

ExxonMobil
Aviation

World Jet Fuel Specifications

with Avgas supplement



2000 Edition

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 reference specifications listed, all of these essentially define a similar product, e.g. for aviation turbine fuel, a wide-cut kerosine. 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 'Checklist' to define fuel quality. This checklist combines the most stringent requirements from ASTM D1655 and Defence Standard 91-91 into one overall guideline which provides a common basis for commercial fuel quality in Jointly operated Systems. There used to be an equivalent checklist for Aviation Gasoline, but this was discontinued in the early 1990's.

In addition to the fuel specifications, we have included for reference a summary of analytical test information and guidance on contamination limits.

Test Method Standards

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

'1999 Annual Book of ASTM Standards, Petroleum Products and Lubricants, Volumes 05.01, 05.02, 05.03', published by ASTM 100 Barr Harbor Drive, West Conshohocken, PA 19428, USA.

'Institute of Petroleum, Standard Methods for Analysis and Testing of Petroleum and Related Products and British Standard 2000 Parts, 1999', published on behalf of The Institute of Petroleum, London by John Wiley & Sons.

The significance of each fuel property stipulated for testing, together with the typical sample volume required by the relevant test method, is summarised in Appendix A.

Approved Additives

Appendix C 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

The brochure includes a section on gasoline fuels used in piston-engined aircraft, covering the three common grades of avgas which 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 and the British Ministry of Defence.

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**TABLE 1
JOINTLY OPERATED SYSTEMS**

| | | | | |
|-------------------------------------|------|------------------------|---|------------------|
| Issuing Agency: | | | | |
| Specification: | | | Joint Fuelling System Check List (Issue 18) | |
| Latest Revision Date: | | | November 1999 | |
| Grade Designation: | | Jet A-1 | Test Method | |
| Fuel Type: | | Kerosine | ASTM | IP |
| COMPOSITION | | | | |
| Appearance | | ¹ | | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | D3242 | 354 |
| Aromatics (vol %) | Max. | 25.0 | D1319 | 156 |
| Sulphur, Total (wt %) | Max. | 0.30 | D1266 or D2622 ² | 107 |
| Sulphur, Mercaptan (wt %) | Max. | 0.0030 | D3227 | 342 |
| or Doctor Test | | Negative ³ | D4952 | |
| H/P Components (vol %) | | Report ⁴ | | |
| Severely H/P Components (vol %) | | Report ⁵ | | |
| VOLATILITY | | | | |
| Distillation Temperature: | | | D86 | |
| 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 ⁶ | D3828 | 170 or 303 |
| Density @ 15°C (kg/m ³) | | 775-840 | D1298 or D4052 | 160 or 365 |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | -47 | D2386 ⁷ | |
| Viscosity @ -20°C (cSt) | Max. | 8.0 | D445 | 71 |
| COMBUSTION | | | | |
| Specific Energy (MJ/kg) | Min. | 42.8 | D4259 ⁸ | 381 |
| Smoke Point (mm) | Min. | 25 | D1322 | 57 |
| or Smoke Point (mm) | Min. | 19 | D1322 | 57 |
| and Naphthalenes (vol %) | Max. | 3.0 | D1840 | |
| CORROSION | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | D130 | 154 |
| STABILITY | | | | |
| JFTOT ΔP (mm Hg) | Max. | 25.0 | D3241 ⁹ | 323 ⁹ |
| Tube Deposit Rating (Visual) | | <3 ¹⁰ | | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | D381 | 131 |
| Water Reaction Interface | Max. | 1b | D1094 | |
| MSEP Rating | Min. | 85 ¹¹ | D3948 | |
| ADDITIVES | | | | |
| Anti-Icing | | Agreement | | |
| Antioxidant | | Required ¹² | | |
| Corrosion Inhibitor | | Agreement | | |
| Metal Deactivator | | Option ¹³ | | |
| Static Dissipator | | Required ¹⁴ | | |
| CONDUCTIVITY | | | | |
| Electrical Conductivity (pS/m) | | 50-450 ¹⁵ | D2624 | 274 |
| LUBRICITY | | | | |
| BOCLE wear scar diam (mm) | Max. | 0.85 ¹⁶ | D5001 | |

NOTES:

- (1) Fuel should be clear, bright and visually free from solid matter and undissolved water at normal ambient temperature.
- (2) Alternative test methods are ASTM D4294 or D1552 or D5453.
- (3) In the event of conflict between Sulphur Mercaptan and Doctor Test results, the Sulphur Mercaptan result shall prevail.
- (4) Report total vol % of hydroprocessed (H/P) fuel (including 'nil' or 100%), to include hydrotreated, hydrofined and hydrocracked material.
- (5) Proportion of severely hydroprocessed components to be reported from 1 Dec 2000.
- (6) Subject to minimum of 40°C if results obtained by (Tag) method ASTM D56.
- (7) Alternative test methods are ASTM D4305, D5901 and D5972. With D4305, use Procedure A only; this method shall not be used on samples with viscosities greater than 5.0 mm²/s at -20°C.
- (8) Calculated Specific Energy by one of the following methods is also acceptable: D3338 or D4809.
- (9) JFTOT to be carried out at a control temperature of 260°C.
- (10) No 'peacock' or 'abnormal' colour deposits should be present.
- (11) For fuel without static dissipator additive (SDA). For fuel with SDA minimum limit is reduced to 70. These MSEP requirements apply only at point of manufacture. If testing is carried out downstream, no specification limits apply and the results are not to be used as the sole reason for rejection of a fuel.
- (12) Antioxidants are mandatory in hydroprocessed fuels and synthetic fuels, and must be added immediately after processing. Use in non-hydroprocessed fuels is optional.
- (13) May be added to fuel under specified conditions. Concentration on initial batching at refinery shall not exceed 2.0 mg/L. Cumulative addition when redoping the fuel shall not exceed 5.7 mg/L.
- (14) 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.
- (15) Conductivity limits apply at the point, time and temperature of delivery to the user.
- (16) Requirement comes into effect 1 Dec 2000. Applies only to fuels containing more than 95% hydroprocessed material where at least 20% of this is severely hydroprocessed, and for all fuels containing synthetic components. The limit applies only at point of manufacture.

**TABLE 2
US PIPELINE SPECIFICATIONS**

| Issuing Agency: Specification: Latest Revision Date: Grade Designation: Fuel Type: | Buckeye P/L March 1999 Grade 182 Kerosine | Colonial P/L Fungible Aviation Kerosine ¹ February 1999 Grade 54 Kerosine | Explorer P/L March 1999 Codes 51,54 Jet A | Test Method ASTM |
|--|--|--|--|--|
| COMPOSITION | | | | |
| Appearance | C & B | C & B | C & B | |
| Acidity, Total (mg KOH/g) | Max. 0.1 | 0.1 | 0.1 | D974 ² , D3242 |
| Aromatics (vol %) | Max. 25 ³ | 25 | 25 | D1319 |
| Sulphur, Total (wt %) | Max. 0.30 | 0.30 | 0.30 | D1266, D1552, D2622, D4294 |
| Doctor Test or Sulphur, Mercaptan (wt %) | Max. Negative 0.003 ⁴ | Negative 0.003 ⁴ | Negative 0.003 ⁴ | D4952 D3227 |
| Colour, Saybolt | Min. Report ⁵ | ... | +15 | D156 |
| VOLATILITY | | | | |
| Distillation Temperature: | | | | D86 |
| 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 ⁶ | D56, D3828 ⁷ |
| Gravity, API @ 60°F | 37-51 | 37-51 | 37-51 | D287, D1298, D4052 ⁸ |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. -40 | -40 | -40 | D2386 |
| Viscosity @ -20°C (cSt) | Max. 8 | 8.0 | 8.0 | D445 |
| COMBUSTION | | | | |
| Net Heat of Comb. (BTU/lb) | Min. 18,400 | 18,400 | 18,400 | D1405 ⁹ , D3338, D4529 ¹⁰ , D4809 ¹⁰ |
| Luminometer No. | Min. 45 | 45 | 45 | D1740 |
| or Smoke Point (mm) | Min. 25 | 25 | 25 | D1322 |
| or Smoke Point (mm) | Min. 19 ¹¹ | 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 |
| STABILITY | | | | |
| JFTOT ΔP (mm Hg) | Max. 25 | 25 | 25 | D3241 ¹² |
| Tube Deposit Rating (Visual) | Max. <3 | <3 | <3 ¹³ | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 mL) | Max. 7 | 7 | 7 | D381 |
| Particulates (mg/gal) | ... | ... | Report | D2276 |
| Water Reaction Interface | Max. 1b | 1b | 1b | D1094 |
| MSEP Rating | Min. Report ¹⁴ | 85 ¹⁵ | 85 | D3948 |
| Filtration Time (min) | ... | Report ¹⁶ | ... | MIL-T-5624P |
| Total Solids | ... | Report ¹⁶ | ... | MIL-T-5624P |
| ADDITIVES | | | | |
| | 14 | 14 | 14, 17 | |
| OTHER | | | | |
| Conductivity (pS/m) | Report ¹⁴ | Report | Report | D2624, D4308 ¹⁸ |

NOTES:

- (1) A 'fungible batch' is defined as a batch of petroleum product meeting carrier's established specifications that may be commingled with other quantities of petroleum product meeting the same specifications.
- (2) D974 not allowed in Explorer specification.
- (3) Fuel over 22 vol % and not exceeding 25 vol % is permitted with notification to purchaser within 90 days of date of shipment, or as agreed by both parties.
- (4) Mercaptan sulphur waived if fuel is negative by Doctor test.
- (5) Product must not exhibit various shades of green, blue or red colour.
- (6) Minimum 108°F applies at origin locations. Minimum of 100°F will apply at destination.
- (7) D3828 not allowed in Buckeye specification.
- (8) D4052 only allowed in Buckeye specification.
- (9) D1405 not allowed in Explorer specification.
- (10) D4529 and D4809 not allowed in Buckeye specification.
- (11) Fuel with Smoke Point less than 19 and not less than 18 and a maximum of 3 vol % Naphthalenes is permitted with notification to purchaser within 90 days of date of shipment, or as agreed by both parties.
- (12) Refer to ASTM D1655-99, (Table 1, Note L).
- (13) No 'peacock' or 'abnormal' colour deposits allowed.
- (14) 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.
- (15) MSEP 85 min. specified at origin, 75 min. at delivery.
- (16) At this time, the test limits described in MIL-T-5624P, Appendix A, parts 70.a(1) and 70.b will not be imposed.
- (17) No rust inhibitor shall be injected unless approved by all shippers.
- (18) D4308 only allowed in Explorer specification.

**TABLE 3
US MILITARY SPECIFICATIONS**

| | | | | |
|-----------------------|-------------------|----------|-------------------|-----------------------------|
| Issuing Agency: | USAF | | | |
| Specification: | MIL-DFL-5624T | | | |
| Latest Revision Date: | 18 September 1998 | | | |
| Grade Designation: | JP-4 | JP-5 | JP-5/JP-8 ST | Test Method ASTM |
| Fuel Type: | Wide-Cut | Kerosine | Special Test Fuel | |
| NATO Code No. | F-40 | F-44 | | |

| COMPOSITION | | | | | |
|---|------|------------------------|------------------------|------------------------|------------------------------------|
| Appearance | | C & B ¹ | C & B ¹ | C & B ¹ | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | 0.015 | 0.015 | D3242 |
| Aromatics (vol %) | Max. | 25.0 | 25.0 | 23.0-27.0 | D1319 |
| Sulphur, Total (wt %) | Max. | 0.40 | 0.40 | 0.40 | D4294 ² |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.002 | 0.002 | 0.002 | D3227 |
| Colour, Saybolt | | Negative Report | Negative Report | Negative Report | D4952 D156 or D6045 |
| VOLATILITY | | | | | |
| Distillation Temperature: ³ | | | | | D86 or D2887 |
| Initial BP (°C) | | Report | Report | Report | |
| 10% Recovery (°C) | Max. | Report | 206 (185) | 206 | |
| 20% Recovery (°C) | Min. | 100 | Report | Report | |
| 50% Recovery (°C) | Min. | 125 | Report | Report | |
| 90% Recovery (°C) | | Report | Report | Report | |
| Final BP (°C) | Max. | 270 | 300 (330) | 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. | | 60 ⁴ | 60 ⁴ | D56, D93, or D3828 |
| Density @ 15°C (kg/m ³) or Gravity, API @ 60°F | | 751-802 57.0-45.0 | 788-845 48.0-36.0 | 815-845 42.1-36.0 | D1298 or D4052 |
| Vapour Pressure @ 37.8°C (kPa) | | 14-21 | ... | ... | D5191 ⁵ |
| FLUIDITY | | | | | |
| Freezing Point (°C) | Max. | -58 | -46 | -46 | D2386, D5901 or D5972 ⁶ |
| Viscosity @ -20°C (cSt) | | ... | 8.5 max | 12 min | D445 |
| COMBUSTION | | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 42.6 | 42.6 | D3338, D4809 or D4529 |
| Cetane Index (calculated) | | | Report | Report | D976 |
| Smoke Point (mm) | Min. | 20 | 19 | 18-21 | D1322 |
| Hydrogen Content (wt %) | Min. | 13.5 | 13.4 | 13.3-13.5 | D3701 ⁷ |
| CORROSION | | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1 | 1 | D130 |
| STABILITY | | | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 | 25 | 25 | D3241 ⁸ |
| Tube Deposit Rating (Visual) | Max. | <3 | <3 | <3 | |
| CONTAMINANTS | | | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | 7 | 7 | D381 |
| Particulates (mg/L) | Max. | 1 | 1 | 1 | D2276 or D5452 ⁹ |
| Filtration Time (min) | Max | 10 | 15 ¹⁰ | 15 ¹⁰ | D2276 ⁹ |
| Water Reaction Interface | Max. | 1b | 1b | 1b | D1094 |
| MSEP Rating | Min. | 90 ¹¹ | 90 ¹¹ | 90 ¹¹ | D3948 |
| ADDITIVES | | | | | |
| Anti-Icing (vol %) | | 0.10-0.15 | 0.15-0.20 | 0.15-0.20 | D5006 |
| Antioxidant | | Required ¹² | Required ¹² | Required ¹² | |
| Corrosion Inhibitor | | Required ¹³ | Required ¹³ | Required ¹³ | |
| Metal Deactivator | | Option ¹⁴ | Option ¹⁴ | Option ¹⁴ | |
| Static Dissipator | | Required | ... | ... | |
| OTHER | | | | | |
| Conductivity (pS/m) | | 150-600 ¹⁵ | | | D2624 |

NOTES:

- In case of dispute, the fuel shall be clear and bright at 21°C and contain no more than 1.0mg/L of particulate matter.
- D4294 is referee test method. D1266, D2622, D3120 or D5453 methods are permitted alternatives.
- D2887 may be used for JP-5 fuel only. D2887 test limits in parentheses.
- 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.
- D5191 is referee test method. D323, D4953, D5190 methods are permitted alternatives.
- D5972 may be used for freeze point determination of JP-5 only.
- D3343 or D3701 may be used to measure hydrogen content to JP-4 only.
- Test at 260°C and 3.45 Mpa pressure. Neither 'peacock' nor 'abnormal' tube deposits by visual rating are acceptable. Report spun TDR rating if Mark 8A tube deposit rater is available.
- Minimum sample size of 1 gallon shall be filtered. Filtration time determined according to procedure in Appendix A.
- Flow reducer ring not required.
- 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.
- Required for all JP-5 and JP-5/JP-8 ST fuels, and for JP-4 fuels containing hydrogen-treated blending stocks. For JP-4 fuels without hydrogen-treated stocks, additive is optional.
- Allowable concentration limits listed in latest revision of QPL-25017.
- Shall not be used in JP-4 or JP-5 fuel without written consent from Procuring Activity and user. Concentration at the refinery shall not exceed 2.0 mg/L, and not exceed 5.7 mg/L when redoping the fuel.
- Conductivity must be within range at ambient fuel temperature or 29.4°C, whichever is lower.

