Ministry of Defence
Defence Standard 91-91

Issue 6 Publication Date 8 April 2008

Turbine Fuel, Aviation Kerosine Type, Jet A-1
NATO Code: F-35
Joint Service Designation: AVTUR

Reprinted 25 August 2008
to incorporate Amendment 1

Contents

Foreword

AMENDMENT RECORD

Amd No	Date	Text Affected	Signature and Date
1	August 2008	FAME limits, Section 5.5 and Annex G Electrical conductivity, Annex H,	SPM 3

REVISION NOTE

Amendment 1 is raised to introduce statement on FAME limits and electrical conductivity

HISTORICAL RECORD

This standard supersedes the following:

Def Stan 91-91 Issue 6	Dated 8 April 2008 (Implementation Date 8 July 2008)
Def Stan 91-91 Issue 5	Reprinted 9 March 2007 (incorporating Amendment 2)
Def Stan 91-91 Issue 5	Reprinted 31 March 2006 (incorporating Amendment 1)
Def Stan 91-91 Issue 5	dated 8 February 2005
Def Stan 91-91 Issue 4	Reprinted 30 January 2004 (incorporating Amendment 1)
Def Stan 91-91 Issue 4	dated 14 June 2002
Def Stan 91-91 Issue 3	dated 12 November 1999
Def Stan 91-91 Issue 2	dated 8 May 1996
Def Stan 91-91 Issue 1	dated 1 September 1994
DERD 2494 Issue 10	dated 30 June 1988

a) This standard provides requirements for Turbine Fuel, Aviation, Kerosine Type.

b) The Technical Authority is the Director, Defence Fuels Group (DDFG), Defence Petroleum Centre, West Moors, Wimborne, Dorset, BH21 6QS, United Kingdom. This standard has been produced on behalf of the Defence Fuels and Lubricants Committee (DF&LC), by the UK Aviation Fuels Committee (AFC).

c) This standard has been agreed by the authorities concerned with its use and is intended to be used whenever relevant in all future designs, contracts, orders etc. and whenever practicable by amendment to those already in existence. If any difficulty arises which prevents application of the Defence Standard, the UK Defence Standardization (DStan) shall be informed so that a remedy may be sought.

d) Any enquiries regarding this standard in relation to an invitation to tender or a contract in which it is incorporated are to be addressed to the responsible technical or supervising authority named in the invitation to tender or contract.

e) Compliance with this Defence Standard shall not in itself relieve any person from any legal obligations imposed upon them.

f) This standard has been devised solely for the use of the Ministry of Defence (MOD) and its contractors in the execution of contracts for the MOD. To the extent permitted by law, the MOD hereby excludes all liability whatsoever and howsoever arising (including, but without limitation, liability resulting from negligence) for any loss or damage however caused when the standard is used for any other purpose.

Introduction

Defence Standard 91-91 is the standard for aviation turbine fuel, which the United Kingdom Civil Aviation Authority (CAA) has agreed is under the technical authority of the Director Defence Fuels Group.

NOTE: The Technical/Specification Authority is the Director Defence Fuels Group, Defence Petroleum Centre, West Moors, Wimborne, Dorset, BH21 6QS, United Kingdom.

Standards for Defence - Turbine Fuel, Aviation Kerosine Type, Jet A-1. NATO Code: F-35. JSD: AVTUR

1 Scope

This Defence Standard specifies the requirements for one grade of kerosine type aviation turbine fuel intended for use in aircraft gas turbine engines. Fuel provided to this specification shall possess satisfactory performance and properties when used in appropriate aircraft or engines operated by the Crown, or for which the CAA is the certificating agency.

2 Warning

The Ministry of Defence (MOD), like its contractors, is subject to both United Kingdom and European laws regarding Health and Safety at Work, without exemption. All Defence Standards either directly or indirectly invoke the use of processes and procedures that could be injurious to health if adequate precautions are not taken. Defence Standards or their use in no way absolves users from complying with statutory and legal requirements relating to Health and Safety at Work.

3 Normative References

3.1 The documents and publications shown in **Annex K** are referred to in the text of this standard. Publications are grouped and listed in alphanumeric order.

3.2 Reference in this standard to any normative reference means in any invitation to tender or contract the edition and all amendments current at the date of such tender or contract unless a specific edition is indicated.

3.3 In consideration of **3.2** above, users shall be fully aware of the issue and amendment status of all normative references, particularly when forming part of an invitation to tender or contract. Responsibility for the correct application of standards rests with users.

3.4 Where conflict exists between this specification and references cited herein, the text of this document takes precedence.

3.5 DStan can advise regarding where normative references are obtainable. Requests for such information can be made to the DStan Helpdesk. How to contact the helpdesk is shown on the outside rear cover of Defence Standards.

4 Materials

4.1 The fuel shall consist wholly of hydrocarbon compounds derived from conventional sources including crude oil, natural gas liquid condensates, heavy oil, oil shale and oil sands, and qualified additives as listed in **Annex A**. Fuels containing synthetic components derived from non-petroleum sources are only permitted provided that they meet the requirements of **Annexes A and D** in addition to those defined in **clause 5**. Only additives and non-petroleum fuel components approved by and on behalf of the UK AFC shall be permitted.

4.2 Additives shall be identified by the appropriate RDE/A/XXX number shown in **Annex A**. The amount, including NIL additions, of all additive additions shall be reported to the purchaser on batch quality certificates or as otherwise directed by the purchaser and/or contract.

4.3 Additional information on aviation turbine fuel lubricity can be found in **Annex B**.

4.4 The Ministry of Defence and/or its appointed agent(s) reserves the right to require that the material and any components used are subject to toxicological and physiological tests to ascertain their suitability for use.

5 Quality Assurance

5.1 Representative samples of each batch of the finished product shall be tested to show batch homogeneity and compliance with the requirements of **clause 4** and **Table 1** of this standard. Results shall be reported on the appropriate batch certificate to show compliance with all requirements of the standard. A batch of fuel is defined as a distinct quantity of jet fuel that can be characterised by one set of test results including types of additives and quantities added. Documentation shall be available on request for the Technical Authority, purchaser or end user to show that the fuel meets the requirements of this standard and show traceability to point of manufacture.

