Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels (DoD Adopted)
ASTM D 4045	Standard Test Method for Sulfur in Petroleum Products by Hydrogenolysis and Rateometric Colorimetry
ASTM D 4052	Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter (DoD Adopted)
ASTM D 4057	Standard Practice for Manual Sampling of Petroleum and Petroleum Products (DoD Adopted)
ASTM D 4177	Standard Practice for Automatic Sampling of Petroleum and Petroleum Products (DoD Adopted)
ASTM D 5452	Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration (DoD Adopted)
ASTM D 5453	Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Motor Fuels, and Oils by Ultraviolet Fluorescence
ASTM D 5623	Standard Test Method for Sulfur Compounds in Light Petroleum Liquids by Gas Chromatography and Sulfur Selective Detection
ASTM E 29	Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (DoD Adopted)

(Copies of these documents are available online at http://www.astm.org or from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken PA 19428-2959)

AMERICAN PETROLEUM INSTITUTE (API)

API/IP Spec 1581	Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators

(Copies of this document are available online at http://api-ep.api.org or from API Publications, Global Engineering Documents, 15 Inverness Way East, M/S C303B, Englewood, CO 80112-5776)

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, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Material. The propellant shall consist completely of hydrocarbon compounds except as otherwise specified herein.

3.2 Chemical and physical properties. The chemical and physical properties of the propellant shall conform to those listed in Table I when tested in accordance with applicable test methods.

TABLE I. Chemical and physical properties.

Property	Limits		ASTM Test Method
	RP-1	RP-2	
Distillation			D86
Initial Boiling Point, °F	\1	\1	
Fuel Evaporated, 10%, °F	365-410	365-410	
Fuel Evaporated, 50%, °F	\1	\1	
Fuel Evaporated, 90%, °F	\1	\1	
End Point, °F	525 max	525 max	
Residue, % Vol	1.5 max	1.5 max	
Distillation Loss % Vol	1.5 max	1.5 max	
Specific Gravity, 60/60°F	0.799 – 0.815	0.799 – 0.815	D 1298\2
Existent Gum, mg/100mL	1 max	1 max	D 381
Sulfur, Total, mg/Kg	30 max	0.1 max	D 5623\3
Mercaptan-sulfur, mg/Kg	3 max	\4	D 3227
Freezing Point, °F	- 60 max	- 60 max	D 2386
Thermal Value: Net Heat of Combustion, BTU/lb	18500 min	18500 min	D 240
Viscosity at - 30°F, cSt	16.5 max	16.5 max	D 445
Aromatics, % Vol	5.0 max	5.0 max	D 1319
Olefins, % Vol	2.0 max	1.0 max	D 1319
Hydrogen Content, % mass	13.8 min	13.8 min	D 3343
Copper Strip Corrosion	1 max	1 max	D 130\5
Water Reaction Interface	\6	\6	D 1094
Flash Point, °F	140 min	140 min	D 93
Thermal Stability (JFTOT)			D 3241\7
JFTOT, change in pressure drop (ΔP) in 5 hours, mm Hg	\4	\1	
JFTOT, delta TDR Spun	\4	\1	
Particulate, mg/L	1.0 max	1.0 max	D 5452

NOTE:

\1 – Report only
\2 – ASTM D 4052 may be used. In case of a dispute, ASTM D 1298 shall be the referee.
\3 – ASTM D 4045 may be used for RP-2 grade. ASTM D 5453 may be used for RP-1 grade. In case of a dispute, ASTM D 5623 shall be the referee.
\4 – Not required
\5 – Follow the procedures specific to kerosene.
\6– See 3.2.1 for requirements and 4.3.2.1 for exceptions to ASTM D 1094.
\7 – For specific test conditions see 4.3.2.2.

3.2.1 Water reaction. When tested as specified in Table I and 4.3.2.1, the propellant shall have separated sharply from the water layer. The interface shall be equal to or better than rating 1b as described in ASTM D 1094, Table 2. In addition, neither layer shall have changed in volume by more than 1 milliliter.

3.3 Additives. The additives listed herein may be used singly or in combination, in amounts not to exceed those specified. No substance of known dangerous toxicity under usual conditions of handling and use shall be added except as specified herein. The type and amount of each additive used shall be reported and shall be specified in the contract or order.

