



Aviation Fuel Handling and Quality Control Procedures Manual

August 2008

Table of Contents

Section 1 **Quality Control and Test Procedures**

| | |
|--|----|
| 1- General | 3 |
| 1.0. White Bucket Test | 3 |
| 1.1. Clear and Bright Test | 5 |
| 1.2. Free Water Detection | 7 |
| 1.3. Solid Particulate Contamination Detection | 8 |
| 1.4. Microbiological Contamination | 12 |
| 1.5. Electrical Conductivity | 15 |
| 1.6. Density | 16 |

Section 2 **Fuel Drum Storage**

| | |
|--|----|
| 2- General | 20 |
| 2.0. Handling of Drums | 20 |
| 2.1. Method of Storage..... | 20 |
| 2.2. Preparation of Servicing from the Drums | 21 |
| 2.3. Fuelling from Drums..... | 21 |
| Precautions, Safety and Quality measures..... | 22 |

Section 3 **Aboveground Fuel Storage Tank**

| | |
|--|----|
| 3- General | 24 |
| 3.0. The above-ground system..... | 24 |
| 3.1. Inspection of Fuel Storage Tanks and Safety Features..... | 25 |
| 3.2. Receiving Fuel | 26 |
| 3.3. Maintaining Fuel in the Aboveground Storage Tanks | 27 |

Section 4 **Fire Prevention**

| | |
|--|----|
| 4. General | 28 |
| 4.0. How fire starts..... | 28 |
| 4.1. Sources of Ignition..... | 29 |
| 4.2. Prevention of Fire Hazard..... | 30 |
| 4.3. Prevention of Ignition Source | 30 |
| a. Prevention of vapour formation | 30 |
| b. Prevention of heat source..... | 31 |

Section 5 **Health and Safety**

5. General32
5.0. Personal Safety.....32

Table of Contents continued

5.1. Minimizing Health Hazards.....32
5.2. Environmental Hazards.....33

List of Annexes

Annex – A MSDS.....34

Aviation Jet Fuel

Section 1 Quality Control and Test Procedures

General

This section describes in detail the test methods, procedures and standard/best practices common to aviation fuel testing and quality control throughout the industry.

Reference: ASTM Manual 5, Aviation Fuel Quality Control Procedures and ASTM Standard Practices for Manual Sampling of Petroleum Products, D 4057.

1.0 White Bucket Test (Cleanliness of fuel)

The white bucket is a simple but reliable test for detection of significant amounts of water and particulates.

Water occurs in different forms in the fuel;

1. Dissolved in the fuel, normally this water can not be removed from the fuel.
2. Suspended or entrained in the fuel. Entrained water can be detected with the naked eyes. The fine droplets of water in fuel reflect light and in high concentration give the fuel a cloudy or hazy appearance.
3. Water in high quantity into fuel may be caused by leakage into storage tanks, delivery of water laden fuel, condensation or the coalescence and subsequent settling of entrained water.

Water Solubility in Jet Fuel

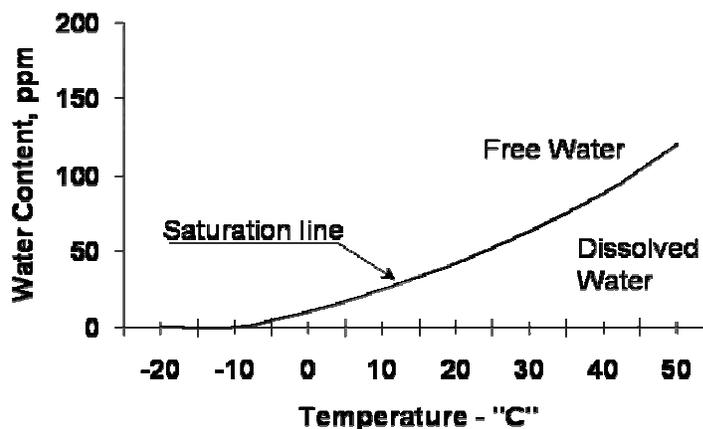


Chart 1.1

Particulate or dirt is normally found in fuel in the form of rust, scale, lint, dust, particles from gaskets and hoses which have been released from the side of the tanks, piping and transportation vehicles.

1.0.1 Precautions to be taken prior to test:

Person testing fuel should be sufficiently protected to prevent contact with fuel by wearing eye protection, gloves and appropriate apparel.

1.0.2 Apparatus:

A bucket, white porcelain lined or stainless steel of a capacity of seven liters (7 L) and with a bonding cable (a separate cable if not equipped, must be provided). A shiny coin with well-defined feature is an additional tool.

1.0.3 Procedure, method of testing and observation:

Bucket must be clean and dry.

- a) A static bonding cable must be connected between bucket and the source of sample container, pipe or valve as required
- b) Take a sample at system operating pressure (except samples from a storage tank or transport trailer). Fuel in the drain or line should be removed or displaced before taking sample. Valve should be completely open without causing spill.
- c) Fill bucket at least 15 cm of its depth.
- d) Place bucket on a level surface and allow it to stand for few minutes to settle sample to ensuring no air bubbles present.
- e) Visually inspect and observe the fuel sample to determine presence of free water, particulates, unusual colour, haze, floating material and lacy substance layers.
- f) Swirling of sample will cause dirt or water to collect at the centre of bucket for easier examination.
- g) Drop a coin with well-defined features into the fuel sample bucket to assist visual detection of haze.

1.0.4 Evaluation of observations and findings:

- a) Observed colour of jet fuel should be colourless to a light straw. Colour should be similar to previously acceptable test if any.
- b) A cloudy or haziness condition in appearance of the fuel sample suggests water contamination.
- c) If sample does not appear cloudy, a drop of food colouring or coffee added to the sample will ensure absence of water when coloured drop settles at the bottom. If it dissolves in the sample the fuel is not pure and contaminated with unacceptable amount of water.

- d) Slime on the bottom surface of container or lacy substance is an indication of Microbiological Contamination.
- e) The following definitions in Table 1.1 and 1.2 should be considered when inspecting a fuel sample;

Table 1.1
Particle Appearance
(Source ASTM)

| | |
|--------------------|--|
| Clean | No visible particles, sediment, dye, rust or solids |
| Slight Particulate | Some fine to small size particles |
| Particulate matter | Many small particles floating or settled on the bottom |
| Dirty | Discolouration, many particles floating or settled on the bottom |

Table 1.2
Water Contamination Appearance
(Source ASTM)

| | |
|-----------------------------------|---|
| Bright | No water present after sample settled down after a minute. Sample sparkle |
| Hazy | Fine water droplets throughout sample Temporary condition due to drop in temperature |
| Cloudy | Extremely fine droplets or particles throughout sample |
| Wet | Droplets or free water found at the side of the container or at the bottom |
| Surfactant or Microbial | Slime on bottom or at fuel water interface, dark brown/black scum or lacy substance |
| Other Product cross-Contamination | Unusual appearance, colour and odor |

1.1 Clear and Bright Test:

Delivered fuel must be clean, bright and not contaminated with free water.
“Clear” is a visual condition of fuel with the absence of cloud, emulsion, visible

particulate matter or entrained water. “Bright” is the quality of fuel refers to the shiny and sparkling appearance of clean and dry fuel.

The “bright and clear” condition of the fuel is not dependent on the natural colour of the fuel.

The “Clear and Bright” test is a visual check and conducted to detect water or other solid contaminants in the fuel. An evidence of external contaminants renders the fuel as “not suitable for use” and points to a requirement of further laboratory analysis.

1.1.1 Precautions to be taken prior to test:

Person testing fuel should be sufficiently protected to prevent contact with fuel by wearing eye protection, gloves and appropriate apparel.

1.1.2 Apparatus:

Glass Jar – a wide mouth glass jar of 7.5 cm (3 in.) in diameter or other similar transparent container. A white paper sheet or light background surface material is a great tool to enhance detection of contaminants.

1.1.3 Procedure, method of testing and observation:

Glass Jar must be clean and dry.

- a) Care should be observed when opening any pressured drain or tap to prevent splash or spill.
- b) Take a sample at system operating pressure (except samples from a storage tank or transport trailer). Fuel in the drain or line should be removed or displaced before taking sample. Valve should be completely open without causing spill.
- c) A fuel sample can be taken immediately after taking a white bucket sample described above by dipping the jar into bucket.
- d) Place jar with the fuel sample in it on a level surface for a minute to allow any air bubble to rise to the surface.
- e) Visually inspect and observe the fuel sample to determine presence of free water and solid contaminants.
- f) Swirling of sample would cause dirt or water to collect at the centre of the jar and would be visible at the bottom of the vortex.
- g) If presence of water is evident, observe the colour and appearance of the surface of water where it contacts the fuel.

1.1.4 Evaluation of observations and findings:

- a) Observed colour of jet fuel should be colourless to a light straw. Colour should be similar to previously acceptable test if any.
- b) A cloudy or haziness condition in appearance of the fuel sample suggests water contamination.

- c) If sample does not appear cloudy, a drop of food colouring or coffee added to the sample will ensure absence of water when coloured drop settles at the bottom. If it dissolves in the sample the fuel is not pure and contaminated with unacceptable amount of water.
- d) Slime on the bottom surface of the jar or lacy substance at the water surface where it contacts fuel is an indication of Microbiological Contamination.
- e) The definitions in Table 1.1 and 1.2 in section 1 should be considered when inspecting a fuel sample.
- f) Contaminants found in fuel sample would suggest a need to inspect the source of contaminants and could also be attributed to the failure of equipment or procedures.