The minimum requirements for information to be shown on the fuel's batch test certificate at point of manufacture are given at **Annex J**.

5.2 The Technical Authority, purchaser or end user reserves the right to require additional testing of the product at any time and to sample and test the product and/or ingredients at any time during or after manufacture.

5.3 If any sample taken from the consignment is found not to comply with the requirements of this standard, the whole consignment may be rejected.

5.4 Materials used in refinery processing might be carried over in trace quantities into aviation fuels and have been known to cause operational problems in aircraft fuel systems. Appropriate management of change measures should be used at manufacturing locations to manage the risk of this type of contamination in aviation fuels. (see **A.9**).

5.5 An approval, by both engine and airframe OEMs, and endorsed by the AFC, has been agreed to allow for the practical operation of the jet fuel supply and distribution systems. Of particular concern are Multi Product Pipelines (MPPs) that transport both jet fuel and automotive diesel fuel containing the bio component FAME (Fatty Acid Methyl Ester) as well as other petroleum based products. It has been deemed necessary for such an approval to be sought due to the possibility of carryover of FAME in trace quantities into jet fuel.

5.5.1 A quantity of FAME, less than 5.0 mg/kg, that meets the requirements of BS EN 14214 or ASTM D6751, as determined using either the Shell Research Ltd Two-dimensional Gas Chromatography method (RTS Report GS.06.50289) or the BP GC-MS method (see Note for further information) is to be considered negligible. Jet fuel that contains less than 5.0 mg/kg of FAME is deemed to be acceptable for use. However, it is envisaged that by careful and practical operation of the jet fuel supply and distribution system, and in particular MPPs as identified in JIG Bulletin number 15 and 16 (www.jointinspectiongroup.org), FAME carryover into jet fuel shall be minimised to ensure that all delivered jet fuel batches are well below this maximum allowable level. Important guidance on how to verify compliance with this requirement is contained in Annex G.

5.5.2 Since this requirement is to define a maximum level of FAME due to carryover or cross contamination within the distribution system, this limit must be applied to protect fuel quality at the skin of the aircraft.

NOTE: The UK Energy Institute is working on a fast-track programme to develop standardised industry test methods with formal precision statements to measure low levels of FAME in jet fuel at the 5 mg/kg level by Q1 2009. (For further information please see Annex G). As soon as additional suitable methods become available the specification will be updated.

6 Testing

6.1 Properties of the product shall not exceed the maximum nor be less than the minimum values set out in **Table 1** when tested by the methods referred to therein or **Annex C**.

NOTE : The IP 367 procedure, which covers the use of precision data, may be used for the interpretation of test results in cases of dispute between purchaser and supplier.

6.2 Methods quoted in **Table 1** are referee methods. In cases of dispute the referee methods shall be used. Approved alternative methods are listed in **Annex C**. A list of ISO methods which were technically equivalent to the IP test methods at the time of issue of the specification can be found at **Annex I**.

6.3 For synthetic blends referee methods will be used. Use of alternative technically equivalent methods may be used following the approval by the Technical Authority.

7 Containers and Marking of Containers

7.1 The product shall be supplied in sound, clean and dry containers, suitable for the product and in accordance with the requirements of the contract or order.

7.2 Coatings and paint finishes shall comply with the requirements of the contract or order. Markings shall be in accordance with the requirements of Def Stan 05-52 (Part 1). The product identification shall be specified in the contract or order.

7.3 It shall be the responsibility of the contractor to comply with any legal requirements for the marking of containers.

Table 1 - Test Requirements

Test	Property	Units	Limits	Method
1	Appearance			
1.1	Visual Appearance		Clear, bright and visually free from solid matter and undissolved water at ambient temperature	Visual
1.2	Colour		Report	ASTM D156 or ASTM D6045 (see NOTE 1)
1.3	Particulate Contamination, at point of manufacture	mg/l	Max 1.0	IP423/ ASTM D5452 (see NOTE 2)
1.4	Particulate, at point of manufacture, cumulative channel particle counts	ISO Code	(See NOTE 3)	IP 564 or IP 565 (see NOTE 4)
1.4.1	≥ 4 µm(c)		Report	
1.4.2	≥6 µm(c)		Report	
1.4.3	≥14 µm(c)		Report	
1.4.4	≥21 µm(c)		Report	
1.4.5	≥25 µm(c)		Report	
1.4.6	≥30 µm(c)		Report	
2	Composition			See NOTE 5
2.1	Total Acidity	mg KOH/g	Max 0.015	IP 354/ ASTM D3242
2.2	Aromatic Hydrocarbon Types			
2.2.1 or	Aromatics	% v/v	Max 25.0	IP 156/ ASTM D1319
2.2.2	Total Aromatics	% v/v	Max 26.5	IP 436/ ASTM D6379 (see NOTE 6)
2.3	Sulfur, Total	% m/m	Max 0.30	IP 336
2.4 or	Sulfur, Mercaptan	% m/m	Max 0.0030	IP 342/ ASTM D3227 (see NOTE 7)
2.5	Doctor Test		Doctor Negative	IP 30

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Table 1: Test Requirements (continued)

2.6	Refining Components, at point of manufacture		.	
2.6.1	Hydroprocessed Components	% v/v	Report	
2.6.2	Severely Hydroprocessed Components	% v/v	Report	(see NOTE 8)
3	Volatility:			
3.1	Distillation:			IP 123/ ASTM D86 (see NOTE 9)
3.1.1	Initial Boiling Point	°C	Report	
3.1.2	10% Recovery	°C	Max 205.0	
3.1.3	50% Recovery	°C	Report	
3.1.4	90% Recovery	°C	Report	
3.1.5	End Point	°C	Max 300.0	
3.1.6	Residue	% v/v	Max 1.5	
3.1.7	Loss	% v/v	Max 1.5	
3.2	Flash Point	°C	Min 38.0	IP 170
3.3	Density at 15 °C	kg/m^3	Min 775.0 Max 840.0	IP 365/ ASTM D4052
4	Fluidity:			
4.1	Freezing Point	°C	Max minus 47.0	IP 16/ ASTM D2386
4.2	Viscosity at minus 20 °C	mm^2/s	Max 8.000	IP 71/ ASTM D445
5	Combustion:			
5.1	Smoke Point	mm	Min 25.0	IP 57/ ASTM D1322 (see NOTE 10)
or				
5.2	Smoke Point	mm	Min 19.0	IP 57 ASTM D1322
	And Naphthalenes	% v/v	Max 3.00	ASTM D1840
5.3	Specific Energy	MJ/kg	Min 42.80	(see NOTE 11)
6	Corrosion:			
6.1	Copper Strip	Class	Max 1	IP 154/ ASTM D130 (see NOTE 12)

