World Jet Fuel Specifications

with Avgas Supplement

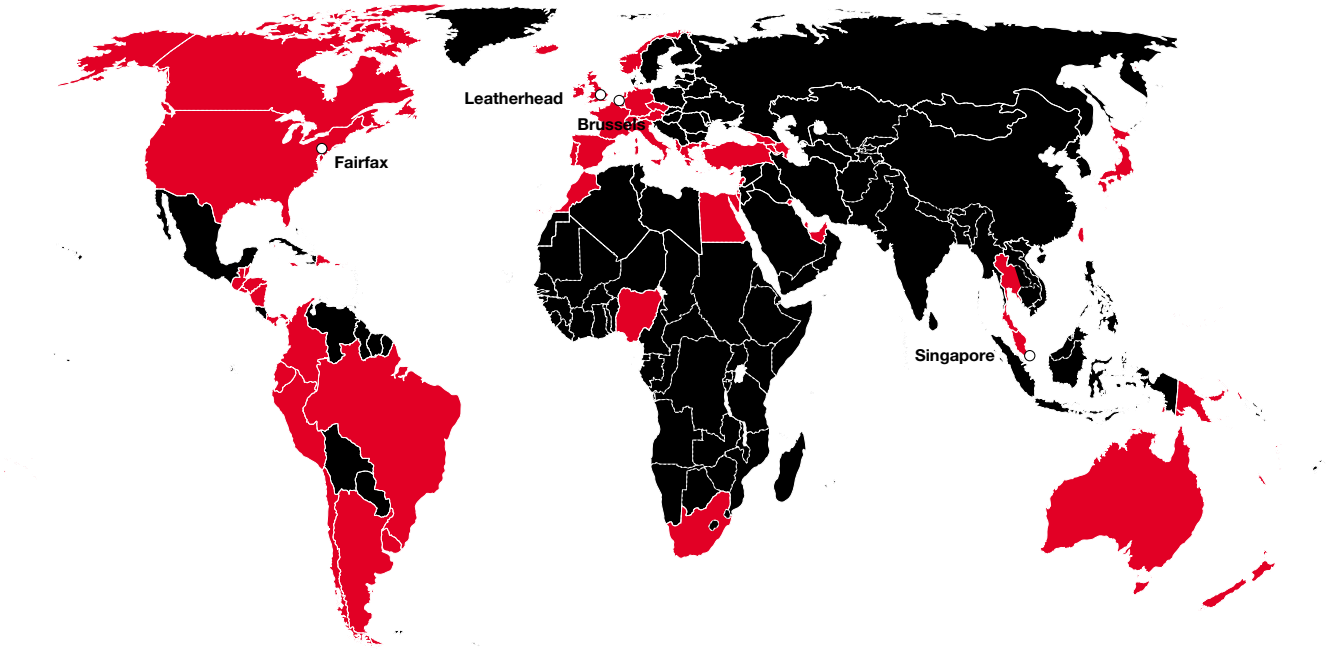
2008

Edition

Photo by Chris Pearsall

Foreword

by Kenneth A. Warren



The areas shaded in red on the map are those countries in which we supply aviation fuel. The cities marked on the map show our principal office locations.

ExxonMobil Aviation is a global organisation committed to providing high quality aviation products to customers worldwide. Our aim is to be the global supplier of choice offering solutions for all your aviation fuelling needs while protecting the safety and health of our employees and safeguarding the environment.

The Marketing Groups act as a global team providing service in all our markets to meet individual customer needs, while our skilled Operations Group provides advice and consultancy services to the industry on operations, technical and engineering issues.

If you have any queries or ideas about how we can better serve your business, please contact a member of the Operations Group at our office in Leatherhead, UK on +44 (0)1372 222 000.

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ExxonMobil Aviation

World Jet Fuel Specifications

The material presented in this brochure is intended to provide a handy and comprehensive source of information on specifications for aviation fuels used around the world. Every effort has been made to include the latest information available at the time of publication; however, since commercial and military specifications for aviation products are subject to change, this publication does not purport to be the official organ for any of the specifications listed. Inquiries concerning the latest official specifications should be directed to the issuing agency or organisation.

Whilst there are a considerable number of aviation turbine fuel specifications listed, all of these essentially define a similar product, a heart-cut kerosene. Some variations in test limits occur to meet specific customer applications; however, at many commercial airports where joint storage and hydrant systems are in place, industry has settled on using the Joint Fuelling System 'Check List' to define fuel quality. This checklist combines the most stringent requirements from ASTM D1655 and Defence Standard (Def Stan) 91-91 into one overall guideline that provides a common basis for commercial aviation turbine fuel quality in Jointly Operated Systems. There used to be an equivalent checklist for aviation gasoline, but this was discontinued in the early 1990s.

In addition to the fuel specifications, we have included for reference a summary of fuel types and additives in use in Russia and Eastern Europe (Appendix A), analytical test information (Appendix B) and guidance on contamination limits (Appendix C). Comments relating to impending change in the Jet fuel and Aviation Gasoline specifications expected to come into effect in 2008 have also been included where appropriate.

TEST METHOD STANDARDS

ASTM and IP test methods, as detailed in the following publications, are quoted whenever applicable in this compilation.

'2007 Annual Book of ASTM Standards, Petroleum Products and Lubricants 05.01, 05.02, 05.03, 05.04', published by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, USA.

'Standard Methods for the Analysis & Testing of Petroleum and Related Products, and British Standard 2000 Parts, 2007', 66th Edition, published by the Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK

For quality parameters where more than one method is listed, the method to be used in case of dispute is listed in red.

APPROVED ADDITIVES

Appendix E gives a description of how additives can be used to enhance certain performance characteristics of jet fuels. Additive formulations approved in the different fuel specifications are tabulated. This list should not be considered official or necessarily complete. Specific information should be sought from issuing agencies. Note that there is a significant difference between the additive requirements for military and commercial fuels.

AVIATION GASOLINE

This brochure includes a section on gasoline fuels used in piston-engine aircraft, covering the common grades of AVGAS that are identified by differences in antiknock quality. Test and limit requirements for these fuels are illustrated by the two major specifications, issued respectively by ASTM International and the British Ministry of Defence.

Compiled by ExxonMobil Aviation
Technical Department
Leatherhead, UK

AVIATION PRODUCTS

ExxonMobil Aviation fuels comply with international specifications. Jet A is supplied in the U.S., while Jet A-1 is supplied throughout the rest of the World. Aviation Gasoline (AVGAS) is available on a regional basis. To view the airports at which we can service your fuelling needs, **visit www.exxonmobilaviation.com** and select the **Airport Network** tab.

Aviation Turbine Fuels (Jet A and Jet A-1)

Jet A and Jet A-1 are kerosene-type fuels. The primary physical difference between the two is the freeze point (the temperature at which wax crystals disappear in a laboratory test).

Jet A, which is mainly used in the United States, must have a freeze point of -40 ºC or below, while Jet A-1 must have a freeze point of -47 ºC or below. Jet A does not normally contain a static dissipator additive, while Jet A-1 often requires this additive. Some of the other key differences between the manufacturing specifications within the United States and Europe/Africa/Middle East/Asia Pacific are:

World Jet Fuel Specifications

ASTM D1655-07:

- Maximum acidity limit of 0.10 mg KOH/g.
- Use of Simulated Distillation via method ASTM D2887 is allowed.
- Minimum Smoke Point of 18 mm if Naphthalene Content is below 3.0 vol %.

Defence Standard 91-91/5 Issue 5 Amendment 2:

- Maximum acidity limit of 0.015 mg KOH/g.
- Additional requirement for measurement of lubricity for Jet A-1.
- Minimum Smoke Point of 19 mm if Naphthalene Content is below 3.00 vol %.
- Requirement to report the Saybolt Colour of the fuel at point of manufacture.
- Maximum Particulate Contamination level of 1.0 mg/l at point of manufacture.

There are additional differences between the two primary specifications related to allowed test methods and the reader is urged to seek out the full specification for more detailed information.

ExxonMobil Jet A and Jet A-1 are typically produced to the requirements of ASTM D1655 and Def Stan 91-91 standards, respectively. ExxonMobil Jet A-1 may also be produced to the Joint Inspection Group (JIG) Check List. In all cases, the most recent issue of the relevant specification applies to the product supplied.

Military Turbine Fuel Grades

ExxonMobil Aviation is a leading supplier of military jet fuels (predominantly JP-5 and JP-8 as defined by MIL-DTL-5624 and MIL-DTL-83133, respectively). These fuels are kerosene type fuels made to more exacting specifications than the commercial jet fuels. They also contain unique performance enhancing additives.

Aviation Gasolines

ExxonMobil Aviation gasolines are leaded fuels satisfying the requirements of ASTM D910 or Def Stan 91-90. The properties of aviation gasoline are specified to give satisfactory performance of spark-ignition aviation engines over a wide range of operating conditions. ExxonMobil supplies AVGAS 100 (dyed green) and AVGAS 100LL (dyed blue), both of which are excellent for use in piston-engine powered private planes, most commercial aircraft and combat-type planes during military training procedures. Both grades are available in a number of regions internationally.

Aviation Lubricants

ExxonMobil Lubricants & Specialties supplies a full range of superior quality aviation lubricants for use in both piston-engine and jet aircraft. A sample of these products includes:

Turbine Engine Oils

Mobil Jet Oil II: High performance aircraft-type gas turbine lubricant, meets MIL-PRF 23699 STD, SAE AS 5780

Mobil Jet Oil 254: Extra high performance aircraft-type gas turbine lubricant, MIL-PRF-23699 HTS, SAE AS 5780

Hydraulic Fluids

Exxon HyJet IV-Aplus: Fire resistant, low density phosphate ester hydraulic fluid

Mobil Aero HF: MIL-PRF-5606G; mineral based red oil, used where hydrocarbon aviation hydraulic oils are required

Greases

Mobilgrease 28: MIL-PRF-81322; wide temperature range antiwear synthetic general purpose grease

Mobil Aviation Grease SHC 100: Synthetic aircraft wheel bearing grease

Mobilgrease 33: High performance synthetic multipurpose grease; all applications for which the aircraft manufacturer specifies MIL-PRF-23827 and/or BMS 3-33 greases.

Piston-Engine Oils

Exxon Aviation Oil Elite 20W-50: Semi-Synthetic, Ashless-Dispersant multigrade

Miscellaneous

Exxon Coolanol: Silicate ester synthetic dielectric heat transfer fluid for sensitive aircraft, missile, and spacecraft electronic components and environmental control systems

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Table 1

Jointly Operated Systems

Issuing Agency:		Joint Inspection Group		
Specification:		Joint Fuelling System Check List (Issue 22)		
Latest Revision Date:		Jun-07	Test Method	
Grade Designation:		Jet A-1 Kerosene	ASTM	IP
COMPOSITION		(1)		
Appearance		C&B (2)		
Colour, Saybolt		Report (3)	D156 or D6045	
Acidity, Total (mg KOH/g)	Max.	0.015	D3242	354
Aromatics (vol %)	Max.	25.0	D1319	156
OR Total Aromatics (vol %)	Max.	26.5 (4)	D6379	436
Sulphur, Total (wt %)	Max.	0.30	D1266, D2622, D4294, D5453	336
Sulphur, Mercaptan (wt %)	Max.	0.0030	D3227	342
OR Doctor Test		Negative (5)	D4952	30
Hydroprocessed Components (vol %)		Report (include “nil” or “100%”) (6)		
Severely Hydroprocessed Comps (vol %)		Report (include “nil” or “100%”) (6)		
VOLATILITY				
Distillation Temperature:		(7), (8)	D86 or D2887	123 or 406
Initial BP (°C)		Report		
10% Recovery (°C)	Max.	205.0		
50% Recovery (°C)		Report		
90% Recovery (°C)		Report		
Final BP (°C)	Max.	300.0		
Distillation Residue (vol %)	Max.	1.5		
Distillation Loss (vol %)	Max.	1.5		
Flash Point (°C)	Min.	38.0 (9)	D3828 or D56	170 or 523
Density @ 15°C (kg/m^3)		775.0 - 840.0	D1298 or D4052	160 or 365
FLUIDITY				
Freezing Point (°C)	Max.	-47.0 (10)	D2386, D7153, D7154 or D5972	16, 435, 528 or 529
Viscosity @ -20°C (cSt)	Max.	8.00	D445	71
COMBUSTION				
Specific Energy, net. (MJ/kg)	Min.	42.80 (11)	D3338 or D4809	57
Smoke Point (mm)	Min.	25.0	D1322	57
OR Smoke Point (mm)	Min.	19.0	D1322	
AND Naphthalenes (vol %)	Max.	3.00	D1840	
CORROSION				
Copper Strip Corrosion (2h ± 5 min @ 100°C ± 1°C)	Max.	1	D130	154
THERMAL STABILITY		(12)		
JFTOT ΔP @ 260 °C (mm Hg)	Max.	25.0	D3241	323
Tube Deposit Rating (Visual)	Max.	<3 (no “Peacock” or “Abnormal” deposits)		
CONTAMINANTS				
Particulates (mg/L)	Max.	1.0 (13)	D5452	423
Existent Gum (mg/100 mL)	Max.	7 (14)	D381, D3948	540
MSEP Rating	Min.	85		
Fuel without SDA	Min.	70		
Fuel with SDA				
OTHER				
Electrical Conductivity (pS/m)		50-600 (15)	D2624	274
BOCLE wear scar diameter (mm)	Max.	0.85 (16)	D5001	
ADDITIVES (21)				
Antioxidant (mg/L)				
In Hydroprocessed & Synthetic Fuels (Mandatory) (ppm)		17.0 - 24.0 (17)		
In Non-hydroprocessed Fuels (Optional) (ppm)	Max.	24.0		
Metal Deactivator (mg/L) (Optional)	Max.	5.7 (18)		
Static Dissipator (mg/L)				
First Doping (Stadis 450)	Max.	3.0		
Re-doping		(19)		
Corrosion Inhibitor		Optional		
Anti-Icing		Agreement (20)		

The Aviation Fuel Quality Requirements for Jointly Operated Systems (AFQRJOS) for Jet A-1 are based on the most stringent requirements of the following two specifications:

(a) British Ministry of Defence Standard DEF STAN 91-91/Issue 5 Amendment 2 of 9 March 2007 for Turbine Fuel, Aviation Kerosene Type, Jet A-1,NATO Code F-35, Joint Service Designation AVTUR.

(b) ASTM Standard Specification D1655-06d of 1 Dec 2006 for Aviation Turbine Fuels ‘Jet A-1’

Jet fuel that meets the AFQRJOS is usually referred to as “Jet A-1 to Check List” or “Check List Jet A-1” and, by definition, generally, meets the requirements of both of the above specifications.

Table 1
Jointly Operated Systems

While the Table & Notes are central to the Joint Check List, fuels produced to this standard must satisfy the requirements detailed in the text of both primary specifications. (22)

NOTES

(1) Attention is drawn to DEF STAN 91-91 Issue 5 which approves the Semi- Synthetic Jet Fuel (SSJF) produced by SASOL Oil under approval reference FS(Air)ssjet/1. For SSJF, additional testing requirements apply and reference should be made to DEF STAN 91-91 Issue 5. This particular semi-synthetic fuel meets the requirements of this Issue of Check List.

(2) Fuel should be clear, bright and visually free from solid matter and undissolved water at ambient temperature. For guidance on contamination limits for into-plane fuelling, refer to IATA Guidance Material for Aviation Turbine Fuels Specifications, 5th Edition, January 2004 (Part III).

(3) The requirement to report Saybolt Colour shall apply at the 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 and investigated. For further information on the significance of colour see Annex E in Def Stan 91-91/5.

(4) Testing for Total Aromatics has been introduced into DEF STAN 91-91. It is included in Check List to promote the adoption of more modern test methods. The DEF STAN note reads: "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 by the two methods to assist verification of the correlation. In cases of dispute IP 156 will be the referee method.

(5) The Doctor Test is an alternative requirement to the Sulphur Mercaptan Content. In the event of a conflict between Sulphur Mercaptan and Doctor Test results, the Sulphur Mercaptan result shall prevail.

(6) The need to report the % vol. of hydroprocessed and severely hydroprocessed components (including "nil" or "100%" as appropriate) on refinery Certificates of Quality for Jet A-1 to Check List derives from DEF STAN 91-91/5. It relates to:
(a) antioxidant additives – additive dose rate cannot be interpreted unless the proportion of hydroprocessed fuel is known and therefore recipients of Jet A-1 cannot check or demonstrate that fuel complies with Check List if this information is omitted from refinery Certificates of Quality.
(b) the requirement to report the vol % of severely hydroprocessed components as part of the lubricity requirement in DEF STAN 91-91/5. Note that "hydroprocessed" includes hydrotreated, hydrofined and hydrocracked. Severely hydroprocessed components are defined as petroleum derived hydrocarbons that have been subjected to hydrogen partial pressure of greater than 7000 kPa (70 bar or 1015 psi) during manufacture.

(7) 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 ºC.

(8) There are different requirements for the use of IP 406 or D2887 as an alternative method between ASTM D1655-07 and DEF STAN 91-91/5 ASTM allows the use of simulated distillation results directly with different limits, while DEF STAN requires a conversion of simulated distillation results to estimated IP 123 results using Annex G of IP 406. These different approaches were taken because of operational considerations rather than technical considerations; there is no intent that one approach is more restrictive than the other. If IP 406 is the method used to generate IP 123 extrapolated data, there is no requirement to report residue or loss. IP 123 extrapolated data may also be used for the calculation of Specific Energy using ASTM D3338.

(9) Subject to a minimum of 40°C, results obtained by ASTM D56 (Tag) may be accepted.

(10) These automatic methods are allowed by Def Stan 91-91/5 . IP 16 /ASTM D2386 remains the referee method.

(11) ASTM D4529 / IP 381 may be used where local regulations permit.

(12) 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. It is the Visual Tube Rating that should be reported. Attention is drawn to Note 10 in Def Stan 91-91/5 which stresses that only approved heater tubes shall be used and lists JFTOT tubes from PAC-Alcor as being technically suitable..

(13) This limit shall apply at point of manufacture only. For more information on particulate contamination refer to Annex F of Def Stan 91-91 Issue 5. For guidance on contamination limits for into plane fuelling refer to 5th Edition IATA Guidance Material (Part III).

(14) Attention is drawn to Note 13 of Def Stan 91-91/5 that states "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.

(15) Due to the requirements of DEF STAN 91-91/5, 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 the requirements of AFQRJOS Check List 22 except for electrical conductivity." Due to the high flow rates and very fine filtration used when fuelling aircraft, it is absolutely essential that these conductivity limits are met at the point of delivery to aircraft.

(16) This requirement comes from DEF STAN 91-91/5. 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 6) and for all fuels containing synthetic components. The limit applies only at the point of manufacture. For important advisory information on the lubricity of aviation turbine fuels see Annex B of DEF STAN 91-91/5. CI/LI additive may be used to improve lubricity; only those additives listed in Table 2 of ASTM D1655-07d are permitted. Refer also to Appendix A.4 of DEF STAN 91-91/5 Amendment 2 for advice on point of addition. When injecting CI/LI downstream of point of manufacture, care must be taken to ensure that maximum dose rates are not exceeded.

(17) Name and approval code from DEF STAN 91-91/5 should be quoted on quality certificates. Approved antioxidant additives are listed in Annex A.1.4 of DEF STAN 91-91/5, together with the appropriate RDE/A/XXX- Qualification Reference for quoting on refinery Certificates of Quality.

(18) The approved Metal Deactivator Additive (MDA), RDE/A/650, appears in Annex A.2.2 of DEF STAN 91-91/5. See also Annex A.2.1 about the need to report thermal stability before and after using when contamination of Jet A-1 by any of the trace metals listed in this Annex is unproven. Note also in A.2.3 that maximum doping at the point of manufacture or on initial doping is limited to 2 mg/L.

