Health Protection Agency

Compendium of Chemical Hazards: Kerosene (Fuel Oil).

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HPA Compendium of Chemical Hazards

Kerosene

Key Points

Fire

- Flammable
- Vapour/air mixtures are explosive
- Use normal foam and normal fire kit with breathing apparatus

Health

- Toxicity occurs if kerosene is inhaled while being ingested (aspiration)
- Irritating to eyes and skin
- Aspiration may cause respiratory irritation
- Acute and chronic exposure to kerosene may result in CNS effects including irritability, restlessness, ataxia, drowsiness, convulsions, coma and death
- The most common health effect associated with chronic kerosene exposure is dermatitis
- Kerosene does not have a measurable effect on human reproduction or development
- IARC concluded that there was inadequate evidence to classify kerosene as s human carcinogen

Environment

- Avoid release into the environment
- Inform Environment Agency of substantial incidents

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Version 1

Contents

Kerosene

General information

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Background

Kerosene is a liquid mixture of chemicals produced from the distillation of crude oil. In the UK, kerosene is also known as paraffin and home heating oil. The word kerosene comes from the Greek word ‘keros’, meaning ‘wax’.

Kerosene is a major component (> 60%) of aviation (jet) fuels, is used for “oil” central heating systems and can be used as a cleaning agent or solvent. Approximately 7½ millions tons of kerosene was used in the UK in 2005.

Kerosene is produced on an industrial scale by distilling crude oil in a process similar to that used to produce diesel or petrol.

The use of paraffin heaters in UK homes has substantially decreased since the second World War due to improved electrical and gas supplies. However, kerosene is still extensively used for cooking, heating and lighting in the developing world and so cases of accidental poisoning by children are still relatively common in such countries.

Kerosene is not particularly poisonous. However, if a child or adult accidentally swallows kerosene, medical advice should be obtained immediately as there is a small risk of short-term lung damage if vomiting occurs. Frequent skin exposure may lead to skin damage (dermatitis).

Kerosene has traditionally been the fuel of choice for fire-breathers!

Production and Uses

Key Points

Production and uses

- Kerosene is a major component of aviation fuel
- It is also used as a solvent, degreaser and domestic fuel

Kerosene is a major component (> 60%) of aviation (jet) fuels and has been used to control mosquito larvae. Kerosene is also used as a solvent (for example in cleaners, pesticides and paints), degreaser and domestic fuel. A deodorised form of kerosene (Deobase™) is sometimes used in domestic products. Approximately 45 million tons of kerosene was transported within the EU in 2001, of which 14 million tons were transported within the UK.

Frequently Asked Questions

What is kerosene?

Kerosene is a liquid fuel, similar in composition to diesel, obtained from the distillation of crude oil. In the UK, kerosene is also known as 'paraffin'.

What is kerosene used for?

The main use of kerosene is as a base for aviation fuel but it also has application as a solvent in paints, cleaners, pesticides and some eye medicines. It was previously a common fuel for stoves, heaters and lamps and is still used today as a fuel for home ('oil') central heating systems.

How does kerosene get into the environment?

Kerosene is found in the environment as a result of accidental release from an industrial site or transport vehicle. There are no natural sources of kerosene.

If there is kerosene in the environment will I have any adverse health effects?

Like most chemicals, the amount of kerosene you are exposed to must be above a certain level to cause adverse health effects. Breathing large quantities of kerosene vapour or drinking kerosene-based liquids may cause non-specific signs such as dizziness, headache and vomiting. Repeated skin exposure may result in dermatitis (eczema). A short, one-off exposure to kerosene is unlikely to result in any long-term effects. However, a severe form of lung injury called pneumonitis (pronounced 'new-mown-eye-tus') may occur if liquid kerosene is inhaled directly into the lungs, for example, whilst manually siphoning a tank or from inhaling vomit after swallowing kerosene. This is why it is important not to make someone sick if they have swallowed a kerosene product.

Can kerosene cause cancer?