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Table 1: Test Requirements (continued)

Test	Property	Units	Limits	Method
7	Thermal Stability, JFTOT			IP 323 /ASTM D3241 (See NOTE 13)
7.1	Test Temperature	°C	Min 260	
7.2	Tube Rating Visual		Less than 3. No Peacock (P) or Abnormal (A)	(See NOTE 14)
7.3	Pressure Differential	mm Hg	Max 25	
8	Contaminants:			
8.1	Existent Gum	mg/100ml	Max 7	IP 540
9	Water Separation Characteristics			
9.1	Microseparometer, at Point of Manufacture:			ASTM D3948 (See NOTE 15)
9.1.1	MSEP Without SDA	Rating	Min 85	
9.1.2	MSEP With SDA	Rating	Min 70	
10	Conductivity:			
10.1	Electrical Conductivity	pS/m	Min 50 Max 600	IP 274/ ASTM D2624 (See NOTE 16)
11	Lubricity: Wear Scar Diameter	mm	Max 0.85	ASTM D5001 (See NOTE 17)

NOTE 1: The requirement to report Saybolt Colour shall apply at point of manufacture, thus enabling a colour change in distribution to be quantified. Where the colour of the fuel precludes the use of the Saybolt Colour test method, then the visual colour shall be reported. Unusual or atypical colours should also be noted. For further information on the significance of colour see Annex E.

NOTE 2: Refer to the information on Particulate Contamination in Annex F

NOTE 3: The number of particles shall be reported as a scale number as defined by Table 1 of ISO 4406:1999

NOTE 4: The implementation date for particle counting is 30th June 2009, but where possible, to help the data collection process, the results should be reported before that date. It is the Specification Authorities intention to replace Test 1.3 with Test 1.4 at the earliest opportunity.

NOTE 5: Concentrations of FAME greater than or equal to 5.0 mg/kg are not acceptable. See section 5 for details.

NOTE 6: Round robin testing has demonstrated the correlation between total aromatics content measured by IP 156/ASTM D1319 and IP 436/ASTM D6379. Bias between the two methods necessitates different equivalence limits as shown. Testing laboratories are encouraged to measure and report total aromatics content by the two methods to assist verification of the correlation. In cases of dispute IP 156 will be the referee method. It is the intention of the Technical Authority to change the referee method to IP 436 at a later date.

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Table 1: Test Requirements (concluded)

NOTE 7: The alternative requirement 2.5 is a secondary requirement to 2.4. In the event of a conflict between Sulfur Mercaptan (2.4) and Doctor Test (2.5) results, requirement 2.4 shall prevail.

NOTE 8: Severely hydroprocessed components are defined as petroleum derived hydrocarbons that have been subjected to a hydrogen partial pressure of greater than 7000 kPa (70 bar or 1015 psi) during manufacture. The severely hydroprocessed components shall be reported on the certificate of quality as a percentage by volume of the total fuel in the batch.

NOTE 9: In methods IP 123 and ASTM D86 all fuels certified to this specification shall be classed as group 4, with a condenser temperature of zero to 4°C.

NOTE 10: Alternative test requirements identified in Table 1; Test Requirements 5.1 or 5.2 are equal primary requirements.

NOTE 11: Specific Energy by one of the calculation methods listed at Annex C will be acceptable. Where a measurement of Specific Energy is deemed necessary, the method to be used shall be agreed between the Purchaser and Supplier.

NOTE 12: The sample shall be tested in a pressure vessel at 100±1°C for 2 hours ± 5 minutes.

NOTE 13: Thermal Stability is a critical aviation fuel test and while competition among equipment manufacturers/suppliers is to be encouraged, aircraft safety must remain paramount. It is known that there are JFTOT tubes being supplied by sources other than the original equipment manufacturer (OEM). Until the alternative manufacturers' tubes have been demonstrated to be equivalent to the OEM's test pieces, to the satisfaction of the AFC, they shall not be used. A list of manufacturers whose JFTOT tubes have been found to be technically suitable is as follows: a) PAC – Alcor.

NOTE 14: Examination of the heater tube to determine the Visual Tube Rating using the Visual Tuberator shall be carried out within 120 minutes of completion of the test.

NOTE 15: No precision data are available for fuels containing SDA; if MSEP testing is carried out during downstream distribution no specification limits apply and the results are not to be used as the sole reason for rejection of a fuel. A protocol giving guidelines on possible actions to be taken following failed MSEP testing can be found in the Joint Inspection Group's Bulletin Number 14, MSEP Protocol at www.jointinspectiongroup.org under 'fuel quality'

NOTE 16: The conductivity limits are mandatory for product to meet this specification. However it is acknowledged that in some manufacturing and distribution systems it is more practical to inject SDA further downstream. In such cases the Certificate of Quality for the batch should be annotated thus: “Product meets requirements of Defence Standard 91-91 except for electrical conductivity”. The Specification Authority is also aware of situations where conductivity can decrease rapidly and the fuel can fail to respond to additional dosing of Stadis 450 (see Annex H for more information).

NOTE 17: The requirement to determine lubricity applies only to fuels containing more than 95% hydroprocessed material and where at least 20% is severely hydroprocessed (see NOTE 8) and for all fuels containing synthetic components. The limit applies only at the point of manufacture.

Annex A

List of Qualified Additives

A.1 General Information on hydrocarbon diluents and additives

A.1.1 Some additives, as qualified, include a hydrocarbon diluent as a solvent and the amount to be added is calculated based on the additive as received. These include Static Dissipator Additive and Lubricity Improver Additive.

A.1.2 Other additives are qualified based on the active ingredient content as listed. These include Antioxidant, Metal Deactivator Additive, Fuel System Icing Inhibitor (FSII), and Leak Detection Additive.