(19) Re-doping limits for Static Dissipator Additive are:
(a) Cumulative concentration of Stadis 450 (RDE A/621) = 5.0 mg/L max
(b) Original dosage not known: Additional concentration of Stadis 450 (RDE/A/621) = 2.0 mg/L

(20) Concentrations of Fuel System Icing Inhibitor (FSII) 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.

(21) Attention is drawn to the guidance in DEF STAN 91-91 Issue 5 and ASTM D1655-07 concerning the need for appropriate management of change measures in refineries manufacturing jet fuel. The implications of any changes to feedstock, processing conditions or process additives on finished product quality and performance need to be considered (for example, experience has shown that some process additives might be carried over in trace quantities into aviation fuels).

(22) It is normal to certify conformance to specifications with statements like "It is certified that the samples have been tested using the Test Methods stated and the Batch represented by the samples conforms to AFQRJOS Checklist Issue 22. Where applicable, Batch Certificates may also confirm, specifically, compliance with DEF STAN 91-91 (latest issue) and/or ASTM D1655 (latest issue).

Table 2

International Air Transportation Association

Issuing Agency:		IATA		Test Method	
Specification:		Guidance Material (5th Edition)			
Latest Revision Date:		Jan-04			
Grade Designation:		Jet A Kerosene	Jet A-1 Kerosene	ASTM	IP
COMPOSITION					
Appearance		C&B (1)	C&B (1)		
Acidity, Total (mg KOH/g)	Max.	0.10	0.015	D3242	354
Aromatics (vol %)	Max.	25	25.0	D1319	156
OR Total Aromatics (vol %)	Max.	---	26.5		436
Sulphur, Total (wt %)	Max.	0.30	0.30	D1266, D1552, D2622, D4294, D5453	107, 243, 336, 373
Sulphur, Mercaptan (wt %)	Max.	0.003	0.0030	D3227	342
OR Doctor Test		Negative	Negative	D4952	30
H/P Components (vol %)		---	Report		
Severely H/P Components (vol %) (2)		---	Report		
VOLATILITY					
Distillation Temperature:				D86	123
Initial BP (°C)		---	Report		
10% Recovery (°C)	Max.	205	205.0		
50% Recovery (°C)		Report	Report		
90% Recovery (°C)		Report	Report		
Final BP (°C)	Max.	300	300.0		
Distillation Residue (vol %)	Max.	1.5	1.5		
Distillation Loss (vol %)	Max.	1.5	1.5		
Flash Point (°C)	Min.	38 (3)	38.0	D56, D3828	170, 303
Density @ 15°C (kg/m^3)		775 - 840	775.0 - 840.0	D1298, D4052	160, 365
FLUIDITY					
Freezing Point (°C)	Max.	-40	-47	D2386, D5972	16
Viscosity @ -20°C (cSt)	Max.	8.0	8.000	D445	71
COMBUSTION					
Net Heat of Comb. (MJ/kg)	Min.	42.8	42.80	D3338, D4529, D4809	12, 381, 355
Smoke Point (mm)	Min.	25	25.0	D1322	57
OR Smoke Point (mm)	Min.	18	19.0	D1322	57
AND Naphthalenes (vol %)	Max.	3.0	3.00	D1840	
CORROSION					
Copper Strip (2h @ 100°C)	Max.	1	1	D130	154
THERMAL STABILITY					
JFTOT ΔP @ 260 °C (mm Hg)	Max.	25	25	D3241	323
Tube Deposit Rating (Visual)	Max.	<3 (4)	<3 (4)		
CONTAMINANTS (5)					
Existent Gum (mg/100 mL) (14)	Max.	7	7	D381	131
Water Reaction Interface	Max.	1b	1b	D1094	289
MSEP Rating (6)				D3948	
Fuel without SDA	Min.	---	85		
Fuel with SDA	Min.	---	70		
OTHER					
Conductivity				D2624	274
At Point of Use	Max.	450			
At Time and Temp of Custody Transfer			50-450		
BOCLE wear scar diameter (mm)	Max.	---	0.85	D5001	
ADDITIVES					
Anti-icing (vol %)		Agreement	Agreement		
Antioxidant		Option	Option (7)		
Corrosion Inhibitor		Agreement	Agreement		
Metal Deactivator		Option	Option		
Static Dissipator		Option	Mandatory		

NOTES

(1) Clear, bright and visually free from solid matter and undissolved water at normal temperature.

(2) Severe hydroprocessing refers to a hydrogen partial pressure of >7000 kPa (70 bar or 1015 psi) during manufacture.

(3) Results by method D56 are usually about 2°C above those obtained by D3828 and IP 170.

(4) No peacock or abnormal colour deposits allowed.

(5) For guidance on contamination limits for into-plane fuelling, refer to IATA Guidance Material for Aviation Turbine Fuels Specifications, 5th Edition, January 2004 (Part III).

(6) Applies only at point of manufacture.

(7) Mandatory in hydroprocessed fuels at 17.0-24.0 mg/L, and must be added immediately after processing.

Table 3
US Pipeline Specifications

Issuing Agency:		Buckeye P/L	Colonial P/L	Explorer P/L	
Specification:		Fungible Aviation Kerosene	Fungible Aviation Kerosene	Fungible Aviation Kerosene	
Latest Revision Date:		May-07	Jun-07	May-07	Test Method
Grade Designation:		Grade 182 Kerosene	Grade 54 Kerosene	Codes 51,54	ASTM
COMPOSITION					
Appearance		C&B (1)	C&B (1)	C&B (1)	
Acidity, Total (mg KOH/g)	Max.	0.10	0.1	0.1	D974 (2), D3242
Aromatics (vol %)	Max.	25	25	25	D1319
Sulphur, Total (wt %)	Max.	0.30	0.3000	0.30	(3) D1266, D1552, D2622, D4294, D5453, D7039
Doctor Test		Negative	Negative	Negative	D4952
OR Sulphur, Mercaptan (wt %)	Max.	0.003 (4)	0.003 (4)	0.003 (4)	D3227
Colour, Saybolt	Min.	15	---	+20 (5)	D156, D6045 (6)
VOLATILITY					
Distillation Temperature:					D86 (7)
10% Recovery (°F)	Max.	400	400	400	
20% Recovery (°F)		Report	---	---	
50% Recovery (°F)		Report	Report	Report	
90% Recovery (°F)		Report	Report	Report	
Final BP (°F)	Max.	572	572	572	
Distillation Residue (vol %)	Max.	1.5	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	1.5	
Flash Point (°F)	Min.	108	108	108 (8)	D56, D3828
Gravity, API @ 60°F		37-51	37-51	37-51	D287, D1298, D4052
FLUIDITY					
Freezing Point (°C)	Max.	-40	-40	-40	D2386, D4305, D5901, D5972 (9)
Viscosity @ -20°C (cSt)	Max.	8.0	8.0	8.0 (10)	D445
COMBUSTION					
Net Heat of Combustion (BTU/lb)	Min.	18,400	18,400	18,400	D3338, D4529, D4809
Luminometer No.	Min.	---	---	45	D1740
OR Smoke Point (mm)	Min.	25	25	25	D1322
OR Smoke Point (mm)	Min.	18	18	18	D1322
AND Naphthalenes (vol %)	Max.	3	3.0	3.0	D1840
CORROSION					
Copper Strip (2h @ 212°F)	Max.	1	1	1	D130
THERMAL STABILITY					
JFTOT ΔP @ 275 ºC (mm Hg)	Max.	25	25 (11)	25 (11)	D3241
Tube Deposit Rating (Visual)	Max.	<3 (12)	<3 (12)	<3 (12)	
CONTAMINANTS					
Existent Gum (mg/100 mL)	Max.	7	7.0	7.0	D381
Water Reaction Interface	Max.	1b	---	1b	D1094
MSEP Rating at Origin	Min.	85	85 (13)	85 (13)	D3948
Particulates (mg/gal)		---	---	Report	D2276
Filtration Time or Volume		---	Report (14)	---	MIL-T-5624P, D5452
Total Solids or Particulate		---	Report (14)	---	MIL-T-5624P, D5452
OTHER					
Conductivity (pS/m)		Report	Report (15)	Report	D2624
ADDITIVES		Report (16)	(16)	(16)	

NOTES

(1) Clear, bright and free from water & suspended matter. Must be undyed.
(2) D974 only quoted in Colonial specification.
(3) D5453 & D7039 not quoted in Buckeye specification. D1266 & D1552 not quoted in Colonial specification. D1522 & D7039 not quoted in Explorer specification.
(4) Mercaptan sulphur waived if fuel is negative by Doctor Test.
(5) Min. colour of +20 specified at origin, min. +18 at destination.
(6) D6045 only quoted in Explorer specification.
(7) Simulated distillation by ASTM D2887 also permitted by Buckeye & Colonial. Different limits apply - see specifications for more details.
(8) Minimum of 108°F applies at origin. Minimum of 100°F applies at destination.
(9) D4305 and D5901 only quoted in Buckeye specification.
(10) Max. of 8.0 cSt at -20ºC and max. of 1.9 cSt at 40ºC.9
(11) For Colonial and Explorer, test at 275 ºC at origin and 260°C at destination.
(12) No peacock or abnormal colour deposits allowed.
(13) At origin, minimum 85 MSEP required. At destination, minimum 75 MSEP required.
(14) Applies to Colonial only. At this time, the test limits described in MIL-T-5624P, Appendix A, Parts 70.a (1) and 70.b will not be imposed.
(15) Colonial requires that Conductivity is reported at 21°C (70°F).
(16) Only those additives specified and within the concentration noted in Section 5.2 through 5.2.2.1 of ASTM D1655 are permitted. The use of any other additives is prohibited. Use of additives must be clearly indicated on the Certificate of Analysis. See individual pipeline specifications for full details on use of additives.

Methods to be used in case of dispute are not shown because they vary for each pipeline. Please refer to individual pipeline specifications for further details.

Table 4

US Pipeline Specifications

Issuing Agency:		Centennial / TEPPCO	Kinder Morgan	Plantation	
Specification:		Fungible Aviation Kerosene	Fungible Aviation Kerosene	Fungible Aviation Kerosene	
Latest Revision Date:		Apr-06	Dec-06	Feb-07	Test Method
Grade Designation:		Code 510 & 520	Code 15	Code 54 & 56	ASTM
COMPOSITION					
Appearance		C&B (1)	C&B (1)	C&B (1)	
Acidity, Total (mg KOH/g)	Max.	0.10	0.10.	0.1	D3242, D974 (2)
Aromatics (vol %)	Max.	25	25 (3)	25	D1319
Sulphur, Total (wt %)	Max.	0.30	0.3	0.3000	D2622, D5453, D7039 (4)
Doctor Test		Negative	Negative	Negative	D4952
OR Sulphur, Mercaptan (wt %)	Max.	0.003 (5)	0.003 (5)	0.003 (5)	D3227
Colour, Saybolt		Report	---	---	D156
VOLATILITY					
Distillation Temperature:					D86 (6)
10% Recovery (°F)	Max.	400	401	400	
50% Recovery (°F)		Report	Report	Report	
90% Recovery (°F)		Report	Report	Report	
Final BP (°F)	Max.	572	572	572	
Distillation Residue (vol %)	Max.	1.5	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	1.5	
Flash Point (°F)	Min.	110 (7)	105 (7)	108 (7)	D56, D3828 (8)
Gravity, API @ 60°F		37.0-51.0	37.0-51.0	37-51	D287, D1298, D4052 (9)
FLUIDITY					
Freezing Point (°C)	Max.	-40	-40	-40	D2386, D5972 (10)
Viscosity @ -20°C (cSt)	Max.	8.0	8.0	8.0	D445
COMBUSTION					
Net Heat of Combustion (BTU/lb)	Min.	18,400	42.8 MJ/kg	18,400	D3338, D4809, D4529 (11)
Smoke Point (mm)	Min.	25	25	25	D1322
OR Smoke Point (mm)	Min.	18	18	18	D1322
AND Naphthalenes (vol %)	Max.	3.0	3.0	3.0	D1840
CORROSION					
Copper Strip (2h @ 100°C)	Max.	1A or 1B	No. 1	1	D130
THERMAL STABILITY					
JFTOT ΔP @ 275 ºC (mm Hg)	Max.	25 (12)	25	25 (12)	D3241
Tube Deposit Rating (Visual)	Max.	<3 (13)	<3 (13)	<3 (13)	
CONTAMINANTS					
Existent Gum (mg/100 mL)	Max.	5.0 (14)	7	7.0	D381
Water Reaction Interface	Max.	1b	1b	1b	D1094
MSEP Rating	Min.	85	85	85 (15)	D3948
Particulate Contamination					D2276, D5452, MIL-T-5624P (16)
Particulates (mg/gal)		Report	2.0	Report	
Membrane Colour		Report	---	---	
Filtration Time		---	---	Report	
OTHER					
Conductivity (pS/m)		Report	---	Report	D2624
ADDITIVES		Report (17)	Report (17)	Report (17)	

NOTES

(1) Clear, bright and free from water & suspended matter.
(2) D974 not quoted in Centennial, TEPPCO & Kinder Morgan specifications.
(3) D6379 can also be used for Kinder Morgan subject to a maximum aromatics concentration of 26.5 vol %.
(4) D2622 and D7039 not quoted in Centennial & TEPPCO specifications. D5453 and D7039 not quoted in Kinder Morgan specification. Plantation also allow origin to qualify sulphur content test method per EPA Performance Based Testing Criteria (CFR 80.584).
(5) Mercaptan sulphur waived if fuel is negative by Doctor test.
(6) Simulated distillation by ASTM D2887 also permitted by all pipelines. Different limits apply - see specifications for more details.
(7) Limits shown apply at origin. Minimum of 100°F applies at destination for all pipelines.
(8) D3828 only permitted as alternative in Plantation specification.
(9) D287 & D4052 not quoted in Centennial & TEPPCO specifications. D1298 & D4052 not quoted in Kinder Morgan specification.
(10) D5972 not quoted in Centennial, TEPPCO, Kinder Morgan specifications.
(11) D4529 not quoted by Centennial & TEPPCO.
(12) For Centennial, TEPPCO and Plantation, test at 275 ºC at origin and 260°C at destination.
(13) No 'peacock' or 'abnormal' colour deposits allowed.
(14) Maximum limit shown in table applies at origin. A maximum existent gum of 7.0 mg/100 ml applies at destination.
(15) For Plantation a minimum 85 MSEP is required at origin and a minimum 75 MSEP is required upon delivery.
(16) D2276 not quoted in Plantation specification. D5452 and MIL-T-5624P not quoted in Kinder Morgan specification. MIL-T-5624P not quoted in Centennial & TEPPCO specifications.
(17) Only those additives specified and within the concentration noted in Section 5.2 through 5.2.2.1 of ASTM D1655 are permitted. The use of any other additives is prohibited. See individual pipeline specifications for full details on use of additives.

Methods to be used in case of dispute are not shown because they vary for each pipeline. Please refer to individual pipeline specifications for further details.

Table 5
US Military Specifications

Issuing Agency:		US Navy		
Specification:		MIL-DTL-5624U		
Latest Revision Date:		5th January 2004		
Grade Designation:		JP-4 Wide-Cut Kerosene	JP-5 Kerosene	Test Method
NATO Code No.		F-40	F-44	ASTM
COMPOSITION				
Appearance		C&B (1)	C&B (1)	
Acidity, Total (mg KOH/g)	Max.	0.015	0.015	D3242
Aromatics (vol %)	Max.	25.0	25.0	D1319
Sulphur, Total (wt %)	Max.	0.40	0.30	D4294, D1266, D2622, D3120, D5453
Sulphur, Mercaptan (wt %)	Max.	0.002	0.002	D3227
OR Doctor Test		Negative	Negative	D4952
Colour, Saybolt		Report	Report	D156, D6045
VOLATILITY				
Distillation Temperature:				D86, D2887 (2)
Initial BP (°C)		Report	Report	
10% Recovery (°C)	Max.	Report	205(186)	
20% Recovery (°C)	Min.	100	Report	
50% Recovery (°C)	Min.	125	Report	
90% Recovery (°C)	Max.	Report	Report	
Final BP (°C)	Max.	270	300(330)	
Distillation Residue (vol %)	Max.	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	
Flash Point (°C)	Min.	---	60 (3)	D56, D93, D3828
Density @ 15°C (kg/L)		0.751-0.802	0.788-0.845	D1298, D4052
OR Gravity, API @ 60°F		57.0-45.0	48.0-36.0	
Vapour Pressure @ 37.8°C (kPa)		14-21	---	D323, D4953, D5190, D5191
FLUIDITY				
Freezing Point (°C)	Max.	-58	-46	D2386, D5972 (4)
Viscosity @ -20°C (cSt)	Max.	---	8.5	D445
COMBUSTION				
Net Heat of Comb. (MJ/kg)	Min.	42.8	42.6	D3338, D4809, D4529
Cetane Index (calculated) (5)		---	Report	D976, D4737
Smoke Point (mm)	Min.	20.0	19.0	D1322
Hydrogen Content	Min.	13.5	13.4 (6)	D3343, D3701
CORROSION				
Copper Strip (2h @ 100°C)	Max.	1	1	D130
THERMAL STABILITY				
JFTOT ΔP (mm Hg)	Max.	25	25	D3241
Tube Deposit Rating (Visual)	Max.	<3 (7)	<3	
CONTAMINANTS				
Existent Gum (mg/100 mL)	Max.	7.0	7.0	D381 (8)
Particulates (mg/L)	Max.	1.0	1.0	D2276, D5452 (9)
Filtration Time (min)	Max.	10	15 (10)	(9)
Water Reaction Interface	Max.	1b	---	D1094
MSEP Rating	Min.	90 (11)	90 (11)	D3948
OTHER				
Conductivity (pS/m)		150-600 (12)	---	D2624
ADDITIVES				
Anti-icing (vol %)		0.10-0.15	0.10-0.15	D5006 (13)
Antioxidant (ppm)		17.2-24.0 (14)	17.2-24.0 (15)	
Corrosion Inhibitor		Required (16)	Required (16)	
Metal Deactivator		Agreement	Agreement	
Static Dissipator		Required	(17)	

NOTES

(1) In case of dispute, the fuel shall be clear and bright at 21°C and contain no more than 1.0 mg/L of particulate matter.

(2) D2887 may be used for JP-5 fuel only; test limits in parentheses.

(3) D3828 may give results up to 1.7°C below the D93 results. D56 may give results up to 1°C below the D93 results.

(4) D5972 may be used for freeze point determination of JP-5 only.

(5) Mid-boiling temperatures shall 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.

(6) For JP-5, only D3701 shall be used to measure the hydrogen content.

(7) No peacock or abnormal colour deposits allowed.

(8) If air is used instead of steam while performing ASTM D381, it shall be recorded. In case of a failure with air, the sample shall be retested using steam.

(9) Minimum sample size of 1 US gallon shall be filtered. Filtration time determined according to procedure in Appendix A of specification.

(10) Flow reducer ring of Appendix A, section A.3.c is not required for JP-5.

(11) Limit for fuel containing antioxidant and metal deactivator. Minimum limit reduced to 85 when third additive is fuel system icing inhibitor; to 80 when third additive is corrosion inhibitor; to 70 with all four additives present.

(12) Conductivity must be within range at ambient fuel temperature or 29.4°C, whichever is lower.

(13) Tests shall be performed with ASTM D5006 using the DiEGME scale of the refractometer.

(14) Limits of active ingredient for JP-4 fuels containing hydrotreated blend stocks. For JP-4 fuels that do not contain any hydrotreated blend stocks, antioxidant may be added to a max. 24 ppm.

(15) Required for all JP-5 fuels.

(16) Allowable concentration limits listed in latest revision of QPL-25017.

(17) Static dissipator additive shall not be used in JP-5 unless written consent has been obtained from NAVAIR 4.4.5.