3.3.1 Antioxidants. The following active inhibitors may be added separately or in combination to the propellant in total concentration not in excess of 8.4 pounds of inhibitor (not including weight of solvent) per 1,000 barrels (6.3.1) of propellant (9.1g/100 US gal) in order to prevent the formation of gum.

(a) 2,6-ditertiary butyl 4-methyl phenol.

(b) N, N' disecondary butyl paraphenylenediamine.

(c) 2,4-dimethyl-6 tertiary-butyl phenol.

(d) 2,6-ditertiary butyl phenol.

3.3.2 Metal deactivator. A metal deactivator, N, N'-disalicylidene-1, 2-propanediamine, may be added in an amount not to exceed 2 pounds of active ingredient per 1,000 barrels of propellant (2.2 g/100 US gal).

3.3.3 Dye. A dye, methyl derivative of azobenzene-4-azo-2-naphthol, shall be added in an amount not to exceed ½ ounce (wt) per 1000 US gallons of RP-1 propellant. Dye shall not be added to RP-2 propellant.

3.4 Limiting values. For purposes of determining conformance with these requirements, an observed value or a calculated value shall be rounded off to the nearest unit in the last right-hand digit used in expressing the specified limit. This rounding off shall be done in accordance with the rounding-off method of ASTM E 29 (Using Significant Digits in Test Data to Determine Conformance with Specifications).

3.5 Filter. A filter/separator (F/S) conforming to the requirements of API/IP Spec 1581 shall be installed on the fill line upstream of the header used for filling the delivery containers.

3.6 Workmanship. At the time of Government acceptance, the finished propellant shall be visually free from undissolved water, sediment or suspended matter and shall be clear and bright (no haze or cloudiness). In case of a dispute, the propellant shall be clear and bright at 70°F.

4. VERIFICATION

4.1 Classification of inspections. The inspection and testing of the propellant requirements specified herein are classified as quality conformance tests (4.2).

4.2 Quality conformance tests. Quality conformance tests shall consist of the following:

Individual test	4.2.1
Sampling test	4.2.2

4.2.1 Individual test. The propellant shall be subjected to the following test:

Examination of product	4.3.1

4.2.2 Sampling tests. The propellant shall be sampled in accordance with 4.2.2.1 and the samples tested for conformance to the limits of Table I utilizing the procedures described under 4.3.

4.2.2.1 Sampling plan.

4.2.2.1.1 Lot. A lot shall consist of one of the following:

a. The propellant produced in not more than 24 consecutive hours from a continuous process which is used to fill shipping containers directly from the process output. A continuous process shall be the production of product by continuous input of raw materials and output of finished product by one manufacturer in one plant with no change in manufacturing conditions or materials.

b. The propellant from individual runs of a batch process which is used to fill shipping containers directly from the process output. A batch process shall be the production of product by single additions of raw materials which are reacted and purified forming the product.

c. The propellant from either or both the continuous and batch processes which is held in a single storage tank and subsequently withdrawn to fill shipping containers. The product shall be homogenous at the time of withdrawal and shall not be added to while being withdrawn. After each addition to the storage tank, the contents shall constitute a separate lot.

4.2.2.1.2 Sample. A sample shall consist of no less than two U.S. gallons. Sampling shall be in accordance with ASTM D 4057 or ASTM D 4177.

4.2.2.1.3 Shipping containers. Each bulk container or packaged lot shall be sampled for verification of product quality. The number of containers to be sampled from a packaged lot shall be in accordance with Table II. The first and last drums to be filled within a given lot shall be sampled. Other samples may be selected at random.

Table II. Sampling Plan

Number of Containers in Lot	Number of Containers to be Sampled
1	1
2 - 40	2
41 – 70	3
Over 70	4

Note: All bulk shipment containers shall be considered a lot and shall be sampled for verification of product quality.

4.3 Test methods.

4.3.1 Examination of product. The propellant sample shall be visually examined while performing tests specified in Table I to determine compliance with the requirement specified in 3.6. Examination shall be conducted after the sample has been transferred to the test apparatus.

4.3.2 Testing. Unless otherwise specified by the procuring activity, tests as specified in 3.2 shall be conducted in accordance with ASTM standards, using applicable methods as listed in Table I.