A.1.3 Where it is necessary to dilute an additive for handling purposes any solvent used shall be hydrocarbon derived from the sources detailed in Clause 4.1. In this case the vendor/manufacturer shall provide directions for calculating dosage. This information shall be placed on the certificate of analysis or additive quality documentation.

A.2 Antioxidants

A.2.1 Antioxidants or mixtures of antioxidants, of a type detailed in **A.2.4** and at a concentration detailed in **A.2.5**, shall be added to a fuel (or component) which has been hydroprocessed (i.e. manufactured using a catalytic hydrogen process such as hydrotreating, hydrofining, hydrocracking, etc) or has been synthesised as defined in **Annex D.** This must be done immediately after hydroprocessing or synthesising and prior to the product or component being passed into storage to prevent peroxidation and gum formation after manufacture.

A.2.2 Where a finished fuel comprises a blend of several different components, the requirement for mandatory addition of antioxidant applies only to the portion of the blend that has been hydroprocessed. In such cases, the proportion of the blend which has been hydroprocessed shall be reported.

A.2.3 For fuel (or fuel component) which has not been hydroprocessed, such addition is optional.

A.2.4 The following antioxidant formulations are qualified:

Formulation	Qualification Reference
(a) 2,6-ditertiary-butyl-phenol	RDE/A/606
(b) 2,6 ditertiary-butyl-4-methyl-phenol	RDE/A/607
(c) 2,4-dimethyl-6-tertiary-butyl-phenol	RDE/A/608
(d) 75 percent minimum, 2,6-ditertiary-butyl-phenol 25 percent maximum, tertiary and tritertiary-butyl-phenols	RDE/A/609
(e) 55 percent minimum, 2,4-dimethyl-6-tertiary-butyl-phenol 15 percent minimum, 4 methyl-2,6-ditertiary-butyl-phenol Remainder, 30 percent maximum, as a mixture of monomethyl and dimethyl-tertiary-butyl-phenols	RDE/A/610
(f) 72 percent minimum, 2,4-dimethyl-6-tertiary-butyl-phenol 28 percent maximum, mixture of tertiary-butyl-methyl-phenols and tertiary-butyl dimethyl phenols	RDE/A/611

A.2.5 The concentrations in which the qualified materials shall be used are as follows:

A.2.5.1 Hydroprocessed fuels or fuel components: The total concentration of active material(s) in fuel or that proportion of the fuel blend that has been hydroprocessed shall not be less than 17.0 mg/l. The total concentration of active material in the final batch shall not exceed 24.0 mg/l.

A.2.5.2 Fuels which have not been hydroprocessed: The total concentration of active material(s) shall not exceed 24.0 mg/l and shall be reported on the certificate of quality.

A.2.6 The concentration of antioxidant added to the fuel should be reported as follows:

A.2.6.1 Where a fuel, or a blend component of the fuel, has been hydroprocessed and or severely hydroprocessed, the concentration of active material added to the hydroprocessed portion of the blend shall be reported on the certificate of quality. If antioxidant has also been added to the non-hydroprocessed portion of the fuel, the concentration of active material added to this portion should be reported on a separate line on the certificate of quality.

A.2.6.2 The active material concentration of any antioxidant added to a fuel that has not been hydroprocessed shall be reported on the certificate of quality.

A.3 Metal Deactivator Additive (MDA)

A.3.1 An MDA, of a type detailed in **A.3.2** and at a concentration detailed in **A.3.3,** may be added to fuel to counteract the effects of metals known to be deleterious to thermal stability, such as Copper, Cadmium, Iron, Cobalt and Zinc, provided that the nature of the contamination is reported. Where metallic contamination is unproven, an MDA may be used to recover thermal stability provided that the JFTOT Test (in accordance with **Table 1**, **Test 7**) is determined before and after MDA addition and reported on the test certificate.

A.3.2 The following material is qualified:

Product	Qualification Reference
N,N'-disalicylidene 1,2-propanediamine.	RDE/A/650

A.3.3 The concentration of active material used on initial doping of the fuel shall not exceed 2.0 mg/l. Cumulative addition of MDA when redoping the fuel shall not exceed 5.7 mg/l. The requirements of **A.3.1** shall be met when doping or redoping.

A.4 Static Dissipator Additive (SDA)

A.4.1 Where necessary an SDA, of a type detailed in **A.4.2** and at a concentration detailed in **A.4.3,** shall be added to the fuel to impart electrical conductivity in accordance with property 10.1 of **Table 1**.

A.4.2 The following material is qualified:

Product	Manufacturer	Qualification Reference
Stadis® 450	Innospec LLC	RDE/A/621

A.4.3 Concentration and redoping limits:

A.4.3.1 The concentration of SDA to be used in newly manufactured, or on first doping of, fuel is 3.0 mg/l maximum.

A.4.3.2 The cumulative concentration of SDA allowed when redoping fuel to maintain conductivity is 5.0 mg/l maximum.

A.5 Lubricity Improver Additive (LIA): previously cited as corrosion inhibitor/lubricity improver additive

A.5.1 An LIA, of a type and at a concentration detailed in **A.5.4** may be added to fuel to impart improved lubricity to the fuel. Further information on Aviation Turbine Fuel Lubricity is available at **Annex B**.

A.5.2 Because LIA exists in equilibrium with the metal surfaces of fuel distribution systems as well as those of aircraft systems, correct delivery to aircraft can be assured only by equilibration of the supply system downstream of the LIA addition or by additive injection at the point of entry to the aircraft.

A.5.3 Qualified materials, their respective qualification references, quality assurance requirements and the concentration limits applicable at the time of delivery to the purchaser, are listed in QPL 68-251, the qualification references and concentration limits are also listed below. In civil use other additives may be used provided that they have been adequately approved in accordance with the certifying authorities and the appropriate aircraft and engine manufacturer.