1.2 Free Water Detection:

Free water contamination in the fuel not detected by visual test methods, because of low volume finely dispersed un-dissolved water in the fuel, can be detected by other methods described in this section.

There are number of free water detection kits available for field use such as Velcon Hydrokit® , Shell Water Detector® and Metrocator®. A water sensitive chemical product is used with the fuel sample which reacts with the suspended water content in the fuel by change its colour. In order to detect free water content such as 15 and 30 ppm, the colour change is compared with a standard colours chart.

Large amount of free water can be detected by a test method using water finding paste. This test is significantly true in measuring depth of water layer in fuel storage tanks. A thin layer of paste is applied on the end of a gauging stick or any other wooden or steel stick and lowered to the bottom of the tank and raised again. Paste which comes in contact with the water layer changes colour, usually grey to purple.

Total water content in fuel or dissolved water content can be tested by a laboratory test methods, one example of such standard is ASTM D 1744.

1.2.1 Procedure, observations and comparison of results:

1.2.1.1 Velcon Hydrokit®

Generally a fuel sample of approximately 10 ml in quantity is drawn under vacuum into a flask containing special powder and shaken. After two (2) minutes the colour is compared with a standard chart.

A pink colour as dark or darker than the standard indicates more than 30 ppm of free water in the sample hence fuel fails the test.

For detail refer to manufacturer's recommended procedure.

1.2.1.2 Shell Water Detector®

Generally a fuel sample of an amount 5 or 10 ml is taken through a capsule fitted with a small chemically treated filter or paper disk by a syringe. Change of filter colour to green indicates free water presence to approximate 30 ppm. At low water contamination a yellow/green colour is observed, changing to blue/green and then to blue/black at significantly high water contamination levels. For detail refer to manufacturer's recommended procedure.

1.2.1.3 Metrocator®

Generally a fuel sample is taken into a glass vial and a chemical dye powder is added. A paper disk is inserted into the vial cap then tightly closed. The sample is inverted and shaken for two minutes in the vial. The vial cap is removed and examined for colour visual comparison with the evaluation guide included in the test kit. No evidence of small purple-blue dots indicates the amount of water presence in the sample fuel to be less than 5 ppm. If the amounts of dots are present, compare it with the evaluation guide to determine results as 5 ppm, 15 ppm, 30 ppm or 60 ppm as applicable. For detail refer to manufacturer's recommended procedure.

1.2.1.4 Other similar available industry level kits are;

1. Aqua Glo® test kit: A sensitive method for measuring free water content in the fuel. Ref. ASTM D3240
2. A.E.L. Free Water Detector: A fixed volume of fuel is filtered through a pad threaded with sodium fluorescein. The chemical on the pad is sensitive to the free water in the sample, producing a fluorescence pattern visible under ultra-violet light. A method measuring free water at levels where water in sample is not visible by naked eye.
3. Aqua Indica: measures the moisture content in a sample of fuel.

1.3 Solid Particulate Contamination Detection:

Rust is generally the leading source of particulate contamination. Frequently the sand or dust could also be present. The main source of this kind of contamination is erosion and corrosion of container surfaces, pipes, fittings, pumps cavity erosion and any other source which come in contact with the fuel.

A regular inspection and maintenance procedure should ensure clean reliable fuel delivery at all times. All precautions should be taken to keep fuel system clean from external contaminants when conducting maintenance and inspection of entire fuel supply systems.

There are specific test methods for the detection of particulate contamination. One such method is Filter Membrane Test - Colorimetric. (Ref. ASTM D 2276/IP-216 – Test Method for Particulate Contamination in Aviation Fuel by Line Sampling)

A fixed volume of pressurized fuel (approximately 5 liters or a gallon) is passed through a filter membrane of pore size of 0.8 microns. Fuel contaminant is determined by comparing the colour and the intensity of the colour of the

membrane, after the fuel has passed through it, against a standardized colour chart with number ranging from 0 for the lightest to 10 for the darkest.

It is advisable to perform simultaneous tests on the inlet and outlet of the points of the equipment, storage tank or pipeline section. A permanently installed connection is strongly recommended at the sampling points and should include a quick disconnect to match the fitting on the inlet of the field sampling kit.

References: 1. ASTM D 2276; 2. ASTM Manual 5 Section B; 3. Gammon Technical Products, Bulletin 101-Mini Monitor Kit®.

1.3.1 Precautions to be taken prior to test:

Person testing fuel should be sufficiently protected to prevent contact with fuel by wearing eye protection, gloves and appropriate apparel. The sampling unit must be bonded accordingly to both to the sampling connection and the measuring container to minimize static discharge.

1.3.2 Apparatus and Equipment:

Sampling kit:

Field sampling kit (Fig 1.1); field monitor each one 37 mm diameter, 0.8 micron membrane, backed by a 34 mm diameter support pad, electrically bondable receiving container and a colour rating booklet (AMST D 2276, Appendix X).

Optional equipment; SGTP-3940 Colour and Particle Assessment Rating Guide are available from Gammon Technical Products Inc.

Figure 1.1
Typical test setup of a field sampling kit
(Source ASTM)

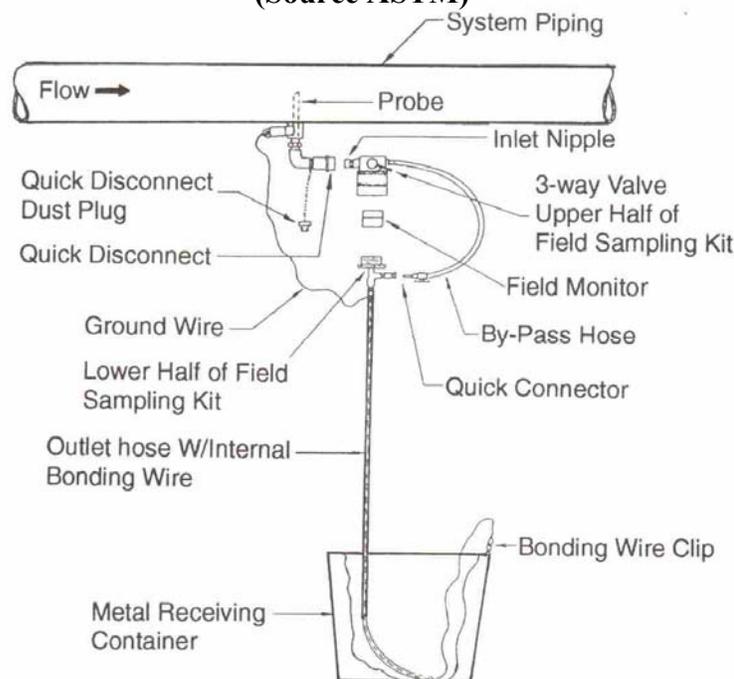
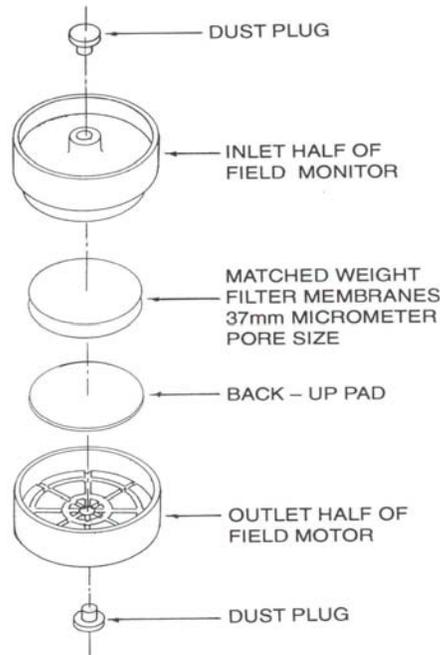


Figure 1.2
Matched weight field monitor (shown disassembled)
(Source ASTM)



1.3.3 Procedure, method of testing and observation:

Field sampling kit and sampling tap should be flushed prior to test.

Do not operate valves in the system during test.

Prepare the field monitor membrane and test procedures as describe in detail in ASTM 2276.

Do not exceed 689 kPa (100 psi).

Line flow rate in the system should be below 50% of rated capacity.

Measure the sample volume accurately.

Care should be taken when removing remaining fuel in the monitor in order not to damage the membrane. A damage membrane is not acceptable for analysis

After completion of test, disconnect field sampling kit from inlet hose. Turn the valve to flush remaining fuel from the kit into receiving container.

Remove remaining fuel from the monitor using a suction device supplied, ensure that the suction is applied gently and to the outlet side of the monitor.

Do not open the plastic field monitor on-site after the test.

Reinstall coloured dust plugs and wipe residual fuel from the exterior of the monitor.

Open monitor in a clean environment, remove membrane carefully by raising it from the outlet pad side using a blunt probe pushing the pad upward, use

tweezers to gently grab the membrane. Let membrane dry on a absorbent paper or letting it air dry for 3 hours.

Colour rating:

Use ASTM approved guides for colour rating.

Select the colour that closely matches the sample, viewing angle should be nearly perpendicular without any shadow casting on the membrane.

Report the match by scale letter and rating number, such as B-1, G-3, A-4. If the shade is between two rating numbers, report the lower number.