Table 6

US Military Specifications

Issuing Agency:		US Air Force	US Air Force	
Specification:		MIL-DTL-38219D	MIL-DTL-83133E	
Latest Revision Date:		21 August 1998	1 April 1999	
Grade Designation:		JP-7 Low Volatility Kerosene	JP-8 (1) Kerosene	Test Method
NATO Code No.			F-34/F-35	ASTM
COMPOSITION				
Appearance		C&B (2)	C&B (2)	
Acidity, Total (mg KOH/g)	Max.	---	0.015	D3242
Aromatics (vol %)	Max.	5	25.0	D1319
Sulphur, Total (wt %)	Max.	0.1	0.30	D4294 (3)
Sulphur, Mercaptan (wt %)	Max.	0.001	0.002	D3227
OR Doctor Test		Negative	Negative	D4952
Colour, Saybolt		---	Report	D156, D6045
VOLATILITY				
Distillation Temperature:				D86, D2887 (JP-8 only, limits in parenthesis)
Initial BP (°C)	Min.	182	Report	
10% Recovery (°C)		196 min.	205(186) max.	
20% Recovery (°C)	Min.	206	Report	
50% Recovery (°C)		Report	Report	
90% Recovery (°C)	Max.	260	Report	
Final BP (°C)	Max.	288	300(330)	
Distillation Residue (vol %)	Max.	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	
Flash Point (°C) (4)	Min.	60	38	D56, D93, D3828
Density @ 15°C (kg/L)		0.779-0.806	0.775-0.840	D1298, D4052
OR Gravity, API @ 60°F		50.1-44.0	51.0-37.0	D1298
Vapour Pressure @ 149°C (kPa)	Max.	20.7	---	(5)
Vapour Pressure @ 260°C (kPa)	Max.	331	---	(5)
FLUIDITY				
Freezing Point (°C)	Max.	-43.3	-47	D2386, D5901 (JP-8 only), D5972 (JP-8 only)
Viscosity @ -20°C (cSt)	Max.	8.0	8.0	D445
COMBUSTION				
Net Heat of Combustion (MJ/kg)	Min.	43.5	42.8	D2382 (JP-7 only), D3338, D4809 (JP-8 only)
Cetane Index (calculated) (5)		---	Report	D976
Smoke Point (mm)	Min.	---	25.0	D1322
OR Smoke Point (mm)	Min.	---	19.0	D1322
AND Naphthalenes (vol %)	Max.	---	3.0	D1840
Hydrogen Content	Min.	14.40	13.4	D3701, D3343 (6)
CORROSION				
Copper Strip (2h @ 100°C)	Max.	1b	1	D130
THERMAL STABILITY				
JFTOT ΔP (mm Hg)	Max.	25.0	25	D3241 (7)
Tube Deposit Rating (Visual)	Max.	12 TDR	<3 Visual (8)	
CONTAMINANTS				
Existent Gum (mg/100 mL)	Max.	5.0 (9)	7.0	D381
Particulates (mg/L)	Max.	0.3 (10)	1.0	D2276, D5452
Filtration Time (min)	Max.	---	15	(11)
Water Reaction Interface	Max.	1b	1b	D1094
Water Reaction Separation	Max.	2	---	D1094
MSEP Rating	Min.	85	90 (12)	D3948
OTHER				
Conductivity (pS/m)			(13)	D2624
ADDITIVES				
Anti-icing (vol %)		0.10-0.15	0.10-0.15 (14)	D5006
Antioxidant (ppm)		24.0	Required (15)	
Corrosion Inhibitor		200-250 (16)	Required (16)	
Metal Deactivator		Agreement	Agreement	
Static Dissipator		---	Required	

NOTES

(1) JP-8 fuel with an approved thermal stability improver additive is designated JP8+100.
(2) Fuel shall be clear and bright at 21°C; JP-8 may contain no more than 1.0 mg/L of particulate matter.
(3) D1266, D2622 and D3120 are permitted alternatives for JP-7 and JP-8 (which also accepts D129 and D5453).
(4) For JP-7, only D93 may be used. For JP-8, D56 may give results up to 1°C below D93 results; D3828 may give results up to 1.7°C below D93 results; method IP170 is also permitted.
(5) Vapour pressure tested according to Appendix A or Appendix C of MIL-DTL-38219D.
(6) May use calculation (D3343) or measurement method (D3701).
(7) Test conditions for JP-7 fuel of 355°C for 5h; for JP-8 fuel at 260°C for 2.5h.
(8) No peacock or abnormal colours allowed.
(9) If air is used instead of steam, it must be reported. In case of failure with air, the sample must be retested with steam.
(10) Limit applies at origin. At destination, max. limit is 0.5 mg/L.
(11) Filtration time determined according to procedure in Appendix A of MIL-DTL-83133E.
(12) Limit for fuel containing antioxidant and metal deactivator. Limit reduced to 85 when third additive is icing inhibitor; to 80 when third additive is corrosion inhibitor; to 70 with all four additives present.
(13) Conductivity limits are 150-450 pS/m for F-34 (JP-8), 50-450 pS/m for F-35, and 150-700 pS/m for JP-8+100 fuel. Conductivity must be within range at ambient fuel temperature or 29.4°C, whichever is lower.
(14) Fuel system icing inhibitor is mandatory for F-34 grade, by agreement in F-35.
(15) Required for fuel containing hydrogen-treated blending stocks.
(16) PWA-536 lubricity additive shall be added to JP-7 fuel. Corrosion inhibitor conforming to MIL-PRF-25017 shall be added to F-34 fuel, but is optional for F-35.

Table 7
Australia

Issuing Agency:		Australian Department of Defence			
Specification:		DEF(AUST)5240D			
Latest Revision Date:		May-07			
Grade Designation:		AVTUR Kerosene	AVCAT High Flash	Test Method	
NATO Code No.		F-34/F-37	F-44	ASTM	IP
COMPOSITION					
Appearance		C&B	C&B	D4176	
Acidity, Total (mg KOH/g)	Max.	0.015	0.015	D3242	354
Aromatics (vol %)	Max.	25.0 (1)	25.0 (1)	D1319	156
OR Total Aromatics (vol %)	Max.	26.5 (1)	26.5 (1)	D6379	436
Sulphur, Total (wt %)	Max.	0.30	0.30	D1266, D2622	336
Sulphur, Mercaptan (wt %)	Max.	0.0030	0.0020	D3227	342
OR Doctor Test		Negative	Negative	D4952	30
Colour, Saybolt		Report (2)	Report (2)	D156, D6045	
Hydroprocess Components (vol %)		Report (3)	Report (3)		
Severely Hydroprocess Components (vol %)		Report (3)	Report (3)		
Shale Oil Derived (vol %)		15	15		
VOLATILITY					
Distillation Temperature:				D86 (4)	123
Initial BP (°C)		Report	Report		
10% Recovery (°C)	Max.	205.0	205.0		
50% Recovery (°C)		Report	Report		
90% Recovery (°C)		Report	Report		
Final BP (°C)	Max.	300.0	300.0		
Distillation Residue (vol %)	Max.	1.5	1.5		
Distillation Loss (vol %)	Max.	1.5	1.5		
Flash Point (°C)	Min.	38.0	61.5	D56, D93, D3828 (5)	34, 170 (5)
Density @ 15°C (kg/m^3)		775.0 – 840.0	788.0 - 845.0	D1298, D4052	160, 365
FLUIDITY					
Freezing Point (°C)	Max.	-47	-46	D2386, D5972	16, 435
Viscosity @ -20°C (cSt)	Max.	8.0.	8.5	D445	71
COMBUSTION					
Net Heat of Combustion (MJ/kg)	Min.	42.8	42.6	D3338, D4809	12, 355
Smoke Point (mm)	Min.	25.0	25.0	D1322	57
OR Smoke Point (mm)	Min.	19.0	19.0	D1322	57
AND Naphthalenes (vol %)	Max.	3.00	3.00	D1840	
CORROSION					
Copper Strip (2h @ 100°C)	Max.	1	1	D130	154
THERMAL STABILITY					
JFTOT ΔP @ 260 °C (mm Hg)	Max.	25	25	D3241	323
Tube Deposit Rating (Visual)	Max.	<3 (6)	<3 (6)		
CONTAMINANTS					
Existent Gum (mg/100 mL)	Max.	7	7	D381	540
Particulates (mg/L)	Max.	1.0 (7)	1.0 (7)	D5452	423
Water Reaction Interface	Max.	1b (8)	1b (8)	D1094	289
MSEP Rating					
Fuel without SDA	Min.	85	85	D3948	
Fuel with SDA	Min.	70	70	D3948	
OTHER					
Conductivity (pS/m)		100-600 (9)	100-600 (9)	D2624, D4308	274
BOCLE wear scar diameter (mm)	Max.	0.65 (10)	0.65 (10)	D5001	
ADDITIVES		(11)			
Anti-icing (vol %)		0.10-0.15	0.12-0.20	D5006	424
Antioxidant (hydroprocessed fuel)		Required	Required		
(non-hydroprocessed fuel)		Option	Option		
Metal Deactivator		Option	Option		
Static Dissipator		Option	Option		
Lubricity Improver		Required	Required		
Thermal Stability Additive		Required for F-37	Not Allowed		

NOTES

(1) Bias between the two techniques to measure aromatics necessitates different equivalence limits as shown.

(2) Applies at point of manufacture enabling downstream colour change to be quantified.

(3) Severely hydroprocessing refers to a hydrogen partial pressure of >7000 kPa (70 bar or 1015 psi) during manufacture.

(4) In method D86, use group 4 test conditions. A condenser bath temperature of 0 °C to 4 °C shall be used.

(5) Results by method D3828 are up to 1.7°C below the ASTM D93 results. Results by method D56 may be up to 1.0°C below the D93 results. In cases of dispute, IP 170 shall be the referee method for F-34 & F-37 and D93 shall be the referee method for F-44.

(6) No peacock or abnormal colour deposits allowed.

(7) Applies at point of delivery to purchaser.

(8) Despite being removed from DEF STAN 91-86 & 91-87, the water reaction test has been retained by Defence as it is a convenient test for Defence personnel testing F-44 on board vessels. It is not necessary for suppliers to perform this test providing an MSEP rating test has been carried out.

(9) At the point, time and temperature of delivery to purchaser. In the event of a discrepancy, the conductivity is to be determined at 15°C.

(10) The requirement to determine lubricity applies only to fuels containing more than 95% hydro processed material and where at least 10% is severely hydro processed, at point of manufacture.

(11) 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.

Table 8

Brazil

Issuing Agency:		National Petroleum Agency		
Specification:		QAV-1		
Latest Revision Date:		12-May-03	Test Method	
Grade Designation:		Jet A-1 Kerosene	ASTM	ABNT NBR (1)
COMPOSITION				
Appearance		C&B (2)	D4176	
Acidity, Total (mg KOH/g)	Max.	0.015	D3242	
Aromatics (vol %)	Max.	25	D1319	
OR Total Aromatics (vol %)	Max.	26.5	D6379	
Sulphur, Total (wt %)	Max.	0.30	D1266, D1552, D2622, D4294, D5453	6563, 14533, 14875
Sulphur, Mercaptan (wt %)	Max.	0.0030	D3227	6298
OR Doctor Test		Negative	D4952	14642
H/P components (vol %) (3)		Report (incl. 'nil' or 100%)		
Severely H/P components (vol %) (3)		Report (incl. 'nil' or 100%)		
VOLATILITY				
Distillation Temperature:			D86	9619
Initial BP (°C)		Report		
10% Recovery (°C)	Max.	205		
50% Recovery (°C)	Max.	Report		
90% Recovery (°C)	Max.	Report		
Final BP (°C)	Max.	300		
Distillation Residue (vol %)	Max.	1.5		
Distillation Loss (vol %)	Max.	1.5		
Flash Point (°C)	Min.	40	D56	7974
		or 38	D3828	
Density @ 15°C (kg/L) (4)		771.3-836.6	D1298, D4052	7148, 14065
FLUIDITY				
Freezing Point (°C)	Max.	-47	D2386, D5972	7975
Viscosity @ -20°C (cSt)	Max.	8.0	D445	10441
COMBUSTION				
Net Heat of Combustion (MJ/kg)	Min.	42.8	D3338, D4529, D4809	
Smoke Point (mm)	Min.	25	D1322	11909
OR Smoke Point (mm)	Min.	19	D1322	11909
AND Naphthalenes	Max.	3.0	D1840	
CORROSION				
Copper Strip (2h @ 100°C)	Max.	1	D130	14359
Silver Strip (4h @50°C) (5)	Max.	1		
THERMAL STABILITY				
JFTOT ΔP (mm Hg)	Max.	25.0	D3241	
Tube Deposit Rating (Visual)	Max.	<3 (6)		
CONTAMINANTS				
Existent Gum (mg/100 mL)	Max.	7	D381	14525
Water Reaction Interface	Max.	1b	D1094	6577
MSEP Rating (7)			D3948	
Fuel without SDA	Min.	85		
Fuel with SDA	Min.	70		
OTHER				
Conductivity (pS/m)		50-450 (8)	D2624	
BOCLE wear scar diameter (mm) (9)		0.85	D5001	
ADDITIVES (10)				
Antioxidant (mg/l)		17.0-24.0 (11)		
Metal Deactivator		Option (12)		
Static Dissipator		Option (13)		
Anti-Icing		Agreement		
Leak Check		Option		
Lubricity Improver		Agreement		

NOTES

(1) Normas Brasileiras (NBR) da Associacao Brasileira de Normas Tecnicas (ABNT)

(2) Clear, bright and visually free of undissolved water and solid material at normal, ambient temperature.

(3) Severely hydroprocessed components are defined having been subjected to a hydrogen partial pressure of greater than 7000 kPa (70 bar or 1015 psi) during manufacture.

(4) The value for density shall be reported at 20 °C. A density at 15 °C may be reported to facilitate commercial transactions. The limits that apply at 15 °C are from 775.0 to 840.0 kg/m^3.

(5) Test (as per IP 227) is only required for military contracts.

(6) No peacock or abnormal colour deposits allowed.

(7) MSEP is required only at point of manufacture. Failure to comply at later stages of distribution shall be cause for investigation, but not rejection in the first instance.

(8) Limit applies at point, time and temperature of delivery to buyer if fuel contains static dissipator additive.

(9) The requirement to determine lubricity applies only to fuels containing more than 95% hydroprocessed material and where at least 20% is severely hydroprocessed, at point of manufacture.

(10) The Certificate of Quality shall indicate the types and concentrations of additives used, inclusive of no addition. Only approved additives listed in the Annex of DEF STAN 91-91 are allowed.

(11) For fuel containing hydroprocessed components. Antioxidant is optional for fuels having no hydroprocessed components.

(12) The maximum allowed concentration on initial doping is 2.0 mg/L. Cumulative addition of MDA upon redoping shall not exceed 5.7 mg/L. JFTOT results must be reported before and after addition of the additive.

(13) The maximum allowed concentration on initial doping is 3.0 mg/L. The cumulative concentration of additive upon redoping to maintain conductivity shall not exceed 5.0 mg/L.

Table 9
Canada

Issuing Agency:		Canadian General Standards Board			
Specification:		CAN/CGSB-3.24-2005			
Latest Revision Date:		2005			
Grade Designation:		Jet A/Jet A-1 Kerosine	AVTUR Kerosine	AVCAT High Flash Kerosine	Test Method
NATO Code No.		F-35	F-34	F-44	ASTM
COMPOSITION					
Appearance		C&B (1)	C&B (1)	C&B (1)	
Acidity, Total (mg KOH/g)	Max.	0.10	0.10	0.03	D3242
Aromatics (vol %)	Max.	25	25	25	D1319
Sulphur, Total (wt %)	Max.	0.30	0.30	0.30	D1266, D2622, D4294, D5453 (2)
Sulphur, Mercaptan (wt %) (3)	Max.	0.003	0.003	0.002	D3227
OR Doctor Test		Negative	Negative	Negative	D4952
VOLATILITY					
Distillation Temperature:					D86
Initial BP (°C)		Report	Report	Report	
10% Recovery (°C)	Max.	205	205	205	
20% Recovery (°C)		---	Report	Report	
50% Recovery (°C)		Report	Report	Report	
90% Recovery (°C)		Report	Report	Report	
Final BP (°C)	Max.	300	300	300	
Distillation Residue (vol %)	Max.	1.5	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	1.5	
Flash Point (°C)	Min.	38	38	60	D93 (F-44), D-56 or D-3828 (F-35 / F-34) (4)
Density @ 15°C (kg/m^3)		775-840	775-840	788-845	D1298, D4052
FLUIDITY					
Freezing Point (°C)	Max.	-40 (Jet A), -47 (Jet A-1)	-47	-46	D2386, D5972
Viscosity @ -20°C (cSt)	Max.	8.0	8.0	8.8	D445
COMBUSTION					
Net Heat of Combustion (MJ/kg)	Min.	42.8	42.8	42.6	D3338, D4529, D4809
Smoke Point (mm)	Min.	25	25	19	D1322
OR Smoke Point (mm)	Min.	18	18	---	D1322
AND Naphthalenes (vol %)	Max.	3.0	3.0	---	D1840
Hydrogen Content		---	---	Report	D3343, D3701
CORROSION					
Copper Strip (2h @ 100°C)	Max.	No. 1	No. 1	No. 1	D130
THERMAL STABILITY					
JFTOT ΔP @260ºC (mm Hg)	Max.	25	25	25	D3241
Tube Deposit Rating (Visual)	Max.	<3 (5)	<3 (5)	<3 (5)	
CONTAMINANTS					
Existent Gum (mg/100 mL)	Max.	---	7	7	D381 (6)
Particulate Matter (mg/L)	Max.	0.44 (7)	0.44 (7)	0.50 (7)	D2276, D5452
MSEP Rating (8)					D3948
Fuel without SDA	Min.	85	85	85	
Fuel with SDA	Min.	70	70	---	
OTHER					
Conductivity (pS/m) (9)		50-450	50-600	600 max	D2624
ADDITIVES (10)					
Anti-icing (vol %)		Option	0.10-0.15	0.10-0.15	D5006
Antioxidant		Required (11)	Required (11)	Required (11)	
Corrosion Inhibitor		Option (12)	Required (12)	Required (12)	
Metal Deactivator		Option	Option	Option	
Static Dissipator		Required (13)	Required (13)	Required (13)	
Leak Detector		Option	Option	Option	

NOTES

(1) Fuel shall be visually clear & free from undissolved water & particulates.

(2) CAN/CGSB 3.0 No.16 is also allowed.

(3) The mercaptan sulphur determination may be waived if the fuel is considered "sweet" by the doctor test described in ASTM D 4952.

(4) The results obtained by ASTM D 3828 may be up to 2°C lower than those obtained by ASTM D 56.

(5) No peacock or abnormal colour deposits allowed.

(6) Air or Steam jet is permitted as per D381.

(7) Limits shown apply at time of delivery to aircraft and refuellers. A limit of 2.2 mg/L max applies at time of delivery to storage.

(8) The minimum micro-separometer (MSEP) rating applies at the point immediately before the fuel enters dedicated transportation to airport/military storage. When the fuel enters dedicated transportation to airport/military storage, or when the fuel is already in airport/military storage, the MSEP rating requirement shall not apply. When an FSII or corrosion inhibitor is added, the MSEP limits apply before its addition.

(9) Applies at point, time and temperature of delivery.

(10) When used, additive names & amounts shall be recorded by the supplier.

(11) Antioxidant at 17.2 - 24 mg/L must be added to any hydroprocessed portion of the fuel. Addition is optional for non-hydroprocessed fuel subject to a maximum concentration of 24 mg/L.

(12) Only corrosion inhibitors qualified to MIL-PRF-25017 and listed in QPL 25017 shall be used.

(13) Original concentration is 3 mg/L max. Cumulative concentration is 5 mg/L max. When additive depletion is evident by conductivity loss and if the original SDA concentration is not known, an original addition of 3 mg/L is assumed and further addition of SDA shall not exceed 2mg/L.