A.5.4 The following materials are qualified at the specified concentrations:

Product	Manufacturer	Qualification Reference	Minimum mg/l	Maximum mg/l
Apollo PRI-19	Apollo Technologies Intl. Corp.	RDE/A/660	18	23
Hitec 580	Afton Chemical Ltd.	RDE/A/661	15	23
Octel DCI-4A	Innospec LLC	RDE/A/662	9	23
Octel DCI-6A	Innospec LLC	RDE/A/663	9	9
Nalco 5403	Nalco Chemical Co.	RDE/A/664	12	23
Tolad 4410	Baker Petrolite	RDE/A/665	9	23
Tolad 351	Baker Petrolite	RDE/A/666	9	23
Unicor J	Dorf Ketal Chemicals	RDE/A/667	9	23

A.6 Fuel System Icing Inhibitor (FSII)

A.6.1 An FSII, of a type detailed in **A.6.2** and at a concentration detailed at **A.6.3**, may be added to the fuel by agreement between purchaser and supplier.

NOTE: Concentrations of less than 0.02% by volume can be considered negligible and do not require agreement/notification. The assent to allow these small quantities of FSII without agreement/notification is to facilitate the changeover from fuels containing FSII to those not containing FSII where the additive may remain in the fuel system for a limited time. This does not allow the continuous addition of FSII at these low concentrations.

A.6.2 The following material is qualified and must comply with Def Stan 68-252:

Product	Qualification Reference
Diethylene Glycol Monomethyl Ether	RDE/A/630

A.6.3 The material shall be added, where mandated, at a concentration not less than 0.10% and not more than 0.15% by volume at the time of delivery to the purchaser. Suitable methods for determining the additive concentration are IP 424 and ASTM D 5006.

A.7 Additive Mixtures

A.7.1 When LIA (clause **A.5)** and FSII (clause **A.6**) are to be used together it may be possible to add the LIA in a mixture with FSII.

A.7.2 The combined additive concentrate for this purpose is Joint Service Designation AL-48 controlled by Defence Standard 68-150. Whatever blending procedure is adopted, the supplier shall satisfy the purchaser that the correct concentration of additives has been incorporated homogeneously. It is known that AL-48 mixtures can be problematic, information on this can be found in Defence Standard 68-150.

A.8 Leak Detection Additive

A.8.1 Where necessary a leak detection additive may be added to the fuel to assist in detecting and locating leaks in ground based fuel storage, delivery and dispensing systems. It should be recognized that other leak detection techniques may have less environmental impact than Tracer A. The additive should only be used when other options have been considered.

A.8.2 The following material is qualified:

Product	Manufacturer	Qualification Reference
Tracer A(LDTA-A)	Tracer Research Corporation	RDE/A/640

A.8.3 The concentration of Tracer A shall not exceed 1.0 mg/kg.

A.9 Contamination by Processing Additives

A.9.1 Experience has shown that refinery processing additives, such as corrosion inhibitors, might be carried over in trace quantities into aviation fuel during refinery production. In some cases, this has resulted in operational problems in aircraft fuel systems. Moreover, these additives can cause problems at levels which may not be detected by the standard specification testing detailed in **Table 1**. Whilst the standard (**4.1**) states that non-approved additives are not permitted, defining a zero level is not straightforward; particularly given that:

(a) modern analytical techniques are capable of detecting extremely low levels of chemical species,
(b) there could be a wide range of materials involved and
(c) in most cases there are no data on their effects in aircraft systems to use to define a no-harm level.

A.9.2 It is therefore not practical for this standard to require detailed chemical analysis of each production batch of aviation fuel beyond the requirements listed in this standard. Instead, it is recommended that manufacturing locations ensure that they have adequate quality assurance and management of change procedures in place to ensure that refinery processing additive use is well defined and controlled. Any changes in additive composition/manufacturing source or refinery processing conditions should be subject to a formal risk assessment to ensure maintenance of finished product quality.

Annex B

Information Statement on Aviation Turbine Fuel Lubricity

B.1 Aircraft/engine fuel system components and fuel control units rely on the fuel to lubricate their moving parts. The effectiveness of a jet fuel as a lubricant in such equipment is referred to as its 'lubricity'. Differences in component design and materials result in varying degrees of equipment sensitivity to fuel lubricity. Similarly, jet fuels vary in their level of lubricity. In-service problems experienced have ranged in severity from reductions in pump flow to unexpected mechanical failure leading to in-flight engine shutdown.

B.2 The chemical and physical properties of jet fuel cause it to be a relatively poor lubricating material under high temperature and high load conditions. Severe hydroprocessing removes trace components, resulting in fuels which tend to have a lower lubricity than straight-run or wet-treated fuels. Lubricity improver additives are widely used in military jet fuels. They have been used occasionally in civil jet fuel to overcome aircraft problems, but only as a temporary remedy while improvements to the fuel system components or changes to fuel were achieved. Because of their polar nature, these additives can have adverse effects on ground-based filtration systems and on fuel/water separation characteristics.

B.3 Some modern aircraft fuel system components have been and are being designed to operate on poor lubricity fuel. With the participation of the international aviation industry the SAE AE-5B group has revised the procedure for the Low Lubricity Endurance Test for aircraft engine fuel pumps, ARP 1797. The procedure now specifies that the test fluid used shall produce a wear scar diameter (wsd) between 0.85 and 0.96 mm as measured by ASTM D5001. The introduction of a lubricity requirement maximum of 0.85 mm wsd is to provide a limit to the fuel lubricity which attempts to ensure that future equipment proven against ARP 1797 procedure does not suffer lubricity related problems in use. The requirement only applies to fuels containing more than 95% hydroprocessed material and where at least 20% is severely hydroprocessed. All the fuels which have caused problems have been in this category. It has been noted that not all fuels containing severely hydroprocessed components produce a wsd greater than 0.85 mm and this has been taken into account in setting the requirement.

B.4 There are older fuel system components still in use which are more sensitive to fuel lubricity. In these cases the aircraft operator should consult with the equipment manufacturer and fuel supplier to determine the best course of action which may include the use of an approved lubricity additive to enhance the lubricity of a particular fuel, a measure which is already permitted by the standard.

