



**Chapter: 13**  
**Characteristics of Petroleum**  
**Products Stored and**  
**Dispensed**

Developing a plan to deal with potential emergencies requires a comprehensive knowledge of the physical properties and characteristics of the petroleum products involved. A brief description is provided on the subject of Diesel, Gasoline and Jet A-1.

### **13.1 Diesel Fuel**

Ultra-low sulfur diesel (ULSD) is a standard for defining diesel fuel with substantially lowered sulfur contents. PPD sells ULSD in all communities of Nunavut including Gjoa Haven. Generally diesel is used in all kinds of diesel engines but in Nunavut the product is also used as home heating fuel, motor fuel, and fuel for power generation etc. Bulk fuel storage tanks are replenished usually once a year during the summer months. Diesel is mostly distributed to customers by trucking. In some communities modern RDR diesel dispensers are used for filling vehicles.



*Figure 13.1: A modern RDR diesel dispenser*



*Figure 13.2: USLD sample*

#### **13.1.1 Physical Properties of USLD**

The physical properties of diesel could be summarized as below.

Form:	Liquid
Appearance:	Clear, straw coloured
Odour:	Characteristic petroleum (kerosene) odour
Flash point-typical:	38°C minimum for diesel, 52°C minimum for #2 Diesel
Auto ignition temperature:	257°C (495°F)
Thermal decomposition:	No decomposition if stored and applied as directed
Lower explosive limit:	0.6 % (V)                      Upper:                      4.7% (V)
pH:	Not applicable
Freezing point:	No data available
Boiling point:	154-372°C (310°-702°F)
Vapour pressure:	<2 mm Hg at 20°C
Density:	0.86g/cm <sup>3</sup>
Water solubility:	Negligible

Viscosity, dynamic: 1.7-40mPa.s at 37.8°C (100°F)

ULSD is produced from the fractional distillation of crude oil between 200°C (392°F) and 350°C (662°F) at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule. As of 2012, the density of petroleum diesel is about 0.832 kg/l, about 86.1% of the fuel mass is carbon, and when burned, it offers a net heating value of 43.1 MJ/kg as opposed to 43.2 MJ/kg for gasoline. However, due to the higher density, diesel offers a higher volumetric energy density at 35.86 MJ/L (128 700 BTU/US gal) vs. 32.18 MJ/L (115 500 BTU/US gal) for gasoline, some 11% higher, which should be considered when comparing the fuel efficiency by volume. The CO<sub>2</sub> emissions from diesel are 73.25 g/MJ, just slightly lower than for gasoline at 73.38 g/MJ. Diesel is generally simpler to refine from petroleum than gasoline, and contains hydrocarbons having a boiling point in the range of 180-360°C (360-680°F). Because of recent changes in fuel quality regulations, additional refining is required to remove sulfur, which contributes to a sometimes higher cost.

### **13.1.2 Chemistry of ULSD**

Petroleum-derived diesel is composed of about 75% saturated hydrocarbons (primarily paraffin including straight chain, branch chain and cyclo paraffin), and 25% aromatic hydrocarbons (including naphthalenes and alkyl benzenes). The average chemical formula for common diesel fuel is C<sub>12</sub>H<sub>23</sub>, ranging approximately from C<sub>10</sub>H<sub>20</sub> to C<sub>15</sub>H<sub>28</sub>. Actually ULSD is a mixture of following hydrocarbons fractions:

Component	CAS-No.	Weight
Fuels, diesel, No.2 Gasoil- unspecified	68476-34-6	100%
Nonane	111-84-2	0-5%
Naphthalene	91-20-3	0-1%
1,2,4-Trimethylbenzene	95-63-6	0-2%
Xylene	1330-20-7	0-2%
Sulfur	7704-34-9	15ppm maximum

***Table 13.1: Composition of ULSD***



***Figure 13.3: Diesel is immiscible with water***

Microbes such as algae can cause some quality and environmental issues when let grow in a fuel tank. Algae need light to live and grow. As there is no sunlight in a closed fuel tank, no algae can survive, but some microbes can survive and feed on the diesel fuel. These microbes form a colony that lives at the interface of fuel and water. They grow quite fast in warmer temperatures. They can even grow in cold weather when fuel tank heaters are installed. Parts of the colony can break off and clog the fuel lines and fuel filters and may result into pipe burst contaminating the environment.