Table 10

France

Issuing Agency:		Service des Essences des Armees				
Specification:		DCSEA 134/B				
Latest Revision Date:		Dec-04				
Grade Designation:		Jet A-1 Kerosene	Test Method			
NATO Code No.		F-35/F-34 (1)	ASTM	IP	ISO	NF
COMPOSITION						
Appearance		C&B (2)				LSEA D 14
Colour	Max.	Report				
Acidity, Total (mg KOH/g)	Max.	0.015	D3242	354		
Aromatics (vol %)	Max.	25.0	D1319	156	3837	M 07-024
OR Aromatics by HPLC (mass %)	Max.	28.0	D6379	436		
Hydrogen Content (vol %)		(3)	D3701			
Sulphur, Total (wt %)	Max.	0.30	D4294	107	8754	EN ISO 8754, M 07-059
Doctor Test		Negative	D4952	30	5275	M 07-029
OR Sulphur, Mercaptan (wt %) (4)	Max.	0.0030	D3227	342	3012	ISO 3012
VOLATILITY						
Distillation Temperature:			D86		3405	EN ISO 3405
Initial BP (°C)		Report				
10% Recovery (°C)	Max.	205.0				
20% Recovery (°C)		(3)				
50% Recovery (°C)		Report				
90% Recovery (°C)	Max.	Report				
Final BP (°C)	Max.	300.0				
Distillation Residue (vol %)	Max.	1.5				
Distillation Loss (vol %)	Max.	1.5				
Flash Point (°C)	Min.	38 (5)	D56, D93 (5)	34 (5), 170	13736	EN 22719 (5), EN ISO 13736
Density @ 15°C (kg/m^3)		775.0 - 840.0	D1298, D4052	160, 365	12185	EN ISO 12185
FLUIDITY						
Freezing Point (°C)	Max.	-47	D2386, D5972	16, 529	3013	ISO 3013
Viscosity @ -20°C (cSt)	Max.	8.0	D445	71	3104	EN ISO 3104
COMBUSTION						
Net Heat of Comb. (MJ/kg)	Min.	42.8	D4529, D4809	381		
Aniline Point (°C)		(3)				M 07-021
Smoke Point (mm)	Min.	25	D1322	57	3014	M 07-028
OR Smoke Point (mm)	Min.	19	D1322	57	3014	M 07-028
AND Naphthalenes	Max.	3.0	D1840			
CORROSION						
Copper Strip (2h @ 100°C)	Max.	1	D130	154	2160	EN ISO 2160
THERMAL STABILITY						
JFTOT ΔP @260°C (mm Hg)	Max.	25	D3241	323	6249	ISO 6249
Tube Deposit Rating (Visual)	Max.	<3 (6)				
Peroxide Number (mEq/dm3)	Max.	(7)				LSEA-D-29
CONTAMINANTS						
Existent Gum (mg/100 mL)	Max.	7	D381	131	6246	EN ISO 6246
Water Reaction Interface	Max.	1b	D1094		6250	
Water Reaction Separation	Max.	(8)	D1094		6250	
MSEP Rating (9)			D3948			
Fuel without SDA	Min.	85				
Fuel with SDA	Min.	70				
OTHER						
BOCLE wear scar diameter (mm)	Max.	0.65 (F-34) or 0.85 (F-35) (10)	D5001			
Conductivity (pS/m)		50 - 450	D2624	274	6297	
ADDITIVES						
Anti-icing (vol %)		0.10-0.15 (Required for F-34 only) (1)	D5006			LSEA-S-21, FTMS 791-5327
Antioxidant		Required (11)				
Corrosion Inhibitor		Required (12)				LSEA-S-18
Metal Deactivator		Option				LSEA-XS-92
Static Dissipator		Required				LSEA-XS-93
Biocide		Option (13)				

NOTES

(1) Addition of icing inhibitor changes fuel designation from F-35 to F-34.
(2) Fuel shall be visually clear & free from undissolved water & particulates.
(3) Requirement is optional; result to be reported.
(4) This test is only performed when the Doctor test result is not negative.
(5) The D56 method is acceptable subject to a 40°C minimum. The NF EN 22719, D93 and IP 34 methods are acceptable subject to a 41°C minimum.
(6) No peacock or abnormal deposits allowed.
(7) Test is optional with a maximum of 2 mEq/dm3 if determined.
(8) Test is optional with a maximum rating of 2 if determined.
(9) These limits apply only at point of manufacture. If MSEP is measured in the distribution system downstream of the refinery, no limits apply, & the result may not be used, on its own, to assert non-compliance of product.
(10) For F-35 BOCLE is only required when fuel is >95% hydrotreated of which >20% is severely hydrotreated (i.e. >70 bar).
(11) To be added to all hydroprocessed and synthetic components at a concentration between 17.0 and 24.0 mg/L. Optional at up to 24.0 mg/L for fuels not containing any hydroprocessed components.
(12) Required as lubricity improver in F-34. Optional in F-35.
(13) Kathon FP 1.5 is the only additive meeting requirements of DCSEA 754 (subject to 50ppm max). Biobor JF additive may be used by agreement16

Table 11
Japan

Issuing Agency:		Japan Defence Agency		
Specification:		DSP K 2206D		
Latest Revision Date:		22-Jan-07		Test Method
Grade Designation:		JP-4 Wide-Cut Kerosene	JP-5 High-Flash Kerosene	JIS, ASTM
COMPOSITION				
Appearance		C&B (1)	C&B (1)	Visual
Colour, Saybolt		Report	Report	JIS K 2580, D156
Acidity, Total (mg KOH/g)	Max.	0.015	0.015	JIS K 2276, D3242
Aromatics (vol %)	Max.	25.0	25.0	JIS K 2536-1, D1319
Olefins (vol %)	Max.	5.0	5.0	JIS K 2536-1, D1319
Sulphur, Total (wt %)	Max.	0.40	0.4	JIS K 2541-1,-2,-3,-4,-5,-6 or -7, D1266, D2622
Sulphur, Mercaptan (wt %)	Max.	0.002	0.002	JIS K 2276, D3227
OR Doctor Test		Negative	Negative	JIS K 2276, D4952
VOLATILITY				
Distillation Temperature:				JIS K 2254, D86, D2887
Initial BP (°C)		Report	Report	
10% Recovery (°C)	Max.	Report	205	
20% Recovery (°C)	Max.	145	Report	
50% Recovery (°C)	Max.	190	Report	
90% Recovery (°C)	Max.	245	Report	
Final BP (°C)	Max.	270	300	
Distillation Residue (vol %)	Max.	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	
Flash Point (°C)	Min.	---	>61	JIS K 2265 (PM), D56
Density @ 15°C (kg/m^3)		751 - 802	788 - 845	JIS K 2249, D1298, D4052
Vapour Pressure @ 37.8°C (kPa)		14 - 21	---	JIS K 2258, D5190
FLUIDITY				
Freezing Point (°C)	Max.	-58 (2)	-46 (2)	JIS K 2275, D2386
Viscosity @ -20°C (cSt)	Max.	---	8.5	JIS K 2283, D445
COMBUSTION				
Aniline-Gravity Product	Min.	5250	4500	JIS K 2206
OR Net Heat of Combustion (MJ/kg)	Min.	42.8	42.6	JIS K 2279, D4809
Hydrogen Content (wt %)	Min.	13.6	13.4	JIS K 2276, D3701
Smoke Point (mm)	Min.	20.0	19.0	JIS K 2537, D1322
CORROSION				
Copper Strip (2h @ 100°C)	Max.	1	1	JIS K 2513, D130
THERMAL STABILITY				
JFTOT ΔP @260°C (kPa)	Max.	3.3	3.3	JIS K 2276, D3241
Tube Deposit Rating (Visual)	Max.	<3	<3	
Peroxide Number (mass ppm)	Max.	---	8.0	JIS K 2276
CONTAMINANTS				
Existent Gum (mg/100 mL)	Max.	7.0	7.0	JIS K 2261, D381
Particulates (mg/L)	Max.	1.0	1.0	JIS K 2276, D5452 (3)
Filtration Time (min)	Max.	10	15	
Water Reaction Interface	Max.	1b	1b	JIS K 2276, D1094
MSEP Rating	Min.	(4)	70	JIS K 2276, D3948
OTHER				
Conductivity (pS/m)		150 - 600 (5)	---	JIS K 2276, D2624
ADDITIVES				
Anti-icing (vol %)		0.10 - 0.15 (6)	0.15 - 0.20 (6)	FED-STD-791 (method 5327, 5340 or 5342), D5006
Antioxidant		Required	Required	
Corrosion Inhibitor		Option	Option	
Metal Deactivator		Option	Option	
Static Dissipator		Required	---	

NOTES

(1) Clear, bright & visually free from solid matter & undissolved water.

(2) If no hydrocarbon is crystallized even when the sample is cooled down more than 4.5 °C below the specified temperature, the report is allowed to describe just as 'below the specified temperature'.

(3) Method also detailed in Appendix 2 of DSP K2206D. The sampling point may be any point of the tank, the delivery pipeline, tanker, rail tank car & tank truck, & the sampling volume shall be minimum 4 L.

(4) For JP-4 the MSEP rating is 70 min. for fuel with static dissipator additive & corrosion inhibitor, and 85 min. for fuel without static dissipator additive.

(5) Applies at ambient fuel temperature or 29.4°C, whichever is lower.

(6) Sampling point shall be the supplier's product vessel.

Table 12

People's Republic of China

Issuing Agencies:		General Administration of QS, I & Q		
Specification:		GB 6537-2006		
Latest Revision Date:		8-Dec-06	Test Method	
Grade Designation:		No. 3 Jet Fuel	GB/T	SH/T
COMPOSITION				
Appearance		C&B (1)	Visual	
Colour, Saybolt	Min.	+25 (2)	3555	
Acidity, Total (mg KOH/g)	Max.	0.015	12574	
Aromatics (vol %)	Max.	20.0 (3)	11132	
Olefins (vol %)	Max.	5.0	11132	
Sulphur, Total (wt %)	Max.	0.20	380, 11140, 17040	0253, 0689
Sulphur, Mercaptan (wt %)	Max.	0.0020 (4)	1792	
OR Doctor Test		Negative (4)		0174
Straight-run Components (vol %)		Report		
Hydrotreated Components (vol %)		Report		
Hydrocracked Components (vol %)		Report		
VOLATILITY				
Distillation Temperature:			6536	
Initial BP (°C)		Report		
10% Recovery (°C)	Max.	205		
20% Recovery (ºC)		Report		
50% Recovery (°C)	Max.	232		
90% Recovery (°C)		Report		
Final BP (°C)	Max.	300		
Distillation Residue (vol %)	Max.	1.5		
Distillation Loss (vol %)	Max.	1.5		
Flash Point - closed cup (°C)	Min.	38	261	
Density @ 20°C (kg/m³)		775 - 830	1884, 1885	
FLUIDITY				
Freezing Point (°C)	Max.	-47	2430	0770
Viscosity @ 20ºC (cSt)	Min.	1.25 (5)	265	
Viscosity @ -20°C (cSt)	Max.	8.0	265	
COMBUSTION				
Net Heat of Comb. (MJ/kg)	Min.	42.8	384, 2429	
Smoke Point (mm)	Min.	25.0	382	
OR Smoke Point (mm)	Min.	20	382	
AND Naphthalenes (vol %)	Max.	3.0		0181
OR Luminometer Number	Min.	45	11128	
CORROSION				
Copper Strip (2h @ 100°C)	Max.	1	5096	
Silver Strip (4h @ 50°C)	Max.	1 (6)		0023
THERMAL STABILITY				
JFTOT ΔP @260°C (kPa)	Max.	3.3	9169	
Tube Deposit Rating (Visual)	Max.	<3 (7)		
CONTAMINANTS				
Existent Gum (mg/100 mL)	Max.	7	509, 8019	
Water Reaction			1793	
Interface Rating	Max.	1b		
Separation Rating	Max.	2 (8)		
Particulates (mg/L)	Max.	1.0		0093
MSEP Rating				0616
Without SDA	Min.	85		
With SDA	Min.	70		
Copper Content (µg/kg)	Max.	150 (9)		0182
OTHER				
BOCLE Wear Scar Diameter (mm)	Max.	0.65 (10)		0687
Conductivity at 20°C (pS/m)		50-450 (11)	6539	
ADDITIVES				
Anti-icing (vol %)		Agreement		
Antioxidant		Required (12)		
Corrosion Inhibitor		Option		
Metal Deactivator		Agreement		
Static Dissipator		Option		

NOTES

(1) Product should be clear, bright and visually free from solid matter and undissolved water at ambient temperature.

(2) For fuel used in civil aviation, changes in Saybolt colour from the refinery to the customer should not be greater than follows:
8 if the initial Saybolt colour at point of manufacture was _+25
5 if the initial Saybolt colour at point of manufacture was ≤25 and ≥15
3 if the initial Saybolt colour at point of manufacture was _15.

(3) For fuel used in civilian aviation the limit is 25.0 vol % max.

(4) In the event of a conflict between Sulphur Mercaptan and Doctor Test results, Sulphur Mercaptan shall prevail.

(5) For fuel used in civil aviation the 20°C viscosity limit is not applicable.

(6) For fuel used in civil aviation this test is not applicable.

(7) No peacock or abnormal colour deposits allowed.

(8) No requirement to report separation rating for civil aviation fuel.

(9) Test only required when fuel has been processed by Copper Treating.

(10) For fuel used in civil aviation the max limit is 0.85 mm.

(11) If it is not required to inject static dissipator additive then these test limits are not applicable. A minimum limit of 150 pS/m applies to fuel leaving the refinery.

(12) Antioxidant only required in hydroprocessed fuel at 17.0 - 24.0 mg/L.

Table 13
Russia

Issuing Agency:		State Standard Committee			
Specification:		GOST 10227-86			
Latest Revision Date:		Aug-95			Test Method
Grade Designation:		TS-1 Premium Kerosene	TS-1 Regular Kerosene	T-1 Regular Kerosene	GOST
COMPOSITION					
Appearance		C&B (1)	C&B (1)	C&B (1)	
Acidity, Total (mg KOH/100 cm^3)	Max.	0.7	0.7	0.7	5985-79
Aromatics (wt %)	Max.	22	22	20	6994-74
Iodine Number (g/100g)	Max.	2.5	3.5	2	2070-82
Sulphur, Total (wt %)	Max.	0.20	0.25	0.10	19121-73
Sulphur, Mercaptan (wt %)	Max.	0.003	0.005	---	17323-71
Hydrogen Sulphite (wt %)		Nil	Nil	Nil	17323-71
VOLATILITY					
Distillation Temperature:					2177-82
Initial BP (°C)		150	150	150	
10% Recovery (°C)	Max.	165	165	175	
50% Recovery (°C)	Max.	195	195	225	
90% Recovery (°C)	Max.	230	230	270	
98% Recovery (ºC)	Max.	250	250	280	
Flash Point (°C)	Min.	28	28	30	6356-75
Density @ 20°C (kg/m^3)	Min.	780	775	800	3900-85
FLUIDITY					
Freezing Point (°C)	Max.	-60 (2)	-60 (2)	-60 (2)	5066-91
Viscosity @ 20°C (cSt)	Min.	1.30	1.25	1.50	33-82
Viscosity @ -40ºC (cSt)	Max.	8	8	16	33-82
COMBUSTION					
Net Heat of Comb. (kJ/kg)	Min.	43,120	42,900	42,900	11065-90 (3)
Smoke Point (mm)	Min.	25	25	20	4338-91
CORROSION					
Copper Strip (3h @ 100°C)	Max.	Pass	Pass	Pass	6321-92
THERMAL STABILITY					
Static Thermal Test @ 150ºC					
Deposit (mg/100 cm^3)	Max.	18	18	35	11802-88
CONTAMINANTS					
Ash Content (%)	Max.	0.003	0.003	0.003	1461-75
Water Soluble Acids & Alkalis		Nil	Nil	Nil (4)	6307-75
Sum of Water-Soluble Alkalines		---	---	Nil	(5)
Naphthenic Acid Soaps		Nil	Nil	Nil	21103-75
Existent Gum (mg/100 cm^3)	Max.	3	5	6	1567-83 or 8489-85
Water Reaction Interface	Max.	1	1	---	27154-86
Water Reaction Separation	Max.	1	1	---	27154-86
OTHER					
Conductivity (pS/m)		50-600 (6) (7)	50-600 (6) (7)		
ADDITIVES		(8)	(8)	(8)	

NOTES

(1) Fuel to be clear and free from suspended and settled solid matter when viewed in glass cylinder of 45-55 mm diameter.

(2) Temperature for start of crystallisation. TS-1 fuels with freezing point not above -50°C intended for use in all climatic zones except zone 11 (GOST 16350-80).In zone 11 TS-1 fuel with freezing point above -50°C may be used when ground temperature is below -30°C for 24 hours before take-off. TS-1 fuel with freezing point not above -60°C intended for use in zone 11 shall be produced as required by the consumers.

(3) In case of dispute, the heat of combustion shall be determined by GOST 21261-91.

(4) Water-soluble acids to be determined by an indicator method for T-1 fuel.

(5) Sum of water-soluble alkaline compounds to be determined according to a procedure described in the specification.

(6) Minimum conductivity limit at temperature of fuelling, maximum limit at 20°C.

(7) Conductivity is limited only for fuels containing Sigbol antistatic additive.

(8) Additives which have been qualified in accordance with established procedures may be used to improve performance characteristics of fuels.

Table 14

Russia

Issuing Agency:		State Standard Committee			
Specification:		GOST 10227-86			
Latest Revision Date:		Aug-95			Test Method
Grade Designation:		T-1S Special Kerosene	T-2 Wide-Cut Kerosene	RT Premium Kerosene	GOST
COMPOSITION					
Appearance		C&B (1)	C&B (1)	C&B (1)	
Acidity, Total (mg KOH/100 cm^3)	Max.	0.7	0.7	0.2 - 0.7	5985-79
Aromatics (wt %)	Max.	20	22	22	6994-74
Iodine Number (g/100g)	Max.	2	3.5	0.5	2070-82
Sulphur, Total (wt %)	Max.	0.10	0.25	0.10	19121-73
Sulphur, Mercaptan (wt %)	Max.	0.001	0.005	0.001	17323-71
Hydrogen Sulphite (wt %)		Nil	Nil	Nil	17323-71
VOLATILITY					
Distillation Temperature:					2177-82
Initial BP (°C)	Min.	---	60	135	
	Max.	150	---	155	
10% Recovery (°C)	Max.	175	145	175	
50% Recovery (°C)	Max.	225	195	225	
90% Recovery (°C)	Max.	270	250	270	
98% Recovery (°C)	Max.	280	280	280	
Flash Point (°C)	Min.	30	---	28	6356-75
Density @ 20°C (kg/m^3)	Min.	810	775	775	3900-85
Vapour Pressure (mm Hg)	Max.	---	100	---	1756-52
FLUIDITY					
Freezing Point (°C)	Max.	-60 (2)	-60 (2)	-55 (2)	5066-91
Viscosity @ 20°C (cSt)	Min.	1.50	1.05	1.25	33-82
Viscosity @ -40°C (cSt)	Max.	16	6	16	33-82
COMBUSTION					
Net Heat of Comb. (kJ/kg)	Min.	42,900	43,100	43,120	11065-90 (3)
Smoke Point (mm)	Min.	20	25	25	4338-91
Naphthalenes (wt %)	Max.	---	---	1.5	17749-72
Luminometer No.	Min.	---	---	50	17750-72
CORROSION					
Copper Strip (3h @ 100°C)	Max.	Pass	Pass	Pass	6321-92 (4)
THERMAL STABILITY					
Static Oxidation Test @ 150°C					11802-88
Deposit (mg/100 cm^3)	Max.	6	18	6	
Soluble Gum (mg/100cm^3)	Max.	---	---	30	
Insoluble Gum (mg/100cm^3)	Max.	---	---	3	
Dynamic Test @ 150-180°C, 5h					17751-79 (5)
Filter ΔP (kPa)	Max.	---	---	10	
Heater Deposit, Number	Max.	---	---	2	
CONTAMINANTS					
Ash Content (%)	Max.	0.003	0.003	0.003	1461-75
Water Soluble Acids & Alkalis		Nil	Nil	Nil	6307-75
Sum of Water-Soluble Alkalis		Nil	Nil	---	(6)
Naphthenic Acid Soaps		Nil	Nil	---	21103-75
Existent Gum (mg/100 cm^3)	Max.	6	5	4	1567-83 or 8489-85
Water Reaction Interface	Max.	---	---	1	27154-86
Water Reaction Separation	Max.	---	---	1	27154-86
OTHER					
Conductivity (pS/m)		---	50-600 (7) (8)	50-600 (7) (8)	25950-83
ADDITIVES		(9)	(9)	(9)	

NOTES

(1) Fuel to be clear and free from suspended and settled solid matter when viewed in glass cylinder of 45-55 mm diameter.