Kerosene is not considered to be a cancer-causing substance (carcinogen) but repeated exposure of animals to kerosene has caused skin cancer.

Does kerosene affect or damage the unborn child?

Exposure to kerosene is not thought to affect the health of the unborn child.

Kerosene

Incident management

Key Points

Fire

- Flammable
- Vapour/air mixtures are explosive
- Low flashpoint
- Use normal foam and normal fire kit with breathing apparatus

Health

- Toxicity occurs if kerosene is inhaled while being ingested
- Harmful
- Irritating to eyes and skin
- Aspiration may cause serious lung injury

Environment

- Avoid release into the environment
- Inform Environment Agency of substantial release incidents

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Hazard Identification[a]

Standard (UK) Dangerous Goods Emergency Action Codes

UN		**1223**	**Kerosene**	
EAC		**3Y**	**Use normal foam. Wear normal fire kit in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Substance can be violently or explosively reactive.**	
APP		**-**		
Hazards	**Class**	**3**	**Flammable liquid**	
	Sub risks	**-**		
HIN		**30**	**Flammable liquid (flash point between 23 °C and 61 °C inclusive).**	

UN – United Nations number; EAC – Emergency Action Code; APP – Additional Personal Protection; HIN - Hazard Identification Number

* Normal fire fighting clothing i.e. fire kit (BS EN 469), gloves (BS EN 659) and boots (HO specification A29 and A30) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).

[a] Dangerous goods emergency action code list, HM Fire Service Inspectorate, Publications Section, The Stationery Office, 2004.

Chemical Hazard Information and Packaging for Supply Classification[a]

Classification	**Xn**	Harmful	
Risk phrases	**R65**	Harmful: may cause lung damage if swallowed	
Safety phrases	**S(2)**	Keep out of the reach of children	
	S23	Do not breathe gas/fumes/vapour/spray	
	S24	Avoid contact with skin	
	S62	If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label	

[a] Approved supply list (seventh edition): information approved for the classification and labelling of substances and preparations dangerous for supply. Chemical (Hazard Information and Packaging for Supply) Regulations 2002. The Stationery Office, 2002.

Physicochemical Properties[a,b]

Volatility	**Low volatility; vapour pressure = 0.48 mm Hg at 20 °C**
Specific gravity	**0.82 at 16 °C (water = 1)**
Flammability	**Flammable**
Lower explosive limit	**0.7%**
Upper explosive limit	**5%**
Water solubility	**Practically insoluble in water**
Reactivity	**Low flashpoint. Vapour/air mixtures are explosive**
Reaction or degradation products	**Data not available**
Odour	**Characteristic odour**

[a] International Chemical Safety Card (ICSC) entry for kerosene. ISCS 0663. International Programme on Chemical Safety,1998.
[b] The Dictionary of Substances and their Effects. Ed. S Gangolli. Second edition, volume 5, 1999.

Threshold Toxicity Values

THRESHOLD LEVELS		
EXPOSURE BY INHALATION		SYMPTOMS
ppm	mg m^{-3}	
Data not available		

Published Emergency Response Guidelines

Emergency Response Planning Guideline (ERPG) Values [a]

	Listed value (ppm)	Calculated value (mg m^{-3})
ERPG-1*	**Data not available**	
ERPG-2*		
ERPG-3*		

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.
** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
*** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.

Acute Exposure Guideline Levels (AEGLs) [b]

	mg m^{-3}				
	10 min	**30 min**	**60 min**	**4 hr**	**8 hr**
AEGL-1†	**Data not available**				
AEGL-2††					
AEGL-3†††					

† The level of the chemical in air at or above which the general population could experience notable discomfort.
†† The level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape.
††† The level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

[a] American Industrial Hygiene Association (AIHA). Emergency Response Planning Guideline values and Workplace Environmental Exposure Level Guides Handbook, Fairfax, VA, 2005.
[b] U.S. Environmental Protection Agency.