4.3.2.1 Water reaction. The water reaction test shall be conducted in accordance with ASTM D 1094, except that a 2-hour rather than a 5-minute standing period shall be used before evaluating the propellant-water interface.

4.3.2.2 Thermal stability. The thermal stability test shall be conducted in accordance with (IAW) ASTM D 3241 (JFTOT), as modified below. The heater tube shall be rated for deposits using the Alcor Mark 8A Tube Deposit Rater (TDR) as modified in appendix A or the Alcor Mark 9 TDR (see 4.3.2.2.1b)

4.3.2.2.1 Test conditions.

a. Heater tube temperature at maximum point: 671°F

b. Fuel system pressure: 3.45 MPa (500 lbs/in^2 of gravity)

c. Fuel flow rate: 3.0 mL/min

d. Test duration: 300 min

e. Quantity of test fuel: 1 L

4.3.2.2.2 Reported data. The following data shall be reported:

a. The maximum differential pressure across the test filter in 5 hours.

b. The maximum SPUN TDR rating (i.e. the maximum difference between the post-test and the pretest TDR rating) reported in TDR units. Both before and after the JFTOT test, use the modified Mark 8A or Mark 9 TDR to rate the heater tube at 2 mm increments from 20 mm to 50 mm along the length of the heater tube.

4.4 Rejection and retest. When any sample of the propellant tested in accordance with 4.2 fails to conform to the requirements specified herein, the entire lot represented by the sample shall be rejected. Rejected material shall not be resubmitted without furnishing full particulars concerning previous rejection and measures taken to overcome defects.

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. The propellant covered by this specification is intended for use in rocket engines and as a hydraulic fluid medium in rocket engine gimbal systems.

6.2 Acquisition requirements. Acquisition documents must specify the following:

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

b. Grade of the propellant required (1.2).

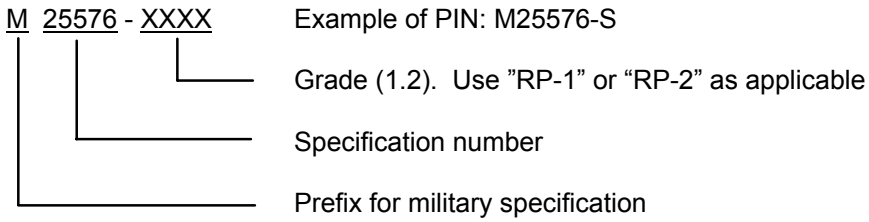
c. Method of shipment, type and capacity of containers.

d. Quantity by weight.

e. Packaging requirements (5. 1).

f. That one copy of the certificate of analysis, signed by the contractor's representative, listing values obtained on all tests shall accompany each shipment delivered to the consignee. In addition, one copy shall also be furnished to DET 3 WR-ALC/AFTT, 2430 C Street, Bldg 70, Area B, Wright-Patterson AFB, OH 45433-7632

6.3 Part or identifying number (PIN). The PINs to be used for rocket grade propellant kerosene acquired to this specification are created as follows:



6.4 Definitions.

6.4.1 Barrel. A barrel as specified herein will contain 42 U.S. gallons.

6.5 Subject term (key word) listing.

Antioxidant

Fuel

Kerosene

Metal deactivator

Propellant

RP-1

RP-2

Rocket engine

6.6 Changes from previous issue. The margins of this specification are marked with change bars to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

APPENDIX A

ALCOR MARK 8A TUBE DEPOSIT RATER MODIFICATIONS

A.1 Scope. This appendix gives instructions for the modification of Alcor Mark 8A Tube Deposit Rater (TDR) so that accurate measurements of the Delta Spun TDR ratings can be obtained. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 Summary. JFTOT heater tubes often have a pretest Spun TDR rating of zero or below when rated with the Mark 8A TDR IAW ASTM D 3241. This occurs because the surface finish of the heater tube test section is difficult to control and new heater tubes have pretest ratings which range from about -5 TDR units to about +5 TDR units. To compensate accurately for differences in the pretest ratings of the JFTOT heater tubes, the pretest rating is subtracted from the post test rating to obtain the Delta Spun TDR rating. However, the production model of the Mark 8A TDR cannot rate tubes below the zero TDR level since the range of the meter is 0 to +50 TDR units. Accurate positive and negative TDR values can be obtained when the original meter is replaced with a digital millivolt meter that can read both positive and negative voltages. (NOTE: If the modification instructions given below are followed, 1 millivolt (mv) will equal 1 TDR unit.) This appendix gives the instructions necessary to make this change.