(2) Temperature for start of crystallisation. T-2 and RT fuels with freezing point not above -50°C intended for use in all climatic zones except zone 11 (GOST 16350-80). In zone 11 RT fuel with freezing point above -50°C may be used when ground temperature is below -30°C for 24 hours before take-off. RT fuel with freezing point not above -55°C intended for use in zone 11 shall be produced as required by the consumers.

(3) In case of dispute, the heat of combustion shall be determined by GOST 21261-91.

(4) Colour change and separate spots of the same colour on a plate permitted for RT fuel with additives.

(5) For RT fuel, 100 dm3 of sample to be taken in containers made of galvanised iron, aluminium or stainless steel.

(6) Sum of water-soluble alkaline compounds to be determined according to a procedure described in the specification.

(7) Minimum conductivity limit at temperature of fuelling, maximum limit at 20°C.

(8) Conductivity is limited only for fuels containing Sigbol antistatic additive.

(9) Additives which have been qualified in accordance with established procedures may be used to improve performance characteristics of fuels.

Table 15
Russia

Issuing Agency:		**Federal Agency on Technical Regulation & Metrology**	
Specification:		**GOST R 52050-2006**	
Latest Revision Date:		**1-Jan-07**	**Test Methods**
Grade Designation:		**Jet A-1 Kerosene**	**ASTM / IP / GOST**
COMPOSITION			
Appearance		C&B (1)	Visual
Colour, Saybolt		Report (2)	D156, D6045
Acidity, Total (mg KOH/g)	Max.	0.10	D3242, IP 354
Aromatics (vol %)	Max.	25.0	D1319, IP 156, GOST R 52063
Sulphur, Total (wt %)	Max.	0.25	D1266, D1552, D2622, D4294, D5453, IP107, IP 243, IP 336, IP 373, IP 447, GOST R 51947, GOST R 51859
Sulphur, Mercaptan (wt %)	Max.	0.0030 (3)	D3227, IP 342, GOST R 52030
OR Doctor Test		Negative (3)	D4952, IP 30
VOLATILITY			
Distillation Temperature:			D86, IP 123
10% Recovery (°C)	Max.	205.0	
50% Recovery (°C)		Report	
90% Recovery (°C)		Report	
Final BP (°C)	Max.	300.0	
Distillation Residue (vol %)	Max.	1.5	
Distillation Loss (vol %)	Max.	1.5	
Flash Point (°C)	Min.	38.0	D56 (4), D3828, IP170
Density @ 15°C (kg/m^3)		775.0 - 840.0	D1298, D4052, IP 160, IP 365, GOST R 51069
FLUIDITY			
Freezing Point (°C)	Max.	-47.0 (5)	D2386, D5972, D 7153, IP 16, IP 435, IP 529
Viscosity @ -20°C (cSt)	Max.	8	D445, IP 71
COMBUSTION			
Net Heat of Combustion (MJ/kg)	Min.	42.80 (6)	D3338, D4529, D4809, IP 12, IP 355
Smoke Point (mm)	Min.	25	D1322, IP 57
OR Smoke Point (mm)	Min.	19	D1322, IP57
AND Naphthalenes (vol %)	Max.	3	D1840
CORROSION			
Copper Strip (2h @ 100°C)	Max.	No.1	D130, IP 154
THERMAL STABILITY			
JFTOT ΔP @ 260ºC (mm Hg)	Max.	25	D3241, IP 123
Tube Rating (Visual)	Max.	<3 (7)	
CONTAMINANTS			
Existent Gum (mg/100 cm^3)	Max.	7 (8)	D381, IP 131
Water Reaction Interface Rating	Max.	1b	D1094
MSEP Rating			D3948
Fuel without SDA	Min.	85	
Fuel with SDA	Min.	70	
Particulates (mg/dm^3)	Max.	1.0 (2)	D5452, IP423
OTHER			
Conductivity (pS/m)		50-600	D2624, IP 274, GOST 25950
Without SDA	Max.	10	
BOCLE Wear Scar Diameter (mm)	Max.	0.85 (9)	D5001
ADDITIVES			
Antioxidant		Optional (24 mg/L max)	
Static Dissipator		Optional (10)	
Lubricity Improver		Optional (11)	

NOTES

(1) Fuel should be clear, bright and visually free from solid matter & undissolved water at ambient air temperature.
(2) Applies at point of manufacture.
(3) In the event of a conflict between Sulphur Mercaptan and Doctor Test results, Sulphur Mercaptan shall prevail.
(4) When testing by method D 56, a minimum Flash Point of 40ºC applies.
(5) Lower freezing point may be agreed between customer & producer.
(6) When determining the Net Heat of Combustion by ASTM D4529, use equation 1 or Table 1, and when using D3338, use equation 2.
(7) No peacock or abnormal colour deposits allowed.
(8) Air can be used instead of steam as the vaporising agent.
(9) Applies at point of manufacture if fuel contains >95 % hydroprocessed material of which >20% has been severely hydroprocessed.
(10) Maximum initial doping is 3 mg/L. Upon redoping the fuel, the maximum allowed cumulative concentration is 5 mg/L.
(11) Hitec 580 may be injected at 15 - 23 mg/L.

Table 16
Spain

Issuing Agency:		Instituto Nacional de Tecnica Aerospacial	
Specification:		Norma INTA 15 13 17 N	
Latest Revision Date:		Nov-92	Test Method
Grade Designation:		Jet A-1 Kerosene	INTA
COMPOSITION			
Appearance		C&B (1)	
Acidity, Total (mg KOH/g)	Max.	0.015	15 04 52
Aromatics (vol %)	Max.	22.0 (1)	15 04 27B
Olefins (vol %)	Max.	5.0	15 04 27B
Sulphur, Total (wt %)	Max.	0.30	15 04 36B, 15 06 21A
Sulphur, Mercaptan (wt %) (3)	Max.	0.0020	15 04 45C
OR Doctor Test		Negative	15 04 43B
VOLATILITY			
Distillation Temperature: (4)			15 02 27E
Initial BP (°C)		Report	
10% Recovery (°C)	Max.	205	
50% Recovery (°C)		Report	
90% Recovery (°C)		Report	
Final BP (°C)	Max.	300	
Distillation Residue (vol %)	Max.	1.5	
Distillation Loss (vol %)	Max.	1.5	
Flash Point (°C)	Min.	38	15 02 33C, 15 02 32B (5), 15 02 17B
Density @ 15°C (kg/m^3)		775 - 840	15 02 13A
FLUIDITY			
Freezing Point (°C)	Max.	-47	15 02 64A
Viscosity @ -20°C (cSt)	Max.	8	15 02 16B
COMBUSTION			
Net Heat of Combustion (MJ/kg) (6)	Min.	42.8	15 01 53, 15 01 52, 15 02 29C
Luminometer Number	Min.	45	15 06 15
OR Smoke Point (mm)	Min.	25	15 06 14B
OR Smoke Point (mm)	Min.	19	15 06 14B
AND Naphthalenes (vol %)	Max.	3.0	15 05 55
CORROSION			
Copper Strip (2h @ 100°C)	Max.	1b	15 04 42C
Silver Strip (4h @ 50°C)	Max.	1	15 04 21B
THERMAL STABILITY			
JFTOT ΔP @ 260ºC (mm Hg)	Max.	25	15 06 23A
Tube Deposit Rating (Tuberator)	Max.	<3 (7)	
OR Tube Deposit Rating (Evaluator Mark 8A)	Max.	15 (7)	
CONTAMINANTS			
Existent Gum (mg/100 mL)	Max.	7	15 04 35C
Water Reaction			
Interface Rating	Max.	1b	15 02 47E
Separation Rating	Max.	2	
MSEP Rating	Min.	85 (8)	15 02 57B, 15 06 25
OTHER			
Conductivity (pS/m)		50 - 450	15 02 99B
ADDITIVES			
Antioxidant		Option (9)	
Metal Deactivator		Option	
Corrosion Inhibitor		Option	
Static Dissipator		Required	
Anti-Icing		Option	

NOTES

(1) Fuel shall be clear, bright and free from suspended material and undissolved water at 21ºC or at the ambient temperature (if it is more than 21ºC).

(2) The max limit is increased to 25.0 vol % if the hydrogen content by method INTA 15 05 66 or INTA 15 02 74 is measured.

(3) The Mercaptan Sulphur Test can be omitted if the 'Doctor Test' gives a negative or 'sweet' result.

(4) The conditions for this test are given in Group 4 of Table 1 of the test method. The temperature of the condenser must be between 0 - 4°C. The thermometer readings must be corrected to 760 mm Hg.

(5) Results obtained by method INTA 15 02 32B have a limit of 40ºC min.

(6) The Net Heat of Combustion Test can be omitted if the density of the fuel, expressed in API (INTA 15 04 43 B), at its aniline point expressed in degrees F (INTA 15 02 48 B), is equal or superior to 4,800.

(7) No peacock or abnormal colour deposits allowed. In cases of dispute the tube rating shall be determined using the "Tuberator".

(8) Limit applies to fuel that does not contain additives (except for antioxidant). For fuel containing static dissipator additive, icing inhibitor or corrosion inhibitor, a minimum MSEP rating of 70 applies. When static dissipator additive and corrosion inhibitor are present there is no limit.

(9) Must be added to hydroprocessed fuel at 17.0 - 24.0 mg/L. May be added to non-hydroprocessed fuel up to 24.0 mg/L

Table 17
Sweden

Issuing Agency:		**Swedish Defence Materiel Administration**	
Specification:		**FSD 8607 E**	
Latest Revision Date:		**10-Feb-95**	
Grade Designation:		**Flygfotogen 75 Kerosene**	**Test Method**
COMPOSITION			
Appearance		C&B (1)	Visual
Colour		Report	ASTM D156
Acidity, Total (mg KOH/g)	Max.	0.015	ASTM D3242
Aromatics (vol %)	Max.	25	ASTM D1319, IP 391
Olefins (vol %)	Max.	5	ASTM D1319, D1159
Sulphur, Total (wt %)	Max.	0.10	ASTM D129, D1266, D2622, IP243
Sulphur Mercaptan, Doctor Test		Negative	ASTM D4952
VOLATILITY			
Distillation Temperature:			SIS 15 51 46 (ISO 3405), ASTM D86
Initial BP (°C)		Report	
10% Recovery (°C)	Max.	205	
20% Recovery (°C)		Report	
50% Recovery (°C)		Report	
90% Recovery (°C)		Report	
Final BP (°C)	Max.	300	
Distillation Residue (vol %)	Max.	1.5	
Distillation Loss (vol %)	Max.	1.5	
Flash Point (°C)	Min.	38	ASTM D93, D3828
Density @ 15°C (kg/m^3)		775-840	ASTM D287, D4052
FLUIDITY			
Freezing Point (°C)	Max.	-50	ASTM 2386
Viscosity @ -20°C (cSt)	Max.	8	SS 02 35 10 (ISO 3104), ASTM D445
COMBUSTION			
Net Heat of Comb. (MJ/kg)	Min.	42.8	SIS 15 51 55 (ISO 3648), ASTM D3338
Smoke Point (mm)	Min.	19	ASTM D1322
AND Naphthalenes (vol %)	Max.	3.0	ASTM D1840
Hydrogen Content (wt %)	Min.	13.4	ASTM D3343
CORROSION			
Copper Strip (2h @ 100°C)	Max.	1b	SS-ISO 2160, ASTM D130
Silver Strip (4h @ 50°C)	Max.	1	IP227
THERMAL STABILITY			
JFTOT ΔP @ 260ºC (mm Hg)	Max.	25	ASTM D3241
Tube Deposit Rating (Visual)	Max.	2 (2)	
CONTAMINANTS			
Existent Gum (mg/100 mL)	Max.	7	ASTM D381
Particulates (mg/l)	Max.	1	MIL-T-83133, App A
Filtration Time (min)	Max.	15	MIL-T-83133, App A
Water Reaction Interface	Max.	1b	ASTM D1094
MSEP Rating	Min.	70 (3)	ASTM D3948
OTHER			
Conductivity (pS/m)		200-600	ASTM D2624
ADDITIVES			
Antioxidant		Required (4)	IP 343
Corrosion Inhibitor		Required (5)	
Static Dissipator		Required (6)	

NOTES

(1) Clear, bright and free of undissolved water.
(2) No abnormal or peacock colour deposits allowed.
(3) Limit is valid for fuel containing all additives, except static dissipater additive.
(4) Antioxidant in accordance with MIL-T-83133 required at 17-24mg/L.
(5) Corrosion inhibitor/lubricity improver Hitec 580 required at 15-22.5 mg/L.
(6) Static dissipater additive in accordance with MIL-T-83133 required.

Table 18

United Kingdom

Issuing Agency:		Ministry of Defence (Defence Procurement Agency)			
Specification:		Def Stan 91-86/5-2	Def Stan 91-88/3-2	Def-Stan 91-91/5-2	
Latest Revision Date:		22 June 2007	22 June 2007	9 March 2007	
Grade Designation:		AVCAT/FSII High Flash Kerosene	AVTAG/FSII Wide-Cut Kerosene	AVTUR Jet A-1 Kerosene	Test Method
NATO Code No.		F-44	F-40	F-35 (1)	ASTM/IP
COMPOSITION					
Appearance		C&B (2)	C&B (2)	C&B (2)	Visual or D4176 (procedure 1)
Colour, Saybolt		Report (3)	Report (3)	Report (3)	D156, D6045 (91/88)
Acidity, Total (mg KOH/g)	Max.	0.015	0.015	0.015	D3242, IP 354
Aromatics (vol %)	Max.	25.0	25.0	25.0	D1319, IP 156
OR Total Aromatics (vol %) (4)	Max.	26.5	26.5	26.5	D6379, IP 436
Sulphur, Total (wt %)	Max.	0.20	0.30	0.30	IP 107, IP 243, IP 336, IP 373, IP 447, D1266 (5), D1552, D2622, D4294, D5453
Sulphur, Mercaptan (wt %)	Max.	0.0030	0.0030	0.0030	D3227, IP 342
OR Doctor Test (6)		Negative	Negative	Negative	D 4952, IP 30
Hydroprocessed Components (vol %)		Report	Report	Report	
Severely Hydroprocessed Comp. (vol %)		Report (7)	Report (7)	Report (7)	
VOLATILITY					
Distillation Temperature:					D86 (8) , IP 123 (8), IP 406 (9)
Initial BP (°C)		Report	Report	Report	
10% Recovery (°C)	Max.	205.0	Report	205.0	
20% Recovery (°C)	Min.	---	100.0	---	
50% Recovery (°C)	Min.	Report	125.0	Report	
90% Recovery (°C)		Report	Report	Report	
Final BP (°C)	Max.	300.0	270.0	300.0	
Distillation Residue (vol %)	Max.	1.5	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	1.5	
Flash Point (°C)	Min.	61.0	---	38.0 (10)	D56, D93, IP 34, IP 170, IP 523 (11)
Density @ 15°C (kg/m^3)		788.0 - 845.0	751.0 - 802.0	775.0 - 840.0	D1298, D4052, IP 365, IP 160
Vapour Pressure @ 37.8°C (kPa)		---	14.0 - 21.0	---	D323, D5190, D5191, IP 69, IP 394 (12)
FLUIDITY					
Freezing Point (°C)	Max.	-46.0	-58.0	-47.0	D2386, D5972, D7153, IP 16, IP 435, IP 528, IP 529 (13)
Viscosity @ -20°C (cSt)	Max.	8.800	---	8.000	D445, IP 71
COMBUSTION					
Net Heat of Comb. (MJ/kg)	Min.	42.60	42.80	42.80	D3338, D4809, IP 12, IP 355 (14)
Smoke Point (mm)	Min.	25.0	25.0	25.0	D1322, IP 57
OR Smoke Point (mm)	Min.	19.0	19.0	19.0	D1322, IP 57
AND Naphthalenes (vol %)	Max.	3.00	3.00	3.00	D1840
CORROSION					
Copper Strip (2h @ 100°C)	Max.	1	1	1	D130, IP 154
THERMAL STABILITY					
JFTOT ΔP @ 260°C (mm Hg)	Max.	25	25	25	D3241, IP 323 (15)
Tube Deposit Rating (Visual)	Max.	<3 (16)	<3 (16)	<3 (16)	
CONTAMINANTS					
Particulates (mg/l)	Max.	1.0 (17)	1.0 (17)	1.0 (17)	D5452, IP 423
Existent Gum (mg/100 mL)	Max.	7	7	7	IP 540
MSEP Rating (18)					
Without SDA	Min.	85 (19)	85 (19)	85	D3948
With SDA	Min.	---	70	70	
OTHER					
Conductivity (pS/m)		---	50 - 600 (20)	50 - 600 (20)	D2624, IP 274
BOCLE Wear Scar Diameter (mm)	Max.	---	---	0.85 (21)	D5001
ADDITIVES					
Anti-icing (vol %)		0.12 - 0.15	0.10 - 0.15	Agreement (22)	D5006, IP 424
Antioxidant		Option (23)	Option (23)	Option (23)	
Corrosion Inhibitor		Required (24)	Required (24)	Option (24)	
Metal Deactivator		Option (25)	Option (25)	Option (25)	
Static Dissipator		---	Required (26)	Required (26)	
Leak Detection Additive		---	---	Option (27)	

Table 18
United Kingdom

NOTES

(1) F-35 fuel plus specified additives is denoted as F-34. Refer to Def Stan 91-87 specification for details of F-34.

(2) Fuel should be clear, bright and visually free from solid matter and undissolved water at ambient temperature.

(3) 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.

(4) Round robin testing has demonstrated the correlation between total aromatics content measured by IP 156 / D1319 and IP 436 / 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.

(5) D1266 is not listed as an alternative method in Def Stan 91-88/3-2.

(6) In the event of a conflict between the Sulphur Mercaptan and the Doctor Test results, the Sulphur Mercaptan requirement shall prevail.

(7) 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.

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

(9) IP 406 is not listed as an alternative method in Def Stan 91-88/3-2. 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.

(10) Def Stan 91-91/5-2 only: subject to a minimum of 40°C, results obtained by Tag method ASTM D56 may be accepted at the discretion of the responsible technical and supervising authority.

(11) D56 and IP 170 are not quoted as alternative methods in Def Stan 91-86/5-2. D93 and IP 34 are not quoted as alternative methods in Def Stan 91-91/5-2.

(12) For IP 394 results shall be reported as Dry Vapour Pressure Equivalent.

(13) D7153 is not quoted as an alternative method in Def Stan 91-86/5-2. D7153, IP 528 and IP 529 are not quoted as alternative methods in Def Stan 91-88/3-2.

(14) IP355 is not quoted as an alternative method in Def Stan 91-88/3-2. Where a measurement of Specific Energy is deemed necessary, the method to be used shall be agreed between the Purchaser & Supplier.