Exposure Standards, Guidelines or Regulations

Occupational standards

WEL	**LTEL(8 hour reference period): No guideline value specified**
	STEL(15 min reference period): No guideline value specified

Public health guidelines

DRINKING WATER QUALITY GUIDELINE	**No guideline value specified**
AIR QUALITY GUIDELINE	**No guideline value specified**
SOIL GUIDELINE VALUE AND HEALTH CRITERIA VALUES	**No guideline values specified**

WEL – Workplace exposure limit; LTEL - Long-term exposure limit; STEL – Short-term exposure limit

Health Effects[a]

Major route of exposure

- Toxicity is principally due to pulmonary complications if some is inhaled while being ingested (aspiration).

Immediate Signs or Symptoms of Acute Exposure[b,c]

- Inhalation: May cause headache, dizziness, drowsiness, incoordination and euphoria. Aspiration into the lungs causes pneumonitis with choking, cough, wheeze, breathlessness, cyanosis and fever.
- Ingestion: Often no symptoms occur but there may be nausea, vomiting and occasionally diarrhoea.
- Ocular: This product is expected to be pH neutral but may be irritating to the eyes causing an immediate stinging and burning sensation with lacrimation.
- Dermal: Irritant. Drying and cracking due to defatting action. There may be transient pain with erythema, blistering and superficial burns.

TOXBASE - http://www.spib.axl.co.uk

[a] TOXBASE: Kerosene, 2002.

[b] TOXBASE: Petroleum distillates – features and management, 2002.

[c] TOXBASE: Eye irritants, 2002.

Decontamination and First Aid[a,b]

Important Notes

- Many patients remain well and need no treatment.
- Ambulance staff, paramedics and emergency department staff treating chemically-contaminated casualties should be equipped with NHS approved liquid-tight PPE and blow-over respirators with a A2B2EK filter, where appropriate.

Dermal exposure[c]

- Remove patient from exposure.
- Remove all soiled clothing.
- Wash the contaminated area thoroughly with soap and water.
- Treat symptomatically.

Ocular exposure[d]

- Remove patient from exposure.
- Remove contact lenses if necessary and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-15 minutes.

Inhalation[c]

- Remove patient from exposure and give oxygen.
- Maintain a clear airway and adequate ventilation.
- Apply other measures as indicated by the patient's clinical condition.

Ingestion[c]

- Gastric lavage should not be undertaken. Consider gastric aspiration within 1 hour of ingestion, if very large amounts have been taken or there is concern about another toxin, provided the airway can be protected.
- Give oxygen if symptomatic.
- Patients who have ingested small amounts and have had no symptoms suggestive of aspiration (choking, coughing, vomiting) or other features since the exposure can be observed at home under supervision for 6 hours after ingestion, with advice to attend hospital if features develop.
- Patients who have had features of possible aspiration should be referred to hospital.
- Patients with persistent respiratory symptoms, drowsiness or convulsions should be admitted to hospital.
- Apply other measures as indicated by the patient's condition.

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[a] Decontamination and chemical personal protective equipment in the National Health Service: Current provision, consensus opinion, specification and training implications. A report on progress. The National Focus on Chemical Incidents, 2001.
[b] TOXBASE: Kerosene, 2002.
[c] TOXBASE: Petroleum distillates – features and management, 2002.
[d] TOXBASE: Eye irritants, 2002.
TOXBASE - http://www.spib.axl.co.uk

Kerosene

Toxicological overview

Key Points

Kinetics and metabolism

- As kerosene is a mixture of chemicals, there is no definitive ADME (absorption, distribution, metabolism and excretion) data
- Limited data from metabolism studies suggest that kerosene is removed from circulation by the liver and lungs

Health effects of acute exposure

- The major route of exposure is by inhalation of liquid (aspiration)
- Kerosene vapours may be mildly irritating to the respiratory system and spray applications of kerosene may provoke signs of pulmonary irritation such as coughing and dyspnoea
- Acute dermal exposure may result in local irritation, but it is not considered to be a skin sensitiser
- Acute exposure to kerosene may result in CNS effects including irritability, restlessness, ataxia, drowsiness, convulsions, coma and death