### **13.1.3 Diesel Related Environmental Concerns**

Accidental release of diesel to the atmosphere is hazardous and could pose a threat to air quality and cause contamination of land and nearby water bodies. A disadvantage of diesel as a vehicle fuel in cold climates, compared to gasoline or other petroleum-derived fuels, is that its viscosity increases quickly as the fuel's temperature decreases, turning into a non-flowing gel at temperatures as high as  $-19^{\circ}\text{C}$  ( $-2.2^{\circ}\text{F}$ ) or  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ), which cannot be pumped by regular fuel pumps. Special low-temperature diesel contains additives to keep it in a more liquid state at lower temperatures, but starting a diesel engine in very cold weather may still pose considerable difficulties. Diesel-powered vehicles generally have a better fuel economy than equivalent gasoline engines and produce less greenhouse gas emission. Their greater economy is due to the higher energy per-litre content of diesel fuel and the intrinsic efficiency of the diesel engine. While petro diesel's higher density results in higher greenhouse gas emissions per litre compared to gasoline, the 20–40% better fuel economy achieved by modern diesel-ignited automobiles offsets the higher per-litre emissions of greenhouse gases and a diesel-powered vehicle emits 10-20 percent less greenhouse gas than comparable gasoline vehicles.

In the past, diesel fuel contained higher quantities of sulfur. North American Emission Standards and preferential taxation have forced oil refineries to dramatically reduce the level of sulfur in diesel fuels. Canadian diesel fuel typically also has a lower octane number (a measure of ignition quality) than European diesel, resulting in worse cold weather performance and some increase in emissions.

Petro diesel spilled on a road will stay there until washed away by sufficiently heavy rain, whereas gasoline will quickly evaporate. After the light fractions have evaporated, a greasy slick is left on the road which can destabilize moving vehicles.

Diesel spills severely reduce tire grip and traction, and have been implicated in many accidents. The loss of traction is similar to that encountered on black ice. High levels of sulfur in diesel are harmful for the environment because they prevent the use of catalytic diesel particulate filters to control diesel particulate emissions, as well as more advanced technologies, such as nitrogen oxide ( $\text{NO}_x$ ) adsorbers (still under development), to reduce emissions. Moreover, sulfur in the fuel is oxidized during



combustion, producing sulfur dioxide and sulfur trioxide, that in presence of water, rapidly convert to sulfuric acid, one of the chemical processes that result in acid rain. However, the process for lowering sulfur also reduces the lubricity of the fuel, meaning that additives must be put into the fuel to help lubricate engines.

## **13.2 Gasoline**



*Figure 13.4: Gasoline sample*

Gasoline is a toxic, translucent, petroleum-derived liquid that is primarily used as a fuel in internal combustion engines. It consists mostly of organic compounds obtained by the fractional distillation of petroleum, enhanced with a variety of additives. Gasoline is more volatile than diesel oil, Jet-A, or kerosene, not only because of the base constituents, but also because of additives. Volatility is often controlled by blending with butane, which boils at  $-0.5\text{ }^{\circ}\text{C}$ . The volatility of gasoline is determined by the Reid vapor pressure (RVP) test. The desired volatility depends on the ambient temperature. In hot weather, gasoline components of higher molecular weight and thus lower volatility are used. In hot weather, excessive volatility results in what is known as "vapor lock", where combustion fails to occur, because the liquid fuel has changed to a gaseous fuel in the fuel lines, rendering the fuel pump ineffective and starving the engine of fuel. This effect mainly applies to camshaft-driven (engine mounted) fuel pumps which lack a fuel return line. Vehicles with fuel injection require the fuel to be pressurized, to within a set range. Because camshaft speed is nearly zero before the engine is started, an electric pump is used. It is located in the fuel tank so the fuel may also cool the high-pressure pump. Pressure regulation is achieved by returning unused fuel to the tank. Therefore, vapor lock is almost never a problem in a vehicle with fuel injection.