(15) Thermal Stability is a critical aviation fuel test and while competetion 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.

(16) 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. No 'peacock' or 'abnormal' colour deposits should be present.

(17) Applies only at point of manufacture. Refer to the information on Particulate Contamination in relevant Annex of specification.

(18) Specification applies at point of manufacture. 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 the rejection of a fuel.

(19) Specification applies at point of manufacture before addition of Lubricity Improver Additive (and Icing Inhibitor Additive in the case of Def Stan 91-88/3-2).

(20) 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 (or 91-88) except for electrical conductivity". Due to the high flow rates and very fine filtration used when fuelling aircraft, it is absolutely essential that these conductivity limits are met at the point of delivery into aircraft.

(21) Applies at point of manufacture only to fuels containing more than 95% hydroprocessed material and where at least 20% of this is severely hydroprocessed (see Note 7) and for all fuels containing synthetic components.

(22) To make F-34 according to Def Stan 91-87, Icing Inhibitor additive must be added to F-35 at a concentration of 0.10 - 0.15 vol %. Corrosion Inhibitor/Lubricity Improver additive must also be added (see note 24).

(23) Required for a fuel (or component) which has been hydroprocessed. Hydroprocessed components shall be treated at 17.0 - 24.0 mg/L while non-hydroprocessed components may be treated at up to 24.0 mg/L.

(24) Additive of type and concentration detailed in QPL 68-251. For F-35, corrosion inhibitor may be added. In civil use additives other than those detailed in QPL 68-251 may be used provided that they have been adequately approved in accordance with the certifying authorities and the appropriate aircraft and engine manufacturer.

(25) A metal deactivator additive (as detailed in the corresponding Def Stan) 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 is determined before and after MDA addition and reported on the test certificate. The maximum initial doping is 2.0 mg/L and the cumulative addition when re-doping must not exceed 5.7 mg/L.

(26) Concentration of SDA on first doping of fuel is 3.0 mg/L max. Cumulative concentration allowed when re-doping fuel is 5.0 mg/L max.

(27) A leak detection additive (as detailed in Def Stan 91-91) may be added to the fuel to assist in detecting and locating leaks in ground based fuel storage, delivery and dispensing systems. The concentration shall not exceed 1.0 mg/kg.

Particle Counting test methods are being developed by the Energy Institute and it is the Specification Authority's intent to incorporate a particle counting requirement into the forthcoming Issue 6 of Def Stan 91-91 in early 2008. Initially this will be a report only requirement at point of manufacture in order to gather sufficient field data to assist in setting a specification limit in future issues of Def Stan 91-91. It is also likely that the particle counting requirement will be extended to locations downstream of the point of manufacture in future issues of Def Stan 91-91.

Table 19

USA

Issuing Agency:		ASTM International		
Specification:		D1655-07	D6615-06	
Latest Revision Date:		1 July 2007	1 May 2006	Test Method
Grade Designation:		Jet A/A-1 Kerosene (1)	Jet B Wide-Cut Kerosene	ASTM
COMPOSITION				
Appearance		C&B (2)	C&B (2)	
Acidity, Total (mg KOH/g)	Max.	0.10	---	D3242
Aromatics (vol %)	Max.	25	25	D1319
OR Aromatics by HPLC	Max.	26.5	26.5	D6379
Sulphur, Total (wt %)	Max.	0.30	0.30	D1266, D2622, D4294, D5453
Sulphur, Mercaptan (wt %)	Max.	0.003	0.003	D3227
OR Doctor Test (3)		Negative	Negative	D4952
VOLATILITY				
Distillation Temperature:				D86, D2887 (4)
10% Recovery (°C)	Max.	205 (185)	---	
20% Recovery (ºC)		--- (---)	90 - 145	
50% Recovery (°C)		Report (Report)	110 - 190	
90% Recovery (°C)	Max.	Report (Report)	245	
Final BP (°C)	Max.	300 (340)	---	
Distillation Residue (vol %)	Max.	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	
Flash Point (°C)	Min.	38 (5)	---	D56, D3828 (6)
Density @ 15°C (kg/m^3)		775 - 840	751 - 802	D1298, D4052
Vapour Pressure @ 38ºC (kPa)		---	14 - 21	D323, D5191
FLUIDITY				
Freezing Point (°C)	Max.	-40 Jet A (7) -47 Jet A-1 (7)	-50 (7)	D2386, D4305 (Jet B) (8), D5901 (Jet B), D5972 (9), D7153 (Jet A/A-1), D7154 (Jet A/A-1) (10)
Viscosity @ -20°C (cSt)	Max.	8.0	---	D445
COMBUSTION				
Net Heat of Combustion (MJ/kg)	Min.	42.8	42.8	D3338, D4529, D4809 (11)
Smoke Point (mm)	Min.	25	25	D1322
OR Smoke Point (mm)	Min.	18	18	D1322
AND Naphthalenes (vol %)	Max.	3.0	3.0	D1840
CORROSION				
Copper Strip (2h @ 100°C)	Max.	No. 1	No. 1	D130
THERMAL STABILITY				
JFTOT ΔP @260°C (mm Hg)	Max.	25	25 (12)	D3241
Tube Deposit Rating (Visual)	Max.	<3 (13)	<3 (13)	
CONTAMINANTS				
Existent Gum (mg/100 mL)	Max.	7	7	D381 (14), IP540 (Jet A/A-1)
MSEP Rating (15)				D3948
Without SDA	Min.	85	85	
With SDA	Min.	70	70	
OTHER				
Conductivity (pS/m)		50 - 600 (16)	50 - 450 (16)	D2624
ADDITIVES				
Anti-icing (vol %)		Agreement (17)	Agreement (17)	D5006
Antioxidant		Option	Option	
Corrosion Inhibitor		Agreement	Agreement	
Leak Detector		Option	Option	
Metal Deactivator		Option	Option	
Static Dissipator		Option (18)	Option (18)	

NOTES

(1) Jet A-1 and Jet A are identical in all properties except Freezing Point.
(2) Fuel shall be visually free of undissolved water, sediment and suspended matter.
(3) The mercaptan sulphur determination may be waived if the fuel is considered sweet by the doctor test.
(4) In D1655 simulated distillation by D2887 can be used as an alternative to D86 (test limits for D2887 quoted in parentheses).
(5) A higher specification can be agreed between purchaser & supplier.
(6) Results obtained by method D3828 may be may be up to 2°C lower than those obtained by method D56.
(7) Other Freezing Points may be agreed between purchaser & supplier.
(8) With method D4305, use procedure A only. This method shall not be used on samples with viscosities greater than 5.0 cSt at -20°C.
(9) D5972 may produce a higher result than D2386 on wide-cut fuels.
(10) D2386 is the referee method for Jet B; D5972 & D7153 are referee methods for Jet A/A-1.
(11) Use either Equation 1 or Table 1 in D4529 or Equation 2 in D3338.
(12) Test at control temperature of 260°C, but if requirements are not met, the test may be conducted at 245°C. In this case report results at both temperatures.
(13) No abnormal or peacock colour deposits allowed.
(14) D381 using the steam jet is the referee method for Jet A/A-1
(15) Limits apply only at point of manufacture.
(16) If SDA is used, the conductivity shall be <600 pS/m for Jet A/A-1 or <450 pS/m for Jet B at point of use of the fuel. When SDA is specified by the purchaser, conductivity shall be 50 - 600 pS/m for Jet A/A-1 or 50 - 450 pS/m for Jet B under the conditions at point of delivery.
(17) DiEGME additive conforming to requirements of D4171, Type III, may be used at 0.10 - 0.15 vol % concentration.
(18) The initial doping of Stadis 450 additive is limited to 3 mg/L max. The cumulative limit after re-doping is 5 mg/L max.

Table 20
Engine Manufacturer's Requirements

Issuing Agency:			General Electric		
Specification:			D50TF2-S15		
Latest Revision Date:			9-Feb-05		Test Method
Grade Designation:		Class A/C Kerosene (1)	Class B Wide-Cut Kerosene	Class D High Flash Kerosene	ASTM
COMPOSITION					
Appearance		C&B (2)	C&B (2)	C&B (2)	
Acidity, Total (mg KOH/g)	Max.	0.1	---	0.1	D3242
Aromatics (vol %)	Max.	25	25	25	D1319
Sulphur, Total (wt %)	Max.	0.30	0.40	0.40	D1266, D1552, D2622, D4294, D5453,
Sulphur, Mercaptan (wt %)	Max.	0.003	0.005	0.003	D3227 (3)
OR Doctor Test		Negative	Negative	Negative	D4952
VOLATILITY					
Distillation Temperature:					D86
10% Recovery (°C)	Max.	205	Report	205	
20% Recovery (°C)	Max.	---	90-145	Report	
50% Recovery (°C)	Max.	Report	110-190	Report	
90% Recovery (°C)	Max.	Report	245	Report	
Final BP (°C)	Max.	300	---	300	
Distillation Residue (vol %)	Max.	1.5	1.5	1.5	
Distillation Loss (vol %)	Max.	1.5	1.5	1.5	
Flash Point (°C)	Min.	38	---	60	D56, D3828
Density @ 15.6°C (kg/m^3)		775-840	751-802	788-845	D1298, D4052
Vapour Pressure @ 38°C (kPa)	Max.	---	21	---	D323, D5191
FLUIDITY					
Freezing Point (°C)	Max.	(1)	-50	-46	D2386, D5972
Viscosity @ -20°C (cSt)	Max.	8.0	---	8.5	D445
COMBUSTION					
Net Heat of Comb. (MJ/kg)	Min.	42.8	42.8	42.6	D3338, D4529, D4809
Smoke Point (mm)	Min.	25	25	25	D1322
OR Smoke Point (mm)	Min.	18	18	18	D1322
AND Naphthalenes (vol %)	Max.	3.0	3.0	3.0	D1840
CORROSION					
Copper Strip (2h @ 100°C)	Max.	1	1	1	D130
THERMAL STABILITY					
JFTOT ΔP @ 260°C (mm Hg)	Max.	25 (4)	25 (4)	25 (4)	D3241
Tube Deposit Rating (Visual)	Max.	<3 (5)	<3 (5)	<3 (5)	
CONTAMINANTS (6)					
Existent Gum (mg/100 mL)	Max.	7	7	7	D381
Water Reaction Interface	Max.	1b	1b	1b	D1094
ADDITIVES (7)					
Anti-icing (vol %)	Max.	0.15	---	0.20	
Antioxidant	Max.	24.0	24.0	24.0	
Corrosion Inhibitor		(8)	(8)	(8)	
Metal Deactivator		5.7	5.7	5.7	
Static Dissipator		(9)	(9)	(9)	
Biocide		(8)	(8)	(8)	
Thermal Stability Improver		(8)	(8)	(8)	
Leak Detection (mg/kg)	Max.	1.0	1.0	---	

NOTES

(1) Class A and Class C requirements are equivalent except for freezing point. Class A fuel has a freezing point of -40°C while Class C fuel has a freezing point of -47°C.

(2) Fuel shall contain no visible free water, sediment or suspended matter.

(3) The mercaptan sulfur determination may be waived if the fuel is considered 'sweet' by the Doctor test.

(4) ASTM D3241 test (JFTOT) shall be conducted for 2.5 hours at a control temperature of 260°C.

(5) Tube deposits shall always be reported by the visual method. If the deposit includes peacock (rainbow) colours, rate these as code 'P'. Fuels that produce peacock colours fail to meet the thermal stability requirements.

(6) ASTM D3948 is applicable at point of manufacture. The Microseparometer rating (without electrical conductivity additive) must have a minimum value of 85. The Microseparometer rating (with electrical conductivity additive) must have a minimum value of 70.

(7) Use of additives is optional, but when used, must be declared by the supplier. Table II in the specification contains a list of approved additives.

(8) Refer to Table II in the specification for specific additive concentrations.

(9) Stadis 450, maximum concentration at initial doping is 3.0 ppm and cumulative 5.0 ppm upon redoping.

Table 21

Engine Manufacturer's Requirements

Issuing Agency:		Pratt & Whitney	Pratt & Whitney Canada		
Specification:		SB No.2016	CPW 204	CPW 46	
Latest Revision Date:		23 February 2007 (Revision 29)	27 July 2000 (Revision B)	27 July 2000 (Revision F)	Test Method
Grade Designation:		Wide-Cut Kerosene	Wide-Cut Kerosene	Arctic Kerosene	ASTM
COMPOSITION					
Appearance		C&B (1)	C&B (1)	C&B (1)	
Acidity, Total (mg KOH/g)	Max.	0.10	---	---	D3242
Aromatics (vol %)	Max.	25	25	20	D1319
Sulphur, Total (wt %)	Max.	0.30	0.4	1.0	D1266, D1552, D2622, D4294, D5453
Sulphur, Mercaptan (wt %)	Max.	0.005	0.005	0.005	D3227
OR Doctor Test		Negative	Negative	Negative	D4952
VOLATILITY					
Distillation Temperature:					D86
10% Recovery (°C)	Max.	205	205	---	
50% Recovery (°C)	Max.	232	232	Report	
90% Recovery (°C)	Max.	Report	---	315.6	
Final BP (°C)	Max.	300	300	338.0	
Distillation Residue (vol %)	Max.	1.5	1.5	---	
Distillation Loss (vol %)	Max.	1.5	1.5	---	
Gravity, API @ 15°C		37 - 57	37-57	37-57	D287, D1298, D4052
OR Density @ 15°C (kg/L)		0.775 - 0.840	0.75 - 0.84	0.75 - 0.84	
Vapour Pressure @ 38°C (psi)	Max.	3 (2)	3	---	D323
Freezing Point (°C)	Max.	-40 (3)	-40	---	D2386, D5972 (4)
Pour Point (°C)	Max.	---	---	-40	D97
Cloud Point (°C)	Max.	---	---	-34.4	D2500
Viscosity (c St)		8.5 max @ -20°C	16.5 max @ -34.4°C	1.4 min @ 37.8°C	D445
COMBUSTION					
Net Heat of Comb. (MJ/kg)	Min.	42.8	42.6	42.8	D240, D1405, D2382, D3338, D4529, D4809 (5)
Luminometer No.	Min.	---	45	---	D1740
OR Smoke Point (mm)	Min.	25	25	---	D1322
OR Smoke Point (mm)	Min.	18	20	---	D1322
AND Naphthalenes (vol %)	Max.	3	3	---	D1840
CORROSION					
Copper Strip (2h @ 100°C)	Max.	No. 1	1b	1	D130
THERMAL STABILITY					
JFTOT ΔP @ 260°C (mm Hg)	Max.	25	25.4 (6)	25.4 (6)	D3241
Tube Deposit Rating (Visual)	Max.	<3	<3	<3	
Potential Gum (mg/100mL)	Max.	---	---	14.0	D873
Carbon Residue (10% btm), %	Max.	---	---	0.2	D524
CONTAMINANTS					
Existent Gum (mg/100 mL)	Max.	7	---	---	D381
Ash (wt %)	Max.	---	---	0.01	D482
Water Reaction, Interface Rating	Max.	---	1b	1b	D1094
Water Reaction, Vol. Change (mL)	Max.	---	1	1	D1094
ADDITIVES					
Anti-icing (vol %)		Option (7)	Option	Option	
Antioxidant		Option (8)	Option	Option	
Corr. Inhibitor/Lubricity Improver		Option (9)	Option	Option	
Metal Deactivator		Option (10)	Option	Option	
Static Dissipator		Option (11)	---	---	
Biocide		Option (12)	---	---	
Thermal Stability Improver		Option (13)	Option	Option	
Leak Detection		Option (14)	---	---	

NOTES

(1) Fuel shall be free from water, sediment and suspended matter. Odour shall not be nauseating or irritating.

(2) Wide-cut fuels characterized by a Reid Vapour Pressure in the range 2.0 - 3.0 psi, at 38°C or a Flash Point less than 28°C, are not acceptable for use in some Pratt & Whitney engines (see SB 2016 for details). These engines require a Reid Vapour Pressure of <2.0psi, at 38°C.

(3) SB 2016: the fuel freezing point shall be no higher than the limit shown in the table. The freezing point shall be at least 3°C below the minimum engine fuel inlet temperature as measured by D5972.

(4) CPW 204 does not quote D5972 as an alternative method.

(5) SB 2016 does not quote D240, D1405 & D2382 as alternative methods.

(6) If test at 260°C fails, repeat at 245°C. Report results of both tests.

(7) DiEGME conforming to Mil-DTL-85470 at 0.15 vol.% max.; Russian Additive "I" (EGME) at 0.15 vol.% max.; Russian Additive "I-M" (50/50 blend of "I" with methyl alcohol) at 0.15 vol.% max.

(8) Required in hydrotreated fuels. Not to exceed 24 mg/L in any fuel.

(9) Refer to QPL 25017 for a list of approved additives.

(10) There is only one approved additive chemistry - see SB 2016 for details

(11) Octel Stadis 450 at 3.0 mg'kg max. and Russian Additive "Sigbol" at 3.0 mg/kg max. are approved to increase electrical conductivity to a range of 150-600 pS/m at point of injection agreed by purchaser & supplier.

(12) May be used on an intermittent basis to sterilize aircraft fuel systems contaminated by microbial organisms. Approved additives are Biobor JF at 270 mg/kg max and Kathon FP 1.5 at 100 mg/kg max.

(13) Approved additives are listed in SB No.2016.

(14) Tracer A at 1 ppm max may be used for purpose of detecting leaks in airport fuel distribution systems on an occasional basis.

Appendix A

Fuels and Additives - Available in Eastern Europe

The contents of this appendix were developed with guidance and review kindly provided by Peter S. Brook of Qinetiq's Fuels and Lubricants Centre. All information contained within this appendix is believed to be current as of August 31, 2007.

FUELS AND ADDITIVES AVAILABLE IN EASTERN EUROPE

Many of the names and grades of jet fuels and additives are carried over from the days of the Warsaw Pact and Russian domination.

Russian fuel grades

GOST Standard 10227-86 (see Tables 13 & 14) lists four grades of fuel, TS-1, T-1, T-2 and RT. Each has a category of quality with TS-1 having both a higher and first category, of which only the first category appears to be in use. An update of Table 1 of this specification, listing TS-1, RT and two Military fuels, T-8V and T-6, requires an antioxidant and a lubricity improver in RT, T-8V and T-6. Another amendment noted is a change in the Crystallization Point (similar to our freezing point) in TS-1 and RT to -50 °C with -60 °C and -55 °C respectively being produced by user demand.

TS-1 (TC-1) is produced by straight atmospheric distillation from a high sulphur crude, 50% being hydrotreated and blended with the remaining 50% straight run product, which may have mild caustic treatment. Although the specification lacks a dynamic thermal stability test, samples tested to Defence Standard 91-91 generally pass the JFTOT at 260 °C and all other requirements (except flash point where the minimum is 28°C). TS-1 is the most widely used fuel in Russia.

RT (PT) can be produced from straight run or hydrotreated kerosene and certain additives are included to improve its properties. This fuel has improved lubricity properties (by use of a lubricity improver) and a wider boiling range.

T-8V and T-6 to GOST 12308-89 are military supersonic fuels. T-8V is a heavier, higher flash point (45 °C), low volatility kerosine while T-6 is a very heavy, high flash (62 °C), low aromatic, hydrotreated low sulphur fuel which cannot be used in engines designed for use on ordinary kerosene.

T-1 is a straight distillation of low sulphur, high naphthalene crude. This fuel is a relatively high-density fuel with poor thermal stability and has no mercaptan sulphur limit. Its production is now very limited and may even be obsolete.

T-2 is a wide-cut Fuel very similar to JP-4, except for lower vapour pressure limits. Western wide-cut fuels could fail to satisfy the aromatic and sulphur limit of T-2. Again this fuel may now be obsolete and is not found at International Airports.

The new Russian Jet A-1 specification GOST R 52050 (see Table 15) became available from January 2004 at some international gateway airports. The specification is developed on the basis of ASTM D1655 and Defence Standard 91-91 and is largely equivalent to these specifications. The intention is to increase availability of this fuel at international gateway airports.