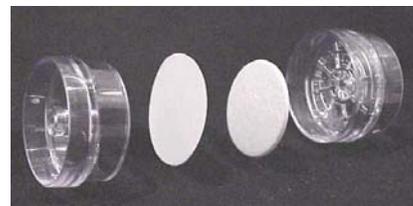
Report the sample volume, flow conditions, sampling pressure.

Report if the membrane was rated wet or dry and the test location and position in the system.

1.3.4 Interpretation of results:

There is no technical significance of any specific rating number unless it is compared with ratings from previous tests on the same fuel. A change of two numbers should cause concern and should be investigated. Unusual change in membrane colour rating may indicate change in fuel contamination level. Colour bodies in the fuel can cause membrane colour change. To verify colour bodies use two membranes in the monitor while performing the test. If both membranes have the same colour after test then it indicates colour bodies in the fuel. If the particulate appearance in the fuel is continued test after test, it will be a must to monitor the situation.

Figure 1.3
Mini Monitor®
Propriety brand equipment



0.8 micrometer (micron) membrane

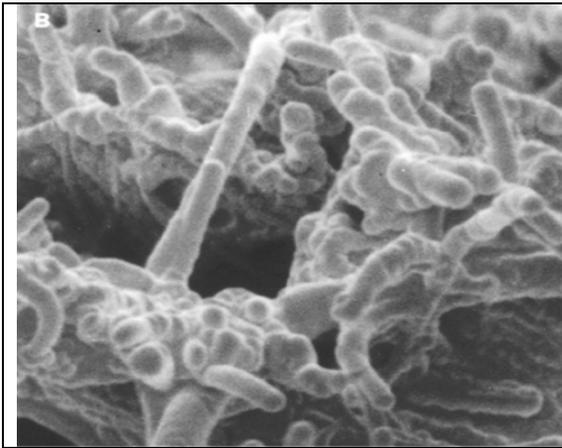


Colour Rating & Particulate Assessment Chart

1.4 Microbiological Contamination:

Micro-organisms may enter in aviation fuel in many ways such as air, sea or fresh water, soil or by other means. Micro-organism causes significant damage to the fuel system by means of slime formation, sludge and corrosion (Ref: Fig 1.5), hindering proper function of the equipment and hence loss of proper performance. Since water is needed for microbial growth, removal of water from aviation fuel system is the preferred method to limit microbiological contamination.

Microbes (Ref; Fig 1.4) are found at the fuel-water interface. They use fuel as food, converting additives into new chemicals and water as the oxygen source, thus ruining fuel. Some of their food becomes new bugs or biomass, and the rest become by-products or metabolites. These metabolite molecules range from carbon dioxide to slime. Some of the metabolites contribute to sludge formation or make organic acids, which make fuel and associated water bottoms corrosive. If you take a look at a slime sample at the fuel and water interface (Ref; Fig. 1.6), you will find the proportion of the mass that is actual bugs is astonishingly small.



SEM Photograph of Microbes living in fuel - University of Wales Report
Figure 1.4



Corrosion in a fuel supply line
Figure 1.5



Microbiological Growth in Aviation Fuel
Figure 1.6

The basic check for microbiological contamination in fuel is a periodical visual examination of a sample taken from the fuel storage, during which the signs of contamination such as black gelatinous matter, small soft particles floating in the fuel, discoloured or hazy fuel etc. should be checked. (Ref: Fig 1.6)

It is crucial to make sure that a representative sample is obtained from the *bottom* of the tank, to avoid being lulled into a false sense of security by a sample taken simply by dipping the top of the tank.

Specialist laboratories which carry out microbiological analysis of samples taken from fuel tanks should provide written reports of their findings, and certification, when requested. Microbiological analysis should include quantitative checks on the number of aerobic bacteria and fungal colonies present, and should also determine whether or not sulfate-reducing bacteria (SRB) are present. A haze test on the fuel should also be carried out. If deemed appropriate, any free water phase should be quantitatively analysed for total dissolved solids (TDS), pH and chloride content. Those tests will then give an indication of the likely source of the water. For example, a very high TDS and chloride content might confirm that the free water was derived from sea water.

Clear and Bright or White Bucket visual testing of fuel collected from storage tanks is important. Clear and bright testing can identify water and particulate contamination, and to a limited degree, microbiological contamination problems. A microbial contamination problem can show up as fine particulates which may or may not settle out to the bottom of the sample bottle. If fuel passes clear and bright criteria, and the fuel stocks are routinely rotated, chances are slight that a fuel quality problem will occur before the fuel has been consumed.

1.4.1 Precautions to be taken prior to test:

Person testing fuel should be sufficiently protected to prevent contact with fuel by wearing eye protection, gloves and appropriate apparel.

1.4.2 Apparatus:

Require a bucket or a clear glass bottle. A white sheet of paper or any bright surface is an additional tool.

1.4.3 Procedure of test:

Bucket or glass bottle must be clean and dry.

- a) Care should be observed when opening any drain or tap to prevent splash or spill.
- b) Take a sample from storage tank sump, filtration equipment or low point drain in a bucket or clean transparent glass bottle.
- c) Place sample on a level surface for few (at least 2 or more minutes) to settle.
- d) Visually inspect and observe the sample to determine presence of dark coloured solids, slime or dark colour water. Tip or swirl the bucket/bottle side to looking for evidence of mucus-like substance.
- e) If substance contamination is observed, carefully collect suspect material in a sample bottle by removing clear fuel into an approved fuel disposal container. Tightly cap the sample bottle, place identification sticker with date, location and sampling point.

1.4.4 Analysis and evaluation of findings:

Content of the sample bottle should be visually examined in front of bright background light.

- a) If the sample substance is mostly dark solid particles it could be rust. To as certain rust particle, take a magnet and slowly run around magnet against the bottle. If particles are rust they will collect and follow the magnet.
- b) Fine particles discolouring the water in the fuel can be further tested for possibility of being suspended rust particles. Filter some of the sample from the bottle through a smooth white paper towel and let paper dry. Inspect the dried particle visually and with a magnet to as certain if it is rust.
- c) If the sample is dark sludge and does not respond to a magnet, presence of fungi is highly likely. If the sample collected properly and contain mostly water, dark brown or black in colour, scum like at the top, with noticeable foul odor, micro-organism may be present.

1.4.5 Interpretation and precautionary notes:

- a) Positive results do not always indicate a microbial contamination induced investigation of an operational problem. Results should be carefully interpreted.

- b) If the visual examination of the sample indicates the possibility of micro-organisms or fungi, the sample should be sent to an approved laboratory for analysis.
- d) Good house keeping can prevent fuel system microbiological contamination by complete removal of water from sump water and periodic checks of coalescers for mats or brown spots on the socks.
- e) Several commercial kits are available for testing fuel for microbiological contaminations namely bacteria, microbial growth and fungi

1.5 Electrical Conductivity:

Reference: ASTM D 2624 – Test Methods for Electrical Conductivity of Aviation and Distillate Fuels.

Hydrocarbon fuels typically have low electrical conductivity and consequently, are susceptible to retaining a static charge. Static charges are induced, especially, when the fuel is pumped at high rates through filters. Due to the relatively low conductivity, the static charge does not readily dissipate and is retained for a considerable period of time. This condition can result in an explosion and/or fire. Aviation fuel low conductivity can be increased by the use of static dissipater additives (SDA). These additives help rapid dissipation of static electricity charges that can build up during normal fuel handling processes, especially during filtration. Refinery operators usually add additives which normally meets desired conductivity range in the field. There are number of reasons where effectiveness of additives dilute over a period of time and may render fuel conductivity to an unsafe level. Conductivity range must be monitored by using specific testing equipment. With the additives used conductivity of the fuel should be within product specification.

1.5.1 Conductivity Testing Procedure:

With a portable meter (Example, Fig. 1.7) conductivity measurement is made almost instantaneously.

Since conductivity is a function of temperature, it is very important to record the fuel temperature at which the measurement was performed.



Digital Conductivity Meter
(EMCEE Electronics Inc.)

Figure 1.7

- a) Rinse the probe and sample container (if container is used in lieu of directly dipping probe in the fuel storage tank) using the fuel under test prior conductivity test.
- b) Sample should be taken from the nozzle or the top hatch of the tanker but not from sump drain.
- c) After taking the sample wait for two (2) minutes for any charge in the fuel to dissipate.
- d) Ensure sampling container is metallic and properly bonded to the instrument.
- e) Calibrate the meter as per manufacturer's instructions.
- f) Immersed the probe in the fuel, energize the instrument and read the conductivity units (C.U.) equivalent to pico-siemens per meter (pS/m).
- g) If checking conductivity within a storage tank, wait at least 30 minutes after pumping into the tank before inserting equipment probe in to fuel. Ensure proper bonding of meter with the tank prior inserting the probe to prevent static discharge in case the fuel is charged.
- h) Do not use probe in areas where water may be present. If the probe has contacted the water, moisture or wet fuel, follow manufacturer's instructions for proper cleaning.

1.5.2 Interpretation and limitation of Results:

Conductivity of untreated fuel is generally less than 10 C.U (pS/m). Properly treated fuel range between 50 and 450 C.U., these readings reflect amount of additive in the fuel and are affected by temperature and time. Discrepancies may occur in repeatability of the readings because of the effect of temperature and time. For every 10 C drop in temperature of fuel, conductivity reading of the fuel will reduce approximately 50 pS/m.