Gasoline vapours are injurious to human health and are carcinogen in nature so there are certain regulations to control its emission. In Canada, volatility is regulated in large cities to reduce the emission of unburned hydrocarbons by the use of so-called reformulated gasoline that is less prone to evaporation. Modern automobiles are also equipped with an evaporative emissions control system (called an EVAP system in automotive jargon), which collects evaporated fuel from the fuel tank in a charcoal-filled canister while the engine is stopped, and then releases the collected vapors into the engine intake for burning when the engine is running (usually only after it has reached normal operating temperature). The evaporative emissions control system

also includes a sealed gas cap to prevent vapors from escaping via the fuel filler tube.

### **13.2.1 Toxic Ingredients of Gasoline**

Gasoline contains the following toxic chemicals subject to reporting requirements of section 313 of Emergency Planning a Community Right-To-Know Act.

<b><u>Ingredient Name (CAS Number)</u></b>	<b><u>Concentration WT. Percent</u></b>
Benzene (71-43-2)	0.1 to 4.9 (0.1 to 1.3 for reformulated gasoline)
Ethyl benzene (100-41-4)	<3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Toluene (108-88-3)	1 to 15
1, 2, 4 Trimethylbenzene (95-63-3)	<6
Xylene, mixed isomers (1330-20-7)	1-15

<b><u>Ingredient name CAS number</u></b>	<b><u>Concentration –Parts per million (ppm) by weight</u></b>
Polycyclic aromatic compounds (PACs)	17
Benzo (g,h,i), perylene (191-24-2)	2.55
Lead (7439-92-1)	0.079

### **13.2.2 Combustible and Physical Properties of gasoline:**

#### **Flammable Properties:**

Flash point:	-45°F (-43°C)
Auto ignition temperature:	Highly variable;>530°F (>280°C)
OSHA/NFPA Flammability Class;	1A (Flammable Liquid)
Lower Explosive Limit (%):	1.4%
Upper Explosive Limit (%):	7.6%

Odour-A strong, characteristic aromatic hydrocarbon odour. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odour and is detectable at a lower concentration than non-oxygenated gasoline.

<b><u>Odour Threshold</u></b>	<b><u>Odour Detection</u></b>	<b><u>Odour Recognition</u></b>
Non-oxygenated gasoline:	0.5-0.6ppm	0.8-1.1ppm
Gasoline with 15% MTBE:	0.2-0.3ppm	0.4-0.7ppm
Gasoline with 15% TAME:	0.1ppm	0.2ppm

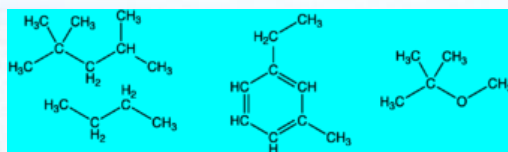
#### **Basic Physical Properties**

Boiling Range:	85 to 437°F (39-200°C)
Vapour pressure:	6.4-15 RVP @ 100°F (38°C) (275-475mm Hg @ 68°F (20°C))

Vapour Density (air=1):	AP 3 to 4
Specific Gravity (H <sub>2</sub> O+1):	0.70-0.78
Evaporation Rate:	10-11 (n-butyl acetate=1)
Percent Volatiles:	100%
Solubility (H <sub>2</sub> O):	Non-oxygenated gasoline-negligible (<0.1% @77°F). Gasoline with 15% MTBE-Slight (0.1-3% @77°F); ethanol is readily soluble in water

Combustibility of gasoline is measured in terms of its octane rating which is determined relative to a mixture of 2,2,4-trimethylpentane (an isomer of octane) and n-heptane. There are different conventions for expressing octane ratings, so a fuel may have several different octane ratings based on the measure used.