A.3 APPARATUS

A.3.1 Tube Deposit Rater (TDR). Alcor Mark 8A Tube Deposit Rater IAW ASTM D 3241.

A.3.2 Digital meter. Digital millivolt meter with a minimum scale range of ±50 mv and a minimum accuracy of ±2 percent at 50 mv. The digital millivolt meter must have a range of ±199.9 mv and input power requirements of 120/240 VAC, 50 to 400 Hz.

A.3.3 Resistor. A 1000 ohm resistor, ¼ watt (required for Option 2, below).

A.3.4 Hardware. Suitable electrical wiring, connectors, and other hardware to connect electrically the digital millivolt meter to the Mark 8A TDR and, if desired, to physically attach the digital millivolt meter to the Mark 8A TDR.

A.4 PROCEDURE

A.4.1 Option 1. Leave the existing meter in place. This option will enable the use of the TDR with either the existing meter or with the digital millivolt meter, but not concurrently. The two meters will not give identical readings; therefore, the TDR must be calibrated using the meter selected for use.

A.4.1.1 Hook-up. Connect the digital millivolt meter in parallel with the existing meter. It may be necessary to drill holes in the TDR case to bring out electrical leads from the existing meter terminals to the digital millivolt meter. The 1000 ohm resistor is not used with this option. To avoid confusion, it is suggested that the face of the existing meter be covered when the digital millivolt meter is used.

A.4.2 Option 2. Replace the existing meter. This option is recommended, as there will be a small but significant difference in the readings of the digital millivolt meter and the existing meter when option 1 is used. Confusion could arise with both meters operational.

A.4.2.1 Hook-up. Remove the existing meter from the Mark 8A TDR. Connect the 1000 ohm resistor between the two leads that were connected to the existing meter. Connect the digital millivolt meter in parallel with the 1000 ohm resistor. With the existing meter removed, leads from the TDR to the digital millivolt meter can be brought out through the front of the TDR, as there will be a 2-inch diameter

hole where the meter was located. If the digital millivolt meter gives negative readings during calibration, reverse the leads that lead to the digital millivolt meter

A.4.3 Digital meter. It may be possible to find a suitable digital millivolt meter that can be installed within the TDR case in lieu of the original meter. However, most digital millivolt meters are considerably deeper than the original TDR meter and there may not be sufficient room to accommodate the new meter within the TDR case. It may be possible, however, to obtain digital meters which have a detachable display that could be mounted on the front of the TDR with the remainder of the digital meter located within the TDR case (if there is room) or attached to the side or back of the TDR (some users may want to connect the AC power input to the digital meter through the TDR on-off switch).

A.5 Calibration. The calibration procedure for the digital millivolt meter is the same as that for the original meter. The Low Cal and High Cal controls are used to adjust the meter readings to agree with the calibration tube ratings as before. Note the greater sensitivity of the digital millivolt meter may cause some jitter, but this should only be in the tenth of a millivolt (i.e. TDR unit) range.

A.6 OPERATION

A.6.1 Tube Deposit Rater (TDR). Mark 8A Tube Deposit Rating methods. See ASTM D 3241.

A.6.2 Delta Spun TDR. With the digital millivolt meter, negative TDR ratings are possible and the sign (i.e. plus [+] or minus [-]) of the TDR rating must be recorded as well as the TDR value. The pretest rating must be algebraically subtracted from the post test rating to obtain the Delta Spun TDR rating. The Delta Spun TDR shall be determined along the length of the JFTOT tube from position 14 to position 56 at 2-mm increments. The largest value shall be reported.

Custodians:
Army – CR4
Navy – AS
Air Force – 68
DLA - PS

Review activities:
Army – MI
Air Force – 19

Civil agency:
NASA – NA

Preparing activity:
Air Force – 68
(Project 9130-2006-001)

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