**TABLE 4
US MILITARY SPECIFICATIONS**

| | | | |
|-----------------------|----------------|-------------------|--------------------|
| Issuing Agency: | USAF | | |
| Specification: | MIL-DTL-38219D | MIL-DTL-83133E | |
| Latest Revision Date: | 21 August 1998 | 1 April 1999 | |
| Grade Designation: | JP-7 | JP-8 ¹ | |
| Fuel Type: | Low Volatility | Kerosine | Test Method |
| NATO Code No. | | F-34/F-35 | ASTM |

| COMPOSITION | | | | |
|---------------------------------------|------|------------------------|-------------------------|--------------------------------|
| Appearance | | C&B | 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 or D6045 |
| VOLATILITY | | | | |
| Distillation Temperature ⁴ | | | | D86 or D 2887 |
| 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) | Min. | 60 | 38 | D56, D93 or D3828 ⁵ |
| Density @ 15°C (kg/m ³) | | 779-806 | 775-840 | D1298 or D4052 |
| or Gravity, API @ 60°F | | 50.1-44.0 | 51.0-37.0 | D1298 |
| Vapour Pressure @ 149°C (kPa) | Max. | 20.7 | ... | ⁶ |
| Vapour Pressure @ 260°C (kPa) | Max. | 331 | ... | ⁶ |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | -43.3 | -47 | D2386, D5901 or D5972 |
| Viscosity @ -20°C (cSt) | Max. | 8.0 ⁷ | 8.0 | D445 |
| COMBUSTION | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 43.5 | 42.8 | D2382, D3338, D4809 |
| Cetane Index (calculated) | | ... | 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 (wt %) | Min. | 14.4 | 13.4 | D3701, D3343 ⁸ |
| CORROSION | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1b | 1 | D130 |
| STABILITY | | | | |
| JFTOT ΔP (mm Hg) | Max. | 25.0 | 25 | D3241 ⁹ |
| Tube Deposit Rating | Max. | 12 TDR | <3 Visual ¹⁰ | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 mL) | Max. | 5 | 7 | D381 |
| Particulates (mg/L) | Max. | 0.3 ¹¹ | 1.0 | D2276 ¹² or D5452 |
| Filtration Time (min) | Max. | ... | 15 | D2276 ¹² |
| Water Reaction | | | | D1094 |
| Interface Rating | Max. | 1b | 1b | |
| Separation Rating | Max. | 2 | ... | |
| MSEP Rating | Min. | 85 | 90 ¹³ | D3948 |
| ADDITIVES | | | | |
| Anti-Icing (vol %) | | 0.10-0.15 | 0.10-0.15 ¹⁴ | D5006 |
| Antioxidant | | Required | Required ¹⁵ | |
| Corrosion Inhibitor | | Required ¹⁶ | Required ¹⁶ | |
| Metal Deactivator | | Option ¹⁷ | Option ¹⁷ | |
| Static Dissipator | | ... | Required | |
| OTHER | | | | |
| Conductivity (pS/m) | | | ¹⁸ | D2642 |

NOTES:

- (1) JP-8 fuel with an approved thermal stability improver additive at the required concentration is designated as JP-8+100.
- (2) 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.
- (3) D4294 is referee test method. D1266, D2622, D3120 or D5453 methods are permitted alternatives.
- (4) D2887 test limits in parentheses.
- (5) 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.
- (6) Vapour pressure to be tested in accordance with procedure in Appendix A or Appendix C of MIL-DTL-38219D.
- (7) Until thermometer calibrated for -20°C becomes available, test may be conducted at -34.5°C with max limit 15.0 cSt.
- (8) May use calculation (D3343) or measurement method (D3701). In case of conflict, D3701 shall apply.
- (9) Test conditions for JP-7 fuel at heater tube temperature of 355°C for 5h; JP-8 fuel at 260°C for 2.5h.
- (10) 'Peacock' or 'abnormal' colour deposits result in failure.
- (11) Limit applies at origin. At destination, max. limit is 0.5 mg/L.
- (12) Minimum sample size of 1 gallon shall be filtered. Filtration time determined according to procedure in Appendix A.
- (13) 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.
- (14) Fuel system icing inhibitor is mandatory for F-34 grade, but is not to be added to F-35 unless directed by the purchaser.
- (15) Required for fuel containing hydrogen-treated blending stocks. Optional for fuel not containing hydrogen-treated stocks.
- (16) PVA-536 lubricity additive shall be added to JP-7 fuel. Corrosion inhibitor conforming to MIL-PRF-25017 shall be added to JP-8 fuel.
- (17) Shall not be used unless supplier has written consent from the Procuring Activity and user.
- (18) 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.

**TABLE 5
BRAZIL**

| | | | |
|-------------------------------------|-------------------------------|----------------------|------------------------|
| Issuing Agency: | National Council of Petroleum | | |
| Specification: | QAV-1 | | |
| Latest Revision Date: | November 1985 | | |
| Grade Designation: | Kerosine | Test Method | MB ¹ |
| Fuel Type: | | ASTM | |
| COMPOSITION | | | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | D3242 |
| Aromatics (vol %) | Max. | 20 ² | D1319 |
| Olefins (vol %) | Max. | 5.0 | D1319 |
| Sulphur, Total (wt %) | Max. | 0.30 | D1266, D2622 |
| Sulphur, Mercaptan (wt %) | Max. | 0.003 | D3227 |
| or Doctor Test | | Negative | D235 |
| | | | MB424 |
| | | | MB424 |
| | | | NBR6563 |
| | | | NBR6298 |
| | | | MB339 |
| VOLATILITY | | | |
| Distillation Temperature: | | | D86 |
| Initial BP (°C) | | Report | |
| 10% Recovery (°C) | Max. | 204 | |
| 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. | 40 | D56 |
| Density @ 20°C (kg/m ³) | | 760-822 | D1298 |
| | | | NBR7974 |
| | | | NBR7148 |
| FLUIDITY | | | |
| Freezing Point (°C) | Max. | -50 | D2386 |
| Viscosity @ -20°C (cSt) | Max. | 8.0 | D445 |
| | | | NBR7975 |
| | | | MB293 |
| COMBUSTION | | | |
| Aniline-Gravity Product | Min. | 4800 | D611/D1298 |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | D1405, D2382 |
| Luminometer No. | Min. | 45 | D1740 |
| or Smoke Point (mm) | Min. | 25 | D1322 |
| or Naphthalenes (vol %) | Max. | 3.0 ³ | D1840 |
| | | | P-MB-569 |
| | | | MB295 |
| CORROSION | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | D130 |
| Silver Strip (4h @ 50°C) | Max. | 1 | |
| | | | MB287 |
| | | | P-MB-453 ⁴ |
| STABILITY | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 | D3241 ⁵ |
| Tube Deposit Rating (Visual) | Max. | <3 | |
| | | | P-MB-431 |
| CONTAMINANTS | | | |
| Copper Content (mg/kg) | Max. | 150 ⁶ | ⁷ |
| Existent Gum (mg/100 ml) | Max. | 7 | D381 |
| Water Reaction: | | | D1094 |
| Interface Rating | Max. | 1b | |
| Separation Rating | Max. | 2 | |
| MSEP, without SDA | Min. | 85 ⁸ | D2250/D3948 |
| with SDA | Min. | 70 ⁸ | |
| | | | MB289 |
| | | | NBR6577 |
| ADDITIVES | | | |
| Antioxidant | | Option ⁹ | |
| Metal Deactivator | | Option | |
| Static Dissipator | | Agreement | |
| OTHER | | | |
| Conductivity (pS/m) | | 50-450 ¹⁰ | D2624 |

NOTES:

- (1) Metodos Brasileiros (MB) da Assosiação Brasileira de Normas Técnicas e do Instituto Brasileiro de Petróleo.
- (2) Aromatics to 22 vol % may be shipped if users informed in advance.
- (3) Plus Smoke Point of 20 mm, min. Smoke Point of 19 mm may be shipped if users informed in advance.
- (4) Alternate method is IP 227.
- (5) Must pass at 260°C test temperature.
- (6) Waived if fuel has not been copper sweetened.
- (7) Use IP 225 or adequate analytical method.
- (8) Stated limits apply 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. No limit for fuel containing both static dissipator and corrosion/lubricity additives, but fuel must have a WSIM of 85 min. prior to addition of both additives and 70 min. with only the static dissipator added.
- (9) Mandatory with hydrogen-treated fuel (17.0 to 24.0 mg/L).
- (10) Limits apply at point, time and temperature of delivery to buyer if fuel contains static dissipator.

**TABLE 6
CANADA**

Issuing Agency: Canadian General Standards Board
 Specification: CAN/CGSB-3.23-97
 Latest Revision Date: May 1999 (Amd 2)
 Grade Designation: Jet A/A-1
 Fuel Type: Kerosine
 NATO Code No. F-34 ¹

Test Method
ASTM

IP

| | | | |
|---|------|----------------------------|---|
| COMPOSITION | | | |
| Appearance | | C & B ² | |
| Acidity, Total (mg KOH/g) | Max. | 0.10 | D3242 |
| Aromatics (vol %) | Max. | 25 | D1319 |
| Olefins (vol %) | Max. | ... ¹ | D1319 |
| Sulphur, Total (wt %) | Max. | 0.30 | D1266, D2622 or D4294 ³ |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.003 Negative | D3227 D4952 |
| VOLATILITY | | | |
| Distillation Temperature: | | | 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 | D56 or D3828 |
| Density @ 15°C (kg/m ³) | | 775-840 | D1298 ³ or D4052 |
| FLUIDITY | | | |
| Freezing Point (°C) | Max. | -40 ⁴ | D2386 ³ , D4305 ⁵ , D5901 or D5972 |
| Viscosity @ -20°C (cSt) | Max. | 8 | D445 |
| COMBUSTION | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | D3338, D4529 or D4809 ³ |
| Luminometer Number | Min. | 45 ⁶ | D1740 |
| or Smoke Point (mm) | Min. | 25 | D1322 |
| or Smoke Point (mm) | Min. | 18 | D1322 |
| and Naphthalenes (vol %) | Max. | 3.0 | D1840 |
| CORROSION | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | D130 |
| Silver Strip (4h @ 50°C) | Max. | 2 ⁷ | 227 |
| STABILITY | | | |
| JFTOT ΔP (kPa) | Max. | 3.4 | D3241 ⁸ |
| Tube Deposit Rating (Visual) | Max. | <3 ⁹ | |
| CONTAMINANTS | | | |
| Existent Gum (mg/100 ml) | Max. | ... ¹ | D381 |
| Particulates (mg/L) | Max. | 0.44 ¹⁰ | D2276 ³ or D5452 |
| Water Reaction Interface | Max. | 1b | D1094 |
| MSEP Rating | Min. | 85 ¹¹ | D3948 |
| ADDITIVES | | | |
| Anti-Icing (vol %) | | 0.10-0.15 ¹² | D5006 |
| Antioxidant | | Option ¹³ | 277 (Method C) |
| Corrosion Inhibitor | | Option ¹³ | |
| Metal Deactivator | | Option ¹³ | |
| Static Dissipator | | Required ^{13, 14} | |
| OTHER | | | |
| Conductivity (pS/m) | | 50-450 ¹⁵ | D2624 |

NOTES:

- (1) For designation as F-34, the following changes apply: Freezing Point is -47°C max, Existent Gum is 7 mg/L max, Olefins is 5.0 vol % max. and conductivity range is 50-600 pS/m. Icing and corrosion inhibitor additives are mandatory.
- (2) Fuel shall be visually clear and free from undissolved water, sediment and suspended matter.
- (3) Referee test method, to be used in the event of a dispute.
- (4) Jet A-1 is similar in all properties except for Freezing Point which is -47°C max.
- (5) With D4305, use Procedure A only; this method shall not be used on samples with viscosities greater than 5.0 cSt at -20°C.
- (6) Fuel with Luminometer Number down to 40 is permitted, provided that purchaser is notified in writing within 30 days of shipment. Notification is not required for F-34 fuel.
- (7) Purchaser's option.
- (8) Thermal stability shall be determined at 260°C max. heater tube temperature.
- (9) Abnormal colour deposits shall be cause for rejection. Report spun tube ratings where Mark 8A tube deposit rater is available.
- (10) Limit at aircraft and refuellers. Limit into purchaser's storage is 2.2 mg/L max. A minimum of 4L shall be filtered.
- (11) For fuel without static dissipator additive (SDA). For fuel with SDA minimum limit is reduced to 70. These limits only apply at the point immediately prior to entering dedicated transportation to airport storage; and prior to addition of corrosion inhibitor.
- (12) Purchaser's option. Additive should conform to CAN/CGSB-3.526 (EGME) or ASTM D4171 Type III (DiEGME).
- (13) If additive is used, amount and name of additive shall be reported on test certificate.
- (14) When additive depletion is evident, further addition is allowed provided original concentration is 3 mg/L max. and cumulative concentration is 5 mg/L max. If initial concentration is not known, further additions shall not exceed 2 mg/L.
- (15) Typical relationship for variation of conductivity with temperature is defined in the specification.