The octane rating became important as the military sought higher output for aircraft engines in the late 1930s and the 1940s. A higher octane rating allows a higher compression ratio, and thus higher temperatures and pressures, which translate to higher power output. Some scientists even predicted that a nation with a good supply of high octane gasoline would have the advantage in air power. The specific gravity (or relative density) of gasoline ranges from 0.71–0.77 (719.7 kg/m<sup>3</sup> ; 0.026 lbs./in<sup>3</sup>; 6.073 lbs./US gal; 7.29 lbs./imp gal), higher densities having a greater volume of aromatics. Gasoline floats on water; water cannot generally be used to extinguish a gasoline fire, unless used in a fine mist. Gasoline is produced in oil refineries. Material that is separated from crude oil via distillation, called virgin or straight-run gasoline, does not meet the required specifications for modern engines (in particular octane rating; see below), but will form part of the blend.



Some of the main components of gasoline: isooctane, butane, an aromatic compound, and the octane enhancer MTBE. The bulk of a typical gasoline consists of hydrocarbons with between 4 and 12 carbon atoms per molecule (commonly referred to as C<sub>4</sub>-C<sub>12</sub>). The various refinery streams blended to make gasoline have different characteristics. Some important streams are:

- Straight-run gasoline is distilled directly from crude oil. Once the leading source of fuel, its low octane rating required lead additives. It is low in aromatics (depending on the grade of crude oil), containing some naphthenes (cycloalkanes) and no olefins. About 0-20% of gasoline is derived from this material, in part because the supply of this fraction is insufficient and its RON is too low.

- Reformate, produced in a catalytic reformer with a high octane rating and high aromatic content, and very low olefins (alkenes). Most of the benzene, toluene, and xylene (the so-called BTX) are more valuable as chemical feed stocks and are thus removed to some extent.
- Cat cracked gasoline or cat cracked naphtha, produced from a catalytic cracker, with a moderate octane rating, high olefins (alkene) content, and moderate aromatics level.
- Hydrocrackate (heavy, mid, and light) produced from a hydrocracker, with medium to low octane rating and moderate aromatic levels.
- Alkylate is produced in an alkylation unit, involving the addition of isobutane to alkenes giving branched chains but low aromatics.
- Isomerate is obtained by isomerising low octane straight run gasoline to isoparaffins (like isooctane).

The terms above are the jargon used in the oil industry but terminology varies. Overall, a typical gasoline is predominantly a mixture of paraffins (alkanes), naphthenes (cycloalkanes), and olefins (alkenes). The actual ratio depends on the oil refinery that makes the gasoline, as not all refineries have the same set of processing units; crude oil feed used by the refinery; the grade of gasoline, in particular, the octane rating.



*Figure13.5: Burning of gasoline produce large quantities of soot*

### **13.2.3 Gasoline Storage**

Good quality gasoline should be stable almost indefinitely if stored properly. Such storage should be in an airtight container, to prevent oxidation or water vapors mixing, and at a stable cool temperature, to reduce the chance of the container leaking. When gasoline is not stored correctly, gums and solids may accumulate resulting in "stale fuel". The presence of these degradation products in fuel tank, lines, and carburetor or fuel injection components, make it harder to start the engine. Upon the resumption of regular vehicle usage, though, the buildups should eventually be cleaned up by the flow of fresh petrol. Users have been advised to keep gasoline containers and tanks more than half full and properly capped to reduce air exposure, to avoid storage at high temperatures, to run an engine for ten minutes to circulate the stabilizer through all components prior to storage, and to run the engine at intervals to purge stale fuel from the carburetor.