Health effects of chronic exposure

- The most common health effect associated with chronic kerosene exposure is dermatitis, usually associated with inappropriate use of personal protective equipment
- Chronic exposure may also cause non-specific CNS effects such as nervousness, loss of appetite and nausea
- Kerosene does not have a measurable effect on human reproduction or development
- IARC concluded that there was inadequate evidence to classify kerosene as a human carcinogen

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Toxicological Overview

Kerosene is a liquid mixture of hydrocarbons (chain length C9 – 16) produced by the distillation of crude oil. The preferred Chemical Abstracts spelling is “kerosine”. The (UK) technical term for kerosene is “C2 Fuel Oil” (Annex I), as it is derived from the “kerosene” fraction of distilled crude oil. Older, flue-less appliances use “paraffin” (C1) fuel.

The general composition of C2 fuel oil is given at Annex II: For the purpose of this document, kerosene will be used as a synonym for C2 domestic fuel oil. It is important to note that kerosene is not a synonym for “jet fuels” (which are a distinct class of petroleum distillate product containing a range of chemical additives).

Summary of Health Effects

The principal adverse effect arising from ingestion of kerosene is chemical pneumonitis secondary to aspiration of vomitus.

Ingestion of kerosene or acute exposure to vapour may lead to general signs of intoxication such as mild CNS symptoms (dizziness, headache, nausea) and vomiting.

Skin exposure to kerosene may result in dermatitis through the extraction of endogenous skin lipids.

Whilst kerosene is not considered a direct-acting dermal carcinogen, chronic skin exposure may result in tumourigenesis.

Kinetics and metabolism

As kerosene is a mixture of chemicals, there is no definitive ADME (absorption, distribution, metabolism and excretion) data.

Two studies have indicated poor oral availability in the baboon and dog [1, 2].

Individual components of kerosene are known to undergo dermal absorption [3-6] and kerosene vapour is absorbed following pulmonary exposure [7]. The extent of dermal and pulmonary absorption is dose and time-dependent [8].

A limited number of (primate) metabolism studies suggest that kerosene is efficiently removed from the circulation by the liver and lungs [9].

There is currently no information on the elimination kinetics of kerosene.

Sources and route of human exposure

The main route of exposure to kerosene causing toxicity is via inhalation during ingestion (aspiration). Acute, oral exposures may occur from accidental or intentional ingestion. Inhalation or dermal absorption of kerosene may occur through occupational exposures (petrochemical and aviation sectors), from the use of commercially-available products such as paints and insecticides, via accidental release (e.g. road traffic incidents) or through substance abuse. Contaminated water may represent a substantial aspiration risk during whole body immersion (e.g. swimming or near-drowning).

Health Effects of Acute / Single Exposure

Human Data

General toxicity

The acute health risks involved in handling and using kerosene are minimal, provided that the product(s) are used in accordance with current safety practices [10]. The main hazard associated with kerosene is chemical pneumonitis, resulting from aspiration of vomitus following ingestion or inhalation of kerosene liquid or contaminated water. A rare complication of kerosene intoxication may be cardiac arrhythmia and ventricular fibrillation, attributed to increased myocardial sensitivity to endogenous catecholamines [8].

Inhalation

Whilst kerosene vapours may be mildly irritating to the respiratory system [8], exposure is not likely to be fatal [7] as the low volatility of kerosene [11] limits air concentrations to below 100 mg m^{-3} [12], which is the approximate NOAEL (no observable adverse effect level) in several animal species [7]. However, exposure within a confined space at elevated temperature may induce narcotic effects such as narcolepsy, cataplexy and confusion [8, 13] and there is one report of a fatal (vapour) exposure in a child [14].

Spray applications may result in exposure to high concentrations of kerosene aerosol [15] which may provoke signs of pulmonary irritation such as coughing and dyspnoea [13], in addition to mild CNS depression.

Inhalation of water contaminated with kerosene may occur when swimming or as a result of near-drowning incidents and has been associated with “exogenous lipoid pneumonia” [16].