Annex C

Alternative Test Methods for use with Table 1 Test Requirements

Table 2: Alternative Test Methods

Table 1 Test Number	Property	Alternative
1	Appearance	ASTM D4176 Procedure 1
2.3	Total Sulfur	IP 107 IP 243 IP 373 IP 447 ASTM D1266 ASTM D2622 ASTM D4294 ASTM D5453
2.5	Doctor Test	ASTM D4952
3.1	Distillation	IP 406 (NOTE 1)
3.2	Flash Point	IP 523 ASTM D56 (NOTE 2)
3.3	Density at 15 °C	IP 160/ ASTM D1298
4.1	Freezing Point	IP 435/ ASTM D5972 IP 528 IP 529/ ASTM D7153
5.3	Specific Energy	IP 12 IP 355 ASTM D3338 ASTM D4809
8.1	Existent Gum	ASTM D381

NOTE 1: The calculation of IP 123 estimated distillation data given in Annex G of IP 406 must be used to extrapolate results to IP 123. The requirement to report loss and residue is waived if IP 406 is used. IP 123 estimated data may also be used for the calculation of Specific Energy.

NOTE 2: Subject to a minimum of 40 °C, results obtained by Tag method ASTM D 56 may be accepted at the discretion of the responsible technical and supervising authority.

Annex D

Additional Requirements Applicable to Fuels Containing Synthetic Components

D.1 Background

D.1.1 Previously this Standard permitted only those fuels solely derived from petroleum sources. There is now a requirement for the Standard to encompass and control the use of fuels containing hydrocarbons synthesised from non-petroleum sources. The use of synthetic hydrocarbons represents a departure from experience and also from some of the key assumptions on which the requirements of this Standard have so far been based. The longer term strategy is to revise the Standard to fully encompass such fuels but this has yet to be defined. As an interim solution it has been deemed necessary to approve fuels containing synthetic components on an individual basis and identify test requirements specific to fully synthetic fuels and blends of synthetic hydrocarbons with conventional fuel (termed semi-synthetic blends). Applications for approval of synthetic fuels or blends should be made to the Technical Authority.

D.2 Investigation for Approval

D.2.1 The following paragraphs are intended to give guidance on the basis upon which individual synthetic and semi-synthetic blends will be approved in the interim period. Testing may also be required to demonstrate satisfactory operational performance. The requirement and scope of such testing will be defined by agreement with the Technical Authority in conjunction with the appropriate certifying authority, aircraft and engine manufacturers. Such testing may include but not be limited to evaluation of prototype blends to assess the impact of synthetic components on the following operational parameters:

D.2.1.1 Correlation between results achieved using referee and technically equivalent methods.

D.2.1.2 Compatibility with elastomeric materials.

D.2.1.3 Lubricity, including response to LIA.

D.2.1.4 Electrical properties (dielectric constant, conductivity and response to SDA).

D.2.1.5 Additive miscibility and compatibility.

D.2.1.6 Compatibility and miscibility with other fuels.

D.2.1.7 Combustion properties including impact on starting and relight performance and emissions.

D.2.1.8 Bulk physical properties including bulk modulus, specific heat, thermal conductivity, low temperature/freezing point, viscosity, volatility characteristics, density/temperature characteristics and true vapour pressure.

D.2.1.9 Trace contaminants and controls thereof including dissolved metals, non-metals and organic species and particulates.

D.2.1.10 Behaviour under test rig and/or whole engine conditions.

D.2.1.11 Storage stability.

D.2.1.12 Thermal stability.

D.3 Manufacturing

D.3.1 Synthetic and semi-synthetic fuel blends must be manufactured according to declared procedures defined during the manufacture of prototype batches which have been submitted for examination and approval. Prototype batches must be shown to comply with all the requirements defined in clause **6**. Changes to declared production procedures may only be undertaken following agreement with the Technical Authority. Such change may require additional testing, as in clause **D.2**, to be carried out before approval is given.

D.4 Specific Approvals

D.4.1 Sasol semi-synthetic blends

D.4.1.1 Sasol semi-synthetic fuel containing synthetic iso-paraffinic kerosine, see clause **D.4.1.3**, blended with kerosine from conventional sources, see clause **D.4.1.4**, with a maximum of 50% synthetic product is currently the only semi-synthetic blend which has been approved for use, see approval reference FS(Air)/ssjet/1.

D.4.1.2 The aromatic content of the Sasol semi-synthetic fuel shall be not less than 8.0% nor greater than 25.0% by volume when using method IP156, or not less than 8.4% nor greater than 26.5% by volume when using method IP436. The fuel shall exhibit a maximum wear scar diameter of 0.85 mm when tested by ASTM D5001. Analysis for these properties shall be made at point of manufacture. These results shall be included on the batch certificate for the fuel.

D.4.1.3 Sasol iso-paraffinic synthetic kerosine is defined as that material manufactured at the Secunda plant by the Fischer - Tropsch process as described in the Southwest Research Institute (SwRI) report number 8531. The synthetic component shall be derived solely from products of the Fischer - Tropsch process which have been polymerised and hydrogenated and consist entirely of n-paraffins and iso-paraffins. The use of synthetic aromatic compounds is not permitted. The amount of synthetic fuel in the final blend shall be included on the batch certificate for the fuel.

D.4.1.4 If the blending kerosene contains severely hydroprocessed material then the final blend must contain at least 25% by volume of Merox or mild hydroprocessed material.

D.4.2 Sasol Fully Synthetic Jet Fuel

D4.2.1 Sasol synthetic kerosene, see clause D.4.2.4, is currently the only fully synthetic jet fuel which has been approved for use.

D.4.2.2 The aromatic content of Sasol fully synthetic fuel shall not be less than 8.0% nor greater than 25.0% by volume when using method IP 156, or less than 8.4% nor greater than 26.5% by volume when using method IP 436. The fuel shall exhibit a maximum wear scar diameter of 0.85 mm when tested by ASTM D5001. Analysis for these properties shall be made at the point of manufacture. These results shall be included on the batch certificate for the fuel.

D.4.2.3 The flash point shall be no greater than 50°C. The boiling point distribution shall have a minimum slope defined by T50-T10 ≥ 20°C and T90-T10 ≥ 40°C when measured by IP 123 / ASTM D 86.

D.4.2.4 Sasol fully synthetic kerosene is defined as that material blended from light distillate, heavy naphtha and iso-paraffinic kerosene streams manufactured at the Secunda plant as described in the SwRI reports number 08-04438 and 08-04438-2. The batch certificate for the fuel shall state that the fuel contains 100% synthetic components.