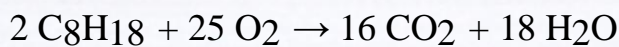
### **13.2.4 Energy Value of Gasoline**

Gasoline contains about 35 MJ/L (9.7 kW·h/L, 132 MJ/US gal, 36.6 kWh/US gal) (Higher heating value) or 13 kWh/kg. Gasoline blends differ, and therefore actual energy content varies according to the season to season and producer by up to 4% more or less than the average. The lower energy content (per litre) of LPG in comparison to gasoline is mainly due to its lower density. Energy content per kilogram is higher than for gasoline (higher hydrogen to carbon ratio). Currently many countries set limits on gasoline aromatics in general, benzene in particular, and olefin (alkene) content. Such regulations led to increasing preference for high octane pure paraffin (alkane) components, such as alkylate, and is forcing refineries to add processing units to reduce benzene content.

Gasoline can also contain other organic compounds, such as organic ethers (deliberately added), plus small levels of contaminants, in particular organic sulfur compounds, but these are usually removed at the refinery. Gasolines are also treated with metal deactivators, which are compounds that sequester (deactivate) metal salts that otherwise accelerate the formation of gummy residues. The metal impurities might arise from the engine itself or as contaminants in the fuel. Gasoline, as delivered at the pump, also contains additives to reduce internal engine carbon buildups, improve combustion, and to allow easier starting in cold climates.

### **13.2.5 Safety & Environmental Issues Related to Gasoline**

Energy is obtained from the combustion of gasoline, the conversion of a hydrocarbon to carbon dioxide and water. The combustion of octane follows this reaction:



The combustion of one US gallon of gasoline produces about 19.4 pounds (8.8 kg) of carbon dioxide (converts to 2.33 kg/litre), a greenhouse gas. Gasoline is one of the hazardous substances and is regulated in United States and Canada by the Occupational Safety and Health Administration. The material safety data sheet for unleaded gasoline shows at least 15 hazardous chemicals occurring in various amounts, including benzene (up to 5% by volume), toluene (up to 35% by volume), naphthalene (up to 1% by volume), tri-methyl benzene (up to 7% by volume), methyl tert-butyl ether (MTBE) (up to 18% by volume, in some provinces) and about ten others. Benzene and many anti knocking additives are carcinogenic. The chief risks of such leaks come not from vehicles, but from gasoline delivery truck accidents and leaks from storage tanks. Because of this risk, most storage tanks now have extensive measures in place to detect and prevent any such leaks, such as sacrificial anodes.

The main concern with gasoline on the environment, aside from the complications of its extraction and refining, are the potential effect on the climate. Unburned gasoline and evaporation from the tank, when in the atmosphere, react in sunlight to produce photochemical smog. Addition of ethanol increases the volatility of gasoline, potentially worsening the problem. Gasoline, when used in high-compression internal combustion engines, has a tendency to auto ignite (detonate) causing damaging "engine knocking" (also called "pinging" or "pinking") noise. The discovery that lead additives modified this behavior led to the widespread adoption of additives use in the 1920s and therefore more powerful, higher compression engines.

The most popular additive was tetra-ethyl lead. With the discovery of the extent of environmental and health damage caused by the lead, however, and the incompatibility of lead with catalytic converters found on virtually all newly sold automobiles since 1975, this practice began to wane (encouraged by many governments introducing differential tax rates) in the 1980s. In North America, where lead had been blended with gasoline (primarily to boost octane levels) since the early 1920s, standards to phase out leaded gasoline were first implemented in 1973. Most countries have phased out leaded fuel now. Different additives have replaced the lead compounds.

The most popular additives include aromatic hydrocarbons, ethers and alcohol (usually ethanol or methanol). Like other alkanes, gasoline burns in a limited range of its vapor phase and, coupled with its volatility, this makes leaks highly dangerous when sources of ignition are present. Gasoline has a lower explosion limit of 1.4% by volume and an upper explosion limit of 7.6%. If the concentration is below 1.4% the air- gasoline mixture is too lean and will not ignite. If the concentration is above 7.6% the mixture is too rich and also will not ignite. However, gasoline vapor rapidly mixes and spreads with air, making unconstrained gasoline quickly flammable. Many accidents involve gasoline being used in an attempt to light bonfires; rather than helping the material on the bonfire to burn, some of the gasoline vaporizes quickly after being poured and mixes with the surrounding air, so when the fire is lit a moment later, the vapor surrounding the bonfire instantly ignites in a large fireball, engulfing the unwary user. The vapor is also heavier than air and tends to collect in garage inspection pit.