Note that not all the aviation fuels contain static dissipater additives (SDA) such as "Jet A" fuel. Therefore sufficient relaxation time must be provided for static charges to dissipate and factored in the fuel delivery system as per API 2003 standard.

1.6 Density:

Scientific definition of density: density (ρ) of a body is the ratio of its mass (m) to its volume (V).

Density is defined by:

Density of fuel is "the mass of fuel per unit volume".

In some cases the density is expressed as a specific gravity or relative density, in which case it is expressed in multiples of the density of some other standard material, usually water or air.

Reference: ASTM D1655 specification, Jet A-1 fuel has a density of between 775.0 and 840.0 kg/m³. Density ranging from 37 to 51 °C API corrected to 15 °C or 60 °F.

1.6.1 Use of Thermometer and Hydrometer:

- Sample cylinder should be in a vertical stationary surface in an area free from air circulating air. Allow 1-2 minutes for air bubbles to disappear. Remaining bubbles from the surface of the sample if any should be removed by touching with a clean paper towel. Ensure the temperature of the sample does not change during the test.
- Gently lower the hydrometer into the sample. When it has settled, depress it about two scale division into the liquid and then release it.
- Determine the temperature of the sample by cautiously stirring with the thermometer for approximately 30 seconds ensure total immersion of mercury head into the sample. Note the temperature to the nearest 0.5 °C.

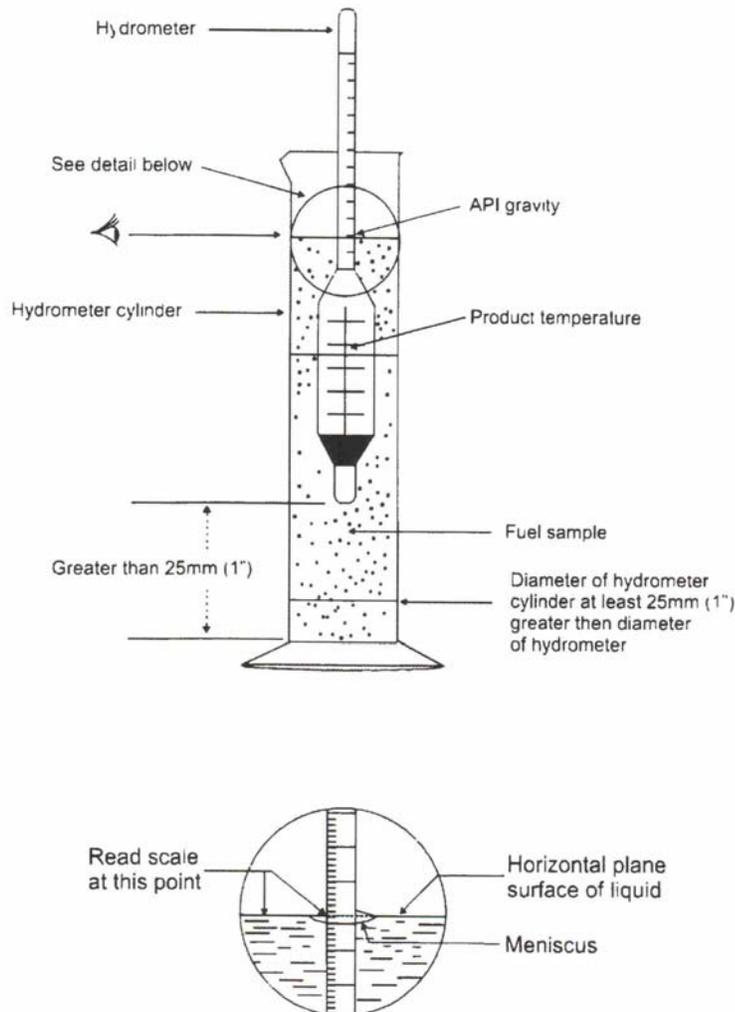


Figure 1.8. Hydrometer Reading

- d) Remove the thermometer and allow hydrometer to settle again. Depress it about two scale division into the liquid and then release it. Gently spin the hydrometer when releasing it to ensure free float away from the walls of the cylinder.
- e) Allow sufficient time to hydrometer to come to rest and take reading at the point where the surface of the liquid cuts the scale to 0.0002. Observe the hydrometer scale just below the surface and then raising eye slightly until the liquid surface appears as a straight line cutting the hydrometer scale. (Ref; Fig. 1.8)
- f) Record observed density reading.

1.6.2 Calculation:

It is necessary to correct the “observed density reading” of different samples to a “Standard Temperature/Pressure” (STP) density reading in order to compare alike.

- a) From Table 1.3 below read the correction coefficient per °C shown against “Observed Density”.

**Table 1.3
Correction Factors**

| Density at Observed Temperature (with metric hydrometer) | Density Correction Coefficient |
|---|--------------------------------|
| 0.6990-0.7020 | 0.00086 |
| 0.7021-0.7160 | 0.00085 |
| 0.7161-0.7300 | 0.00083 |
| 0.7301-0.7420 | 0.00081 |
| 0.7541-0.7650 | 0.00077 |
| 0.7651-0.7760 | 0.00076 |
| 0.7761-0.7870 | 0.00074 |
| 0.7871-0.7990 | 0.00072 |
| 0.7991-0.8020 | 0.00070 |
| 0.8021-0.8280 | 0.00068 |
| 0.8281-0.8600 | 0.00067 |
| 0.8601-0.9250 | 0.00065 |

- b) Multiply the coefficient by the difference between 15 °C and the temperature of the sample product when the density was recorded. This will be the actual correction factor to be applied to correct the density to STP.

- c) If the recorded temperature (taken at the time of recording density) is above 15 °C then correction factor is added to the observed density.
- d) If the recorded temperature (taken at the time of recording density) is below 15 °C then correction factor is subtracted from the observed density.

1.6.3 Example :

| | |
|---|---------|
| Observed density of sample | 0.7010 |
| Temperature of sample during determination of Density | 21 °C |
| Correction coefficient from Table 1.3 is | 0.00086 |
| Correction factor = (21-15) x 0.00086 | 0.00516 |
| Corrected density (STP) = 0.7010 + 0.00516 | 0.70616 |

Note: If the temperature of the sample would have been less than 15 °C, then the correction factor would have been subtracted from the observed density rather than added.

Aviation Jet Fuel

Section 2

Fuel Drum Storage

General

This section describes method and procedure of fuel stored in drums. Drums of aviation fuel meet all quality requirements at the time of packing. Improper storage, exposure to extreme temperatures, extended storage period or any other abnormality may impair the quality of the fuel in the drum.

References: Exxon Mobil, Transport Canada, various best practices and industry standards.

The following procedures and practices will ensure maintain quality of fuel in the drums.

2.0 Handling of Drums



Figure 2.1

- 2.0.1 Extreme care should be taken not to drop fuel contained drums off the vehicles, platforms or drum stacks.
- 2.0.2 Seals should not be damaged and checked for tightness.
- 2.0.3 Any other damage to be observed and reported.

2.1 Method of Storage

- 2.1.1 Drum marking must be legible.
- 2.1.2 Drums should be stored on their sides if possible.
- 2.1.3. Stacking should allow withdrawal of older drum first (first in – first out)
- 2.1.4 If drums must be placed upright, they should be kept under cover.
- 2.1.5 If drums must be placed upright in an open space they should be tilted slightly to prevent water from collecting around the bungs.



Figure 2-2

2.2 Preparation of Servicing from the Drums

Stand up drums prior to their usage (up to two days, if dry conditions can be assured) to allow contaminants in the fuel time to settle down. Avoid agitating the drums when refuelling.

For a safe and acceptable quality fuel delivery from drums to the aircraft, the following should be observed;

- 2.2.1 The drum identification markings should be checked for proper fuel grade.
- 2.2.2 Seals should not be damaged or broken.
- 2.2.3 Check drum contents for water by using dipstick and water finding paste.
- 2.2.4 If water found present in the drum, water should be removed prior using the content of the drum.
- 2.2.5 Ensure suitable filter/separators/monitors are used to service the aircraft with fuel.
- 2.2.6 Barrel pumps and filter/separators/monitors must be bonded to barrel before bungs are removed.

2.3 Fuelling from Drums

- 2.3.1 Mount filter/separator or fuel monitor on the side of the drum and bond correctly.
- 2.3.2 Tilt drum slightly sideways, ensure large bung is on the high side of the drum.
- 2.3.3 Open large bung and insert suction pump to the bottom.
- 2.3.4 Bond pump to the drum.
- 2.3.5 Bond discharge nozzle to the aircraft before opening aircraft fuel tank.
- 2.3.6 Fuelling nozzle should be inserted into aircraft tank to the lowest possible to prevent fuel from splashing while fuelling.
- 2.3.7 Commence delivery.

2.4 Switching to a fresh Drum

- 2.4.1 Remove nozzle from aircraft fuel tank and cap aircraft fuel tank.
- 2.4.2 Remove bonding cables and nozzle from aircraft vicinity.
- 2.4.3 Remove pump, filter/separator or monitor from drum.
- 2.4.4 Empty drum should be resealed and bonding cables removed from drum.
- 2.4.5 Proceed again with the fresh drum as described above.