Annex E

Information on Saybolt Colour

E.1 Colour can be a useful indicator of fuel quality. Darkening of fuel or a change in fuel colour may be the result of product contamination or instability.

E.2 Changes in Saybolt Colour from the original Certificate of Quality for the batch would usually be cause for investigation as follows:-

Initial Saybolt Colour at Point of Manufacture	Significant Change
>25	>8
<=25, but >=15	>5
<15	>3

E.3 Normally fuel colour ranges from water white (colourless) to a straw/pale yellow. Other fuel colours may be the result of crude oil characteristics or refining processes. If unusual colours are produced at the point of manufacture, this should be noted on the batch certificate to provide information to downstream users. Unusual colours such as pink, red, green or blue that do not significantly impact the Saybolt Colour number should also be investigated to determine the cause.

Annex F

Information on Particulate Contamination

F.1 The visual appearance of the product is a good indication of contamination and remains a key requirement for fuel throughout the distribution system. However, interpretation of the Appearance requirement can lead to problems due to the subjective nature of the visual assessment. Therefore, a quantitative limit has been established for particulate contamination. A maximum particulate contamination of 1.0 mg/l, when tested to IP 423/ ASTM D5452, shall apply at point of manufacture only.

F.2 Fuels containing visual particulate or with particulate levels greater than 1.0 mg/l will require additional handling procedures, such as extended settling and/or filtration.

F.3 Where fuel is being delivered into aircraft, the IATA Guidance Material for Aviation Turbine Fuels Part III – Cleanliness and Handling, shall be referred to for appropriate information on contamination limits.

F.4 It is the intent of the Technical/Specification Authority to extend particulate contamination limits throughout the distribution system at a later date.

Annex G

Information Statement on the Carryover of FAME (Fatty Acid Methyl Ester) In Trace Quantities During Transportation Through Multi Product Pipelines

G.1. When biodiesel containing FAME was first introduced into Multi Product Pipelines (MPPs) co-transporting jet fuel in 1995, trials conducted using the best available analytical methods at that time indicated no detectable trail back of the FAME component into following jet fuel batches. Pipeline sequencing operations were not altered based on these data. However, with significant advances in experimental analytical techniques, some evidence of very low level FAME was detected in interface samples in 2006 prompting both refinement of the analytical methods and a further controlled pipeline trial in 2007. This controlled trial demonstrated that low level trail back of the FAME component from biodiesel into a following jet fuel batch can occur at detectable levels. In the absence of reliable data on historical trace level FAME carryover in MPPs, the initial fuel supply industry advice required revision of the sequencing of batches of biodiesel and jet fuel by employing a non-aviation buffer material between the products.

G.2. The widespread mandatory introduction of bio-materials in automotive fuels during 2008 has presented a significant challenge to the operators of fuel supply and distribution systems. Whilst the use of non-aviation buffer materials between diesel fuel containing FAME and jet fuel should still be followed whenever possible, it is acknowledged that this places a significant operational constraint on the pipeline operator and may not be practical to maintain the required supply integrity. Following discussions with the engine and airframe OEM's in 2007, the approval of an effective “non-detection” limit of FAME using the latest analytical technique was agreed. The Joint Inspection Group Ltd.(JIG) issued a detailed guidance bulletin (Number 15) (www.jointinspectiongroup.org) in November 2007 for the fuel supply and distribution industry. Careful control of a combination of sequencing, batch size and interface management can be used to ensure the level of FAME trail back into jet fuel is below this detection limit. Operators of multiproduct handling systems should also verify that bulk contamination, even at very low levels (e.g. 0.01%), cannot occur.

G.3. Whilst pipeline operators and fuel distributors will need to go through a management of change activity that will involve some testing for low level FAME using the new analytical tests, it is not envisaged that routine testing of every batch will be required for two primary reasons. Firstly, the general consistency of bulk fuel distribution operations provides surety that once initial conditions have been tested and shown to provide the necessary control of FAME, only periodic confirmatory testing should be needed. Secondly, management of change systems shall be employed to ensure that any significant alteration to the distribution operation is appropriately controlled and further FAME testing is triggered to verify the new mode of operation. The sophisticated analytical techniques used to detect the low levels of FAME are neither simple to run and interpret nor readily available. There are currently no precision data for these methods.

G.4. Based on learning from an incident in the UK, it is important to note that testing activities conducted to verify the effectiveness of QA procedures should focus on the final batch tanks where jet fuel leaves a multiproduct handling system. The handling system downstream of the tested tank should be completely segregated from diesel containing FAME and there must be no risk of any other contamination mechanism. If this is not the case and downstream segregation cannot be guaranteed then FAME testing to verify downstream operations should be performed. See JIG Bulletin 16 for further details and guidance.

G.5. The less than 5 mg/kg approval is granted on the basis that the aviation petroleum industry is working towards an approval of 100 mg/kg FAME in jet fuel under the guidance of the engine and airframe OEMs and that the ASTM protocol for additive and alternative fuel approval shall be followed.

Annex H

Electrical Conductivity

The Specification Authority is aware of situations where conductivity can decrease rapidly and the fuel can fail to respond to additional dosing of Stadis 450. The industry investigation revisited the early work on conductivity. This demonstrated that the static hazard was mitigated once conductivity was >20 pS/m (see JIG PQ Committee Report). The current minimum 50 pS/m represents a cautious doubling of the 20 pS/m. On this basis, and as an emergency provision when low conductivity occurs at airports, the Specification Authority will accept conductivities down to a minimum of 25 pS/m. The fuel should be fully tested according to the specification and the Tank Release Note annotated with the explanation “Product released below 50 pS/m due to conductivity loss as per Annex H in Defence Standard 91-91”.

Annex I

Technically Equivalent ISO Methods for Table 1 and Table 2 Test Methods

Table 3: Technically Equivalent ISO Methods

IP / ASTM Test Methods	ISO Methods
IP 57 / ASTM D1322	ISO 3014
IP 71 / ASTM D445	ISO 3104
IP 123	ISO 3405
IP 154 / ASTM D130	ISO 2160
IP160 / ASTM D1298	ISO 3675
IP 170	ISO 13736
IP 243	ISO 4260
IP 336	ISO 8754
IP 342 / ASTM D3227	ISO 3012
IP 365 / ASTM D4052	ISO 12185
IP 367	ISO 4259
IP 447	ISO 14596
IP 523	ISO 3679

The methods listed above were technically equivalent at the date of issue of the specification.