### **13.3 Jet Fuel**

Product Name:	Jet A-1
CAS Number:	8008-20-6
Formula:	C <sub>9</sub> H <sub>20</sub> to C <sub>16</sub> H <sub>34</sub>
Chemical Family:	Petroleum Hydrocarbon
Synonyms:	Aviation Fuel-Jet A, Turbo Fuel A, Aviation Turbine Fuel

Jet fuel is a type of aviation fuel designed for use in aircraft powered by gas-turbine engines. It is clear to straw-colored in appearance. Petroleum Products Division of Government of Nunavut only sells Jet A-1 which is produced to a standardized international specification. Jet fuel is a mixture of a large number of different hydrocarbons. The range of their sizes (molecular weights or carbon numbers) is restricted by the requirements for the product, for example, the freezing point or smoke point. Kerosene-type jet fuel (Jet A-1) has a carbon number distribution between about 8 and 16 carbon numbers. Jet A-1 Fuel must meet the specification for DEF STAN 91-91 (Jet A-1), ASTM specification D1655 (Jet A-1) and IATA Guidance Material (Kerosene Type), NATO Code F-35.

### **13.3.1 Physical Properties**

Boiling Point:	300-570°F
Vapour Pressure:	0.50mm Hg
Vapour Density (Air = 1):	Greater than 1
Solubility in Water:	Less than 0.1%
Odour Threshold:	N.A
Specific Gravity (Water=1):	0.78 - 0.84
Auto Ignition Temp:	410°F
Physical Hazard:	Combustible Liquid and Flammable Vapour, May accumulate static charge
Freezing Point	-47°C (-52.6°F)
Open air burning temperatures	260-315°C (500-599°F)
Density at 15°C (59°F)	0.804 kg/L
Specific energy	43.15 MJ/kg
Energy density	34.7 MJ/L

The first jet fuels were based on kerosene or a gasoline-kerosene mix, and most jet fuels are still kerosene-based. The details of specifications were adjusted, such as minimum freezing point, to balance performance requirements and availability of fuels. Very low temperature freezing points reduce the availability of fuel. Higher flash point products required for use on aircraft carriers are more expensive to produce. Jet A-1 is safer to handle than traditional avgas. The primary differences between Jet A and Jet A-1 are the higher freezing point of Jet A (-40°C vs. -47°C for Jet A-1), and the mandatory requirement for the addition of an anti-static additive to Jet A-1.

### **13.3.2 Jet A-1 Additives**

Jet A-1 specifications allow for certain additives to be used to jet fuel,



- Antioxidants to prevent gumming usually based on alkylated phenols, e.g., AO-30, AO-31, or AO-37;
- Antistatic agents, to dissipate static electricity and prevent sparking; Stadis 450, with dinonylnaphthylsulfonic acid (DINNSA) as the active ingredient, is an example
- Corrosion inhibitors, e.g., DCI-4A used for civilian and military fuels, and DCI- 6A used for military fuels;
- Fuel System Icing Inhibitor (FSII) agents, e.g., Di-EGME; FSII is often mixed at the point-of-sale so that users with heated fuel lines do not have to pay the extra expense.
- Biocides are to remediate microbial (i.e., bacterial and fungal) growth present in aircraft fuel systems. Currently, two biocides are approved for use by most aircraft and turbine engine original equipment manufacturers (OEMs); Kathon FP1.5 Microbiocide and Biobor JF.
- Metal deactivator can be added to remediate the deleterious effects of trace metals on the thermal stability of the fuel. The one allowable additive is N, N'- disalicylidene 1,2-propanediamine.