Precautions, Safety and Quality measures:

- 1 Ensure that the drum you are using contains the proper fuel, regardless of what is printed on the outside! Also note: different oil companies have different colours for drums, but a drum's colour is not a foolproof indicator. Confirm by the appearance and odour of the fuel each time.
- 2 Be suspicious of any drum that seems light or heavy: water weighs 20% more, and Avgas 10% less, than Jet B. Whatever is printed on the drum cannot be trusted if the original seal is broken or missing.
- 3 Somewhere on the drum is a fill date. Most oil companies discourage using fuel that is more than two years old. One reason is that a nasty fungus (*cladosporium resinae*) can thrive in small amounts of water in jet fuel, and will clog fuel lines. Older fuel can be used safely with caution. Check for any strange odour, or a dark or cloudy condition. If you have any doubt, do not use it.
- 4 Check all unsealed drums for an "X" marked on the end. This is the accepted marking for contamination. However, the lack of an "X" is no guarantee of quality! Many pilots who use a part drum will mark the date, aircraft registration, and approximate amount used, near the bung. (If you have any doubt, don't use it!)
- 5 Store the drum in the proper manner, and be suspicious of any drum that is not, especially if you have reason to doubt whether it has been well resealed (bung or vent loose; gaskets torn, missing, or twisted). Even when properly resealed and stored, a part drum is more likely to contain moisture because of the increased "breathing" (more air content equals greater compressibility.)
- 6 All fuel drums should be stored on their side, with bungs and vents at the 3 o'clock and 9 o'clock positions. Make sure that the top of the drum (with the openings) is lower than the bottom. This will minimize breathing (air and moisture exchange from the outside).
- 7 When opening a drum, observe the following:
- 8 Stand the drum on end and block it with the high side at 12 o'clock, the bung at 3 o'clock, and the vent at 9 o'clock. This prevents water or dirty fuel from reaching the openings.
- 9 Ensure that the standpipe cannot reach the lowest point in the drum. Thus, any small amount of water or dirt will remain in the drum. You should not need the last gallon badly enough to risk using it.
- 10 If possible, stand up your drums prior to their usage (up to two days, if dry conditions can be assured) to allow contaminants time to settle out. Avoid agitating the drums when refuelling.

- 11 If you have a helicopter and you must hot-refuel, avoid putting loose items such as bungs and wrenches on top of the drum.

Note: Hot refuelling from drums should be done only during an emergency, or under very controlled conditions in compliance with CAR 602.09 and the approved Company Operations Manual (lots of ground crew, no passengers on board, pilot at the controls, and a developed refuelling procedure complete with individual duties and signals). The potential for disaster normally outweighs the potential for time saved.

- 12 Upon emptying the drum, locate it (with bung and vent reinstalled) so that it will not become a rolling or flying hazard to yourself or others using the fuel dump.
- 13 Proper grounding is critical, especially during winter operations. Dry winter air and blowing snow transform the rotors into powerful static generators. Moreover, snow insulates, and static may not dissipate on touchdown. Avoid wearing nylon clothing or wiping plexiglass when refuelling. Dusty or sandy conditions are also conducive to static build up. Check the condition of the ground cables, and replace any doubtful connections.

Note: The proper sequence for grounding is: drum to ground (anchor post), drum to pump, pump to aircraft, nozzle to aircraft, then open cap. When finished, reverse order.

- 14 Fuel caches should be located clear of sandy, dusty, or debris-strewn areas. They should be organized to expedite refuelling, with a good approach/departure path. (Remember: you will be heavier leaving, than arriving, unless you arrived with a load of uranium)
- 15 Always carry and use water finding paste, such as Kolor Kut. A tube will fit unobtrusively in your map case and last for a long time. A dab on the end of the standpipe will give a positive indication of water.
- 16 Ensure that the pump is equipped with a clean and serviceable go-no-go filter and particle filter in series, with intact o-rings. The go-no-go is designed to bind up and prevent flow in the presence of water. Increased pressure usually means blockage or contamination. Observe the sight glass for dirt or water in the sediment filter.
- 17 Squirt the first pump strokes into a container before putting the nozzle into the aircraft. Any dirt downstream of the filters will be flushed out of the hose, and can thus be examined.
- 18 Dispose of plastic caps, metal rings, and date tags from your used drums carefully to prevent the risk of foreign object damage (FOD) in the refuelling area.
- 19 Don't forget that the first pre-flight of the day should include a draining and catching of the aircraft's sump/airframe fuel-filter contents. Do this before disturbing the aircraft.

Aviation Jet Fuel

Section 3 Aboveground Fuel Storage Tank

General

More owners are considering the alternative of aboveground fuel storage systems. While these systems increase the risk of fire and the problems of evaporation and condensation, they are competitive with underground systems, require less management, and reduce the risk of groundwater contamination.

References: Exxon Mobil, USCG, various best practices and industry standards.

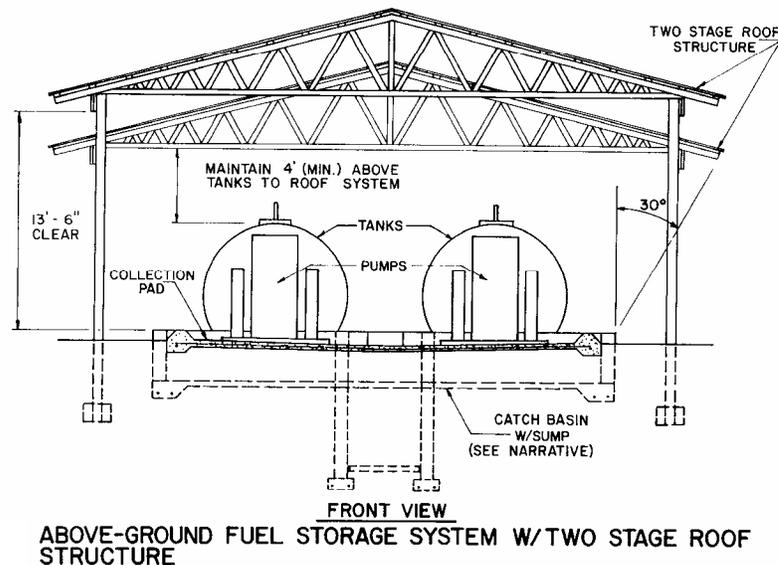


Fig 3.1
Illustration purposes only
(Source; University of Florida)

- 3.0 The above-ground system** is made up of the tank itself, a catch basin to trap fuel (should a tank leak or rupture), a concrete pad to retain fuel spilled during vehicle servicing and a roof structure to reduce evaporation and to keep water from collecting in the catch basin. If a complete roof structure is not constructed as part of the total above-ground fuel storage system, quantities of rainwater will accumulate in the catch basin, more than can be expected to dissipate by evaporation. A sump pump system can handle this excess water. An opening at the base of the basin wall to drain excess water is not an acceptable practice. Figure 3.1 shows how these components are arranged to form the above-ground system. Because all of the fuel components of this system are above ground, a leak can be visually detected as soon as it occurs. Also, if a leak does occur, all fuel will be contained by the concrete catch basin until it can be disposed of properly.



Figure 3.2
Aboveground Fuel Storage Tank
(Source; SuperSafe Tanks Inc.)



Figure 3.3
Large Aboveground Fuel Storage Tank

3.1 Inspection of Fuel Storage Tanks and Safety Features

- 3.1.1 All fuel storage tanks are to be visibly inspected on a weekly basis, and as soon as possible following adverse weather, to check the integrity of the storage systems and associate plumbing.
- 3.1.2 All storage tanks are to be checked monthly to verify contents.
- 3.1.3 A record of these inspections, including the internal cleaning of tanks, shall be maintained at the station. A logbook should be established for this purpose with the date, name of personnel and results for all maintenance and inspections of fuel handling and response equipment undertaken
- 3.1.4 All pumps, valves and associated equipment are to be maintained in good working order.
- 3.1.5 Any defective fixtures or fittings shall be replaced or repaired as soon as is practicable.

- 3.1.6 All tanks should be numbered and have the grade of fuel and maximum capacity clearly marked. All valves shall be tagged or numbered to facilitate clear and unambiguous description in operating procedures.
- 3.1.7 The delivery pump shall have an emergency stop switch or other appropriate mechanism located in a prominent, accessible position. Alternatively, a master valve shall be fitted immediately downstream of the pump to facilitate emergency shutdown.

3.2 Receiving Fuel



Figure 3.4
Typical fuel transport truck

The following procedure is recommended before loading fuel into storage tanks;

- 3.2.1 Check receiving tank levels. Ensure receiving tank will hold the quantity to be delivered. Check that contained fuel is of the same type and grade.
- 3.2.2 Ensure that all alarm systems, if any, are in place and operational.
- 3.2.3 Ensure receiving tanks to have no free water present.
- 3.2.4 Conduct all required quality tests of the receipt fuel.
- 3.2.5 Allow the fuel carrier/transport tanker to sit stationery at the unloading point for long enough to permit water and particulates to settle. Allow at least 30 minutes. Check that all compartment seals are intact.
- 3.2.6 Electrically bond the carrier/transporters to the fuel receiving equipment.
- 3.2.7 Ensure there is at least one each approved dry chemical fire extinguisher on each side of the carrier. In addition, one approved dry chemical fire extinguisher shall be within 30 feet of the receiving tank.
- 3.2.8 Check all fittings for tightness to ensure no leaks and no contamination will be introduced into the fuel.
- 3.2.9 Check valve alignment for proper set up and set all valves in the storage system to make sure that the fuel will go only into the proper tank.
- 3.2.10 Check to see that all containment walls are in place and are not damaged. Ensure that all water, and other fluids or debris, are removed from containment areas.
- 3.2.11 Ensure there shall be no smoking, open flames, spark or flame producing items, or radio transmission items within 50 feet of a fuelling operation.
- 3.2.12 Remove all unnecessary personnel from the area.
- 3.2.13 Check all seals on carrier tanks to ensure no tampering has taken place.
- 3.2.14 Check weather reports to ensure no lightening storms within five miles of the fuelling area.