**TABLE 7
CANADA**

| | |
|-----------------------|-----------------------------------|
| Issuing Agency: | Canadian General Standards Board |
| Specification: | CAN/CGSB-3.22-97 3-GP-24c |
| Latest Revision Date: | May 1999 (Amd 4) May 1999 (Amd 3) |
| Grade Designation: | Jet B High Flash |
| Fuel Type: | Wide-Cut Kerosine |
| NATO Code No. | F-40 ¹ |

**Test Method
ASTM**

IP

| | | | | |
|---|------|----------------------------|----------------------------|--|
| COMPOSITION | | | | |
| Appearance | | C & B ² | C & B ² | |
| Acidity, Total (mg KOH/g) | Max. | 0.10 | 0.03 | D3242 |
| Aromatics (vol %) | Max. | 25.0 | 25.0 | D1319 |
| Olefins (vol %) | Max. | 5.0 | 5.0 | D1319 |
| Sulphur, Total (wt %) | Max. | 0.40 | 0.40 | D1266, D2622 or D4294 ³ |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.003 Negative | 0.002 Negative | D3227 D4952 |
| VOLATILITY | | | | |
| Distillation Temperature: | | | | D86 |
| Initial BP (°C) | | Report | Report | |
| 10% Recovery (°C) | Max. | Report | 205 | |
| 20% Recovery (°C) | | 90 min 145 max | Report | |
| 50% Recovery (°C) | | 110 min 190 max | Report | |
| 90% Recovery (°C) | Max. | 245 | Report | |
| Final BP (°C) | Max. | Report | 300 | |
| Distillation Residue (vol %) | Max. | 1.5 | 1.5 | |
| Distillation Loss (vol %) | Max. | 1.5 | 1.5 | |
| Flash Point (°C) | Min. | ... | 60 | D93 |
| Density @ 15°C (kg/m ³) | | 750-801 | 788-845 | D1298 ³ or D4052 |
| Vapour Pressure (kPa) | Max. | 21 | | D323 ³ or D5191 |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | -51 | -46 | D2386 ³ , D4305 ⁴ , D5901 or D5972 ⁵ |
| Viscosity @ -20°C (cSt) | Max. | ... | 8.8 | D445 |
| COMBUSTION | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 42.6 | D3338, D4529 or D4809 ³ |
| Luminometer Number | Min. | 45 | ... | D1740 |
| or Smoke Point (mm) | Min. | 25 | 19 | D1322 |
| or Smoke Point (mm) | Min. | 20 | ... | D1322 |
| and Naphthalenes (vol %) | Max. | 3.0 | ... | D1840 |
| Hydrogen Content | | ... | Report | D1322, D3343 or D3701 |
| CORROSION | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1 | D130 |
| Silver Strip (4h @ 50°C) | Max. | 2 ⁶ | ... | 227 |
| STABILITY | | | | |
| JFTOT ΔP (kPa) | Max. | 3.4 | 3.4 | D3241 ⁷ |
| Tube Deposit Rating (Visual) | Max. | <3 ⁸ | <3 ⁸ | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 ml) | Max. | ... ¹ | 7 | D381 |
| Particulates (mg/L) | Max. | 0.44 ⁹ | 0.50 ⁹ | D2276 ³ or D5452 |
| Water Reaction Interface | Max. | 1b | 1b | D1094 |
| MSEP Rating | Min. | 70 ¹⁰ | 85 ¹¹ | D3948 |
| ADDITIVES | | | | |
| Anti-Icing (vol %) | | 0.10-0.15 ¹² | 0.15-0.20 ¹³ | D5006 |
| Antioxidant | | Option ¹⁴ | Option ^{14, 15} | 277 (Method C) |
| Corrosion Inhibitor | | Option ¹⁴ | Option ¹⁴ | |
| Metal Deactivator | | Option ¹⁴ | Option ¹⁴ | |
| Static Dissipator | | Required ^{14, 16} | Required ^{14, 16} | |
| OTHER | | | | |
| Conductivity (pS/m) | | 50-500 ¹⁷ | 50-600 ¹⁷ | D2624 |

NOTES:

- (1) For designation as F-40, the following changes apply: Freezing Point is -58°C max, Vapour Pressure is 14 kPa min, Existent Gum is 7 mg/L max, and conductivity range is 100-600 pS/m. Silver strip corrosion test, icing and corrosion inhibitor additives are mandatory.
- (2) Fuel shall be visually clear and free from undissolved water, sediment and suspended matter.
- (3) Referee test method, to be used in the event of a dispute.
- (4) With D4305, use Procedure A only; this method shall not be used on samples with viscosities greater than 5.0 cSt at -20°C.
- (5) Method D5972 may produce a higher (warmer) result than D2386 on wide-cut fuels such as Jet B or F-40.
- (6) Purchaser's option. Mandatory for F-40.
- (7) Thermal stability shall be determined at 260°C max. heater tube temperature.
- (8) Abnormal colour deposits shall be cause for rejection. Report spun tube ratings where Mark 8A tube deposit rater is available.
- (9) Limit at aircraft and refuellers. Limit into purchaser's storage is 2.2 mg/L max. A minimum of 4L shall be filtered.
- (10) Limit applies after addition of Stadis 450. If fuel is re-doped with Stadis 450, MSEP rating shall not apply, provided the fuel is in dedicated transportation or storage. When the fuel also contains corrosion inhibitor, no MSEP limit shall apply.
- (11) Limit is applicable to fuels containing all additives except static dissipator additive and corrosion inhibitor.
- (12) Purchaser's option. Additive should conform to CAN/CGSB-3.526 (EGME) or ASTM D4171, Type III (DiEGME).
- (13) Use additive conforming to ASTM D4171, Type III (DiEGME).
- (14) If additive is used, amount and name of additive shall be reported on test certificate.
- (15) Antioxidants are mandatory in hydrogen-treated fuels, optional in others.
- (16) When additive depletion is evident, further addition is allowed provided original concentration is 3 mg/L max. and cumulative concentration is 5 mg/L max. If initial concentration is not known, further additions shall not exceed 2 mg/L.
- (17) Typical relationship for variation of conductivity with temperature is defined in the specification.

**TABLE 8
COLOMBIA**

| | | | |
|-----------------------|-----------------|----------|--------------------|
| Issuing Agency: | ICONTEC | | |
| Specification: | NTC 1899 | | |
| Latest Revision Date: | 23 October 1996 | | |
| Grade Designation: | Jet A/A-1 | Jet B | Test Method |
| Fuel Type: | Kerosine | Wide-Cut | ASTM |

| COMPOSITION | | Jet A/A-1 | Jet B | Test Method |
|---|------|-----------------------------|-----------------------------|------------------------------------|
| | | Kerosine | Wide-Cut | ASTM |
| COMPOSITION | | | | |
| Appearance | | C & B ¹ | C & B ¹ | D4176 |
| Acidity, Total (mg KOH/g) | Max. | 0.1 | ... | D3242 |
| Aromatics (vol %) | Max. | 22 | 22 | D1319 |
| Sulphur, Total (wt %) | Max. | 0.3 | 0.3 | D1266, D2622, D1552, D4294 |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.003 Negative Report | 0.003 Negative Report | D3227 D4952 D156 |
| Colour, Saybolt | | | | |
| VOLATILITY | | | | |
| VOLATILITY | | | | |
| Distillation Temperature: | | | | D86 |
| Initial BP (°C) | | Report | Report | |
| 10% Recovery (°C) | Max. | 205 | ... | |
| 20% Recovery (°C) | Max. | ... | 145 | |
| 50% Recovery (°C) | Max. | Report | 190 | |
| 90% Recovery (°C) | Max. | Report | 245 | |
| Final BP (°C) | Max. | 300 | ... | |
| Distillation Residue (vol %) | Max. | 1.5 | 1.5 | |
| Distillation Loss (vol %) | Max. | 1.5 | 1.5 | |
| Flash Point (°C) | Min. | 38 | ... | D56, D3828 |
| Density @ 15°C (kg/m ³) or Gravity, API @ 60°F | | 775-840 | 751-802 | D1298, D4052 |
| Vapour Pressure @ 38°C (kPa) | Max. | 51-37 | 57-45 | |
| | | ... | 21 | D323, D5191 ² |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | -40 ³ | -50 | D2386 |
| Viscosity @ -20°C (cSt) | Max. | 8.0 | ... | D445 |
| COMBUSTION | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 42.8 | D4529, D3338 D4809 ⁴ |
| Luminometer No. | Min. | 45 | 45 | D1740 |
| or Smoke Point (mm) | Min. | 25 | 25 | D1322 |
| or Smoke Point (mm) | Min. | 19 | 19 | D1322 |
| and Naphthalenes (vol %) | Max. | 3 | 3 | D1840 |
| CORROSION | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1 | D130 |
| STABILITY | | | | |
| JFTOT ΔP (kPa) | Max. | 3.3 | 3.3 | D3241 |
| Tube Deposit Rating (Visual) | Max. | <3 | <3 | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 ml) | Max. | 7 | 7 | D381 |
| Water Reaction Interface | Max. | 1b | 1b | D1094 |
| MSEP Rating | Min. | 85 ⁵ | ... | D3602, D3948 |
| Filter Membrane Colour | Max. | 5 ⁶ | ... | D2276 |
| ADDITIVES | | | | |
| Anti-Icing (vol %) | | 0.10-0.15 ⁷ | 0.10-0.15 ⁷ | D5006 |
| Antioxidant | | Option | Option | |
| Corrosion Inhibitor | | Option | Option | |
| Metal Deactivator | | Option | Option | |
| Static Dissipator | | Required | Required | |
| OTHER | | | | |
| Conductivity (pS/m) | | 50-450 ⁸ | 50-450 ⁸ | D3114 |

NOTES:

- (1) Fuel shall be free from water, sediment and suspended matter. Odour shall not be nauseating or irritating.
- (2) D5191 is referee test method to be used in case of dispute.
- (3) For Jet A-1, Freezing Point is -47°C max.
- (4) D4809 is referee test method to be used in case of dispute.
- (5) This requirement is for control at the refinery on sample taken after 24 hours settling time in tankage.
- (6) This requirement applies to fuel at point of entry into aircraft.
- (7) Additive should conform to ASTM D4171, Type I (EGME) or Type III (DiEGME).
- (8) Conductivity limits apply to fuel at point of entry into aircraft. Concentration of Stadis 450 additive limited to 3 mg/L max. on production, and cumulative total of 5 mg/L max. for downstream addition.

**TABLE 9
FRANCE**

Issuing Agency: Service des essences des armées
 Specification: DCSEA 134
 Latest Revision Date: Edn. 2, March 1998
 Grade Designation:
 Fuel Type:
 NATO Code No.

| | | Kerosine F-34/F-35 ⁷ | Test Method ASTM | IP | NF |
|--|------|------------------------------------|--------------------------|------------|----------------------|
| COMPOSITION | | | | | |
| Appearance | | ¹ | | | LSEA D 14 |
| Acidity, Total (mg KOH/g) | Max. | 0.0150 | D3242 | 354 | |
| Aromatics (vol %) | Max. | 22.0 | D1319 | 156 | M 07-024 |
| or Aromatics (vol %) | Max. | 25.0 | D1319 | 156 | M 07-024 |
| and Hydrogen Content (wt %) | Min. | 13.5 | D3701, D3343 | 338 | |
| Sulphur, Total (wt %) | Max. | 0.30 | D1552, D2622 or D4294 | 336 | EN ISO 8754 |
| Sulphur, Mercaptan (wt %) | Max. | 0.0030 | D3227 | 342 | M 07-059 |
| or Doctor Test | | Negative | D4952 | 30 | M 07-022 M 07-029 |
| VOLATILITY | | | | | |
| Distillation Temperature: | | | D86 | 123 | M 07-002 |
| Initial BP (°C) | | Report | | | |
| 10% Recovery (°C) | Max. | 205.0 | | | |
| 20% Recovery (°C) | | Report | | | |
| 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 ² | D3828 | 170, 303 | M 07-011 |
| Density @ 15°C (kg/m ³) | | 775-840 | D1298, D4052 | 160, 365 | EN ISO 12185 |
| FLUIDITY | | | | | |
| Freezing Point (°C) | Max. | -47 | D2386 | 16 | M 07-048 |
| Viscosity @ -20°C (cSt) | Max. | 8.0 | D445 | 71 | EN ISO 3104 |
| COMBUSTION | | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | D4529 ³ | | |
| Smoke Point (mm) | Min. | 25 | D1322 | 57 | M 07-028 |
| or Smoke Point (mm) | Min. | 19 | D1322 | 57 | M 07-028 |
| and Naphthalenes (vol %) | Max. | 3.0 | D1840 | | |
| CORROSION | | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1b | D130 | 154 | EN ISO 2160 |
| Silver Strip (4h @ 50°C) | Max. | 2 | | 227 | |
| STABILITY | | | | | |
| JFTOT ΔP (kPa) | Max. | 3.30 | D3241 ⁴ | 323 | M 07-051 |
| Tube Deposit Rating (Visual) | Max. | <3 ⁵ | | | |
| Peroxide Number (mEq/dm ³) | Max. | 2 | | | LSEA-D-29 |
| CONTAMINANTS | | | | | |
| Existent Gum (mg/100 ml) | Max. | 7 | D381 D1094 | 131 289 | EN 26246 |
| Water Reaction: | | | | | |
| Interface Rating | Max. | 1b | | | |
| Separation Rating | Max. | [2] | | | |
| MSEP Rating | Min. | 85 ⁶ | D3948 | | |
| ADDITIVES | | | | | |
| Anti-Icing (vol %) | | 0.10-0.15 ⁷ | | | |
| Antioxidant | | Required ⁸ | | | |
| Corrosion Inhibitor | | Required ⁹ | | | |
| Metal Deactivator | | Option | | | |
| Static Dissipator | | Required ¹⁰ | | | |
| Biocide | | Option ¹¹ | | | |
| Others | | ¹² | | | |
| OTHER | | | | | |
| Conductivity (pS/m) | | 50-450 | D2624 | 274 | |