ExxonMobil Aviation gratefully acknowledges the input received from:

QinetiQ

Appendix A

Fuels and Additives - Available in Eastern Europe

FUEL GRADES AVAILABLE IN FORMER EASTERN BLOC COUNTRIES

(with local names and specifications where known)

Many of the specifications listed below are old and/or obsolete. The majority of fuel produced in these countries for use at major airports is made to either Defence Standard 91-91 (or its predecessor) or to the Joint Checklist. Local names continue to be used and are listed for information only.

COUNTRY	FUEL (SPECIFICATION)	FUEL (SPECIFICATION)	FUEL (SPECIFICATION)	FUEL (SPECIFICATION)
Bulgaria	RT (BDS 5075)	TS-1 (BDS 5075)	JFSCL (Def Stan 91-91)	
Czech and Slovak Republics	PL-5 (□SN 65 6519)	PL-6 (PND25-005-76)	PL-7 (Based on JFSCL)	
Former Yugoslavia	GM-1 (JUS B.H2.331)	GM-4 (JUS B.H2.334)		
Poland	P-3 (PN-72/C-96026)	P-2 (PN-72/C-96026)	PSM-2 (PN-72/C-96026)	ATK (BN-76/0533-01)
Romania	T-1 (STAS 5639)	TH (STAS 5639)		

Additives

Anti-Oxidants

2,6-ditertiary-butyl-4-methyl-phenol (BHT) is the most commonly used anti-oxidant. One local trade name is Agidol-1. A similar material, RDE/A/607, is an approved anti-oxidant in Def Stan 91-91. An anti-oxidant is required in RT fuel.

Anti-Static Additive

The anti-static additive available is known as SIGBOL. It is similar to the now withdrawn/obsolete Shell ASA3, but has never been in regular use. It is available upon customer request.

Lubricity Improver

The common lubricity improver is a Naphthenic Acid and is required in all RT Fuel. Since 1991, Afton's Hitec 580 is increasingly being used, but at a much higher treat rate (0.0030-0.0035% mass) than permitted in the West.

Icing Inhibitor

A number of icing inhibitors based on ethylene glycol ethyl ether (EGEE) were used (and still may be). The prime specification was GOST 8313. Local trade names include Bikanol E-1, Solvid and ethylcellosolv.

Fluid E, sometimes denoted I'-M, is an ether (perhaps ethyl cellosolve) blended with Methanol 50/50. It is believed to be similar in performance to EGME (ethylene glycol monomethyl ether). TGF is a tetrahydrofurfuryl alcohol, but is thought to be obsolete.

SPECIFIC INFORMATION ON ANTI-ICING INHIBITORS

Bikanol E-1, Western names – cellosolve, ethylene glycol ethyl ether (EGEE)

COUNTRY	POLAND	FORMER EAST GERMANY	ROMANIA	RUSSIA
Local Name	Bikanol E-1	Äthylglycol rein	Solvid	Ethylcellosolv
Specification	WT-ICSO-1983	TGL 8116	NID 4142-68	GOST-8313-76
Purity, %m	99	95	99	99
Distillation range °C	127 – 140	127 – 138	---	---
Refractive index	0.928 – 0.933	0.930 – 0.933	0.930-0.935	0.928 – 0.933
Water content (% max)	0.2	1.0	0.5	0.2
Acidity as ascetic acid (% max)	0.01	---	0.01	0.005

Fluid E (I'- M), is an Ether (perhaps an ethyl cellosolve) with Methanol 50/50. It is believed to be similar to EGME (ethylene glycol monomethyl ether).
TGF is a tetrahydrofurfuryl alcohol, but is apparently no longer used.

Appendix B

Significance of Aviation - Fuel Test Requirements

SIGNIFICANCE OF AVIATION FUEL TEST REQUIREMENTS

The significance of each of the properties that must be tested under fuel specification requirements is briefly described. The conventional test method for each property is shown, together with the minimum sample volume of fuel required by the method. This does not take into account any extra margin needed to cover handling losses or repeat determinations. Note that for a group of tests, volumes are not necessarily cumulative. The fuel from a non-destructive test, e.g. from the Appearance test, can generally be reused for a different test.

FUEL PROPERTY AND SIGNIFICANCE	TEST METHOD ASTM/IP	SAMPLE VOLUME REQUIRED FOR TEST (mL)
COMPOSITION		
Appearance is usually assessed in a qualitative pass/fail test of fuel cleanliness, to preclude free water, sediment and suspended matter.	D4176	1000
Total Acidity of combined organic and inorganic acids indicates the corrosive potential of fuel to metals. Trace organic acids can affect water separation properties.	D3242 / IP 534	100
Aromatics Content relates directly to flame radiation, carbon deposition and smoke. Also affects swelling of elastomers in the fuel system.	D1319 / IP 156 D6379 / IP 436	<1 <1
Hydrogen Content contributes to combustion cleanliness and is broadly related to Aromatics content.	D3701 / IP 338	30
Olefins are unsaturated hydrocarbons, which are potential contributors to instability in storage.	D1319 / IP 156	5
Total Sulphur (1) is controlled because sulphur oxides formed during combustion can cause corrosion of turbine metal parts.	D4294 / IP 336	20
Mercaptan Sulphur compounds are limited because they have a very unpleasant odour and attack certain elastomer materials.	D3227 / IP 342	55
Doctor Test detects the presence of reactive sulphur compounds, and is an alternative method of measuring Mercaptan Sulphur.	D4952 / IP 30	10
VOLATILITY		
Distillation curve defines the kerosene boiling range, which needs to be appropriate for balanced vaporisation of the whole fuel volume.	D86 / IP 123 D2887	100 5
Flash Point (2) is related to volatility and therefore affects combustibility. It is a leading factor determining fire safety in fuel handling.	IP 170	50
Density (3) must be known for aircraft weight loading calculations, since fuel is customarily metered by volume. Also relates to Specific Energy.	D4052 / IP 365	5
Vapour Pressure (4) is significant for wide-cut fuels. Indicates venting loss of light ends at altitude and in hot climates. A lso relates to cold starting.	D5191 IP 69	10 800
FLUIDITY		
Freezing Point (5) limits higher molecular weight hydrocarbons that crystallise at low temperatures; it therefore influences low temperature pumpability during flight.	D2386 / IP 16	30
Viscosity affects fuel pumpability over the operating temperature range, and relates to droplet size in sprays produced by burner nozzles.	D445 / IP 71	50
COMBUSTION		
Specific Energy (Net Heat of Combustion) denotes the amount of heat energy obtainable from a fuel to provide power (value is calculated).	D3338	---
Smoke Point indicates the tendency of a fuel to form soot, which is related to the type of hydrocarbons making up its composition.	D1322 / IP 57	20
Naphthalenes are polycyclic aromatics high in carbon content, exacerbating the problems of carbon formation, flame radiation and smoke.	D1840	5

Appendix B

Significance of Aviation - Fuel Test Requirements

FUEL PROPERTY AND SIGNIFICANCE		TEST METHOD ASTM/IP	SAMPLE VOLUME REQUIRED FOR TEST (mL)
CORROSION			
Copper Strip Corrosion test pass ensures that organic sulphur compounds will not corrode copper components in the fuel system.		D130 / IP 154	50
STABILITY			
Thermal Stability (JFTOT) measurements relate to the amount of deposits formed at high temperature in the engine fuel system.		D3241 / IP 323	600
CONTAMINANTS			
Existent Gum is a non-volatile residue left on evaporation of a fuel. Also serves as a check for fuel contamination within product distribution systems.		IP 540	50
Particulates such as dirt and rust are undesirable and are detected by filtration through a membrane filter.		D5452 / IP 423	5000
Filtration Time is measured by the same test procedure as Particulates.		MIL-DTL-83133E (App A)	5000
Water Reaction determines the presence of materials that react with water and affect the stability of the fuel-water interface.		D1094 / IP 289	100
Water Separation (MSEP) index rates the ability of fuel to release entrained or emulsified water when passed through a fibreglass filter coalescer.		D3948	50
OTHER			
Electrical Conductivity needs to be high enough to dissipate any electrostatic charges generated during fuel handling operations, so as to prevent fire or explosion hazards.		D2624 / IP 274	1000
Lubricity (BOCLE) refers to the effectiveness of lubricating moving parts in engine fuel system components such as pumps and control units.		D5001	50
VOLUME REQUIREMENTS FOR ALTERNATIVE TEST METHODS			
(1) **Total Sulphur**	Lamp Combustion	IP 107 / D1266	20
	Wickbold Combustion	IP 243	5
	Microcoulometry	IP 373	<1
	High Temperature Combustion	D1552	300
	X-ray Spectometry	D2622	100
	Ultraviolet Fluorescence	D5453	<1
(2) **Flash Point**	Tag Closed Cup Tester	D56	50
	Abel Closed Cup Tester	IP 170	250
(3) **Density**	Hydrometer Method	D1298 / IP 160	500
(4) **Vapour Pressure**	Reid Method	D323	800
	Automatic Method	D5190	800
	Air Saturation Vapour Pressure	IP 394	800
(5) **Freezing Point**	Setapoint Filter Flow	D4305	5
	Automated Optical Method	D5901	30
	Automatic Phase Transition	D5972	<1

NOTES

Recertification tests must be carried out on aviation fuel after transportation in non-dedicated/non segregated systems (e.g. in ocean tankers or multi-product pipelines) to verify that the quality has not changed and remains within specification limits. The following tests are required to recertify Jet A-1 fuel batches (6):

Appearance; Distillation; Flash Point; Density; Freeze Point; Copper Corrosion; Existent Gum; Water Reaction; MSEP & Conductivity (if SDA added).

These tests require a combined sample volume of 2L minimum. Test results should be compared with data from original test certificates using accepted variability limits.

(6) Requirement stipulated in JIG Guidelines for Aviation Fuel Quality Control & Operating Procedures for Jointly Operated Supply & Distribution Facilities, Issue 9, January 2004.

Appendix C
Guidance on Contamination Limits

Guidance on fuel contamination is provided by both the IATA Guidance Material 5th Edition and Defence Standard 91-91 Issue 5 (Amendment 2). Details of both documents are provided here for reference.

IATA GUIDANCE MATERIAL 5TH EDITION

The international airlines have recommended standards and test methods used to define cleanliness limits for fuels supplied into-plane. A monitoring system composed of spot and continuous testing shall be used to evaluate the quality and cleanliness of the fuel and the efficiency of the defence system. Fuel shall be sampled and tested regularly for both particulate matter and undissolved water contamination. The limits set out in the Table below are those detailed in IATA's Guidance Material for Aviation Turbine Fuels Specifications, 5th Edition, Part III – Cleanliness and Handling. The limits are intended to apply to fuels at the point of delivery into the aircraft. Two categories of contamination limits are defined – 'Notification' and 'Rejection', which determine the course of action to be followed.

The intention of the 'Notification' limit is to cause the fuel supplier to alert the airline without delay, but to continue fuelling. The airline and supplier would confer on results between 'Notification' and 'Rejection' limits to agree a course of action.

Results of tests that are above the 'Rejection' limits should also be immediately notified to the airline and fuelling terminated. Urgent action should be taken to provide fuel for the airline's use for which test results fall below the 'Rejection' limits. It is possible for the airline to release or accept delivery of stocks that by test are beyond the rejection limits, but it is not intended to release the supplier from an obligation to provide fuel free of contaminant and preferably below the 'Notification' limits.

TYPE OF VEHICLE	SAMPLING FREQUENCY (MINIMUM)		TEST METHOD	LIMITS
	PARTICULATE MATTER	UNDISSOLVED WATER		
Refueller Truck	After Loading	Before Fuelling	Visual Inspection of fuel in glass jar (minimum 1L)	Clear & Bright
			Visual Inspection & Water Detector (1)	30 ppm maximum at the temperature of delivery
	Monthly Colourimetric 6 Monthly Gravimetric (2)		ASTM D2276 / IP 216 (5L sample) (3)	Notification Limit 0.2 mg/L Rejection Limit 1.0 mg/L
Hydrant Dispenser	Daily	During Fuelling	Visual Inspection of fuel in glass jar (minimum 1L)	Clear & Bright
			Visual Inspection & Water Detector (1)	30 ppm maximum at the temperature of delivery
	Monthly Colourimetric 6 Monthly Gravimetric (2)		ASTM D2276 / IP 216 (5L sample) (3)	Notification Limit 0.2 mg/L Rejection Limit 1.0 mg/L

(1) The presence of moisture shall be determined by visually inspecting the sample in good light to determine brightness, cleanliness, transparency and uniformity. The presence of insoluble material shall be determined as well. In addition to checking the absence of water by visual check, other effective methods of checking the presence of water are used. The following are approved methods that guarantee the detection of 30ppm or greater of free water:

Appendix C

Guidance on Contamination Limits

Shell Water Detector:
Faint colour change occurs with water contents as low as 5 ppm, which is acceptable under this specification. Free water amounts of 30 ppm or greater changes the indicator to a definite green or blue-green colour.

Velcon Hydrokit:
If no colour change occurs within two minutes or if the powder colour is lighter than the dark colour of the Colour Card, then the sample contains less than 30 ppm of free water. At 30 ppm or greater of free water, the powder colour matches or is darker than the dark colour (marked 'Fail') on the Colour Card.

Mobil Moisture Detector:
Isolated purplish-blue spots appear on the pad as low as 5 ppm of free water. At 30ppm of free water, large purplish-blue spots are apparent. **This test is no longer available.**

Aqua-Glo:
Directly measures the free water content of a measured sample of fuel. When a 100 mL sample is taken, the measurable free water content ranges from 5 to 60 ppm.

POZ-T:
Measures the emulsified water content and suspended solid content in fuel (In use at Russian airports). The device can measure water content of less than 10 ppm, less than 20 ppm (notification) or 30 ppm or higher (rejection). The limits for particulate matter are established by the civil aviation authority in Russia by colourimetric comparison to standards, similar to colourimetric membrane ratings.

(2) A gravimetric test may not be required at regular intervals provided the following conditions are met:

1) When fixed inbound and outbound filtration is by API/IP 1581 (Filter/water separators) qualified filtration; storage tanks are fully epoxy-lined, have cone-down bottoms and floating suctions; and into-plane filtration also meets API/IP 1581 or API/IP 1583 (Filter monitors).

2) A colourimetric membrane rating of 3-Dry or less. If a colour rating of 4-Dry or greater is observed, proceed as follows (a colour rating of 4-Dry or greater may indicate a particulate contamination problem):

Perform a subsequent particulate test consisting of two membranes in the plastic holder to compare colour differences between top and bottom membranes. If top and bottom membranes have a colour rating difference of 2 or less, fuel is to be considered clean and acceptable. If the difference is 3 or greater, conduct a gravimetric analysis. Fuel is acceptable if less than 0.20 mg/L; above 0.20 mg/L, further investigation is required and if above 1.0 mg/L, the fuel should be rejected.

A gravimetric membrane test must be carried out on all new or re-commissioned vehicles, when new hoses or filters are fitted and on new hydrant lines and storage tanks before commissioning.

(3) Periodic gravimetric and colourimetric membrane testing.

Method A: Gravimetric determination of Total Contamination shall be determined at least once every six months on each refueller/dispenser.

Method B: Colourimetric membrane ratings may be determined (by agreement between buyer/consumer and seller/supplier) monthly on a rotating basis where the number of refuellers/dispensers is such that:

1) At least one dispenser is tested successively by Method 1 and Method 2 in the same test group.

2) Membranes for tests on the other refuellers/dispensers visually match the colourimetric check in paragraph 1).

Any test showing an unusual colourimetric result shall be immediately retested gravimetrically (Method 1). A colour difference of 2 or more is considered unusual.

Note that Joint Guidelines requires monthly colourimetric membrane tests to be determined downstream of all filters on vehicles supplying jet fuel.

Appendix C
Guidance on Contamination Limits

DEFENCE STANDARD 91-91 ISSUE 5 (Amendment 2)

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 D 5452, 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 Specification Authority to extend particulate contamination limits throughout the distribution system at a later date.

F.5 A particle counter test method is being developed by the Energy Institute and has been published as IP PM DK/07 with precision from a ruggedness trial. Before the method becomes a full IP method work will be performed to determine the methods capability of measuring particulate and water content and a round robin will be completed to validate the methods precision. It is the Specification Authority's intent to incorporate this and other developing particle counting methods into the specification at a later date.

Appendix D

Additives in Aviation Fuel

As the aviation industry's jet kerosene demands have increased to more than 5% of all refined products derived from crude, it has been necessary for the refiner to optimize the yield of jet kerosene, a high value product, by varying process techniques. New processes have allowed flexibility in the choice of crudes, the use of coal tar sands as a source of molecules and the manufacture of synthetic blend stocks. Due to the number and severity of the processes used, it is often necessary and sometimes mandatory to use additives. These additives may, for example, prevent the formation of harmful chemical species or improve a property of a fuel to prevent further engine wear. In all cases, the additives have undergone an extensive and often expensive process by which their effects on all fuel properties and acceptability for use is studied. This process can literally take decades before an additive is approved.

Approval may be subdivided into two levels.

1. Acceptance by turbine and airframe manufacturers with listing/recognition in their certification of the aircraft.

2. Listing in major specifications.

Additives must always have the approval of the major turbine and airframe manufacturers before they can be included in the specifications.

Additives are generally given one of three statuses when included in specifications.

Required - The additive must be introduced at the level specified to meet a specific handling requirement. The point of addition is not necessarily into refinery production.

Optional - The additive may be added by the fuel manufacturer to the extent permitted by specification without consulting customers. The supplier may be required to declare its presence.

Agreement - Purchasing authorities may require that an additive be used to the extent permitted by specification. If the fuel supplier desires to add it, agreement by the customer must be secured.

There are exceptions where the manufacturers of aircraft approve additives but these are not approved by specification writing authorities. Biocides are an example.

ADDITIVES FOUND IN AVIATION FUEL

The following additives are either required or added by agreement for use in aviation fuel.

Static Dissipator

Refinery processing can remove naturally present polar species generating fuels with poor conductivity. These fuels have an increased risk of charge generation and ultimately static discharge, especially during loading or as the fuel passes through filters. To virtually eliminate this risk, static dissipator additive is widely used in jet kerosene. The minimum and maximum fuel conductivity requirements for Def Stan 91-91 and JFSCL are 50 to 600 pS/m, whereas for JP-8 it is 150 to 450 pS/m. The addition of static dissipator is not mandatory under ASTM D1655. Stadis® 450 is the only additive currently manufactured for use in aviation turbine fuels approved by the major turbine and airframe manufacturers.

Metal Deactivators

Metal ions in fuel can catalyze oxidation reactions that contribute to poor thermal stability. Copper and zinc are the two most common metal contaminants found in jet fuel. Metal deactivator additive (MDA) is a chelating agent that binds metal ions and prevents fuel degradation. It has also been observed that MDA improves thermal stability in the JFTOT test in the absence of metal ions. MDA can be used to improve thermal stability provided that the JFTOT test is determined before and after MDA addition and reported accordingly.

Antioxidants

Hydroprocessing of aviation fuels removes naturally occurring antioxidants that provide protection from peroxidation. Peroxides are known to attack elastomers causing embrittlement while also contributing to gum and particulate formation. The use of antioxidants effectively prevents peroxidation from occurring and under JFSCL and Def Stan 91-91, 17 to 24 mg/L of an approved antioxidant must be added to the proportion of the fuel blend that has been hydroprocessed. All of the additives are approved by chemistry and so there may be any number of suppliers for each individual antioxidant type. The use of antioxidants is optional under ASTM D1655.