Aspiration of kerosene-contaminated vomitus is a secondary source of pulmonary exposure that may lead to chemical (lipoidal) pneumonitis [17], a delayed onset and potentially fatal lung disorder characterised by cyanosis, dyspnoea and chest x-ray opacities [18].

Ingestion

Signs of oral kerosene poisoning include diarrhoea, nausea and vomiting. Approximately 30 – 50% of children presenting with suspected kerosene ingestion are asymptomatic [7].

Children have survived ingestion of up to 1.7 g kg^{-1} and recorded instances of fatal poisoning have been associated with doses ranging from ~ 2 to 17 g kg^{-1} [7, 19, 20]. However, death following oral exposure is normally associated with aspiration of vomit rather than systemic toxicity *per se;* vomiting occurs in approximately one third to one half of patients [21].

Dermal / ocular exposure

Kerosene is a mild, transient ocular irritant that may produce conjunctivitis, hyperaemia and lacrimation [3, 13].

Acute dermal exposure may result in local irritation (erythema, pruritis) but is not considered to be a skin sensitiser [3]. A small proportion of individuals (<5%) may exhibit hyper-sensitivity to kerosene and skin contact may result in "burn-like" injuries [22-24]: histological analysis of full-blown pustular eruptions have shown inter- and intra-cellular oedema with intra-epidermal vesicles [24, 25]. It is conceivable that hypersensitivity may be the result of concurrent dermatitis resulting in "excited skin syndrome" ("angry back syndrome") [26].

Neurotoxicity

Acute exposure to kerosene in humans has been associated with a variety of CNS effects, including irritability, restlessness, ataxia, drowsiness, convulsions, coma and death [12]; these are generally considered to be secondary effects resulting from hypoxia [27]. Lethargy and "other CNS complications" were reported in ~ 5% of volunteers ingesting 10 – 30 ml of kerosene [12].

Delayed effects following an acute exposure

There is limited evidence to suggest that long-term pulmonary residua may occur following chemical pneumonitis [17, 21]. These effects are considered minor and are of unknown clinical relevance [11].

Animal and In-Vitro Data

General toxicity

The oral toxicity (LD_{50}) of kerosene in a variety of laboratory animals is of the order 20 – 30 g kg^{-1} [7, 28]. Intra-tracheal dosing of kerosene liquid (which models the aspiration of vomit in humans) results in a substantial (10- to 150-fold) increase in toxicity and is consistent with known human health effects. However, studies with monkeys (unspecified strain) and guinea pigs have indicated that lung pathology may occur following oral or parenteral exposure to kerosene, although this effect is not reproducible in all species [7, 28]. It has not been possible to determine a LCt_{50} for kerosene vapour due to its relatively low volatility: An 8 hour exposure to saturated (deodorised) kerosene vapour in dogs, cats or rats did not result in mortality [29].

Delayed effects following an acute exposure

The available literature pertaining to the long-term effects of kerosene following acute exposure is mainly concerned with jet fuels [12, 30] and thus its relevance is uncertain due to the presence of chemical additives. In general, single (acute) oral, dermal and ocular exposures do not result in persistent effects.

Health Effects of Chronic / Repeated Exposure

Human Data

General toxicity

The most common health effect associated with chronic / repeated kerosene exposure is dermatitis [30] which may be associated with insufficient or inappropriate use of personal protective equipment (PPE) in occupational environments. Lung effects (such as dyspnoea) have been reported, but tend to be associated with "high level" exposures [30]. It is conceivable that similar lung and skin effects may be observed in some individuals following a single, acute exposure.

Inhalation

There are currently no unequivocal studies to relate chronic or repeated kerosene exposures to long-term pulmonary dysfunction (other than that putatively associated with aspiration of contaminated water or vomit). There is limited evidence to suggest that chronic exposure may be associated with a tightness of chest and breathing difficulties, although a review of the duration and extent of exposure in such studies was not reported [30].

Ingestion

Chronic, oral exposure to kerosene is unlikely to arise under normal circumstances and there is currently no human data on the chronic effects of kerosene ingestion.