NOTES:

- Fuel to be free from water, other petroleum products and suspended matter. Colour to be noted.
- Result of 40°C accepted with method D56. Result of 41°C accepted with methods NF EN 22719, ASTM D93 and IP 34.
- Referee test method, to be used in the event of a dispute, is NF M 07-030 (ASTM D4809).
- JFTOT test at 260°C.
- 'Abnormal' or 'peacock' colour on tube not accepted.
- For fuel without static dissipator additive (SDA). For fuel with SDA minimum limit is reduced to 70. These limits apply only at point of manufacture. If MSEP is measured in distribution system, no limits apply, and results shall not be cause for rejection of product.
- Addition of icing inhibitor changes fuel designation from F-35 to F-34.
- Add immediately after hydrodesulphurisation of fuel in refinery. Not mandatory for kerosines not produced by processes other than hydrotreatment or synthesis.
- Required as lubricity improver in F-34 for military use, and in F-35 of synthetic or hydrotreated origin.
- Concentration on first addition is limited to 3 mg/L. Cumulative concentration allowed when redoping fuel is 5 mg/L.
- Concentration of biocide in fuel entering aircraft should not exceed 50 ppm. Kathon FP 1.5 is the only additive meeting requirements of DCSEA 754. Biobor JF additive may be used by agreement.
- Leak detectors (e.g. SF₆), pipeline drag reducers and anti-misting additives are not authorised in the present specification.

**TABLE 10
JAPAN**

Issuing Agency: Petroleum Association of Japan
 Specification: Joint Fuelling System Check List (Issue 13) ¹
 Latest Revision Date: 25 January 1999
 Grade Designation: Jet A-1
 Fuel Type: Kerosine

| | | | Test Method ASTM | IP | JIS |
|-------------------------------------|------|------------------------|---------------------------|------------------|--------------------|
| COMPOSITION | | | | | |
| Appearance | | ² | D4176 Procedure 1 | | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | D3242 | 354 | K2276 |
| Aromatics (vol %) | Max. | 22 | D1319 | 156 | K2536 |
| or Aromatics (vol %) | Max. | 25 | D1319 | 156 | K2536 |
| and Hydrogen content (wt %) | | Report | D3701 or D3343 | 338 | K2276 |
| Sulphur, Total (wt %) | Max. | 0.30 | D1266, D2622 ³ | 107 | K2541 |
| Sulphur, Mercaptan (wt %) | Max. | 0.003 | D3227 | 342 | K2276 |
| or Doctor Test | | Negative ⁴ | D4952 | 30 | K2276 |
| H/P Components (vol %) | | Report ⁵ | | | |
| VOLATILITY | | | | | |
| Distillation Temperature: | | | D86 | 123 | K2254 |
| 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 ⁶ | D3828 | 170 or 303 | |
| Density @ 15°C (kg/m ³) | | 775-840 | D1298 or D4052 | 160 or 365 | K2249 |
| FLUIDITY | | | | | |
| Freezing Point (°C) | Max. | -47 | D2386 ⁷ | 16 | K2276 |
| Viscosity @ -20°C (cSt) | Max. | 8 | D445 | 71 | K2283 |
| COMBUSTION | | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | D4809 ⁸ | 12 ⁸ | K2279 |
| Smoke Point (mm) | Min. | 25 | D1322 | ... | K2537 |
| or Luminometer | Min. | 45 | D1740 | ... | K2276 |
| or Smoke Point (mm) | Min. | 19 | D1322 | ... | K2537 |
| and Naphthalenes (vol %) | Max. | 3 | D1840 | ... | K2276 |
| CORROSION | | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | D130 | 154 | K2513 |
| Silver Strip (4h @ 50°C) | Max. | 2 | ... | 227 | K2276 |
| STABILITY | | | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 | D3241 ⁹ | 323 ⁹ | K2276 ⁹ |
| Tube Deposit Rating (Visual) | Max. | <3 ¹⁰ | | | |
| CONTAMINANTS | | | | | |
| Existent Gum (mg/100 ml) | Max. | 7 | D381 | 131 | K2261 |
| Water Reaction Interface | Max. | 1b | D1094 | 289 | K2276 |
| MSEP Rating | Min. | 85 ¹¹ | D3948 | | |
| ADDITIVES | | | | | |
| Anti-Icing | | Agreement | | | |
| Antioxidant | | Required ¹² | | | |
| Corrosion Inhibitor | | Agreement | | | |
| Metal Deactivator | | Option | | | |
| Static Dissipator | | Required ¹³ | | | |
| OTHER | | | | | |
| Conductivity (pS/m) | | 50-450 ¹⁴ | D2624 | 274 | K2276 |

NOTES:

- (1) Reference: international JFSCCL Issue 17.
- (2) Fuel should be clear, bright and visually free from solid matter and undissolved water at normal ambient temperature.
- (3) Alternative test methods are ASTM D1552, D4294, D5453, and IP 336, 243, 373.
- (4) In the event of conflict between Sulphur Mercaptan and Doctor Test results, the Sulphur Mercaptan result shall prevail.
- (5) Report total vol % of hydroprocessed fuel (including 'nil' or 100%), to include hydrotreated, hydrofined and hydrocracked material.
- (6) Subject to minimum of 40°C if results obtained by (Tag) method ASTM D56, JIS K2265.
- (7) Alternative test methods are ASTM D4305, D5901, and D5972.
- (8) Calculated Specific Energy by one of the following methods is also acceptable: D3338, D4529/IP 381 or IP 355.
- (9) JFTOT to be carried out at a control temperature of 260°C.
- (10) No 'peacock' or 'abnormal' colour deposits should be present.
- (11) For fuel without static dissipator additive (SDA). For fuel with SDA minimum limit is reduced to 70. These MSEP requirements apply only to point of manufacture. If testing is carried out downstream, no specification limits apply and the results are not to be used as the sole reason for rejection of fuel.
- (12) Antioxidants are mandatory in hydroprocessed fuels and synthetic fuel, and must be added immediately after processing and prior to the product or component being passed to storage.
- (13) 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.
- (14) Conductivity limits apply at the point, time and temperature of delivery to the user.

TABLE 11
JAPAN

| | | | |
|-------------------------------------|----------------------|------------------|--|
| Issuing Agency: | Japan Defense Agency | | |
| Specification: | DSP K2206D | | |
| Latest Revision Date: | 21 March 1996 | | |
| Grade Designation: | JP-4 | JP-5 | Test Method |
| Fuel Type: | Wide-Cut | Kerosine | JIS or other |
| COMPOSITION | | | |
| Appearance | C&B ¹ | C&B ¹ | Visual |
| Colour | Report | Report | JIS K2580 |
| Acidity, Total (mg KOH/g) | Max. 0.015 | 0.015 | JIS K2276 |
| Aromatics (vol %) | Max. 25 | 25 | JIS K2536 |
| Olefins (vol %) | Max. 5 | 5 | JIS K2536 |
| Sulphur, Total (wt %) | Max. 0.4 | 0.4 | JIS K2541 |
| Sulphur, Mercaptan (wt %) | Max. 0.002 | 0.002 | JIS K2276 |
| or Doctor Test | Negative | Negative | |
| VOLATILITY | | | |
| Distillation Temperature | | | JIS K2254 |
| 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 K2265 |
| Density @ 15°C (kg/m ³) | 751-802 | 788-845 | JIS K2249 |
| Vapour Pressure @ 37.8°C (kPa) | 14-21 | ... | JIS K2258 |
| FLUIDITY | | | |
| Freezing Point (°C) | Max. -58 | -46 | JIS K2276 ² |
| Viscosity @ -20°C (cSt) | Max. ... | 8.5 | JIS K2283 |
| COMBUSTION | | | |
| Aniline-Gravity Product | Min. 5250 | 4500 | JIS K2206 |
| Net Heat of Comb. (MJ/kg) | Min. 42.8 | 42.6 | JIS K2279 |
| Hydrogen Content (wt %) | Min. 13.6 | 13.4 | JIS K2276 |
| Smoke Point (mm) | Min. 20 | 19 | JIS K2537 |
| CORROSION | | | |
| Copper Strip (2h @ 100°C) | Max. 1 | 1 | JIS K2513 |
| STABILITY | | | |
| JFTOT ΔP (kPa) | Max. 3.3 | 3.3 | JIS K2276 ³ |
| Tube Deposit Rating (Visual) | Max. <3 | <3 | |
| Peroxide Number (mass ppm) | Max. ... | 8 | ASTM D3703 |
| CONTAMINANTS | | | |
| Existent Gum (mg/100 ml) | Max. 7 | 7 | JIS K2261 |
| Particulates (mg/L) | Max. 1 | 1 | JIS K2276 or ⁴ |
| Filtration Time (min) | Max. 10 | 15 | ⁴ |
| Water Reaction Interface | Max. 1b | 1b | JIS K2276 |
| MSEP Rating | Min. ⁵ | 70 | JIS K2276 |
| ADDITIVES | | | |
| Anti-Icing (vol %) | 0.10-0.15 | 0.15-0.20 | FED-STD-791 method 5327, 5340 or 5342 ⁶ |
| Antioxidant | Option | Option | |
| Corrosion Inhibitor | Option | Option | |
| Metal Deactivator | Option | Option | |
| Static Dissipator | Required | Required | |
| OTHER | | | |
| Conductivity (pS/m) | 150-600 ⁷ | ... | JIS K2276 |

NOTES:

- (1) Fuel should be clear, bright and visually free from solid matter and undissolved water.
- (2) If the Freezing Point is more than 4.5°C below the regulation value, maximum limit shall be reduced.
- (3) Thermal stability shall be determined at 260°C max. heater tube temperature.
- (4) Method detailed in Appendix 2 of DSP K2206D. Sampling point at tank, shipping pipeline, tanker or tank car, with 4L sample required.
- (5) MSEP rating is 70 min. for fuel with static dissipator additive, and 85 min. without static dissipator additive.
- (6) Sampling point to be at an end user vessel.
- (7) Applies at ambient fuel temperature or 29.4°C, whichever is the lower.

TABLE 12
PEOPLES' REPUBLIC OF CHINA

| Issuing Agency: | | PRC Ministry of Petroleum Industry Standards | | | | |
|-------------------------------------|------|--|-------------------|------------|--------------------|-------------|
| Specification: | | GB 438-88 | GB 1788-88 | SH 0348-92 | | |
| Latest Revision Date: | | 1988 | 1988 | 1992 | | |
| Grade Designation: | | RP-1 | RP-2 | RP-4 | Test Method | |
| Fuel Type: | | Kerosine | Kerosine | Wide-Cut | GB/T | SH/T |
| COMPOSITION | | | | | | |
| Appearance | | 1 | 1 | 1 | | |
| Acidity, Total (mg KOH/g) | Max. | 1.0 | 1.0 | 1.0 | 258 | |
| Aromatics (vol %) | Max. | 20 | 20 | 20 | | 0177 |
| Iodine Value (g/100g) | Max. | 3.5 | 4.2 | 4.2 | | 0294 |
| Sulphur, Total (wt %) | Max. | 0.2 | 0.2 | 0.25 | 380 | |
| Sulphur, Mercaptan (wt %) | Max. | 0.005 | 0.002 | 0.005 | 1792 | |
| VOLATILITY | | | | | | |
| Distillation Temperature: | | | | | 6536 | |
| Initial BP (°C) | | 150 | 150 | 60 | | |
| 10% Recovery (°C) | Max. | 165 | 165 | Report | | |
| 20% Recovery (°C) | | ... | ... | Report | | |
| 50% Recovery (°C) | Max. | 195 | 195 | 195 | | |
| 90% Recovery (°C) | Max. | 230 | 230 | ... | | |
| 98% Recovery (°C) | Max. | 250 | 250 | 280 | | |
| Residue plus Loss (vol %) | Max. | 2.0 | 2.0 | 3.0 | | |
| Flash Point (°C) | Min. | 28 | 28 | ... | 261 | |
| Density @ 20°C (kg/m ³) | Min. | 775 | 775 | 750 | 1884 or 1885 | |
| FLUIDITY | | | | | | |
| Crystallisation Point (°C) | Max. | -60 | -50 | -40 | | 0179 |
| Viscosity @ -20°C (cSt) | Min. | 1.25 | 1.25 | 1.0 | 265 | |
| Viscosity @ -40°C (cSt) | Max. | 8.0 | 8.0 | 6.0 | 265 | |
| COMBUSTION | | | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 42.9 | 42.7 | 384 ² | |
| Luminometer No. | Min. | 45 | 45 | ... | 11128 | |
| or Smoke Point (mm) | Min. | 25 | 25 | Report | 382 | |
| or Smoke Point (mm) | Min. | 20 | 20 | ... | 382 | |
| and Naphthalenes (vol %) | Max. | 3 | 3 | ... | | 0181 |
| CORROSION | | | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1 | | 5096 | |
| Copper Strip (3h @ 50°C) | Max. | ... | ... | 1 | 5096 | |
| Silver Strip (4h @ 50°C) | Max. | 1 | 1 | ... | | 0023 |
| STABILITY | | | | | | |
| Thermal Stability | | Pass ³ | Pass ³ | ... | | |
| CONTAMINANTS | | | | | | |
| Water Soluble Acids or Alkalis | Max. | Nil | Nil | Nil | 259 | |
| Existent Gum (mg/100 mL) | Max. | 5.0 | 5.0 | 5.0 | 509 | |
| Water Reaction: | | | | | 1793 | |
| Interface Rating | Max. | 1b | 1b | Report | | |
| Separation Rating | | Report | Report | Report | | |
| Volume Change (mL) | Max. | 1 | 1 | Report | | |
| Ash Content (wt %) | Max. | 0.005 | 0.005 | ... | 508 | |
| ADDITIVES | | | | | | |
| | | 4 | 4 | 4 | | |

NOTES:

- (1) For appearance test, pour 100mL of sample into a measuring cylinder, maintaining the temperature at 15-25°C. The fuel should be free from water and solid (suspended) matter. In case of dispute, test procedures GB/T 511 and GB/T 260 should be used.
- (2) Calculation method SY 2210 may also be used.
- (3) Dynamic thermal stability of fuel should be tested at least annually by method SY 2226.
- (4) Additives are allowed to be added to the fuel, but type and dosage are not specified.