Annex J

Minimum requirements of information on aviation turbine fuel refinery batch certificates

The minimum requirements of information to be included on the fuel's refinery batch test certificate are given below:

- Specification name, issue and any amendment number;
- Name and address of testing laboratory;
- Batch number or unique identifier;
- Quantity of fuel in the batch;
- Properties tested and including specification limit, test method and result of test;
- Additives, including qualification reference and quantity added;
- Name and position of authorised test certificate signatory or an electronic signature;
- Date of certification.

Annex K

Normative References

Designation	Title
Def Stan 05-52 (Part 1)	Markings for the Identification of Fuels, Lubricants and Associated Products: Containers Holding 216.5 Litres or Less
Def Stan 68-150	Mixture of Fuel System Icing Inhibitor and Lubricity Improving Additive JSD: AL-48
Def Stan 68-251	Fuel Soluble Lubricity Improving Additives for Aviation Turbine Fuels JSD: AL-61
Def Stan 68-252	Fuel System Icing Inhibitor JSD: AL-41
QPL 68-251	Qualified Products List of Aircraft Materials to Def Stan 68-251
IP 12	Determination of Specific Energy
IP 16	Petroleum Products – Determination of the Freezing Point of Aviation Fuels
IP 30	Detection of Mercaptans, Hydrogen Sulfide, Elemental Sulfur and Peroxides – Doctor Test Method
IP 57	Petroleum Products – Determination of the Smoke Point of Kerosine
IP 71	Petroleum Products – Transparent and Opaque Liquids – Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
IP 107	Determination of Sulfur – Lamp Combustion Method
IP 123	Petroleum Products – Determination of Distillation Characteristics at Atmospheric Pressure
IP 154	Petroleum Products – Corrosiveness to Copper – Copper Strip Test
IP 156	Determination of Hydrocarbon Types in Petroleum Products – Fluorescent Indicator Adsorption Method
IP 160	Crude Petroleum and Liquid Petroleum Products – Laboratory Determination of Density – Hydrometer Method
IP 170	Petroleum Products and other Liquids– Determination of Flash Point – Abel Closed Cup Method
IP 243	Petroleum Products and Hydrocarbons – Determination of Sulfur Content – Wickbold Combustion Method
IP 274	Petroleum Products – Aviation and Distillate Fuels - Determination of Electrical Conductivity
IP 323	Petroleum Products - Determination of Thermal Oxidation Stability of Gas Turbine Fuels – JFTOT Method
IP 336	Petroleum Products – Determination of Sulfur Content – Energy-Dispersive - X-Ray Fluorescence Method

IP 342	Petroleum Products – Determination of Thiol (Mercaptan) Sulfur in Light and Middle Distillate Fuels – Potentiometric Method
IP 354	Determination of the Acid Number of Aviation Turbine Fuels – Colour-Indicator Titration Method
IP 355	Estimation of Net Specific Energy of Aviation Turbine Fuels, using Hydrogen Content Data
IP 365	Crude Petroleum and Petroleum Products – Determination of Density – Oscillating U-tube Method
IP 367	Petroleum Products – Determination and Application of Precision Data in Relation to Methods of Test
IP 373	Determination of Sulfur Content of Light and Middle Distillates by Oxidative Microcoulometry
IP 406	Petroleum Products – Determination of Boiling Range Distribution by Gas Chromatography
IP 423	Determination of Particulate Contaminant in Aviation Turbine Fuels by Laboratory Filtration
IP 424	Determination of Fuel System Icing Inhibitor Content of Aviation Turbine Kerosines by High Performance Liquid Chromatography
IP 435	Determination of the Freezing Point of Aviation Turbine Fuels by the Automated Phase Transition Method
IP 436	Determination of Aromatic Hydrocarbon Types in Aviation Fuels and Petroleum Distillates – High Performance Liquid Chromatography Method with Refractive Index Detection
IP 447	Petroleum Products – Determination of Sulfur Content – Wavelength-Dispersive X-Ray Fluorescence Spectrometry
IP 523	Determination of Flash Point – Rapid Equilibrium Closed Cup Method
IP 528	Determination of the Freezing Point of Aviation Turbine Fuels – Automated Fibre Optic Method
IP 529	Determination of the Freezing Point of Aviation Fuels – Automatic Laser Method
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 fuels - Portable automatic particle counter method
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 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 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 the Calculation of Dynamic Viscosity)
ASTM D1266	Standard Test Method for Sulfur in Petroleum Products (Lamp Method)
ASTM D1298	Standard Test Method for Density, Relative Density (Specific Gravity), 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 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 Spectrophotometry
ASTM D2624	Standard Test Methods for Electrical Conductivity of Aviation and Distillate Fuels
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 (JFTOT Procedure)
ASTM D3242	Standard Test Method for Acidity in Aviation Turbine Fuel
ASTM D3338	Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
ASTM D3948	Standard Test Method for Determining Water Separation Characteristics of Aviation Turbine Fuels by Portable Separometer
ASTM D4052	Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter
ASTM D4176	Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)
ASTM D4294	Standard Test Method for Sulfur in Petroleum Products by Energy-Dispersive X-Ray Fluorescence Spectrometry
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 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 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 D7153	Standard Test Method for Freezing Point of Aviation Fuels (Automatic Laser Method)
ISO 4406:1999	Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid particles.
FS(Air)/ssjet/1 SwRI – 8531	Qualification of Sasol Semi-Synthetic JET A-1 as Commercial Jet Fuel
Joint Guidelines	www.jointinspectiongroup.org
SwRI 08-04438	Evaluation of Sasol Synthetic Kerosene for Suitability as Jet Fuel
SwRI 08-04438-2	Evaluation of Sasol Synthetic Kerosene for Suitability as Jet Fuel. Phase II, Engine and Combustion Tests.

Defence Standards are Published by and Obtainable from:

Defence Equipment and Support

UK Defence Standardization

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File Reference

The DStan file reference relating to work on this standard is D/DStan/91/91.

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