3.3 Maintaining Fuel in the Aboveground Storage Tanks

- 3.3.1 Allow three hours of settling time per foot of fuel after delivery.
(Time may vary depending on the size of the storage tank)
- 3.3.2 Storage tank content should be periodically checked for water.
- 3.3.3 Ensure all water is drained from the filter/separator after every circulation.
- 3.3.4 Maintain accurate records of fuel quality, condition and age.

Aviation Jet Fuel

Section 4 Fire Prevention

General

Jet fuel can be hazardous if not handled properly. Jet fuel is easy to ignite and it burns rapidly. Personal handling jet fuel should have proper training on fuel handling, fire and safety. They should obtain and read Material Safety Data Sheet (MSDS). (Refer Annex- A)

References: Exxon Mobil- Fuelling Guide, USCG, various best practices and industry standards.

4.0 How fire starts

Fire is a chemical reaction. For fire to occur and materials (including liquid fuel) to continue burning, three elements must be present; first is Oxygen, second is Fuel and third is heat (source of ignition). If one of the three elements is removed, fire can't occur, or an active fire will be extinguished. This concept is known as "fire triangle". (Refer; Figure 4.1 and 4.2)

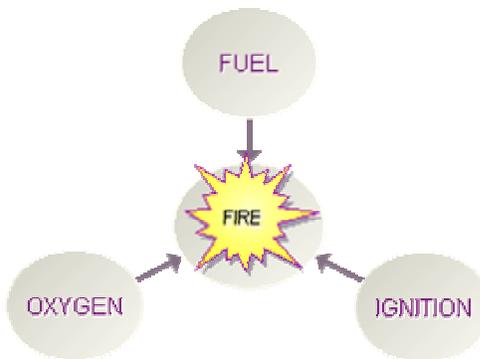


Figure 4.1

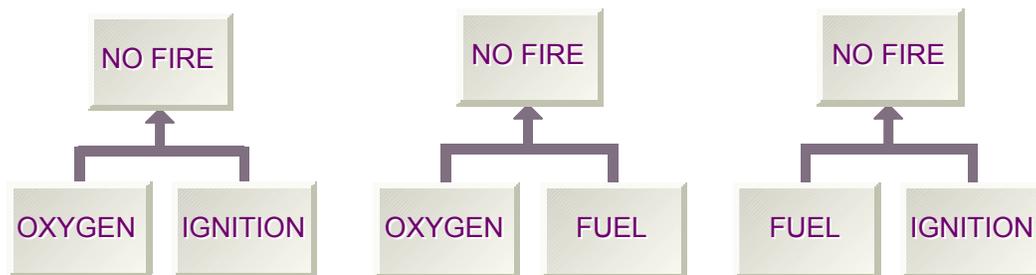


Figure 4.2

The fire hazards of most aviation fuels are best described in terms and characteristics of vapours, flash point and auto ignition.

4.1 Sources of Ignition

How a fuel ignites depends on its physical properties. The properties of aviation and turbine fuels that relate to ease of ignition are flash points, flammability limits, vapour pressure, auto ignition, temperature, distillation range and electrostatic susceptibility.

**Table 4.1.
Properties of Aviation Fuel**

| Fuel Type | Gasoline | Kerosene grades | Blends of gasoline and kerosene |
|---|-------------------------------|------------------------------------|---------------------------------|
| Property | AVGAS | JET A, JP-5, JP-6 JET A-1, JP-8 | JET B, JP-4 |
| Flash Point (By Closed-Cup Method at Sea Level) | -50°F | +95° to +145°F | -10° to +30°F |
| Flash Point (By Air Saturation Method) | -75° to -85°F | None | -60°F |
| Flammability Limits Lower Limit Upper Limit Temp Range for Flam Mixtures | 1.4% 7.6% -50° to +30°F | 0.6% 4.9% +95° to +165°F | 0.8% 5.6% -10° to +100°F |
| Vapour Pressure ASTM D 323 | 5.5 to 7.0 lb/sq in | 0.1 lb/sq in | 2.0 to 3.0 lb/sq in |
| Auto Ignition Temperature | +825° to +960°F | +440° to +475°F | +470° to 480°F |
| Freeze Point | -76°F | -40°F -58°F | -60°F |
| Boiling Points Initial End | 110°F 325°F | 325°F 450°F | 135°F 485°F |
| Pool Rate of Flame Spread* | 700 to 800 ft per min | 100 ft per min or less | 700 to 800 ft per min |
| *In mist form, rate of flame spread in all fuels is very rapid. | | | |

4.2 Prevention of Fire Hazard

Fuel Storage Area



The following items should be included in a fuel storage facility fire safety checks;

- 4.3.1. Check the general condition of the area for appearance and cleanliness. It should be free of weeds or any other combustible materials. Assure all “NO SMOKING”, “FLAMMABLE” and other safety signs are in place.
- 4.3.2 Check the location of emergency shut-off controls. Be familiar with the operation of those controls.
- 4.3.3 Regularly check tanks, piping, valves, hoses, meters, filters and other equipment for fuel leaks. Any visible leak must be repaired immediately.
- 4.3.4 Check the condition of static bonding, cables, reels and clamps.
- 4.3.5 Verify that the fire extinguishers are in the proper place with no obstructions. Check all seals, pressure gauges and inspection tags regularly. If the pressure is low or the seal is broken, the fire extinguisher must be replaced immediately.
- 4.3.6 Prior to receiving fuel into storage, check the liquid level of all tanks and ensure that all valves are in the proper position to prevent overfill and spillage.
- 4.3.7 Keep all equipment and work areas clean, neat and in good working order. Ensure that all equipment is properly stowed away after use with caps and dust covers.

4.3 Prevention of Ignition Source

(a) Prevention of vapour formation:

- 4.4.1 Spilled fuel should be immediately be wiped up, washed away with water or surface covered with a suitable absorbent. Remove the absorbent immediately after the hazard no longer exists.
- 4.4.2 Keep fuel in closed containers to eliminate unnecessary contact with air.
- 4.4.3 Keep fuel in as cool a place as possible.
- 4.4.4 Treat empty containers as though they still contain fuel, they may contain dangerous fuel vapours.
- 4.4.5 Never drive or move a tank trailer tat is leaking jet fuel.
- 4.4.6 Avoid splash filling any vessel or tank.

- 4.4.7 Do not fuel or de-fuel aircraft or otherwise dispose fuel in hangers or other closed areas.
- 4.4.8 Never dispose of waste fuel in storm drains or sanitary sewage systems.

(b) Prevention of heat source:

- 4.4.9 Allow no open fires, lighted cigarettes, matches, mobile phones and others non-intrinsically safe electrical equipment in the vicinity of the fuelling operation and storage area.
- 4.4.10 Non-sparking shoes (rubber, cord or sewn leather soles) should be used.
- 4.4.11 Controlling electrostatic charge reduces the chances for electrostatic sparks, which are ignition sources and could result in an explosion or fire. All static bonding and ground/earth connection must be made in accordance with the established procedures. Allow adequate time for static electricity to dissipate before beginning fuelling or de-fuelling operations.
- 4.4.12 Do to clean containers, drums, or ant other vessels since residue is difficult to remove. “Empty” drums should be completely drained, properly bunged, and promptly returned to a drum re-conditioner. All other containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.
- 4.4.13 Extreme caution is necessary during lightning and severe stormy weather conditions. Operations should be suspended whenever lightning is in the immediate area of the fuelling.
- 4.4.14 All vehicles serving the area should be well maintained for no spark or heat source present including but not limited to; spark from the motor, electrical circuitry, vehicle exhaust, static or heat from a headlight that is missing a lens cover.
- 4.4.15 A visual inspection of the area prior to any fuelling operation is helpful to prevent any mishaps.

Aviation Jet Fuel

Section 5 Health and Safety

General

Jet fuel can be hazardous if not handled properly. Personal and property damage may occur if jet fuel is not handled with the maximum caution because of the obvious dangers associated with the possible fires, explosions and hazard to humans. Any safety procedures and requirements are no substitute for a through knowledge of aviation fuels and their inherent characteristics and dangers.

Anyone planning to handle jet fuel should obtain Material Safety Data Sheet (MSDS) and get acquainted with it. (Refer; Annex A)

Any jet fuel handling situation should be considered hazardous and the appropriate safety measure observed.

- Safety is not to be compromised at any time or for any reason.
- Training employees are essential to have a safe workplace.
- Accident prevention is wise business.

5.1 Personal Safety

The most effective way to maintain a high level of personal safety is through initial and recurrent training of personal on safety procedures that are designed to protect everyone in the work environment. It is important that correct procedures are followed and the correct safety equipment used when handling jet fuel.