Dermal / ocular exposure

Chronic skin exposure to kerosene is known to cause dermatitis: Table 1 summarises the result of a dermatological study of ball-bearing workers (n=79) exposed on a daily basis to kerosene.

Table 1: Summary of lesion severity (as a function of overt skin pathology), expressed as a percentage of a total factory population [24, 31].

Lesion Severity	Corresponding Sign	% Presenting
Absent	Asymptomatic	16
Low	Erythema	65
Moderate	Eczematous lesions	15
Severe	Defatting dermatitis	4

Neurotoxicity

Long-term exposures to "low" concentrations of kerosene have been reported to produce non-specific CNS effects such as nervousness, loss of appetite and nausea that are not related to hypoxia [12].

Genotoxicity

An increase in cytogenetic changes (chromosomal aberrations in peripheral lymphocytes and bone-marrow micronuclei) has been reported in a limited study of workers exposed to a mixture of kerosene, bunker fuels, white spirit and xylene [32]. However, the mixed exposure precludes any specific conclusions and the results do not correlate with the effects of kerosene-only exposure in animals or *in vitro* mutagenicity tests.

Carcinogenicity

An excess of lung cancer was seen in a large cohort of Japanese workers exposed to kerosene, diesel oil, crude petroleum and mineral oil [28]. In another Japanese study, an excess of stomach cancer was observed amongst workers possibly exposed to kerosene, machine oil or grease [28]. Three case-control studies found an association between lung cancer and the use of kerosene stoves for cooking amongst women in Hong Kong; however, no distinction was made between exposure to kerosene *per se* and exposure to its combustion products [28]. Given that such studies could not attribute the effects to a particular chemical, the IARC evaluated mid-distillate fuel oils as being "not classifiable as to their carcinogenicity to humans (Group 3)" [28]: there is "inadequate evidence" to classify kerosene as a human carcinogen and "limited evidence" for the carcinogenicity of kerosene to experimental animals.

Reproductive and developmental toxicity

Current evidence indicates that kerosene does not have a measurable effect on human reproduction or development [3]. This is in accordance with animal studies.

Animal and In-Vitro Data

General toxicity

In general, animal data is in accordance with the known human effects of kerosene.

Inhalation

Pulmonary pathology (inflammatory cell infiltrates and morphological changes to tracheal epithelia) and cardiovascular changes (resembling atherosclerosis) have been observed in guinea pigs following exposure to high concentrations (up to 34 g m^{-3}) of kerosene aerosol for 15 minutes per day over a three week period [33-35]. Continuous (3 month) exposure of rats and mice to up to 1 g m^{-3} aviation fuel (JP-8) vapour resulted in male rat-specific pathology (nephropathy) that was not thought to be of relevance to humans [36].

Ingestion

No studies on the chronic effects of oral exposure to kerosene were identified. In a study with JP-8 jet fuel, male rat-specific effects (α-2-microglobulin nephropathy) were noted following three month oral gavage (up to 3 g kg^{-1}) [37]. Interestingly, there were also effects that were not species-specific, including perianal dermatitis and gastritis. However, it should be noted that JP-8 contains a variety of chemical moieties in addition to those associated with kerosene.

Dermal / ocular exposure

Dermatitis was observed in mice topically exposed to kerosene (applied in muslin cloth) for 15 to 60 minutes each day for one week which resolved within three weeks [38]. Pathological changes (hyperplasia and visual scores of irritation) were also observed in mice exposed twice a week for two weeks to deodorised kerosene, but the lesion severity did not correlate with tumour-promoting activity when compared against four other petroleum products [39]. When applied three times a week for up to six weeks, repeated cycles of necrosis and regeneration were observed that were deemed sufficient to represent an epigenetic mechanism for tumourigenesis.

Genotoxicity

Negative results were obtained when kerosene was investigated for its ability to induce gene mutation using Salmonella typhimurium TA98 or TA100, with and without an exogenous metabolic activation system [28].