TABLE 13
PEOPLES' REPUBLIC OF CHINA

| | | | | |
|-------------------------------------|--|---------------------|--------------------------|-------------|
| Issuing Agency: | National Technology Supervisory Bureau | | | |
| Specification: | GB 6537-94 | | | |
| Latest Revision Date: | 1 June 1995 | | | |
| Grade Designation: | No. 3 Jet Fuel | | Test Method | |
| Fuel Type: | Kerosine | | GB/T | SH/T |
| COMPOSITION | | | | |
| Appearance | | C & B ¹ | ² | |
| Colour | | Report | 3555 | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | 12574 | |
| Aromatics (vol %) | Max. | 20.0 | 11132 | |
| Olefins (vol%) | Max. | 5.0 | 11132 | |
| Sulphur, Total (wt %) | Max. | 0.20 | 380 | |
| Sulphur, Mercaptan (wt %) | Max. | 0.0020 | 1792 | |
| or Doctor Test | | Negative | | 0174 |
| VOLATILITY | | | | |
| Distillation Temperature: | | | 6536 ³ | |
| Initial BP (°C) | | Report | | |
| 10% Recovery (°C) | Max. | 205 | | |
| 20% Recovery (°C) | | 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 (°C) | Min. | 38 | 261 | |
| Density @ 20°C (kg/m ³) | | 775-830 | 1884 or 1885 | |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | -47 | 2430 | |
| Viscosity @ 20°C (cSt) | Min. | 1.25 | 265 | |
| Viscosity @ -20°C (cSt) | Max. | 8.0 | 265 | |
| COMBUSTION | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 384 or 2429 ⁴ | |
| Smoke Point (mm) | Min. | 25 | 382 | |
| or Luminometer Number | Min. | 45 | 11128 | |
| or Smoke Point (mm) | Min. | 20 | 382 | |
| and Naphthalenes (vol %) | Max. | 3.0 | | 0181 |
| CORROSION | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 5096 | |
| Silver Strip (4h @ 50°C) | Max. | 1 | | 0023 |
| STABILITY | | | | |
| Filter ΔP (kPa) | Max. | 3.3 | 9169 | |
| Tube Deposit Rating (Visual) | Max. | <3 ⁵ | | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | 8019 ⁶ | |
| Water Reaction: | | | 1793 | |
| Interface Rating | Max. | 1b | | |
| Separation Rating | | Report | | |
| Particulates (mg/L) | | Report | | 0093 |
| ADDITIVES | | | | |
| | | ⁷ | | |
| OTHER | | | | |
| Conductivity @ 20°C (pS/m) | | 50-450 ⁸ | | 6539 |

NOTES:

- (1) Product should be clear and bright, without undissolved water and sediment.
- (2) Sample should be placed in a 100 mL glass graduated cylinder and observed at room temperature. In case of dispute, test procedures GB/T 511 and GB/T 260 should be used.
- (3) Alternative test method is GB/T 255 Petroleum Distillation Test. In case of dispute, refer to GB/T 6536.
- (4) In case of dispute, refer to GB/T 384.
- (5) No 'peacock' or 'abnormal' colour deposits allowed.
- (6) Alternative test method is for Existent Gum is GB/T 509. In case of dispute, refer to GB/T 8019.
- (7) It is permitted to add approved additives.
- (8) If static dissipator additive is not required and no request is made on this specification item, fuel leaving the refinery should have conductivity of 150 pS/m min.

**TABLE 14
RUSSIA**

Issuing Agency:
Specification:
Latest Revision Date:
Grade Designation:
Fuel Type:

State Standard Committee
GOST 10227-86
August 1995

TS-1
Kerosine
Premium

TS-1
Kerosine
Regular

T-1
Kerosine
Regular

**Test Method
GOST**

| COMPOSITION | | | | | |
|--|------|------------------------|------------------------|------------------|-----------------------|
| Appearance | | C & B | C & B | 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/100 g) | Max. | 2.5 | 3.5 | 2.0 | 2070-82 |
| Sulphur, Total (wt %) | Max. | 0.20 | 0.25 | 0.10 | 19121-73 |
| Sulphur, Mercaptan (wt %) | Max. | 0.003 | 0.05 | ... | 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 (°C) | 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 @ -40°C (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) | | Pass | Pass | Pass | 6321-92 |
| STABILITY | | | | | |
| Static Oxidation Test @ 150°C | | | | | 11802-88 |
| Deposit (mg/100 cm ³) | Max. | 18 | 18 | 35 | |
| 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: | | | | | 27154-86 |
| Interface Rating | Max. | 1 | 1 | ... | |
| Separation Rating | Max. | 1 | 1 | ... | |
| ADDITIVES | | ⁶ | ⁶ | ⁶ | |
| OTHER | | | | | |
| Conductivity (pS/m) | | 50-600 ^{7, 8} | 50-600 ^{7, 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) Additives which have been qualified in accordance with established procedures may be used to improve performance characteristics of fuels.
- (7) Minimum conductivity limit at temperature of fuelling, maximum limit at 20°C.
- (8) Conductivity is limited only for fuels containing Sigbol antistatic additive.

TABLE 15
RUSSIA

| | | | | | |
|--|--------------------------|----------------------|------------------------|------------------------|-----------------------------|
| Issuing Agency: | State Standard Committee | | | | |
| Specification: | GOST 10227-86 | | | | |
| Latest Revision Date: | August 1995 | | | | |
| Grade Designation: | T-1S | T-2 | RT | | |
| Fuel Type: | Kerosine Test Special | Kerosine Wide-Cut | Kerosine Premium | | Test Method GOST |
| COMPOSITION | | | | | |
| Appearance | | C & B | C & B | 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/100 g) | Max. | 2.0 | 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 | 755 | 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) | | Pass | Pass | Pass | 6321-92 ⁴ |
| STABILITY | | | | | |
| Static Oxidation Test @ 150°C | | | | | 11802-88 |
| Deposit (mg/100 cm ³) | Max. | 6 | 18 | 6 | |
| Soluble Gum (mg/100 cm ³) | Max. | ... | ... | 30 | |
| Insoluble Gum (mg/100 cm 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 Alkalines | | 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: | | | | | 27154-86 |
| Interface Rating | Max. | ... | ... | 1 | |
| Separation Rating | Max. | ... | ... | 1 | |
| ADDITIVES | | | | | |
| | | ⁷ | ⁷ | ⁷ | |
| OTHER | | | | | |
| Conductivity (pS/m) | | ... | 50-600 ^{8, 9} | 50-600 ^{8, 9} | 25950-83 |

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) Additives which have been qualified in accordance with established procedures may be used to improve performance characteristics of fuels.
- (8) Minimum conductivity limit at temperature of fuelling, maximum limit at 20°C.
- (9) Conductivity is limited only for fuels containing Sigbol antistatic additive.

TABLE 16
SPAIN

Issuing Agency: INTA
 Specification: NORMA INTA 15 13 17N
 Latest Revision Date: April 1994
 Grade Designation:
 Fuel Type: Kerosine
 NATO Code No. F-35

Test Method
INTA

| | | | |
|---|------|-----------------------|---|
| COMPOSITION | | | |
| Appearance | | C & B ¹ | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | 15 04 52 |
| Aromatics (vol %) | Max. | 22.0 ² | 15 04 27 B |
| Olefins (vol%) | Max. | 5.0 | 15 04 27 B |
| Sulphur, Total (wt %) | Max. | 0.30 | 15 04 36 B or 15 06 21 A |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.0030 Negative | 15 04 45 C 15 04 43 B |
| VOLATILITY | | | |
| Distillation Temperature: | | | 15 02 27 E |
| 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 ³ | 15 02 33 C, 15 02 32 B or 15 02 17 B |
| Density @ 15°C (kg/m ³) | | 775-840 | 15 02 13 A |
| FLUIDITY | | | |
| Freezing Point (°C) | Max. | -47 | 15 02 64 A |
| Viscosity @ -20°C (cSt) | Max. | 8.0 | 15 02 16 B |
| COMBUSTION | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 15 01 52 |
| Smoke Point (mm) | Min. | 25 | 15 06 14 B |
| or Luminosity Index | Min. | 45 | 15 06 15 |
| or Smoke Point (mm) | Min. | 19 | 15 06 14 B |
| and Naphthalenes (vol %) | Max. | 3.0 | 15 05 55 |
| CORROSION | | | |
| Copper Strip (2h @ 100°C) | Max. | 1b | 15 04 42 C |
| Silver Strip (4h @ 50°C) | Max. | 1 | 15 04 21 B |
| STABILITY | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 | 15 06 23 A ⁴ |
| Tube Deposit Rating (Visual) | Max. | <3 ⁵ | |
| Tube Deposit Rating (TDR) ⁶ | Max. | 15 ⁵ | |
| CONTAMINANTS | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | 15 04 35 C |
| Water Reaction Interface | Max. | 1b | 15 02 47 E |
| MSEP Rating | Min. | 85 ⁷ | 15 06 25 |
| ADDITIVES | | | |
| Anti-Icing (vol %) | | 0.10-0.15 | |
| Antioxidant | | Required ⁸ | |
| Corrosion Inhibitor | | Option | |
| Metal Deactivator | | Option | |
| Static Dissipator | | Required | |
| OTHER | | | |
| Conductivity (pS/m) | | 50-450 | 15 02 99 B |

NOTES:

- (1) Product should be clear and bright, without water or suspended matter, measured at 21°C or ambient temperature if this is higher.
- (2) Fuel with aromatics content to 25 vol % max. is permitted, provided hydrogen content is also determined by INTA 15 05 66 or INTA 15 02 74 and reported.
- (3) Minimum limit is 40°C if method INTA 15 02 32 B is used.
- (4) Thermal stability to be determined at 260°C heater tube temperature.
- (5) Heater tube shall have no peacock or blue/grey colour deposits.
- (6) In case of dispute, tube deposits will be determined by Visual Tuberator.
- (7) Limit applies to fuel containing only antioxidant additive. When fuel contains static dissipator, icing inhibitor or corrosion inhibitor, minimum limit is reduced to 70. When both static dissipator and corrosion inhibitor are present, no limit is applied.
- (8) Required if fuel has been hydrogen treated. To be added immediately after processing and before storage, at concentration range 17.0-24.0 mg/L.

**TABLE 17
SWEDEN**

Issuing Agency: Swedish Defence Materiel Administration
 Specification: FSD 8607E
 Latest Revision Date: 10 February 1995
 Grade Designation: Flygfotogen 75
 Fuel Type: Kerosine

**Test Method
ASTM or other**

| | | | |
|-------------------------------------|------|-----------------------|------------------------------------|
| COMPOSITION | | | |
| Appearance | | C & B Report | Visual inspection |
| Colour | | 0.015 | ASTM D156 |
| Acidity, Total (mg KOH/g) | Max. | 25 | ASTM D3242 |
| Aromatics (vol %) | Max. | 5 | ASTM D1319, IP 391 |
| Olefins (vol %) | Max. | 0.10 | ASTM D1319, D1159 |
| Sulphur, Total (wt %) | Max. | Negative | ASTM D129, D1266, D2622, IP 243 |
| Sulphur, Mercaptan, Doctor Test | | | ASTM D4952 |
| VOLATILITY | | | |
| Distillation Temperature: | | | SIS 15 51 46 (ISO 3405) |
| Initial BP (°C) | | Report | ASTM D86 |
| 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 D2386 |
| 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 |
| 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 | IP 227 |
| STABILITY | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 | ASTM D3241 |
| Tube Deposit Rating (Visual) | Max. | 2 ¹ | |
| 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 | | No visible amount | Visual inspection |
| Water Reaction Interface | Max. | 1b | ASTM D1094 |
| MSEP Rating | Min. | 70 ² | ASTM D3948 |
| ADDITIVES | | | |
| Antioxidant | | Required ³ | IP 343 |
| Corrosion Inhibitor | | Required ⁴ | IR |
| Static Dissipator | | Required ⁵ | |
| OTHER | | | |
| Conductivity (pS/m) | | 200-600 | ASTM D2624 |

NOTES:

- (1) 'Abnormal' or 'peacock' type deposits are not accepted.
- (2) MSEP limit is valid for fuel containing all additives, but without static dissipator additive.
- (3) Antioxidant in accordance with MIL-T-83133 required at 17-24 mg/L.
- (4) Corrosion inhibitor/lubricity improver Hitec 580 required at 15-22.5 mg/L.
- (5) Static dissipator additive in accordance with MIL-T-83133 required.

**TABLE 18
UNITED KINGDOM**

| | | | |
|-----------------------|---|---------------------|---------------------|
| Issuing Agency: | Ministry of Defence (Procurement Executive) | | |
| Specification: | Def Stan 91-86/2 | Def Stan 91-88/1 | Def Stan 91-91/3 |
| Latest Revision Date: | 23 May 1997 | 23 May 1997 | 12 Nov 1999 |
| Grade Designation: | AVCAT/FSII | AVTAG/FSII | AVTUR/Jet A-1 |
| Fuel Type: | High Flash | Wide-Cut | Kerosine |
| NATO Code No. | F-44 | F-40 | F-35 ²¹ |

Test Method ¹
ASTM IP

| | | | | | | |
|---|------|------------------------|------------------------|------------------------|---------------------|---------------------|
| COMPOSITION | | | | | | |
| Appearance | | C & B | C & B | C & B | ² | |
| Acidity, Total (mg KOH/g) | Max. | 0.015 | 0.015 | 0.015 | D3242 | 354 |
| Aromatics (vol %) | Max. | 22.0 ³ | 25.0 | 25.0 | D1319 | 156 |
| Sulphur, Total (wt %) | Max. | 0.30 | 0.30 | 0.30 | ⁴ | 336 ⁴ |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.0030 | 0.0030 | 0.0030 | D3227 | 342 |
| H/P Components (vol %) | | Negative | Negative | Negative | ⁵ | 30 |
| Severely H/P Components (vol %) | | | | Report ⁶ | | Report ⁷ |
| VOLATILITY | | | | | | |
| Distillation Temperature: | | | | | D86 | 123 |
| Initial BP (°C) | | Report | Report | Report | | |
| 10% Recovery (°C) | Max. | 205 | Report | 205 | | |
| 20% Recovery (°C) | Min. | ... | 100 | ... | | |
| 50% Recovery (°C) | Min. | Report | 125 | Report | | |
| 90% Recovery (°C) | Max. | Report | Report | Report | | |
| Final BP (°C) | Max. | 300 | 270 | 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. | 61 | | 38 | | |
| Density @ 15°C (kg/m ³) | | 788-845 | 751-802 | 775-840 | ⁸ | 170 ⁸ |
| Vapour Pressure @ 37.8°C (kPa) | | | 14-21 | | D4052 ⁹ | 365 ⁹ |
| | | | | | | 69 |
| FLUIDITY | | | | | | |
| Freezing Point (°C) | Max. | -46 | -58 | -47 | D2386 ¹⁰ | 16 ¹⁰ |
| Viscosity @ -20°C (cSt) | Max. | 8.8 | ... | 8.0 | D445 | 71 |
| COMBUSTION | | | | | | |
| Specific Energy (MJ/kg) | Min. | 42.6 | 42.8 | 42.8 | ¹¹ | ¹¹ |
| Smoke Point (mm) | Min. | 25 | 25 | 25 | D1322 | 57 |
| or Smoke Point (mm) | Min. | 19 | 19 | 19 | D1322 | 57 |
| and Naphthalenes (vol %) | Max. | 3.0 | 3.0 | 3.0 | D1840 | |
| CORROSION | | | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1 | 1 | D130 | 154 |
| Silver Strip (4h @ 50°C) | Max. | 2 | ... | ... | | 227 |
| STABILITY | | | | | | |
| JFTOT ΔP (mm Hg) @ 260°C | Max. | 25 | 25 | 25 | D3241 | 323 |
| Tube Deposit Rating (Visual) | Max. | <3 ¹² | <3 ¹² | <3 ¹² | | |
| CONTAMINANTS | | | | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | 7 | 7 | D381 | 131 |
| Water Reaction Interface | Max. | 1b | 1b | 1b | D1094 | 289 |
| MSEP Rating | Min. | 85 ¹³ | ... | 85 ¹³ | D3948 | |
| ADDITIVES | | | | | | |
| Anti-Icing (vol %) | | 0.12-0.15 | 0.10-0.15 | Option ¹⁴ | | |
| Antioxidant | | Required ¹⁵ | Required ¹⁵ | Required ¹⁵ | | |
| Corrosion Inhibitor/Lubricity Improver | | Required | Required | Option ¹⁶ | | |
| Metal Deactivator | | Option | Option | Option ¹⁷ | | |
| Static Dissipator | | | Required ¹⁸ | Required ¹⁸ | | |
| OTHER | | | | | | |
| Conductivity (pS/m) | | 100-600 ¹⁹ | 100-600 ¹⁹ | 50-450 ¹⁹ | D2624 | 274 |
| BOCLE wear scar diam (mm) | Max. | | | 0.85 ²⁰ | D5001 | |

NOTES:

- (1) Methods quoted in table are referee methods, to be used in cases of dispute. Alternative methods are listed in Notes below.
- (2) Alternative test method is ASTM D4176 Procedure 1.
- (3) Aromatics content up to 22.0 vol % or up to 25.0 vol % together with report on hydrogen content (D3701/IP338).
- (4) Alternative test methods are ASTM D1266, D1552, D2622, D4294 and D5453; IP107, IP243 and IP373.
- (5) Alternative test method is ASTM D4952.
- (6) Report total vol % hydroprocessed (H/P) fuel (including 'nil' or 100%), to include hydrotreated, hydrofined and hydrocracked material.
- (7) Proportion of severely hydroprocessed (H/P) components to be reported from 1 Dec 2000.
- (8) Subject to minimum of 40°C if results obtained by (Tag) method ASTM D56. Alternative test method is ASTM D3828/IP303.
- (9) Alternative test method is ASTM D1298/IP160.
- (10) Alternative test methods are ASTM D4305, D5901 and D5972. With D4305, use Procedure A only; this method shall not be used on samples with viscosities greater than 5.0 mm²/s at -20°C.
- (11) Any of the following calculation methods is acceptable: IP12, IP355, ASTM D3338, D4529/IP381, D4809.
- (12) Heater tube deposit rating using the Visual Tubercator to be carried out within 120 minutes of completion of test. No 'peacock' or 'abnormal' colour deposits should be present.
- (13) For fuel without static dissipator additive (SDA). For fuel with SDA minimum limit is reduced to 70. These MSEP requirements apply only at point of manufacture. If testing is carried out downstream, no specification limits apply and the results are not to be used as the sole reason for rejection of a fuel.
- (14) May be added by agreement between purchaser and supplier at concentration 0.10-0.15 vol%.
- (15) Antioxidants are mandatory in hydroprocessed and synthetic fuels. Concentration of additive 17.0-24.0 mg/L.
- (16) Additive of type and concentration detailed in QPL 68-251 may be added by agreement between purchaser and supplier.
- (17) May be added to fuel under specified conditions. Concentration on initial batching at refinery shall not exceed 2.0 mg/L. Cumulative addition when redoping the fuel shall not exceed 5.7 mg/L.
- (18) Concentration of SDA on first doping of fuel is 3.0 mg/L max. Cumulative concentration allowed when redoping fuel is 5.0 mg/L max.
- (19) Limits must be met at point of delivery into aircraft.
- (20) Requirement comes into effect 1 Dec 2000. Applies only to fuels containing more than 95% hydroprocessed material where at least 20% of this is severely hydroprocessed and for all fuels containing synthetic components. The limit applies only at point of manufacture.
- (21) F-35 fuel plus specified additives is denoted as F-34. Refer to Def Stan 91-87 specification for details of F-34.

TABLE 19
USA

| Issuing Agency: | | ASTM | | |
|---|------------------------|-------------------------|-------------------------|--|
| Specification: | | D1655-99 | | |
| Latest Revision Date: | | 10 June 1999 | | |
| Grade Designation: | Jet A/A-1 ¹ | Jet B | Test Method | |
| Fuel Type: | Kerosine | Wide-Cut | ASTM | |
| COMPOSITION | | | | |
| Acidity, Total (mg KOH/g) | Max. | 0.10 | ... | D3242 |
| Aromatics (vol %) | Max. | 25 | 25 | D1319 |
| Sulphur, Total (wt %) | Max. | 0.30 | 0.30 | D1266, D1552, D2622, D4294, D5453 |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.003 Negative | 0.005 Negative | D3227 D4952 |
| VOLATILITY | | | | |
| Distillation Temperature: | | | | D86 |
| 10% Recovery (°C) | Max. | 205 | ... | |
| 20% Recovery (°C) | Max. | ... | 145 | |
| 50% Recovery (°C) | Max. | Report | 190 | |
| 90% Recovery (°C) | Max. | Report | 245 | |
| Final BP (°C) | Max. | 300 | ... | |
| Distillation Residue (vol %) | Max. | 1.5 | 1.5 | |
| Distillation Loss (vol %) | Max. | 1.5 | 1.5 | |
| Flash Point (°C) | Min. | 38 | ... | D56 or D3828 ² |
| Density @ 15°C (kg/m ³) | | 775-840 | 751-802 | D1298 or D4052 |
| Vapour Pressure @ 38°C (kPa) | Max. | ... | 21 | D323 or D5191 ³ |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | -40 ^{1, 4} | -50 ⁴ | D2386, D4305 ⁵ , D5901 or D5972 ⁶ D445 |
| Viscosity @ -20°C (cSt) | Max | 8.0 | ... | |
| COMBUSTION | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 ⁷ | 428 ⁷ | D3338, D4529, D4809 |
| Luminometer No. | Min. | 45 | 45 | D1740 |
| or 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. | 1 | 1 | D130 |
| STABILITY | | | | |
| JFTOT ΔP (kPa) | Max. | 3.3 | 3.3 | D3241 ⁸ |
| Tube Deposit Rating (Visual) | Max. | <3 ⁹ | <3 ⁹ | |
| CONTAMINANTS | | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | 7 | D381 |
| Water Reaction Interface | Max. | 1b | 1b | D1094 |
| ADDITIVES | | | | |
| Anti-Icing | | Option ¹⁰ | Option ¹⁰ | |
| Antioxidant | | Option | Option | |
| Corrosion Inhibitor | | Agreement | Agreement | |
| Metal Deactivator | | Option | Option | |
| Static Dissipator | | Agreement ¹¹ | Agreement ¹¹ | |
| OTHER | | | | |
| Conductivity (pS/m) | | 50-450 ¹² | 50-450 ¹² | D2642 |

NOTES:

- (1) Jet A-1 is similar to Jet A in all properties except Freezing Point at -47°C max.
- (2) Results obtained by method D3828 may be up to 2°C lower than those obtained by method D56. In case of dispute, method D56 will apply.
- (3) D5191 shall be the referee method.
- (4) Other Freezing Points may be agreed upon between supplier and purchaser.
- (5) 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. In case of dispute, D2386 shall be the referee method.
- (6) D5972 may produce a higher (warmer) result than D 2386 on wide-cut fuels. D2386 shall be referee method.
- (7) In case of dispute method D4809 shall be used.
- (8) 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.
- (9) Heater tube should have no 'abnormal' or 'peacock' colour deposits.
- (10) DiEGME additive conforming to requirements of D4171, Type III, may be used at 0.10-0.15 vol % concentration.
- (11) Stadis 450 additive limited to 3 mg/L max. at manufacture, and cumulative total 5 mg/L max. on retreatment.
- (12) When electrical conductivity additive is specified by the purchaser, conductivity shall be 50-450 pS/m under the conditions at point of delivery.

Since compiling this document Tracer A has been approved for use by ASTM similar to UK Def Stan 91-91/3. Refer to latest published version for details.

**TABLE 20
ENGINE MANUFACTURER'S REQUIREMENTS**

| | | | | | |
|---|------|------------------------|---------------------|---------------------|-----------------------------|
| Issuing Agency: | | General Electric | | | |
| Specification: | | D50TF2-S13 | | | |
| Latest Revision Date: | | 11 November 1999 | | | |
| Grade Designation: | | Class A/C ¹ | Class B | Class D | Test Method ASTM |
| Fuel Type: | | Kerosine | Wide-Cut | High-Flash | |
| COMPOSITION | | | | | |
| Acidity, Total (mg KOH/g) | Max. | 0.10 | ... | 0.10 | D974, D3242 |
| Aromatics (vol %) | Max. | 25 | 25 | 25 | D1319 |
| Sulphur, Total (wt %) | Max. | 0.30 | 0.40 | 0.40 | D1266, D1552, D2622 |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.003 Negative | 0.005 Negative | 0.003 Negative | D3227 D4952 |
| VOLATILITY | | | | | |
| Distillation Temperature: | | | | | D86 |
| 10% Recovery (°C) | Max. | 205 | Report | 205 | |
| 20% Recovery (°C) | Max. | ... | 145 | Report | |
| 50% Recovery (°C) | Max. | Report | 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 | |
| Flash Point (°C) | Min. | 38 | ... | 60 | D56, D3828 |
| Specific Gravity @ 15.6°C or Gravity, API @ 60°F | | 0.775-0.840 | 0.751-0.802 | 0.788-0.845 | D1298, D4052 |
| Reid Vapour Pressure (kPa) | Max. | 51-37 | 57-45 | 48-36 | |
| | | ... | 21 | ... | D323 |
| FLUIDITY | | | | | |
| Freezing Point (°C) | Max. | -40 ¹ | -58 | -51 | D2386 |
| 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 |
| Luminometer No. | Min. | 45 | 45 | 45 | D1740 |
| or Smoke Point (mm) | Min. | 25 | 25 | 25 | D1322 |
| or Smoke Point (mm) | Min. | 18 | 18 | 18 | D1322 |
| and Naphthalenes (vol %) | Max. | 3.0 | 3.0 | 3.0 | D1840 |
| CORROSION | | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1 | 1 | D130 |
| STABILITY | | | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 | 25 | 25 | D3241 ² |
| Tube Deposit Rating (Visual) | Max. | <3 | <3 | <3 | |
| CONTAMINANTS | | | | | |
| Existent Gum (mg/100 mL) | Max. | 7 | 7 | 7 | D381 |
| Water Reaction Interface | Max. | 1b | 1b | 1b | D1094 |
| ADDITIVES | | | | | |
| Anti-Icing | | Option | Option | Option | |
| Antioxidant | | Option | Option | Option | |
| Corrosion Inhibitor | | Option | Option | Option | |
| Metal Deactivator | | Option ³ | Option ³ | Option ³ | |
| Static Dissipator | | Option ⁴ | Option ⁴ | Option ⁴ | |
| Biocide | | Option ⁵ | Option ⁵ | Option ⁵ | |
| Thermal Stability Improver | | Option ⁶ | Option ⁶ | Option ⁶ | |
| Leak Check | | Option ⁷ | Option ⁷ | Option ⁷ | |

NOTES:

- (1) Class C is the same as class A except for Freezing Point at -47°C max.
- (2) Test for 2.5h at control temperature of 260°C, but if requirements are not met, the test may be conducted at 245°C. Results at both temperatures shall be reported. If tube deposit displays 'peacock' (rainbow) colours, rate as code 'P'. Fuels that produce 'peacock' colours fail to meet thermal stability requirements.
- (3) Maximum concentration of metal deactivators 5.7 g/m³.
- (4) Stadis 450 at 3.0 g/m³ max. initial concentration, 5.0 g/m³ max. total concentration.
- (5) Biobor JF at 270 ppm max. and Kathon FP 1.5 at 100 ppm max. are approved biocides.
- (6) BetzDearborn SpecAid 8Q462 at 256 ppm max. and AeroShell Additive 101 at 256 ppm max. are approved additives.
- (7) Sulphur hexylfluoride (SF₆) at 1.0 ppm max. is allowed for airport fuel delivery system leak detection at EPA request.

**TABLE 21
ENGINE MANUFACTURER'S REQUIREMENTS**

| Issuing Agency: | Pratt & Whitney | Pratt & Whitney Canada | | Test Method ASTM |
|---|----------------------------------|-------------------------------|--------------------------------|-----------------------|
| Specification: | SB No.2016 | CPW 204 | CPW 46 | |
| Latest Revision Date: | 2 February 1999 (Revision 24) | 10 March 1997 (Revision A) | 19 August 1999 (Revision E) | |
| Fuel Type: | Kero/Wide-Cut | Kero/Wide-Cut | Arctic | |
| COMPOSITION | | | | |
| Appearance | | ¹ | ¹ | ¹ |
| Aromatics (vol %) | Max. | 20 ² | 25 | 20 ² |
| Sulphur, Total (wt %) | Max. | 0.30 | 0.4 | 1.0 |
| Sulphur, Mercaptan (wt %) or Doctor Test | Max. | 0.005 Negative | 0.005 Negative | 0.005 Negative |
| VOLATILITY | | | | |
| Distillation Temperature: | | | | D86 |
| 10% Recovery (°C) | Max. | 204.4 ⁵ | 205 | |
| 50% Recovery (°C) | Max. | 232.2 ⁵ | 232 | Report |
| 90% Recovery (°C) | Max. | ... | | 315.6 ⁵ |
| Final BP (°C) | Max. | 300 | 300 | 343.3 ⁵ |
| Distillation Residue (vol %) | Max. | 1.5 | 1.5 | |
| Distillation Loss (vol %) | Max. | 1.5 | 1.5 | |
| Gravity, API @ 60°F | | 57-37 | 57-37 | 57-37 |
| Vapour Pressure @ 38°C (kPa) | Max. | 20.7 ⁶ | 21 | |
| FLUIDITY | | | | |
| Freezing Point (°C) | Max. | ⁷ | -45 | |
| Viscosity @ -34.4°C (cSt) | Max. | 15 | 16.5 | 1.4 min. ⁸ |
| Pour Point (°C) | Max. | | | -40 |
| Cloud Point (°C) | Max. | | | -34.4 |
| COMBUSTION | | | | |
| Net Heat of Comb. (MJ/kg) | Min. | 42.8 | 42.6 | 42.8 |
| Luminometer No. | Min. | 45 | 45 | |
| or Smoke Point (mm) | Min. | 25 | 25 | |
| or Smoke Point (mm) | Min. | 20 ¹⁰ | 20 ¹⁰ | |
| and Naphthalenes (vol %) | Max. | 3.0 | 3 | |
| CORROSION | | | | |
| Copper Strip (2h @ 100°C) | Max. | 1 | 1b | 1 |
| STABILITY | | | | |
| JFTOT ΔP (mm Hg) | Max. | 25 ¹¹ | 25 ^{12, 13} | 25 ^{12, 13} |
| Tube Deposit Rating (Visual) | Max. | <3 | <3 | <3 |
| Potential Gum (mg/100 mL) | Max. | | | 14.0 |
| Carbon Residue on 10% btm (%) | Max. | | | 0.2 |
| CONTAMINANTS | | | | |
| Ash (wt %) | Max. | | | 0.01 |
| Water Reaction: | | | | D482 D1094 |
| Interface Rating | Max. | 1b | 1b | 1b |
| Volume Change (mL) | Max. | 1 | 1 | 1 |
| ADDITIVES | | | | |
| Anti-Icing | | Option | Option | Option |
| Antioxidant | | Option | Option | Option |
| Corrosion Inhibitor | | Option | Option | Option |
| Metal Deactivator | | Option | Option | Option |
| Static Dissipator | | Option ¹⁴ | | |
| Biocide | | Option ¹⁵ | | |
| Thermal Stability Improver | | Option ¹⁶ | Option | Option |
| Leak Check | | Option ¹⁷ | | |

NOTES:

- (1) Fuel shall be free from water, sediment and suspended matter. Odour shall not be nauseating or irritating.
- (2) Waiver is currently in world-wide effect authorising the use, as necessary, of fuels with aromatics up to 25 vol %.
- (3) Only method D1323 is specified for CPW 204 fuels.
- (4) Method D235 is specified for CPW 204 fuels.
- (5) Temperature in Celsius equivalent to primary temperature specified in Fahrenheit.
- (6) Wide-cut fuels characterised by a Reid Vapour Pressure in the range 13.8-20.7 kPa, or a Flash Point less than 28°C, are not acceptable for use in some specific Pratt & Whitney engine models.
- (7) The Freezing Point shall be equal to or below the minimum engine fuel inlet temperature.
- (8) Viscosity determined at 37.8°C.
- (9) Method D1405 permitted for CPW 46 fuel.
- (10) Waiver currently in effect permits relaxation of Smoke Point down to 18 mm min. with naphthalenes of 3.0% max.
- (11) Test shall be conducted at heater tube temperature of 260°C.
- (12) Test at heater tube temperature of 260°C. If test at 260°C fails, repeat at 245°C. Report results of both tests.
- (13) The Fuel Coker is accepted as an alternative test method.
- (14) Octel Stadis 450 at 3.0 ppm max. is approved to increase electrical conductivity to a range of 150-600 pS/m.
- (15) May be used on limited basis to sterilise aircraft fuel systems contaminated by microbial organisms. Approved additives are Biobor JF at 270 ppm max. and Kathon FP 1.5 at 100 ppm max.
- (16) Approved additive is Octel JFA-5 at 11 mg/L max.
- (17) Tracer A (sulphur hexylfluoride) at 1 ppm max. may be used for purpose of detecting leaks in airport fuel distribution systems.

APPENDICES

Appendix A:

Significance of Aviation Fuel Test Requirements

Appendix B:

Guidance on Contamination Limits

Appendix C:

Additives in Aviation Fuel

APPENDIX A

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 reqd for Test (mL) |
|--|------------------------|---|
| <p>COMPOSITION</p> <p>Appearance is visually assessed in a qualitative pass/fail test of fuel cleanliness, to preclude free water, sediment and suspended matter.</p> <p>Total Acidity of combined organic and inorganic acids indicates the corrosive potential of fuel to metals. Trace organic acids can affect water separation properties.</p> <p>Aromatics Content relates directly to flame radiation, carbon deposition and smoke. Also affects swelling of elastomers in the fuel system.</p> <p>Hydrogen Content contributes to combustion cleanliness and is broadly related to Aromatics Content.</p> <p>Olefins are unsaturated hydrocarbons, which are potential contributors to instability in storage.</p> <p>Total Sulphur is controlled because sulphur oxides formed during combustion can cause corrosion of turbine metal parts.</p> <p>Mercaptan Sulphur compounds are limited because they have a very unpleasant odour, and attack certain elastomer materials.</p> <p>Doctor Test detects the presence of reactive sulphur compounds, and is an alternative method of measuring Mercaptan Sulphur.</p> | D4176 | 1000 |
| | D3242/IP354 | 100 |
| | D1319/IP156 | 5 |
| | D3701/IP338 | 30 |
| | D1319/IP156 | 5 |
| | D4294 IP336 | 20 ¹ |
| | D3227/IP342 | 55 |
| D4952 IP30 | 10 | |
| <p>VOLATILITY</p> <p>Distillation curve defines the kerosine boiling range, which needs to be appropriate for balanced vaporisation of the whole fuel volume.</p> <p>Flash Point is related to volatility and therefore affects combustibility. It is a leading factor determining fire safety in fuel handling.</p> <p>Density must be known for aircraft weight loading calculations, since fuel is customarily metered by volume. Also relates to Specific Energy.</p> <p>Vapour Pressure is significant for wide-cut fuels. Indicates venting loss of light ends at altitude and in hot climates. Also relates to cold starting.</p> | D86/IP123 | 100 |
| | IP170 | 250 ² |
| | D4052/IP365 | 5 ³ |
| | D323 IP69 | 800 ⁴ |
| <p>FLUIDITY</p> <p>Freezing Point limits higher molecular weight hydrocarbons that crystallise at low temperatures; it therefore influences low temperature pumpability during flight.</p> <p>Viscosity affects fuel pumpability over the operating temperature range, and relates to droplet size in sprays produced by burner nozzles.</p> | D2386/IP16 | 30 ⁵ |
| | D445/IP71 | 50 |
| <p>COMBUSTION</p> <p>Specific Energy (Net Heat of Combustion) denotes the amount of heat energy obtainable from a fuel to provide power (value is calculated).</p> <p>Smoke Point indicates the tendency of a fuel to form soot, which is related to the type of hydrocarbons making up its composition.</p> <p>Naphthalenes are polycyclic aromatics high in carbon content, exacerbating the problems of carbon formation, flame radiation and smoke.</p> | D3338 | -- |
| | D1322/IP57 | 20 |
| | D1840 | 5 |
| <p>CORROSION</p> <p>Copper Strip Corrosion test pass ensures that organic sulphur compounds will not corrode copper components in the fuel system.</p> <p>Silver Strip Corrosion test detects corrosiveness of fuel towards silver.</p> | D130/IP154 | 50 |
| | IP227 | 250 |
| <p>STABILITY</p> <p>Thermal Stability (JFTOT) measurements relate to the amount of deposits formed at high temperature in the engine fuel system.</p> | D3241/IP323 | 600 |

| Fuel Property and Significance | | Test Method ASTM/IP | Sample Volume reqd for Test (mL) |
|---|---|--|---|
| 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. Particulates such as dirt and rust are undesirable and are detected by filtration through a membrane filter. Filtration Time is measured by the same test procedure as Particulates. Water Reaction determines the presence of materials that react with water and affect the stability of the fuel-water interface. Water Separation (MSEP) index rates the ability of fuel to release entrained or emulsified water when passed through a fibreglass filter coalescer. | | D381/IP131 D5452 D5452 D1094/IP289 D3948 | 50 4500 4500 100 50 |
| CONDUCTIVITY 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/IP274 | 1000 |
| LUBRICITY 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 High temperature combustion X-ray spectrometry Ultraviolet fluorescence Lamp combustion Wickbold combustion Microcoulometry | D1266 D1552 D2622 D5453 IP107 IP243 IP373 | 100 300 10 <1 10 50 <1 |
| (2) Flash Point | Tag closed tester Small scale closed tester | D56 D3828/IP303 | 50 50 |
| (3) Density | Hydrometer method | D1298/IP160 | 500 |
| (4) Vapour Pressure | Automatic method Mini method Air saturation vapour pressure | D5190 D5191 IP394 | 800 10 800 |
| (5) Freezing Point | Setapoint filter flow Automated optical method Automatic phase transition | D4305 D5901 D5972 | 5 30 <1 |

Note: Recertification tests must be carried out on aviation fuel after transportation in non-dedicated/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/Colour; Distillation; Flash Point; Density; Freezing Point;

Copper Corrosion; Existent Gum; Water Reaction.

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

(6) JIG Guidelines for Aviation Fuel Quality Control & Procedures for Jointly Operated Supply & Distribution Facilities, Issue 7, Feb 1999.

APPENDIX B

CONTAMINATION LIMITS FOR JET FUEL

The international airlines have recommended contamination limits for fuels supplied into-plane. The limits set out in the Table below are those detailed in IATA's guidance material for Aviation Turbine fuels (3rd edition). The indicated limits would apply to fuels at the point of delivery into the aircraft. These limits which are recommended for results of spot sampling are relevant to airport fuelling systems at or close to the point of delivery. Two categories are detailed – 'Notification' and 'Rejection'.

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 this is not intended to release the supplier from an obligation to provide fuel free of contaminant and preferably below the 'Notification' limits.

| Sampling Pattern | Sampling Frequency (minimum) | | Test Method | Limits |
|------------------|---------------------------------------|-------------------|---|---|
| | Particulate Matter | Undissolved Water | | |
| | After Loading | Before Fuelling | Visual Inspection of fuel in glass jar (minimum 1L) | Clear & Bright |
| Refueller | | | Visual Inspection & Water Detector ² | 30 ppm maximum at the temperature of delivery |
| Truck | Monthly at Major Centres ¹ | | ASTM D2276/IP216 (5L samples) ³ | Notification Limit 0.2 mg/L Rejection Limit 1.0 mg/L |
| | Daily | During Fuelling | Visual Inspection of fuel in glass jar (minimum 1L) | Clear & Bright |
| Hydrant | | | Visual Inspection & Water Detector ² | 30 ppm maximum at the temperature of delivery |
| Dispenser | Monthly at Major Centres ¹ | | ASTM D2276/IP216 (5L samples) ³ | Notification Limit 0.2 mg/L Rejection Limit 1.0 mg/L |

Note 1:

Alternate frequencies may be negotiated with individual buyers/consumer for other nominated locations.