Personal should take advantage of the protective equipment provided such as non-absorbent gloves, earplugs, safety goggles and protective footwear.

Certain clothing will generate enough static electricity to cause a spark, which can cause an explosion and fire. It is recommended that wool, nylon, Dacron and other similar material not be worn by fuelling personal. Cotton clothing is preferable. Smoking is not permitted in any fuelling area such as in the storage areas, on the ramp or in the hangers.

Personal not directly involved in the fuelling or fuel storage operation, shall remain clear of the area.

5.2 Minimizing Health Hazards

- 5.2.1 Avoid entering enclosed area where fuel vapours may be present.
- 5.2.2 Always minimize the exposure to fuel vapours. Good ventilation of workspace is essential.
- 5.2.3 Stay on the upwind side of a fuel spill if it is necessary to remain in an area where a large spill has occurred.

- 5.2.4 Stay on the upwind side of a fuel spill occurring during fuel handling operations, where the formation of vapours is unavoidable, such as at a truck fill stand.
- 5.2.5 Stop the fuel handling operation and move to a fresh air location immediately if dizziness or nausea occurs.
- 5.2.6 Avoid skin contact with fuels that can contain FSII. If fuel does contact the skin, immediately wash with soap and water.
- 5.2.7 Never wash hands in gasoline or jet engine fuels.
- 5.2.8 Do not allow fuel to dry on skin or clothing. Remove fuel-soaked clothing and wash skin areas with soap and water. Do not wear fuel-soaked clothing in shop spaces.
- 5.2.9 Wear eye protection and clothing that leaves a minimum amount of skin exposed during refuelling operations. In case of a fire, appropriate protection will minimize burns.

5.3 Environmental Hazards

Turbine Jet fuel is highly toxic. It can damage the environment and endanger the health of humans and wildlife if handled improperly.

All safety procedures should be followed to keep fuel spills to a minimum and ensure contaminated fuels are disposed of safely.

Immediate steps to be taken to avoid any environmental damage in the following cases;

5.3.1 Fuel Spills

- Limit the size of the spill.
- Contain the spill
- Notify fire department, maintenance control and HAZMAT response team.
- Clean it up as quickly as possible.

5.3.2 Leaking Tanks

- Empty the tank by pumping it into another tank or empty refueler truck.
- Check the tank containment system, ensure it is intact and no fuel has escaped. Place buckets or barrels under the leaking section if possible.
- Clean up the spill in accordance with the procedures.

5.3.3 Used Test Samples

Used fuel test samples contaminated with chemicals should be disposed of into waste oil tank for proper disposition according to the local environmental regulations.



Annex – A

Product Name: KEROSENE TYPE AVIATION TURBINE FUEL
Revision Date: 25Jul2007
Page 35 of 45

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: (see Section 16 for Synonyms) **KEROSENE TYPE AVIATION TURBINE FUEL**
Product Description: Hydrocarbons and Additives
MSDS Number: 8525
Intended Use: Aviation fuel

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

Reportable Hazardous Substance(s) or Complex Substance(s)

| Name | CAS# | Concentration* | Acute Toxicity |
|-----------------------------|-----------|----------------|--|
| 2-(2-METHOXYETHOXY)-ETHANOL | 111-77-3 | 0 - 0.15% | Dermal Lethality: LD50 > 2.0 g/kg (Rabbit); Oral Lethality: LD50 7.0 g/kg (Rat) |
| KEROSENE | 8008-20-6 | > 99 % | Dermal Lethality: LD50 > 2000 mg/kg (Rabbit); Inhalation Lethality: LC50 > 5.0 mg/l (Rat); Oral Lethality: LD50 > 5000 mg/kg (Rat) |

Hazardous Constituent(s) Contained in Complex Substance(s)

| Name | CAS# | Concentration* | Acute Toxicity |
|-------------|---------|----------------|---|
| Naphthalene | 91-20-3 | 0.1 - 1% | Dermal Lethality: LD50 > 20 g/kg (Rabbit); Oral Lethality: LD50 0.49 g/kg (Rat) |

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

SECTION 3 HAZARDS IDENTIFICATION

This material is considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

PHYSICAL/CHEMICAL EFFECTS

Combustible. Material can release vapours that readily form flammable mixtures. Vapour accumulation could flash and/or explode if ignited. Material can accumulate static charges which may cause an incendiary electrical discharge.

HEALTH EFFECTS

Irritating to skin. Danger of serious damage to health by prolonged exposure. May cause harm to the unborn child. If swallowed, may be aspirated and cause lung damage. May be irritating to the eyes, nose, throat, and lungs. Breathing of high vapour concentrations may cause dizziness, light-headedness, headache, nausea and loss of co-ordination. Continued inhalation may result in unconsciousness. High-pressure injection under skin may cause serious damage.

Target Organs: Reproductive system | Skin |

| | | | |
|------------------------|-----------|-----------------|---------------|
| NFPA Hazard ID: | Health: 2 | Flammability: 2 | Reactivity: 0 |
| HMIS Hazard ID: | Health: 2 | Flammability: 2 | Reactivity: 0 |

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4

FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIAN

If ingested, material may be aspirated into the lungs and cause chemical pneumonitis. Treat appropriately.

PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE

Hydrocarbon Solvents/Petroleum Hydrocarbons- Skin contact may aggravate an existing dermatitis.

SECTION 5

FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Combustible. Vapour is flammable and heavier than air. Vapour may travel across the ground and reach remote ignition sources, causing a flashback fire danger. Hazardous material. Firefighters should consider protective equipment indicated in Section 8.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulphur Oxides, Incomplete combustion products, Oxides of carbon

FLAMMABILITY PROPERTIES

Flash Point [Method]: 38C (100F) [ASTM D-93]

Flammable Limits (Approximate volume % in air): LEL: 0.7 UEL: 5.0

Autoignition Temperature: N/D

SECTION 6

ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding and downwind areas if required, due to toxicity or flammability of the material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for Personal Protective Equipment.

SPILL MANAGEMENT

Land Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do so without risk. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Prevent entry into waterways, sewer, basements or confined areas. A vapour-suppressing foam may be used to reduce vapour. Use clean non-sparking tools to collect absorbed material. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Large Spills: Water spray may reduce vapour, but may not prevent ignition in enclosed spaces.

Water Spill: Stop leak if you can do so without risk. Eliminate sources of ignition. If the Flash Point exceeds the Ambient Temperature by 10 deg C or more, use containment booms and remove from the surface by skimming or with suitable absorbents when conditions permit. If the Flash Point does not exceed the Ambient Temperature by 10°C, or is less than the Ambient Temperature, use booms as a barrier to protect shorelines and allow the material to evaporate. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Avoid contact with skin. Do not siphon by mouth. Use proper bonding and/or earthing procedures. Do not use as a cleaning solvent or other non-motor fuel uses. For use as a motor fuel only. It is dangerous and/or unlawful to put petrol into unapproved containers. Do not fill container while it is in or on a vehicle. Static electricity may ignite vapour and cause fire. Place container on ground when filling and keep nozzle in contact with container. Do not use electronic devices (including but not limited to cellular phones, computers, calculators, pagers or other electronic devices etc) in or around any fuelling operation or storage area unless the devices are certified intrinsically safe by an approved national testing agency and to the safety standards required by national and/or local laws and regulations. Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source).

Static Accumulator: This material is a static accumulator.

STORAGE

Keep container closed. Handle containers with care. Open slowly in order to control possible pressure release. Store in a cool, well-ventilated area. Storage containers should be earthed and bonded. Drums must be earthed and bonded and equipped with self-closing valves, pressure vacuum bungs and flame arresters.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

| Substance Name | Form | Limit/Standard | | Note | Source |
|-------------------------------------|-------------|----------------|-----------------------|------|--------|
| KEROSENE [total hydrocarbon vapour] | Non-Aerosol | TWA | 200 mg/m ³ | Skin | ACGIH |
| Naphthalene | | STEL | 15 ppm | Skin | ACGIH |
| Naphthalene | | TWA | 10 ppm | Skin | ACGIH |

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

Use explosion-proof ventilation equipment to stay below exposure limits.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be

considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly affect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

Chemical resistant gloves are recommended.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

Chemical / oil resistant clothing if contact with material is likely.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Colour: Pale yellow

Odour: Petroleum/solvent

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.81

Flash Point [Method]: 38C (100F) [ASTM D-93]

Flammable Limits (Approximate volume % in air): LEL: 0.7 UEL: 5.0

Autoignition Temperature: N/D

Boiling Point / Range: < 205C (401F)

Vapour Density (Air = 1): 4 at 101 kPa

Vapour Pressure: [N/D at 20°C] | < 1 kPa (7.5 mm Hg) at 38C

Evaporation Rate (N-Butyl Acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: [N/D at 40°C] | 8.8 cSt (8.8 mm²/sec) at -20C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D
 Melting Point: N/A
 Pour Point: -40°C (-40°F)

SECTION 10

STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Avoid heat, sparks, open flames and other ignition sources.