Appendix D
Additives in Aviation Fuel

Corrosion Inhibitors (Lubricity Improvers)

Corrosion inhibitors were originally added to military jet fuels to protect the fuel distribution system and aircraft engines from corrosion. Many aircraft fuel system components, especially pumps, rely on the fuel to lubricate moving parts. Hydroprocessing of fuels removes components that provide the fuel with natural lubricating properties. As military aircraft are most susceptible to lubricity problems, it is required under UK and US Military specifications to add corrosion inhibitors/lubricity additives. Civilian fuel specifications do not require the use of lubricity additives. Both Def Stan 91-91 and ASTM D1655 allow the use of approved lubricity improvers without prior agreement between purchaser and supplier.

The following corrosion inhibitors/lubricity improvers are qualified for use by Def Stan 91-91/5 (Amendment 2) at the specified concentrations:

PRODUCT	MANUFACTURER	QUALIFICATION REFERENCE	MINIMUM mg/L	MAXIMUM mg/L
Apollo PRI-19	Appollo Technologies Intl. Corp.	FL/11/10/LIA/QUAL/APOLLO	18	23
Hitec 580	Ethyl Petroleum Additives Ltd.	FL/11/10/LIA/QUAL/ETHYL	15	23
Innospec DCI-4A	Innospec	FL/11/10/LIA/QUAL/DCI	9	23
Innospec DCI-6A	Innospec	FL/11/10/LIA/QUAL/DCI	9	9
Nalco 5403	Nalco Chemical Co.	FL/11/10/LIA/QUAL/NALCO	12	23
Tolad 4410	Baker Petrolite	FL/11/10/LIA/QUAL/CHEM	9	23
Tolad 351	Baker Petrolite	QINETIQ/EMEA/S&DU/RF0703478	9	23
UNICOR-J	Dorf Ketal Chemicals India Pvt Ltd.	QINETIQ/EMEA/S&DU/RF0703480	9	23

(Qualified Products List 68-251 Issue 4)

Fuel System Icing Inhibitors (FSII)

Water dissolved in fuel can come out of solution at low temperatures in the form of very fine droplets. Although the amounts are small, the droplets formed can freeze at altitude and cause filter plugging. Fuel system icing inhibitors have been developed to protect the system from this problem. The most widely used additive is diethylene glycol monomethyl ether (DiEGME). The use of FSII is required in UK and US military jet kerosene and although optional in many civilian specifications is very seldom used.

Note: As allowed in Def Stan 91-91/5, 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.

Thermal Stability Additive (Only allowed for use in certain military jet kerosenes)

Modern military jet engines require aviation fuel that has a higher thermal stability and heat sink capacity than is currently available. The US Military has in conjunction with additive suppliers developed an additive package that provides these benefits when added to jet fuel. The additive is not compatible with current commercially available filter/water separators and is not approved for use in Jet A or Jet A-1. Manufacturers are currently looking at alternative filter/water separator designs that will overcome this problem.

The following additives may be found in aviation fuels, but are not necessarily discussed under current specifications.

Tracer A

Tracer A (sulphur hexafluoride, SF6) is used as a part of a tracer system for fuel system leak detection at major airports. Airports occasionally run leak detection testing of hydrants, which may be carried out monthly or quarterly. Current use requires agreement by purchasers on a case by case basis.

Biocides

Biocides are permitted by engine and airframe manufacturers for intermittent use during maintenance turnaround. The aircraft are refilled and fully dosed and, as a general rule, will fly on the treated fuel until it is fully used up. Fuel System Icing Inhibitor may also serve to inhibit fungal and bacterial growth in aircraft fuel systems, but may not do so reliably. As an example, it is known that fuels containing FSII, which have not been stored or handled properly, are susceptible to microbiological contamination.

Appendix D

Additives in Aviation Fuel

KEY ADDITIVES APPROVED IN AVIATION TURBINE SPECIFICATION

ADDITIVE TYPE Chemical or Brand Name ISSUING AGENCY	AFQRJOS Jet A-1 (JOINT CHECK LIST)	ASTM (Jet A)	DEF STAN 91-91 (Jet A-1)	DEF STAN 91-86 (F-44)	DEF STAN 91-88 (F-40)	IATA (JET A-1)	MILSPEC 5624U (JP-4/JP-5)	MILSPEC 38219D (JP-7)	MILSPEC 83133E (JP-8 (+100))	CAN-CGSB 3.24 (F-34/F-44)	GE D50TF2	P&W SB. No. 2016
ANTI-OXIDANT	**R**	**O**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**O/R**	**O**	**R**
2,6-Ditertiary-butyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
2,6-Ditertiary-butyl-4-methyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
2,4-Dimethyl-6-tertiary-butyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
Mix 75%(min) 2,6-Ditertiary-butyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
25%(max) Teriary and Tritertiary butyl phenols	•	•	•	•	•	•	•	•	•	•	•	•
Mix 72%(min) 2,4-Dimethyl-6-tertiary-butyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
28%(max) Methyl and Dimethyl teriary-butyl phenols	•	•	•	•	•	•	•	•	•	•	•	•
Mix 55%(min) 2,4-Dimethyl-6-tertiary-butyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
15%(min) 2,6-Ditertiary-butyl-4-methyl phenol	•	•	•	•	•	•	•	•	•	•	•	•
30%(max) Methyl and Dimethyl tertiary-butyl phenols	•	•	•	•	•	•	•	•	•	•	•	•
STATIC DISSIPATOR ADDITIVE	**R**	**O**	**R**		**R**	**R**	**R/A**		**R**	**R**	**O**	**R**
Stadis 450		•	•		•	•	•		•	•	•	•
Sigbol												•
ANTI-ICING ADDITIVE	**A**	**A**	**O**	**R**	**R**	**A**	**R**	**R**	**R**	**O/A**	**O**	**O**
Ethylene glycol monomethyl ether										•		•
Ethylene glycol monomethyl ether & Methyl Alcohol												•
Diethylene glycol monomethyl ether	•	•	•	•	•	•	•	•	•	•	•	•
CORROSION INHIBITORS		**A**	**O**	**R**	**R**	**A**	**R**	**R**	**R**	**A**	**O**	**O**
Apollo PRI-19		•	•	•	•					•	•	•
Hitec 580		•	•	•	•	•	•		•	•	•	•
Nalco 5403		•	•	•	•	•	•		•	•	•	•
DCI-4A		•	•	•	•	•	•		•	•	•	•
DCI-6A			•	•	•	•	•		•	•	•	•
Nalco 5405						•	•		•	•	•	•
Spec-Aid 8Q22						•	•		•	•		•
Unicor J						•	•		•	•		•
Tolad 351						•	•		•	•		•
Tolad 4410			•	•	•	•	•		•	•		•
RPS-613						•	•		•	•		•
Hitec 515											•	
Tolad 245											•	
Mobilad F-800												•
PWA-536								•				
METAL DEACTIVATOR	**O**	**O**	**O**	**O**	**O**	**O**	**A**	**A**	**A**	**O**	**O**	**O**
N,N'-Disalicylidene-1,2-propanediamine	•	•	•	•	•	•	•	•	•	•	•	•
N,N'-Disalicylidene-1,2-cyclohexanediamine											•	
THERMAL STABILITY ADDITIVE		**A**						**A**			**O**	**O**
Spec-Aid 8Q462								•			•	•
AeroShell Performance Additive 101								•			•	•
Turboline FS100C											•	•
Turboline FS100											•	•
JFA-5												•
LEAK DETECTION ADDITIVE		**O**	**O**							**O**	**O**	**O**
Tracer A		•	•							•	•	•
BIOCIDE		**E**				**O**					**O**	**O**
Biobor JF						•					•	•
Kathon FP 1.5						•					•	•

LEGEND:

OPTION (O): The additive may be added by the fuel manufacturer to the extent permitted by specification without consulting customers. The supplier may be required to declare its presence.

AGREEMENT (A): Purchasing authorities may require that an additive be used to the extent permitted by specification. If the fuel supplier desires to add it, he must secure agreement of the customer.

ENGINE MANUFACTURER'S AGREEMENT (E): Specification authorities may require agreement by engine manufacturers.

REQUIRED (R): The additive must be introduced at the level specified to meet a specific handling requirement. The point of addition is not necessarily into refinery production. (R for anti-oxidant treatment refers to hydrotreated fuel)

NOTE: Not all additives approved by specification and engine manufacturers have necessarily been listed. Consult the Issuing Authority for full details.

SUPPLEMENT AVIATION GASOLINE

Fuel grades

ExxonMobil Aviation Gasolines are leaded fuels satisfying the requirements of ASTM D910 and Def Stan 91-90. Critical properties must be controlled within defined limits for Aviation Gasoline to comply with these specifications.

The properties of aviation gasoline are specified to give satisfactory performance of spark-ignition aviation engines over a wide range of operating conditions. Specifications cover antiknock quality, which differs between grades of fuel, and other requirements that are common to all grades.

Four grades of aviation gasoline are identified, with names based on their antiknock quality as measured by Octane Number:

Grade 80 Grade 91 Grade 100 Grade 100LL (Low Lead)

Different colours, obtained by the use of specific dyes, are used to differentiate the fuel grades. Service experience has indicated that only certain dyes and concentration levels can be tolerated without causing deposition in engine fuel induction systems. ExxonMobil supplies Grades 100 and 100LL, which are identical in antiknock quality but differing in maximum lead content, the lower the lead content being suitable for engines having a low tolerance for lead.

Antiknock characteristics

Although the grade designations show only a single octane rating, antiknock quality is expressed by two values, the lean mixture motor rating and the rich mixture supercharge rating. Both values are determined in standardized laboratory single-cylinder test engines that are operated under prescribed conditions. The lean rating method is intended to simulate the lean air/fuel mixture of aircraft at cruise conditions, whereas the rich rating method simulates the rich air/fuel mixture under take-off conditions.

Common quality requirements

Requirements common for all grades either prescribe a balance of properties to ensure satisfactory engine performance, or limit the concentrations of components that could have an adverse effect on engine performance.

Use of automotive gasoline (mogas) in aircraft engines

The question of whether light aircraft engines can be operated on automotive fuel is often raised. It is, however, a practice that is discouraged and even forbidden by most engine manufacturers and fuel suppliers. Some of the reasons for this are as follows:

1. The distillation characteristics of automotive gasoline are different than those of aviation gasoline. Mogas includes heavier petroleum fractions that tend to include hydrocarbons less stable to oxidation, less clean-burning and more prone to form carburettor, induction system and combustion chamber deposits.

2. Automotive gasoline normally has a much higher vapour pressure, which varies seasonally. With a high RVP fuel the risk of vapour lock increases at high altitude, during landing, take-off and climb, particularly if the aircraft had been parked or operated in high ambient temperatures. Moreover, gravity-fed fuel systems are typically more susceptible to vapour lock.

3. Automotive gasolines may contain many different types of additives not permitted in aviation gasoline. There is no consistency or control on mogas additives between different suppliers. Aviation gasoline, regardless of where it is manufactured or purchased, is limited to certain specific additives.

4. In many areas of the world, MTBE is being replaced by Ethanol in mogas to meet current environmental requirements. Government regulatory authorities and STC owners forbid the use of automotive fuel that contains Ethanol.

Many properties critical to aviation use (for example, vapour pressure and cleanliness) are not controlled to the same degree in automotive gasoline manufacture and handling.

ExxonMobil Aviation does not support or approve the use of automotive gasoline or diesel fuel in piston-engine powered aircraft.

Table 22

Aviation Gasoline

Issuing Agency:				ASTM		Test Method
Specification:				D910-07		
Latest Revision Date:				Aug-07		
Grade Designation:		Grade 80	Grade 91	Grade 100	Grade 100LL	ASTM
PERFORMANCE						
Knock Value, lean mixture: (1)						
Motor Octane Number	Min.	80.7	90.8	99.6	99.6	D2700
Aviation Lean Rating	Min.	80.0	91.0	100.0	100.0	D2700
Knock Value, rich mixture:						
Octane Number	Min.	87	98			D909
Performance Number (2) (3)	Min.			130.0	130.0	D909
TETRAETHYL LEAD						
mL TEL/L	Max.	0.13	0.53	1.06	0.53	D3341, D5059
g Pb/L	Max.	0.14	0.56	1.12	0.56	
COLOUR		Red	Brown	Green	Blue	D2392
Dye Content: (4)						
Blue dye (mg/L)	Max.	0.2	3.1	2.7	2.7	
Yellow dye (mg/L)	Max.	None	None	2.8	None	
Red dye (mg/L)	Max.	2.3	2.7	None	None	
Orange dye (mg/L)	Max.	None	6.0	None	None	
APPEARANCE						
Visual				C&B (5)		
VOLATILITY						
Distillation:						D86
Initial Boiling Point (°C)				Report		
Fuel Evaporated:						
10% volume at °C	Max.			75		
40% volume at °C	Min.			75		
50% volume at °C	Max.			105		
90% volume at °C	Max.			135		
Final Boiling Point (°C)	Max.			170		
Sum of E10 + E50 (°C)	Min.			135		
Recovery Volume (%)	Min.			97		
Residue (vol %)	Max.			1.5		
Loss (vol %)	Max.			1.5		
Vapour Pressure at 38°C (kPa)				38.0 - 49.0		D323, D5190, D5191
OTHER						
Density @ 15°C (kg/m³)				Report		D1298, D4052
Freezing Point (°C)	Max.			-58 (6)		D2386
Sulphur (wt %)	Max.			0.05		D1266, D2622
Net Heat of Combustion (MJ/kg) (7)	Min.			43.5		D4529, D3338, D4809
Corrosion, Copper (2h @ 100°C)	Max.			1		D130
Oxidation Stability, 5hr ageing: (8) (9)						D873
Potential Gum (mg/100mL)	Max.			6		
Lead Precipitate (mg/100 mL)	Max.			3		
Water Reaction:						D1094
Volume Change (mL)	Max.			±2		
Conductivity (pS/m)	Max.			50 - 450 (10)		D2624
ADDITIVES						
Anti-Icing (vol %)				Option (11)		
Antioxidant				Option (12)		
Corrosion Inhibitor				Option (13)		
Static Dissipator				Option (14)		

NOTES

(1) Knock value shall be reported as MON.

(2) A performance number of 130.0 is equivalent to a knock value determined using iso-octane plus 0.34 mL TEL/L.

(3) Knock ratings shall be reported to the nearest 0.1 Octane/Performance Number.

(4) The maximum dye concentrations shown do not include solvent in dyes supplied in liquid form.

(5) Fuel shall be free from undissolved water, sediment and suspended matter. The odour of the fuel shall not be nauseating or irritating.

(6) If no crystals have appeared on cooling to -58 ºC, the freezing point may be reported as "less than -58 ºC".

(7) For all grades use either Eq 1 or Table 1 in D4529, or Eq 2 in D3338. Test method D4809 may be used as an alternative.

(8) If mutually agreed upon between purchaser & supplier, a 16 hour ageing gum requirement may be specified instead of the 5 hour ageing gum test; in such case the gum content shall not exceed 10 mg/100 mL and the visible lead precipitate shall not exceed 4 mg/ 100mL. In such fuel the permissible antioxidant shall not exceed 24 mg/L.

(9) The D381 existent gum test can provide a means of detecting quality deterioration or contamination, or both, with heavier products following distribution from refinery to airport.

(10) Limits apply under the condition at point of use & only when an electrical conductivity additive is used; when a customer specifies fuel containing conductivity additive.

(11) Isopropyl Alcohol, conforming to D4171 (Type II), or DiEGME, conforming to D4171 (Type III), may be used.

(12) Optional up to 12 mg/L maximum. See D910 specification for a list of acceptable additive chemistries.

(13) Corrosion inhibitor of a type and amount specified in Section 6.3.4 of D910 may be added.

(14) Stadis 450 up to 3 mg/L is permitted. When necessary, further addition to cumulative total of 5 mg/L is permissible. The quantity added must be reported by the supplier.

Table 23
Aviation Gasoline

Issuing Agency:		Ministry of Defence (Procurement Executive)			
Specification:		Def Stan 91-90/2			
Latest Revision Date:		31-Mar-06			Test Method
Grade Designation:		Grade 80	Grade 100	Grade 100LL	ASTM/IP
PERFORMANCE					
Knock Value, lean mixture:					
Motor Octane Number	Min.	80.0 (1)	99.5 (1)	99.5 (1)	D2700, IP 236
Knock Value, rich mixture:					
Octane Number	Min.	87.0 (1)	---	---	D909, IP 119
Performance Number	Min.	---	130 (1)	130 (1)	D909, IP 119
TETRAETHYL LEAD					
g Pb/L	Max.	0.14	0.85	0.56	IP 270
COLOUR		Red (2)	Green (2)	Blue (2)	Visual
Dye Content:					
Blue dye (mg/L)	Max.	0.2	2.7	2.7	
Yellow dye (mg/L)	Max.	None	2.8	None	
Red dye (mg/L)	Max.	2.3	None	None	
Colour, Lovibond					IP 17 (3)
Blue		---	1.7 - 3.5	1.7 - 3.5	
Yellow		---	1.5 – 2.7	---	
Red		6.7 - 9.1	---	---	
APPEARANCE					
Visual			C&B (4)		Visual, D4176 (Procedure 1)
VOLATILITY					
Distillation:					D86, IP 123
Initial Boiling Point (°C)			Report		
Fuel Evaporated:					
10% volume at °C	Max.		75.0		
40% volume at °C	Min.		75.0		
50% volume at °C	Max.		105.0		
90% volume at °C	Max.		135.0		
Final Boiling Point (°C)	Max.		170.0		
Sum of E10 + E50 (°C)	Min.		135.0		
Residue (vol %)	Max.		1.5		
Loss (vol %)	Max.		1.5		
Vapour Pressure at 37.8°C (kPa)			38.0 - 49.0 (5)		D323, D5190, D5191, IP 69, IP 394
OTHER					
Density @ 15°C (kg/m³)			Report		D1298, D4052, IP 160, IP 365
Freezing Point (°C)	Max.		-58.0 (6)		D2386, IP 16
Sulphur (wt %)	Max.		0.05		D1266, D2622, D5453, IP 107, IP 243
Existent Gum (mg/100 mL)	Max.		3.0		D381, IP 131
Specific Energy (MJ/kg)	Min.		43.50		D3338, D4809, IP 12
Corrosion, Copper (2h @ 100°C)	Max.		1		D130, IP 154
Oxidation Stability, 16 hours:					D873, IP 138
Potential Gum (mg/100mL)	Max.		6		
Precipitate (mg/100 mL)	Max.		2		
Water Reaction:					D1094, IP 289
Volume Change (mL)	Max.		2		
Conductivity (pS/m)	Max.		50 - 600 (7)		D2624, IP 274
ADDITIVES					
Anti Icing (vol %)			Agreement (8)		
Antioxidant			Option (9)		
Corrosion Inhibitor			Option (10)		
Static Dissipator			Option (11)		

NOTES

(1) Knock rating shall be reported to the nearest 0.1 for Octane Number and nearest whole number for Performance Number.

(2) The visual colour must also comply with Lovibond Colour limits.

(3) Use test method IP 17 (method A) using a 50.8 mm cell.

(4) Fuel shall be clear, bright and visually free from solid matter and undissolved water at ambient temperature.

(5) For test methods D5190, D5191 and IP394, results shall be reported as dry vapour pressure equivalent (DVPE).

(6) If no crystals have appeared on cooling to -58 ºC, the freezing point may be reported as "less than -58 ºC".

(7) Limits shown apply at the point, time and temperature of delivery to the purchaser and only when a static dissipator additive has been added to the fuel.

(8) Upon agreement between Purchaser and Supplier, Isopropyl Alcohol, conforming to D4171 (Type II), or DiEGME, conforming to Def Stan 68-252, may be used.

(9) Optional up to 24.0 mg/L maximum. See Def Stan 91-90 specification for a list of acceptable additive chemistries.

(10) Corrosion inhibitor of a type and amount specified in Def Stan 91-90 Annex A.6 may be added.

(11) Stadis 450 may be added up to 3.0 mg/L maximum.

Notes

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