Note 2:

The presence of moisture shall be determined by visually inspecting the sample in good light to determine brightness, cleanliness, transparency, 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 to guarantee the detection of 30 ppm of free water or more:

- Shell Detector: Faint colour change occurs with water contents as low as 5 ppm which is acceptable under this specification. Colour at 30 ppm is definite green or blue green.
- Velcon Hydrokit: No colour change 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 more 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 wad as low as 5 ppm. At 30 ppm large spots are apparent.
- Aqua-Glo: Measures directly the moisture content with a measured sample of fuel. When a 100 mL sample is taken the measurable water content ranges from 5 to 60 ppm.

Note 3:**Method 1:**

Determination of Total Contamination shall be determined at least once every three months on each refueller/dispenser at Centres where colorimetric evaluation is practised.
The Joint Guidelines limit of testing every six months may be acceptable.

Method 2:

Colorimetric 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) Membrane for tests on the other refueller/dispensers visually match the colorimetric check in paragraph 1).
- 3) Any test showing unusual colorimetric result shall be immediately rechecked gravimetrically (Method 1).

Note the Joint Guidelines requires monthly colorimetric membrane ratings to be determined downstream of all fitters on vehicles supplying jet fuel.

APPENDIX C

ADDITIVES IN AVIATION FUEL

As the aviation industry's jet kerosine demands have increased to more than 5% of all refined products derived from crude, it has been necessary for the refiner to optimise the yield of jet kerosine, a high value product, by varying processing 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 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 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, he must secure agreement of the customer.

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

ADDITIVES FOUND IN AVIATION FUEL

The following types of additive are either required or added by agreement for use in aviation fuel:

Static dissipator

Removal of polar species by processing can lead to poor fuel conductivity with obvious risks of charging and static discharge when loading or when the fuel passes through filters. To virtually eliminate this risk, static dissipator additive is widely used in Jet kerosine. The minimum and maximum fuel conductivity requirements for Def Stan 91/91, JP8 and JSCL are 50 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

Copper contamination can lead to significant fuel degradation. Metal deactivator additive (MDA) was developed to bind copper thus maintaining fuel stability. It was also found the MDA improved thermal stability in the JFTOT test even when no copper was present. MDA can be used to improve thermal stability provided that the JFTOT test is determined before and after MDA addition and reported accordingly.

Antioxidants

Hydrogen treating of aviation fuels removes naturally occurring antioxidants that provide protection from peroxidation. Peroxides are known to attack elastomers causing embrittlement. The use of antioxidants effectively prevents peroxidation from occurring and under JSCL 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 hydrogen treated. 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.

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. Hydrofining 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 though they can be added by agreement if problems are specifically identified.

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. Anti-icing additives have been developed to protect the system from this problem. The most widely used additive is diethylene glycol mono methyl ether (DiEGME).

The use of FSII is required in UK and US military jet fuels and although optional in many civilian specifications is very seldom used.

The following additive is allowed only for use in certain Military jet fuels:

JP8+100

Modern military jet engines require aviation fuel that has a higher thermal stability and heat sink capacity than is currently readily 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, JP8+100, is not compatible with current coalescers. Manufacturers are currently looking at alternative coalescer designs that will overcome this problem. The use of JP8+100 is currently limited to selected military specifications.

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

Tracer A

Tracer A (Sulphur hexylfluoride 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. This leak testing may be carried out monthly or quarterly. Current use requires acceptance by purchasers on a case by case basis.

Biocides

Biocides are permitted by engine and airframe manufacturers for intermittent use at 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. FSII also behaves as a biostat, inhibiting fungal and bacterial growth in aircraft fuel systems. As British and American Military fuels contain FSII, it is not necessary to use a dedicated biocide in these fuels.

AVIATION GASOLINES

Fuel Grade Differences

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

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

- Grade 80
- Grade 100
- Grade 100LL

Grades 100 and 100LL (Low Lead) represent gasolines identical in antiknock quality but differing in maximum lead content, the lower lead content being suitable for engines having a low tolerance to lead.

Different colours are used to differentiate the three fuel grades, obtained by adding specific dyes. Service experience has indicated that only certain dyes and concentration levels can be tolerated without causing deposition in engine fuel induction systems. Permissible dye compositions and their maximum concentrations are therefore specified for each grade.

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 standardised laboratory single-cylinder test engines which are operated under prescribed conditions. The lean rating method is intended to simulate the lean air/fuel mixture of aircraft cruise conditions, whereas the rich rating method simulates takeoff under rich mixture, supercharging conditions.

Common Quality Requirements

Requirements common for all grades either prescribe the proper 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 Motor Gasoline 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, the fuel suppliers and government regulatory authorities. Some of the reasons for this are as follows:

1. Motor gasoline has different distillation characteristics than aviation gasoline. Mogas includes heavier petroleum fractions which tend to include hydrocarbons less stable to oxidation, less clean-burning, more prone to form combustion chamber and induction system deposits.
2. Motor gasoline normally has much higher vapour pressure, which varies seasonally. With a high RVP fuel the risk of vapour lock during takeoff and climb increases, particularly if the aircraft has been parked in high ambient temperatures and does not have a gravity-fed fuel system.
3. Motor 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.

A purchaser intending to use motor gasoline in an aircraft would have no knowledge of the physical properties or composition of the gasoline being supplied. It will vary markedly on a seasonal basis and by geographic region. Octane quality can only be known approximately and can also vary substantially between grades and suppliers.

**TABLE 22
AVIATION GASOLINES**

| Issuing Agency: Specification: Latest Revision Date: Grade Designation: Fuel Type: | | Grade 80 Avgas | ASTM D910-97 10 July 1997 Grade 100 Avgas | Grade 100LL Avgas | Test Method ASTM |
|--|--------------|-------------------|---|----------------------|-----------------------------------|
| Knock Value, lean mixture: Motor Method | | | | | D2700 |
| Octane Number | Min. | 80.0 | 99.5 | 99.5 | |
| Knock Value, rich mixture: Supercharge Rating | | | | | D909 |
| Octane Number | Min. | 87.0 | | | |
| Performance Number ^{1,2} | Min. | | 130.0 | 130.0 | |
| Tetraethyl lead (mL TEL/L) (g Pb/L) | Max. Max. | 0.13 0.14 | 1.06 1.12 | 0.53 0.56 | D3341 or D5059 |
| Colour | | Red | Green | Blue | D2392 |
| Dye Content: ³ | | | | | |
| Blue dye (mg/L) | Max. | 0.2 | 2.7 | 2.7 | |
| Yellow dye (mg/L) | Max. | None | 2.8 | None | |
| Red dye (mg/L) | Min. | 2.3 | None | None | |
| Appearance | | | C & B ⁴ | | |
| Density @ 15°C (kg/m ³) | Max. | | Report | | D1298 or D4052 |
| 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 10%+50% evaporated temperatures (°C) | Min. | | 135 | | |
| Recovery Volume (%) | Min. | | 97 | | |
| Residue (vol %) | Max. | | 1.5 | | |
| Loss (vol %) | Max. | | 1.5 | | |
| Vapour Pressure at 38°C (kPa) | | | Min. 38.0 Max. 49.0 | | D323, D5190 or D5191 ⁵ |
| Freezing Point (°C) | Max. | | -58 | | D2386 |
| Sulphur (wt %) | Max. | | 0.05 | | D1266 or D2622 |
| Net Heat of Comb. (MJ/kg) ⁶ | Min. | | 43.5 | | D4529 or D3338 |
| Corrosion, Copper (2h @ 100°C) | Max. | | 1 | | D130 |
| Oxidation Stability, 5 hours: ^{7,8} | | | | | D873 |
| Potential Gum (mg/100 mL) | Max. | | 6 | | |
| Lead Precipitate (mg/100 mL) | Max. | | 3 | | |
| Water Reaction: | | | | | D1094 |
| Volume Change (mL) | Max. | | ±2 | | |
| Conductivity (pS/m) | Max. | | 50-450 ⁹ | | D2624 |
| ADDITIVES | | | | | |
| Anti-Icing | | | Option ¹⁰ | | |
| Antioxidant | | | Option | | |
| Static Dissipator | | | Option ¹¹ | | |

NOTES:

- (1) A performance number of 130.0 is equivalent to a knock value determined using iso-octane plus 0.34 mL TEL/L.
- (2) Knock ratings shall be reported to the nearest 0.1 Octane/Performance Number.
- (3) The maximum dye concentrations shown do not include solvent in dyes supplied in liquid form.
- (4) Fuel shall be free from undissolved water, sediment and suspended matter. The odour of the fuel shall not be nauseating or irritating.
- (5) Test method D5191 shall be the referee vapour pressure method.
- (6) 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. In case of dispute, test method D4809 shall be used.
- (7) If mutually agreed upon between purchaser and supplier, a 16 hour ageing gum requirement may be specified; in such case the gum content shall not exceed 10 mg/100 mL and the visible lead precipitate shall not exceed 4 mg/100 mL. In such fuel the permissible antioxidant shall not exceed 24 mg/L.
- (8) 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.
- (9) Limits apply under the condition at point of use, and only when a customer specifies fuel containing conductivity additive. The supplier shall report the amount of additive added.
- (10) Isopropyl Alcohol, conforming to D4171 (Type II), or DIEGME, conforming to D4171 (Type III) may be used.
- (11) Stadis 450 up to 3 mg/L is permitted. When necessary, further addition to cumulative total of 5 mg/L is permissible.

**TABLE 23
AVIATION GASOLINES**

| Issuing Agency: | | Ministry of Defence (Procurement Executive) | | | | |
|-------------------------------------|------|---|----------------------|-----------------|--------------------|------------------|
| Specification: | | Def Stan 91-90/1 | | | | |
| Latest Revision Date: | | 8 May 1996 | | | | |
| Grade Designation: | | Grade 80 | Grade 100 | Grade 100LL | Test Method | |
| Fuel Type: | | Avgas | Avgas | Avgas | ASTM | IP |
| Knock Value, lean mixture: | | | | | | |
| Motor Method | | | | | D2700 | 236 |
| Octane Number ¹ | Min. | 80.0 | 99.5 | 99.5 | | |
| Knock Value, rich mixture: | | | | | | |
| Supercharge Rating | | | | | D909 | 119 |
| Octane Number ¹ | Min. | 87.0 | | | | |
| Performance Number ¹ | Min. | | 130 | 130 | | |
| Tetraethyl lead (g Pb/L) | Max. | 0.14 | 0.85 | 0.56 | ² | 270 ² |
| Colour ³ | | Red | Green | Blue | D2392 | |
| Dye Content: | | | | | | |
| Blue dye (mg/L) | Max. | 0.2 | 2.2 | 2.7 | | |
| Yellow dye (mg/L) | Max. | None | 2.8 | None | | |
| Red dye (mg/L) | Min. | 2.3 | None | None | | |
| Colour, Lovibond | | | | | | 17 ³ |
| Blue | | ... | Min 1.7 Max 2.9 | Min 1.7 Max 3.5 | | |
| Yellow | | ... | Min 1.5 Max 2.7 | ... | | |
| Red | | Min 6.7 Max 9.1 | ... | ... | | |
| Appearance | | | C & B ⁴ | | ⁵ | |
| Density @ 15°C (kg/m ³) | Max. | | Report | | D1298 ⁶ | 160 ⁶ |
| Distillation: | | | | | D86 | 123 |
| 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 10%+50% evaporated | | | | | | |
| temperatures (°C) | Min. | | 135 | | | |
| Residue (vol %) | Max. | | 1.5 | | | |
| Loss (vol %) | Max. | | 1.5 | | | |
| Vapour Pressure at 37.8°C (kPa) | | | Min. 38.0 Max. 49.0 | | D323 ⁷ | 69 ⁷ |
| Freezing Point (°C) | Max. | | -60 | | D2386 | 16 |
| Sulphur (wt %) | Max. | | 0.05 | | D1266 ⁸ | 107 ⁸ |
| Existent Gum (mg/100 ml) | Max. | | 3 | | D381 | 131 |
| Specific Energy (MJ/kg) | Min. | | 43.5 | | ⁹ | 12 ⁹ |
| Corrosion, Copper (2h @ 100°C) | Max. | | 1 | | D130 | 154 |
| Oxidation Stability, 16 hours: | | | | | D873 | 138 |
| Potential Gum (mg/100 ml) | Max. | | 6 | | | |
| Precipitate (mg/100 ml) | Max. | | 2 | | | |
| Water Reaction: | | | | | D1094 | 289 |
| Interface Rating | Max. | | 2 | | | |
| Volume Change (ml) | Max. | | 2 | | | |
| Conductivity (pS/m) | Max. | | ¹⁰ | | D2624 | 274 |
| ADDITIVES | | | | | | |
| Antioxidant | | | Option | | | |
| 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) Alternative test methods for tetraethyl lead content are IP 228/ASTM D5059 and IP 248/ASTM D3341.
- (3) The visual colour must comply with limits for Lovibond 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) Alternative test method for Appearance is ASTM D4176, Procedure 1.
- (6) Alternative test method for Density is ASTM D4052/IP 365.
- (7) Alternative test methods for Vapour Pressure are ASTM D5190, D5191 and IP 394.
- (8) Alternative test methods for Total Sulphur are ASTM D2622 and IP 243.
- (9) Alternative test methods for Specific Energy are ASTM D3338, D4809 and D4529/IP 381.
- (10) When a static dissipator additive has been added to the fuel the conductivity at the point, time and temperature of delivery to the purchaser shall be in the range 50-600 pS/m.
- (11) Stadis 450 may be added at concentration not exceeding 3 mg/L.

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