MATERIALS TO AVOID: Halogens, Strong Acids, Alkalies, Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11

TOXICOLOGICAL INFORMATION

Acute Toxicity

| <u>Route of Exposure</u> | <u>Conclusion / Remarks</u> |
|---|---|
| INHALATION | |
| Toxicity (Rat): LC50 > 5000 mg/m ³ | Minimally Toxic. Based on test data for structurally similar materials. |
| Irritation: No end point data. | Elevated temperatures or mechanical action may form vapours, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs. Based on assessment of the components. |
| INGESTION | |
| Toxicity (Rat): LD50 > 2000 mg/kg | Minimally Toxic. Based on test data for structurally similar materials. |
| Skin | |
| Toxicity (Rabbit): LD50 > 2000 mg/kg | Minimally Toxic. Based on test data for structurally similar materials. |
| Irritation (Rabbit): Data available. | Moderately irritating to skin with prolonged exposure. Based on test data for structurally similar materials. |
| Eye | |
| Irritation (Rabbit): Data available. | May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials. |

CHRONIC/OTHER EFFECTS

For the product itself:

Vapour/aerosol concentrations above recommended exposure levels are irritating to the eyes and respiratory tract, may cause headaches, dizziness, anaesthesia, drowsiness, unconsciousness and other central nervous system effects including death. Small amounts of liquid aspirated into the lungs during ingestion or from vomiting may cause chemical pneumonitis or pulmonary edema.

Jet fuel: Some jet fuels have potential in mice to suppress indicators of immune system functionality. The relevance of these effects to humans is uncertain.

Contains:

DIETHYLENE GLYCOL MONOMETHYL ETHER: Oral maternal exposure of animals resulted in teratogenicity. Dermal maternal exposure of animals resulted in slight toxicity to the fetus. KEROSENE: Carcinogenic in animal tests. Lifetime skin painting tests produced tumours, but the mechanism is due to repeated cycles of skin damage and restorative hyperplasia. This mechanism is considered unlikely in humans where such prolonged skin irritation would not be tolerated. Did not cause mutations in-vitro. Inhalation of vapours did not result in reproductive or developmental effects in laboratory animals. Inhalation of high concentrations in animals resulted in respiratory tract irritation,

lung changes and some reduction in lung function. Non-sensitizing in animal tests.
 NAPHTHALENE: Exposure to high concentrations of naphthalene may cause destruction of red blood cells, anemia, and cataracts. Naphthalene caused cancer in laboratory animal studies, but the relevance of these findings to humans is uncertain.

Additional information is available by request.

CMR Status:

| Chemical Name | CAS Number | List Citations |
|---------------|------------|----------------|
| KEROSENE | 8008-20-6 | 4 |
| Naphthalene | 91-20-3 | 3, 4 |

--REGULATORY LISTS SEARCHED--

1 = IARC 1
 2 = IARC 2A

3 = IARC 2B
 4 = ACGIH ALL

5 = ACGIH A1
 6 = ACGIH A2

| | |
|-------------------|-------------------------------|
| SECTION 12 | ECOLOGICAL INFORMATION |
|-------------------|-------------------------------|

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Expected to be toxic to aquatic organisms.

MOBILITY

More volatile component -- Highly volatile, will partition rapidly to air. Not expected to partition to sediment and wastewater solids.
 High molecular wt. component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Majority of components -- Expected to be inherently biodegradable

Atmospheric Oxidation:

More volatile component -- Expected to degrade rapidly in air

BIOACCUMULATION POTENTIAL

Majority of components -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

| | |
|-------------------|--------------------------------|
| SECTION 13 | DISPOSAL CONSIDERATIONS |
|-------------------|--------------------------------|

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning Empty Container Warning (where applicable): Empty

containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14**TRANSPORT INFORMATION****LAND (TDG)**

Proper Shipping Name: FUEL, AVIATION, TURBINE ENGINE
Hazard Class & Division: 3
UN Number: 1863
Packing Group: III
Special Provisions: 17

Footnote: In containers of 454 litres or less this material is exempt from TDG regulations.

LAND (DOT)

Proper Shipping Name: FUEL, AVIATION, TURBINE ENGINE
Hazard Class & Division: COMBUSTIBLE LIQUID
ID Number: 1863
Packing Group: III
ERG Number: 128
Label(s): NONE
Transport Document Name: FUEL, AVIATION, TURBINE ENGINE, COMBUSTIBLE LIQUID, UN1863, PG III

Footnote: The flash point of this material is greater than 38°C/100°F. Regulatory classification of this material varies. DOT: Flammable liquid or combustible liquid. OSHA: Combustible liquid. IATA/IMO: Flammable liquid. This material is not regulated under 49 CFR in a container of 450 litre/119 gallon capacity or less when transported solely by land, as long as the material is not a hazardous waste, a marine pollutant, or specifically listed as a hazardous substance.

SEA (IMDG)

Proper Shipping Name: FUEL, AVIATION, TURBINE ENGINE
Hazard Class & Division: 3
EMS Number: F-E, S-E
UN Number: 1863
Packing Group: III
Label(s): 3
Transport Document Name: FUEL, AVIATION, TURBINE ENGINE, 3, UN1863, PG III

AIR (IATA)

Proper Shipping Name: FUEL, AVIATION, TURBINE ENGINE
Hazard Class & Division: 3
UN Number: 1863
Packing Group: III
Label(s): 3
Transport Document Name: FUEL, AVIATION, TURBINE ENGINE, 3, UN1863, PG III

SECTION 15**REGULATORY INFORMATION**

WHMIS Classification: Class B, Division 3: Combustible Liquids Class D, Division 2, Subdivision A: Very Toxic Material Class D, Division 2, Subdivision B: Toxic Material

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: AICS, IECSC, DSL, EINECS, ENCS, KECI, PICCS, TSCA

The Following Ingredients are Cited on the Lists Below:

| Chemical Name | CAS Number | List Citations |
|----------------------|-------------------|-----------------------|
| Naphthalene | 91-20-3 | 1, 6 |

--REGULATORY LISTS SEARCHED--

1 = TSCA 4
2 = TSCA 5a2

3 = TSCA 5e
4 = TSCA 6

5 = TSCA 12b
6 = NPRI

| | |
|-------------------|--------------------------|
| SECTION 16 | OTHER INFORMATION |
|-------------------|--------------------------|

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 05: Fire Fighting Measures - Fire Fighting Instruction was modified.

Section 06: Protective Measures was modified.

Section 13: Empty Container Warning was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Color was modified.

Section 09: Physical State was modified.

Section 09: Boiling Point C(F) was modified.

Section 08: Hand Protection was modified.

Section 09: Vapour Pressure was modified.

Section 07: Handling and Storage-Handling was modified.

Hazard Identification: Physical/Chemical Hazard was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Relative Density - Header was modified.

Section 09: Flash Point C(F) was modified.

Section 09 Viscosity was modified.

Hazard Identification: Emergency Overview Target Organs was modified.

Composition: Component Table was modified.

Section 16: Target Organs was modified.

Composition: Component Table was modified.

Section 08: Exposure Limits Table was modified.

Section 16: Water Spill was modified.

Section 15: Canadian List Citations Table was modified.

Section 11: Tox List Cited Table was modified.

Section 11: Chronic Tox - Component - WHMIS was modified.

Section 16: Synonyms was added.

Section 16: Synonyms - Header was added.

Section 01: Product Name - Header was added.

Section 16: Materials Covered was deleted.

Section 16: NA Materials Covered- Header was deleted.

SYNONYMS: ESSO JET A-1, JET A, JET A-1, TURBO FUEL A, TURBO FUEL A-1, TURBO FUEL A-1 F34, TURBO FUEL A-1 JP8, JET A-1 (FSII), CAN/CGSB-3.23 GRADE F34, KEROSENE TYPE AVIATION TURBINE FUEL, ESSO TURBO FUEL A, ESSO TURBO FUEL A-1, ESSO JET A

Precautionary Label Text:

WHMIS Classification: Class B, Division 3: Combustible Liquids Class D, Division 2, Subdivision A: Very Toxic Material Class D, Division 2, Subdivision B: Toxic Material

HEALTH HAZARDS

Irritating to skin. Danger of serious damage to health by prolonged exposure. May cause harm to the unborn child. If swallowed, may be aspirated and cause lung damage. May cause central nervous system depression.

Target Organs: Reproductive system | Skin |

PHYSICAL HAZARDS

In use, may form flammable/explosive vapour-air mixture. Combustible. Material can accumulate static charges which may cause an incendiary electrical discharge.

PRECAUTIONS

Avoid contact with skin. Do not siphon by mouth. Use proper bonding and/or earthing procedures.

FIRST AID

Eye: Flush thoroughly with water. If irritation occurs, get medical assistance.

Oral: Seek immediate medical attention. Do not induce vomiting.

Skin: Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse.

FIRE FIGHTING MEDIA

Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

SPILL/LEAK

Land Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do so without risk. Prevent entry into waterways, sewer, basements or confined areas. A vapour-suppressing foam may be used to reduce vapour. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.

Water Spill: Stop leak if you can do so without risk. Eliminate sources of ignition. Report spills as required to appropriate authorities. If the Flash Point exceeds the Ambient Temperature by 10 deg C or more, use containment booms and remove from the surface by skimming or with suitable absorbents when conditions permit. If the Flash Point does not exceed the Ambient Temperature by 10°C, or is less than the Ambient Temperature, use booms as a barrier to protect shorelines and allow the material to evaporate. Seek the advice of a specialist before using dispersants.

Use

Not intended or suitable for use in or around a household or dwelling.

The information and recommendations contained herein are, to the best of Imperial Oil's

knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5007485 (1012675)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety