B22-1.0 DIESEL, FUEL OIL No. 2, FUEL OIL No. 4

B22-1.1 Background Information

Diesel fuels are middle distillates, from refined crude oil. Diesel fuels usually contain a mixture of paraffins, cycloparaffins, aromatics, and olefins in approximately 9 to 20 carbon compound fractions (Irwin, 1997a). The name diesel usually implies a wide range of petroleum products that may vary significantly in exact chemical composition (Irwin, 1997a). The three most common forms of diesel fuels are Fuel oil no. 1-D (Grade 1-D), Fuel oil no. 2-D (Grade 2-D) and Fuel oil no. 4 (Grade 4-D)(Irwin, 1997a). In PMRA's list 2 of formulants, the adjuvants, diesel, fuel oil no. 2 and fuel oil no.4 all refer to a type of diesel fuel.

Synonyms:

Fuel oil no. 1-D: Diesel fuel; diesel fuel oil no. 1; diesel oil no. 1; no. diesel; diesel oil(light); arctic diesel (ATSDR, 1995)

Fuel oil no. 2: API no. 2 fuel oil; gas oil; home heating oil no. 2; number 2 burner oil; **diesel fuel**; furnace oil no. 2 (ATSDR, 1995)

Fuel oil no. 2-D: Diesel fuel; diesel fuel oil no. 2; diesel oil no. 2; no. 2 diesel; diesel oil (medium) (ATSDR, 1995)

Fuel oil no. 4: Oil, fuel, no. 4; residual fuel oil no. 4; no. 4 fuel oil; residual fuel oil; marine boiler fuel; **marine diesel fuel; diesel fuel no. 4**; grade 4(ATSDR, 1995)

CASRN: 68334-30-2 [Fuel oil no. 2]; 68334-30-5; 68476-34-6 [Grade 2-D]; 68476-31-3 [Grade 4-D]

DIESEL FUEL USAGE:

Diesel was utilized as a solvent for the following pesticides used at CFB Gagetown: 2,4-D, 2,4,5-T, Picloram isocytyl ester, 2,4,5-T propyleneglycol, butyl ester and triclopyr. Between 1960 and 1993, approximately 420,000 kg of diesel fuels were used in pesticide mixtures, and was applied over an area of 13,000 ha at CFB Gagetown.

Year	Amount of Diesel Fuel Applied (kg)	Total Area Treated (ha)
1960	24,460	3,645
1961	12,888	2,100
1963	184,620	3,705
1964	196,093	3,936
1966	286	31
1967	30	0.66
1993	301	2.2
Total	**4.2E+05**	**1.3E+04**

[a] Adapted from Demaree and Haws, 1968; Demaree *et al*., 1966; Demaree and Creager, 1968; Boynton, 1969; and JW, 2006.

B22-2.0 CHEMICAL AND PHYSICAL PROPERTIES

Average Formula: $C_{16}H_{34}$ (ATTI, 2006)

Activity: Hydrocarbon distillate fractions, high energy combustible (ATSDR, 1995).

Notes: Fuel oil no. 1-D (C8 to C19, primarily C10 to C14), designated as automotive diesel fuel (vapour pressure ≤ 1.0 mm Hg at 28°C), is used to power automobiles, trucks and other heavy vehicles; fuel oil no. 2 (C11 to C28) is designated as home heating oil, gas oil, or no. 2 burner oil; fuel oil no. 2-D, designated as diesel fuel oil no. 2, is a diesel fuel with increased viscosity over no. 2 fuel oil, and is used to power industrial and heavy mobile service equipment; fuel oil no. 4 is designated as diesel fuel marine (DFM; C9 to C20; vapour pressure = negligible at 28 to 38°C), and is used to power maritime vessels. The form of diesel fuel employed in herbicide applications at CFB Gagetown was not disclosed, but was assumed to be either 1-D or 2-D.

Diesel fuel is a complex mixture (300-800+) of hydrocarbons (predominantly C9 to C15; range C6 to C30), and a number of contaminants. The contaminants include normal, branched, and cyclic alkanes (60 to 90% by volume); aromatic compounds, especially alkylbenzenes (5 to 40%); alkenes (1 to 10%); and olefinic hydrocarbons (1 to 2%) obtained from the middle distillate, gas-oil fraction (200 to 380°C) during petroleum separation (ATSDR, 1995).

Diesel fuels contain trace quantities of benzene, xylene, toluene, n-hexane, and a small percentage of potentially neurotoxic C9 to C12 carbon fractions. This suggests that there could be a neurotoxic or neurobehavioral risk from dermal and oral exposures to raw diesel fuels or from respiratory exposures to the diesel fuel vapour (Richie *et al*., 2001).

Known toxicants and carcinogens that have been reported in diesel fuels include benzene (0.008 to 0.1%), toluene (0.8 to 0.25%), ethylbenzene (0.08 to 0.2%), xylenes (0.08 to 0.5%), methylbenzene (unknown %), trimethylbenzene (unknown %), methyoxyethanol (unknown %), trimethylpentane (unknown %) and *n*-hexane (0.01 to <1.0%). Also typically present are polycyclic aromatic hydrocarbons (PAH) that may constitute ≤5% of the mixture of hydrocarbons.

Hydrocarbon fuels may demonstrate differential health effects on specific individuals as a function of susceptibility factors. Of primary importance among these factors are rates of absorption, delivery to target tissue compartments (integrity of the blood brain barrier), rates of bioactivation, bioinactivation and body elimination, and the induction of adaptive or protective responses.

Structure: Mixture of hydrocarbons, no representative structure found (ATSDR, 1995).

Table B22-2 Chemical and Physical Properties of Diesel Fuel

Chemical/Physical Property	Fuel oil no. 1-D	Fuel oil no. 2	Fuel oil no. 2-D	Fuel oil no. 4	Reference
Molecular weight	No data	No data	No data	No data	ATSDR, 1995
Colour	Colourless to brown	Colourless to brown	Colourless to brown	Colourless to brown	ATSDR, 1995
Physical state	Liquid	Liquid	Liquid	Liquid	ATSDR, 1995
Melting point	-34ºC	-29ºC	18ºC	-29ºC to -9ºC; -46ºC	ATSDR, 1995
Boiling point	193-293ºC	160-360	282-338ºC	101-588ºC	ATSDR, 1995
Odour	Kerosene-like	Kerosene-like	Kerosene-like	Kerosene-like	ATSDR, 1995
Density	0.810-0.9360 g/mL at 15ºC	No data	0.8700-0.9500 g/mL at 15ºC	1 g/mL at 20ºC	ATSDR, 1995
Solubility	5 mg/L in water	5 mg/L in water	5 mg/L in water	5 mg/L in water	ATSDR, 1995
Partition coefficient/Log K_{ow}	3.3-7.06	3.3-7.06	3.3-7.06	3.3-7.06	ATSDR, 1995
Partition coefficient/Log K_{oc}	3.0-6.7	3.0-5.7	3.0-6.7	3.0-6.7	ATSDR, 1995
Vapour pressure	2.12-26.4 mm Hg at 21ºC	2.12-26.4 mm Hg at 21ºC	2.12-26.4 mm Hg at 21ºC	2.12-26.4 mm Hg at 21ºC	ATSDR, 1995
Henry's law constant	5.9 x 10^{-5}-7.4 atm m^3/mol at 20ºC	5.9 x 10^{-5}-7.4 atmm^3/mol at 20ºC	5.9 x 10^{-5}-7.4 atm m^3/mol at 20ºC	5.9 x 10^{-5}-7.4 atm m^3/mol at 20ºC	ATSDR, 1995

B22-3.0 PMRA EVALUATION

PMRA categorized formulants found in pest control products registered in Canada based on the level of concern with respect to human health and the environment. Diesel fuel, Fuel Oil no. 2 and Fuel Oil no. 4 were categorized in List 2 of the formulants. List 2 contains formulants that are considered potentially toxic, based on either structural similarity to List 1 formulants or data suggestive of toxicity (PMRA, 2005).

B22-4.0 TOXICOLOGICAL SUMMARY

The following toxicological profile for diesel fuel is a short summary based on the Agency for Toxic Substances and Disease Registry's toxicological profile for fuel oils.

B22-4.1 Human Health Effects

Table B22-3 Human Health Effects Resulting from Acute Exposure to Diesel Fuel [a,b]

Exposure	Effects	Response
	Occular	Eye contact with diesel fuels may lead to transient pain and/or hyperaemia.
	Cardiovascular	Dysrhythmias may occur following inhalation
	Respiratory	Coughing, choking, tachypnea, dyspnea, cyanosis, rales. Respiratory arrest can occur secondary to CNS depression following vapour inhalation. Moptysis, pulmonary edema, pneumatoceles, lipoid pneumonia, or respiratory arrest may develop following ingestion and aspiration.
	Neurologic	Mild central nervous system depression or excitation may occur after ingestion or vapor inhalation. CNS effects can appear secondary to hydrocarbon pneumonitis and hypoxia, or from additives and contaminants (aniline, heavy metals, camphor, or pesticides). Some hydrocarbons are simple asphyxiants (*e.g*., methane, ethane, propane gasses) which can produce CNS effects secondary to hypoxia.
	Gastrointestinal	Nausea, vomiting, diarrhea, and abdominal pain may occur following ingestion.
	Hepatic	Elevated transaminases may occasionally occur following ingestion or vapor inhalation of some hydrocarbons. Carbon tetrachloride is a potent hepatotoxin which can produce potentially fatal hepatorenal damage following ingestion, inhalation or dermal exposure.
	Genitourinary	Renal effects such as acute renal tubular necrosis, proteinuria, or hematuria occur infrequently following acute exposure. Increased risk of glomerulonephritis following long term inhalation and/or dermal exposure.
	Hematologic	Disseminated intravascular coagulation, hemolytic anemia and pancytopenia have occasionally been reported following vapor inhalation, aspiration, or ingestion.
	Dermalogic	Acute dermal exposure may result in local irritation leading to erythema, pruritis.

[a] Rumack and Hall, 2006.
[b] MEDITEXT®, 2006.

B22-4.2 Health Effects by Route of Exposure

Table B22-4 Mammalian LD50 Values Resulting from Exposures to Diesel Fuels

Test Organism (Species/Sex)	Route of Exposure	LD50 (mg/kg)	Reference
Acute			
Mice[a]	Oral	>1,6000	Schultz *et al*., 1981
Mice[a]	Dermal	>16,000	Schultz *et al*., 1981
Rats[b]	Oral	7,500	Beck *et al*., 1984
Rats[b]	Oral	14.35 - 21.1	API, 1987a,b,c
Rabbit[b]	Dermal	5,000	Beck *et al*., 1984

[a] Grade-4D diesel fuel used.
[b] Unspecified diesel fuel used.

B2-4.2.1 Inhalation Exposure

Table B22-5 Mammalian Effects Resulting from Inhalation Exposure to Diesel Fuel

Test Organism (Species)	Exposure	Dose (Duration)	Response	Reference
Sub-chronic				
Rat	Inhalation	0.05 and 0.3 mg/L/day for 90 days with 24 months recovery	Nephrotoxic effects specific to male rats	Bruner, 1984
Rat	Inhalation	1.5 mg/L at 4 hours/day, 2 days/week for 13 weeks with 8 weeks recovery	Reversible loss of body weights observed.	Lock *et al*., 1984a

Table B22-6 Mammalian NOAELs and LOAELs Values Derived from Inhalation Exposure to Diesel Fuel

Test Organism (Species)	Effect	Value (mg/m^3) (duration)	Endpoint	Reference
Acute Exposure				
CD-1 mice[a]	LOAEL	204 for 8 hours/day over 5 days	Mortality	Kainz and White, 1984
CD-1 mice[a]	NOAEL	65 at 8 hours /day for 5 days	Vasodilation in male mice	Kainz and White, 1984
	LOAEL	135 at 8 hours /day for 5 days		
	NOAEL	135 at 8 hours /day for 5 days	Decreased water and food consumption with 30% subsequent weight loss in male mice	
	LOAEL	204 at 8hr/day for 5 days		
CD-1 mice[a]	LOAEL	65 at 8 hours /day for 5 days	Ataxia, disturbed gaiting reflex	Kainz and White, 1984
Sprague Dawley rat[b]	LOAEL	4,000 for 6 hours /day over one day	30% mortality	Dalbey and Lock, 1983
CRL: COBS CD(SD) BR rat[b]	LOAEL	401.5 ppm at 6 hours/day for 10 days	Decreased food intake in females rats	API, 1979
Chronic				
Sprague Dawley rat[b]	NOAEL	750 at 4 hours /day, 2 days/week for 13 weeks.	Respiratory effects	Lock *et al*., 1984b
	NOAEL	1,500 at 4 hours /day, 2 days/week for 13 weeks	Cardiovascular effects	
	NOAEL	1,500 at 4 hours /day, 2 days/week for 13 weeks	Gastrointestinal effects	
	NOAEL	1,500 at 4 hours r/day, 2 days/week for 13 weeks	Hematological effects	
	NOAEL	1,500 at 4 hours r/day, 2 days/week for 13 weeks	Hepatic effects	
	NOAEL	1,500 at 4 hours /day, 2 days/week for 13 weeks	Renal effects	
	NOAEL	1,500 at 4 hours /day, 2 days/week for 13 weeks	Dermal effects	
	LOAEL	250 at 4 hours /day, 2	Decreased body weight	

Table B22-6 Mammalian NOAELs and LOAELs Values Derived from Inhalation Exposure to Diesel Fuel

Test Organism (Species)	Effect	Value (mg/m^3) (duration)	Endpoint	Reference
		days/week for 13 weeks		
Sprague Dawley rats[b]	LOAEL	250 at 4 hr/day, 5 days/week for 13 weeks	Increased response time in the startle reflex assay	Lock *et al*., 1984b
Sprague Dawley rats[b]	NOAEL	1,500 at 4 hr/day, 2 days/week for 13 weeks	Reproductive effects	Lock *et al*., 1984b

[a] Fuel oil no. 2-D used.
[b] Unspecified diesel fuel used.

B22-4.2.2 Dermal Exposure

Table B22-7 Mammalian Effects Resulting from Dermal Exposure to Diesel Fuel

Test Organism (Species)	Exposure	Dose (Duration)	Response	Reference
Chronic				
Mice	Dermal	0, 250 and 500 mg/kg/day at 5 days a week, for 103 weeks	Squamous-cell papillomas and carcinomas observed in both males and females after 104 weeks.	NTP, 1986

Table B22-8 Mammalian NOAELs and LOAELs Values Derived from Dermal Exposure to Diesel fuel

Test Organism (Species)	Effect	Value (mg/kg/day) (duration)	Endpoint	Reference
Acute Exposure				
B6C3F1 mice[a]	LOAEL	20,000 at 7 days a week for 2 weeks	Mortality	NTP/NIH, 1986
B6CF1 mice[a]	LOAEL	2,000	Acanthosis, inflammation, parakerotosis, hyperteratosis	NTP/NIH, 1986
Sub-Chronic Exposure				
C3HF/Bd mice[a]	LOAEL	45.5 mg per application at 3 times/week for 40 weeks	60% mortality in females and 20% mortality in males.	Schultz *et al*., 1981
B6C3F1 mice[a]	NOAEL	4,000 at 7 days/week, for 13 weeks	Respiratory effects	NTP/NIH, 1986
	NOAEL	4,000 at 7 days/week, for 13 weeks	Cardiovascular effects	
	NOAEL	4,000 at 7 days/week for 13 weeks	Gastrointestinal effects	
	NOAEL	4,000 at 7 days/week, for 13 weeks	Hematological effects	
	NOAEL	4,000 at 7 days/week, for 13 weeks	Hepatic effects	
	NOAEL	4,000 at 7 days/week, for 13 weeks	Renal effects	
	NOAEL	2,000 at 7 days/week,	Mild chronic active dermatitis	

Table B22-8 Mammalian NOAELs and LOAELs Values Derived from Dermal Exposure to Diesel fuel

Test Organism (Species)	Effect	Value (mg/kg/day) (duration)	Endpoint	Reference
		for 13 weeks		
	LOAEL	4000 at 7 days/week, for 13 weeks		
	NOAEL	250 at 7 days/week, for 13 weeks	9% decreased in body weight gains.	
	LOAEL	500 at 7 days/week, for 13 weeks		
BALB/C mice[a]	LOAEL	22.9 mg/appl-ication, 3 apps/week for 40 weeks	Increased spleen weight	Schultz *et al.,*1981
	LOAEL	22.9 mg/appl-ication, 3 apps/week for 40 weeks	Hepatic effects	
	LOAEL	22.9 mg/appl-ication, 3 apps/week for 40 weeks	Increased kidney weight in females	
	LOAEL	22.9 mg/appl-ication, 3 apps/week for 40 weeks	Decreased kidney weight in males	
	LOAEL	22.9 mg/appl-ication, 3 apps/week for 40 weeks	4-21% decreased in body weight	
B6C3F1 mice[a]	LOAEL	250 at 5 days a week, for 84-103 weeks	74% mortality in females, 54% mortality in males	NTP/NIH, 1986
B6C3F1 mice[a]	NOAEL	500	Respiratory effects	NTP/NIH, 1986
	NOAEL	500	Cardiovascular effects	
	NOAEL	500	Gastrointestinal effects	
	LOAEL	250	Hematopoiesis of spleen and liver	
	NOAEL	500	Musculetal effects	
	LOAEL	250	Inflammation of urinary bladder	
	LOAEL	250	Ulcer, dermatitis	
	LOAEL	250	14-23% decreased in body weight gain	
B6C3F1 mice[a]	LOAEL	250 at 5 days a week, for 84-103 weeks	Lymph node plasmocyosis	NTP/NIH, 1986
B6C3F1 mice[a]	NOAEL	500 at 5 days a week, for 84-103 weeks	Neurological effects	NTP/NIH, 1986
B6C3F1 mice[a]	NOAEL	500 at 5 days a week, for 84-103 weeks	Reproductive effects	NTP/NIH, 1986
B6C3F1 mice[a]	NOAEL	500 at 5 days a week, for 84-103 weeks	Hepatocellular adenoma or carcinoma	NTP/NIH, 1986

[a] Diesel marine fuel used (Fuel oil no. 4).

B22-4.2.3 Oral Exposure

Since oral exposure to diesel fuels is not expected to occur during normal pesticide application procedures. Acute and chronic studies involving oral exposure to diesel fuels were not investigated.

B22-4.3 Carcinogenicity

Increased risks for prostate cancer and squamous cell carcinoma in the lungs have been reported in a multi-site, case control study (Siemiatycki *et al.*, 1987). However, it was conceded that these effects could have resulted from any particular chemical (WHO, 1996). IARC (1989) classified distillate (light) diesel fuels in Group 3 which indicated that light diesel fuels were not classifiable as to its carcinogenicity in humans (IRWIN, 1997a). Diesel fuel does contain poly-aromatic hydrocarbons which could be potential carcinogens (IRWIN, 1997a). However, the composition of diesel fuels is variable, with low concentrations of PAH, hence generally not considered to be carcinogenic. Conversely, IARC classified Grade-4D diesel fuel as possible human carcinogen in Group 2B (Irwin, 1997c).

In vitro tests using *S.typhimurium* did not provide clear evidence for the mutagenic potential of diesel fuels (WHO, 1996). Various positive results attained from *S. typhimurium* and in mouse lymphoma cells were considered to be ambiguous and inconsistent (WHO, 1996). Similarly, induction of micronuclei or chromosomal aberrations *in vivo* using the mouse model also gave mostly equivocal or negative responses (WHO, 1996). There is no clear evidence that diesel fuels are genotoxic. Hence, cancer could be induced by nongenotoxic mechanisms, such as chronic dermal irritation characterized by repeated cycles of skin lesions, causing epidermal hyperplasia (WHO, 1996).

Populations at Special Risk

No information found.

B22-4.4 Toxicokinetics

Since diesel fuels are a mixture of chemicals, limited information is available regarding the absorption, distribution, metabolism, and excretion of diesel fuels. The onset of local or systemic effects following dermal, oral or pulmonary exposure indicates that these are all potential routes of absorption for diesel (ATSDR, 1995).

Some individuals may experience adverse effects to diesel fuels due to genetic polymorphisms in their ability to biotransform xenobiotics and solvents (Ritchie *et al.*, 2001). This susceptibility to environmental chemicals is the result of the polymorphisms in a couple of genes for drug metabolizing enzymes (Ritchie *et al*., 2001). The imbalance in phase I drug metabolizing enzymes and phase II drug detoxification enzymes will lead to increased levels of bioactivated compounds and impaired detoxification leading to potential adverse health effects (Ritchie, 2001).

B22-4.5 Exposure Limits

Since diesel fuel is a variable mixture, an exposure limit specifically for diesel was not found in any regulatory documents. Appendix 5, Table 9 of the Atlantic RBCA user guidance document, provides a typical fractional composition of diesel (RBCA, 2003). The fractions were divided into 2 groups, aliphatic carbon fractions and aromatic carbon fractions. The aliphatic carbon fractions include >C6-C8; >C8-C10; >C10-C12; >C12-C16; >C16-C21; and >C21-C34 fraction. The aromatic carbon fractions include: >C7-C8; >C8-C10; >C10-C12; >C12-C16; >C16-C21;

and >C21-C34 fractions. The fractions are provided in Table B-22, below. CCME, in the Canada-Wide Standards for Petroleum Hydrocarbons in Soil: Scientific Rationale, supporting technical document, provide chronic TDIs and RfCs of each of the carbon fractions listed by the Atlantic RBCA (CCME, 2002). The TDIs and RfCs for each carbon fraction have been listed Table B-22. A weighted TDI and a weighted RFC for diesel was derived assuming the typical composition of diesel provided by RBCA (2003) and the relative toxicity of each carbon fraction provided by CCME (2002), To derive the diesel TDI, each carbon fraction TDI was multiplied by its proportion of the diesel mix to yield a fractional TDI. The TDI for diesel was then estimated by summing all of the fractional TDIs. Similarly a weighted RfC for diesel was derived.

Table B22-9 Chronic Reference Dose Calculations for Diesel Fuel[a]

Carbon Fraction	Diesel Fraction[c]	End Points	TDI[d] (mg/kg/day)	RfC[e] (mg/m^3)	TDI Diesel[f] (mg/kg/day)	RfC Diesel[g] (mg/m^3)
Aliphatic Fractions[b]						
>C6-C8	0	Neurotoxicity	5	18.4	0	0
>C8-C10	0.05	Hepatic and hematological changes	0.1	1	0.005	0.05
>C10-C12	0.19	Hepatic and hematological changes	0.1	1	0.019	0.19
>C12-C16	0.26	Hepatic and hematological changes	0.1	1	0.026	0.26
>C16-C21	0.17	Hepatic granuloma	2	N/A	0.34	N/A
>C21-C34	0.03	Hepatic granuloma	2	N/A	0.06	N/A
Aromatic Fractions[c]						
>C7-C8	0	Hepatotoxicity, neurotoxicity	0.2	0.4	0	0
>C8-C10	0.01	Decreased body weight	0.04	0.2	0.0004	0.002
>C10-C12	0.06	Decreased body weight	0.04	0.2	0.0024	0.012
>C12-C16	0.12	Decreased body weight	0.04	0.2	0.0048	0.024
>C16-C21	0.09	Nephrotoxicity	0.03	N/A	0.0027	N/A
>C21-C34	0.02	Nephrotoxicity	0.03	N/A	0.0006	N/A
Diesel						
cRfD[h]					**0.46**	**0.15**

[a] Adapted from CCME, 2002; RBCA, 2003.
[b] Organic compound fractions in which carbon atoms are joined together in straight or branched chains.
[c] Organic compound fractions that contains aromatic rings (arenes) obeying Hückel's rule.
[d] Chronic Tolerable Daily Intake(TDI) of each organic compound fraction from oral exposure.
[e] Chronic Reference concentration (RfC) of each organic compound fraction from inhalation exposure.
[f] TDI fraction from multiplying the corresponding diesel fraction value with a TDI value.
[g] RfC fraction from multiplying the corresponding diesel fraction value with a RfC value.
[h] Total TDI diesel fractions represent cRFD from oral exposure, total RfC diesel fractions represent cRFD from inhalation exposure.

Chronic oral and inhalation RfDs (TDI and RfC, repectively) of 0.46 and 0.15 mg/kg/day, respectively, were selected for the risk assessment purposes of this report.

B22-5.0 ENVIRONMENTAL FATE AND EXPOSURE

Limited information is available regarding the environmental fate of diesel fuels. Since diesel fuel is composed of organic hydrocarbons, when exposed to water it will form a 'slick'. The lower molecular mass components of diesel dissolve and leach out from the slick to water. Other volatile component of diesel fuel will be volatilized. Higher molecular species of diesel such as primary branched alkanes, cycloalkanes, and remaining aromatic compounds can persist in sediments for more than a year. Information was not found to show whether diesel fuel went through photooxidation (WHO, 1996).

Diesel fuels are biodegradable. This process is dependent on temperature, hence in colder waters diesel fuel tend to become more persistent than in temperate waters. Out of all the components of diesel fuel, the n-alkane, n-alkylaromatic, and simple aromatic molecules in the 10 carbon to 22 carbon range are the most degradable. Smaller molecular weight components are generally rapidly metabolized. Long-chain n-alkanes are degraded very slowly, due to their hydrophobicity and physical state (viscous to solid) at ambient temperatures. Out of all the compounds that make up diesel fuel, branched alkanes, cycloalkanes and polycyclic-aromatic hydrocarbons are the most resistant to biological breakdown. In general, the degradation rates of hydrocarbons in water are limited by temperature, water content, oxygen, pH, inorganic nutrients, and microbial metabolic versatility (WHO, 1996).

No bioaccumulation information was found regarding marine species. No information was found regarding the movement of diesel fuel through soil and air (WHO, 1996).

B22-6.0 SUMMARY

Diesel fuels are middle distillates, from refined crude oil. Diesel fuels usually contain a mixture of paraffins, cycloparaffins, aromatics, and olefins in approximate 9 to 20 carbon compound fractions (Irwin, 1997a). The name diesel usually implies a wide range of petroleum products that may vary significantly in exact chemical composition (Irwin, 1997a). Diesel was utilized as a solvent for the following pesticides used at CFB Gagetown: 2,4-D, 2,4,5-T, Picloram isocytyl ester, 2,4,5-T propyleneglycol butyl ester and triclopyr. Between 1960 and 1993, approximately 420,000 kg of diesel fuels were used in pesticide mixtures, and was applied over an area of 13,000 ha at CFB Gagetown.

Diesel fuels contain trace amounts of the potentially neurotoxic C9 to C12 carbon fractions. This suggests that there could be a neurotoxic or neurobehavioral risks from dermal and oral exposures to diesel fuels or from respiratory exposures to the fuel vapour (Richie *et al*., 2001). Furthermore, known toxicants and carcinogens have been reported in diesel fuels. These include benzene (0.008 to 0.1%), toluene (0.8 to 0.25%), ethylbenzene (0.08 to 0.2%), xylenes (0.08 to 0.5%), methylbenzene (unknown %), trimethylbenzene (unknown %), methyoxyethanol (unknown %), trimethylpentane (unknown %) and n-hexane (0.01 to <1.0%). Polycyclic aromatic hydrocarbons (PAH) may also be present (≤5%) in the mixture of chemicals that makes up "diesel" (ATSDR, 1995).

Diesel fuels have low acute toxicity in rodents *via* the dermal and oral routes of exposure. Some short-term adverse effects include decreased body weight and neurological impediment. Rodents that were exposed to diesel vapour for a long period of time exhibited adverse effects in the hepatic and renal systems. Furthermore, discrepancies in the blood chemistry and reproductive fitness were also observed. Long-term dermal exposures of diesel fuel in rodents, not only produced adverse systemic and dermal effects, hepatocellular adenomas, carcinomas, squamous-cell papillomas and carcinomas were also observed. IARC (1989) classified distillate (light) diesel fuels as a Group 3 carcinogen (not classifiable as to its carcinogenicity in humans) (Irwin, 1997a). Conversely, IARC classified Grade-4D diesel fuel as a possible human carcinogen (Group 2B) (Irwin, 1997b).

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