Negative results were also obtained in a mammalian cell assay, using the mouse lymphoma L5178Y $TK^{+/-}$ cells (also in the presence or absence of metabolic activation) [28].

There is one report of an *in vivo* assay investigating the ability of kerosene to induce chromosomal aberrations in the bone marrow of rats using the intra-peritoneal route of administration (single dose or daily for five days). No aberrations were observed [28].

Together, these data imply that kerosene does not have any significant mutagenic activity.

Carcinogenicity

There is limited evidence from skin-painting studies that kerosene can induce skin tumours in mice and the IARC concluded that there was limited evidence in animals for the carcinogenicity of straight-run kerosene and fuel oil [28].

It is recognised that kerosene does not have any significant mutagenic potential and that the tumorigenic activity of middle distillate fuels (including kerosene) is likely a result of a non-genotoxic processes resulting from chronic irritation [8, 13, 28, 30, 40, 41].

Reproductive and developmental toxicity

Deodorised kerosene was assessed using OECD (Organisation for Economic Cooperation and Development) Guideline 421 for reprotoxic or developmental effects in rats [42]. The evaluation involved dermal exposure to up to 494 mg kg^{-1} day^{-1} for up to 8 weeks. No

pathological effects were observed on reproductive organs and no excessive anomalies were found in the first generation of pups. The authors concluded that the NOAEL for deodorised kerosene was 494 mg kg^{-1} day^{-1}. Kerosene (unspecified grade) was also investigated in a developmental toxicity study in rats using inhalation exposure of up to 315 ppm (2.55 g m^{-3}): no teratogenic effects were noted [43].

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Annex I: Classification of Fuel Oils.

Classification of various grades of fuel oil according to crude distillate fraction ("crude fraction") and application. Source: Annex A to BS 2869:1998 [44].

Category	Crude Fraction	Primary Application
A1	Middle distillate	Automotive diesel fuel.
A2		Agricultural engine fuel.
C1	Paraffin	Flue-less heating appliances.
C2	Kerosene	Vaporising or atomising domestic heating appliances.
D	Middle distillate	Atomising burners for domestic, commercial or industrial applications.
E - H	Residual distillate	Atomising burners for boilers or certain industrial engines which may require pre-treatment or additives.

Conversion factor 1ppm = 6.99 mg/m^3; 1 mg/m^3 = 0.143 ppm.

Annex II: Composition of C2 Fuel Oil (Example).

Summary of the main constituents of kerosene (C2 Fuel Oil), expressed as average percentage weight per volume (% w/v). Note that the actual composition will differ according to batch and geographical source. Adapted from Potter and Simmons [45] and IARC Monograph 45 [28].

Class	Example Compound(s)	Average Concentration (%)
n-Alkanes	*n*-heptane	80
	n-octane	
	n-nonane	
	n-decane	
	n-undecane	
	n-dodecane	
	n-tridecane	
	n-tetradecane	
	n-pentadecane	
	n-hexadecane	
	n-heptadecane	
	n-octadecane	
	n-nonadecane	
	n-eicosane	
	n-heneicosane	
Branched alkanes	Isodecane	
	Isoundecane	
	Isododecane	
	Isotridecane	
	Isotetradecane	
Alkyl-monoaromatics	1,2,3,4-tetramethylbenzene	13
Di-aromatics	Fluorene	7
Mono-aromatics	Indene	
	Tetralin	
	1-methyltetralin	
	2-methyltetralin	
Naphthalenes	Napthalene	
	1-methylnaphthalene	
	2-methylnaphthalene	
	1,4-dimethylnaphthalene	
Polynuclear aromatics	Acenaphthene	
	Acenaphthylene	
	Anthracene	
	Phenanthrene	
	2-methylanthracene	
	9,10-dimethlanthracene	
	Fluoranthene	
	Pyrene	
	2,3-benzofluorene	
	Benzo(α)fluorene	
	7,12-dimethylbenz(α)anthracene	

This document will be reviewed not later than 3 years or sooner if substantive evidence becomes available.