### **13.3.3 Water in Jet Fuel**

It is very important that jet fuel be free from water contamination. During flight, the temperature of the fuel in the tanks decreases, due to the low temperatures in the upper atmosphere. This causes precipitation of the dissolved water from the fuel. The separated water then drops to the bottom of the tank, because it is denser than the fuel. From this time on, as the water is no longer in solution, it can freeze, blocking fuel inlet pipes. Removing all water from fuel is impractical; therefore fuel heaters are usually used on commercial aircraft to prevent water in fuel from freezing. There are several methods for detecting water in jet fuel. A visual check may detect high concentrations of suspended water, as this will cause the fuel to become hazy in appearance. An industry standard chemical test for the detection of free water in jet fuel uses a water-sensitive filter pad that turns green if the fuel exceeds the specification limit of 30ppm (parts per million) free water.

### **13.3.4 Hazardous Nature of Jet Fuel**

The air transport industry is responsible for 2 percent of man-made carbon dioxide emitted. Due to a fairly high percentage of aromatics (10 to 20%), Jet fuel is associated with many potential environmental hazards, including short- and long-term potential effects. Jet fuel in the water column can depress Daphnia (Zooplankton) populations for several weeks, resulting in algae blooms. Short-term (acute) hazards of the some of the lighter, more volatile and water soluble aromatic



compounds (such as benzenes, toluene, and xylenes) in Jet include potential acute toxicity to aquatic life in the water column (especially in relatively confined areas) as well as potential inhalation hazards. Benzenes, toluene, and xylenes (all common components of jet fuels) tend to cause narcosis. Jet fuels possess moderate to high acute toxicity to biota with product-specific toxicity related to the type and concentration of aromatic compounds. Since Je A-1 is a mix of middle distillates and gasoline, some of the same compounds found in gasoline are also found in Jet. As might be expected, there is therefore some overlap between the toxic effects potentially resulting from Jet spills and gasoline spills.

Jet fuel spills could result in potential acute toxicity to some forms of aquatic life. Oil coating of birds, sea otters, or other aquatic life which come in direct contact with the spilled oil is another potential short term hazard. In the short term, spilled oil will tend to float on the surface; water uses threatened by spills include: recreation; fisheries; industrial; and irrigation. Long-term (chronic) potential hazards of the some of the lighter, more volatile and water soluble aromatic compounds in Jet include contamination of groundwater. Chronic effects associated with middle distillates are mainly due to exposure to aromatic compounds, which are found primarily in all types of Jet fuel. Chronic effects of some of the constituents in jet fuel (benzene, toluene, xylenes, naphthalene's, alkyl benzenes, and various alkyl PAHs) include changes in the liver and harmful effects on the kidneys, heart, lungs, and nervous system.

Although PAHs, particularly heavy PAHs, do not make up a large percentage of jet fuels by weight, there are some PAHs in jet fuels, including naphthalene, and alkyl naphthalenes. Due to their relative persistence and potential for various chronic effects (like carcinogenicity), PAHs (and particularly the alkyl PAHs) as well as alkyl benzenes such as xylenes, can contribute to long-term (chronic) hazards of jet fuels in contaminated soils, sediments, and ground waters. Present up to 3% by weight, the PAH naphthalene can absorb to soil particles and is soluble in groundwater. Note: PAHs in general are more frequently associated with chronic risks. These risks include cancer and often are the result of exposures to complex mixtures of chronic-risk aromatics (such as PAHs, alkyl PAHs, benzenes, and alkyl benzenes), rather than exposures to low levels of a single compound. Some fuel additives may contribute to environmental problems.

One source states that methyl cyclic hexane may be one of the more toxic components of jet fuel. This compound (cyclohexane, methyl, also known as toluene hexahydride, CAS# 108-87-2) can account for 2-16% of jet fuel 4 by weight. Exposure to jet fuel vapors has been reported to cause neurobehavioral symptoms, including dizziness, headache, nausea and fatigue. Some of the PAHs in this product can move into plants and some have either harmful or positive effects on plants.

Many of the PAHs found in this product are phototoxic, that is they display greatly enhanced toxicity in sunlight or other UV source than elsewhere.

