SIDS INITIAL ASSESSMENT PROFILE

Chemical Category	**C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category**
CAS Numbers and Chemical Names	**Substance Name (Synonyms, Common Names)** — **CAS Number** Solvent naphtha, (petroleum), heavy aromatic — 64742-94-5 Hydrocarbons, C_{10}, aromatics, >1% naphthalene Hydrocarbons, C_{10}, aromatics, <1% naphthalene Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene Hydrocarbons, C_{10}-C_{13}, aromatics, <1% naphthalene C_{9-10} Aromatics, Predominantly C_9-C_{10} Alkylbenzenes and Naphthalene Aromatics Hydrocarbons, C9 – 11 — 70693-06-0 Naphthalene, methyl- (Mixed) — 1321-94-4 Hydrocarbons, C11, aromatics
CAS Numbers with Structural Formula	**Structural Formula** — **CAS Number** UVCB substances containing aromatic (one-ring or two-ring) molecules of carbon and hydrogen. They consist of C_9-C_{16} aromatic hydrocarbons having carbon numbers predominantly (approximately 80%) in the C_{10} to C_{13} range. The category only includes substances that have boiling ranges falling within approximately ~182 °C to ~288°C. — 64742-94-5 70693-06-0
	The category has been defined for members with specific constituents/component profiles or composition as outlined in the full SIDS Initial Assessment Report and the SIDS Dossiers. The carbon number range of category members identifies at minimum approximately 80% of the chemical constituents in the substance. There may be instances where a category member could fall slightly below the 80% carbon number range. In these situations the justification for keeping those members in the C10-13 aromatics category is because their composition allows their evaluation within this category. The substances in this category contain >98% aromatic hydrocarbons. The composition of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category (CAS Registry Number (RN) 64742-94-5, 70693-06-0 and 1321-94-4) will vary somewhat, but generally contains aromatic (one- or 2-ring) molecules composed of carbon and hydrogen, predominantly in the C_{10}-C_{13} range. No molecules with three or more rings are present. These substances may contain traces of benzene (<1 ppmv; <0.0001%), sulphur (<10 ppmv; <0.001%), and nitrogen (<10 ppmv; <0.001%). As complex hydrocarbon substances, some of the category members share CAS RNs with some petroleum process streams. This assessment only applies to CAS RNs with the constituent profiles and compositions described within this assessment. Consequently, the conclusions of this assessment do not apply to petroleum process streams with the same CAS number as those belonging to the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category.

Identification of chemicals defined by processing procedures	Typical Carbon Number Range (%)					
	C9	**C10**	**C11**	**C12**	**C13**	**C14-C16**
Hydrocarbons C10, aromatics, >1% naphthalene (CAS RN 64742-94-5) Boiling Range ~ 185-205°C	~9	~77	~14	-	-	-
Hydrocarbons, C10, aromatics, <1% naphthalene (CAS RN 64742-94-5) Boiling Range ~185-200°C	~10	~81	~9	-	-	-
C_{9-10} Aromatics, Predominantly C_9-C_{10} Alkylbenzenes and Naphthalene (CAS RN 64742-94-5) Boiling Range ~179-214°C	~ 22	~78	-	-	-	-
Aromatics Hydrocarbons, $C_9 - C_{11}$ (CAS RN 70693-06-0) Boiling Range~182-188°C	≤10	≤90	<2			
Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene (CAS RN 64742-94-5) Boiling Range ~ 230-285°C	-	~10	~36	~26	~17	~11
Hydrocarbons, C_{10}-C_{13}, aromatics, <1% naphthalene (CAS RN 64742-94-5) Boiling Range ~ 235-275°C	-	< 1	~39	~22	~15	~23
Hydrocarbons, C11, aromatics (CAS RN1321-94-4) Boiling Range ~238-242°C	-	-	~100	-	-	-

SUMMARY CONCLUSIONS OF THE SIAR

Category Justification

The C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category is comprised of aromatic hydrocarbons composed of alkylated benzenes and alkylated naphthalenes, with a predominant (approximately 80%) carbon number in the range of C_{10} to C_{13}. A few products in this category may contain approximately 10% naphthalene. The multi-constituent category members are also referred to as chemical substances of unknown or variable composition, complex reaction products or biological materials (UVCBs), a term that is used to characterize these members in the European Union REACH (Registration, Evaluation, and Authorization of Chemicals) legislation and the USEPA Toxic Substances Control Act (TSCA) Inventory Representation Guidance.

Assignment of CAS RNs to hydrocarbon substances is generally based on a hierarchy of considerations including hydrocarbon type(s), carbon number and/or range, distillation temperature and/or range, and last processing step in the production process. One documented source of criteria for assignment of CAS RNs for multi-constituent hydrocarbon substances is provided by the U.S. EPA on proceedings for development of the TSCA inventory for U.S. chemicals. These criteria, however, may allow the same CAS RN to be applied to differing hydrocarbon and petroleum-derived substances (hydrocarbon streams) with somewhat different compositions and applications (e.g., solvents, fuels, lubricants, etc.). Similarly, different CAS RNs can be applied to substances of similar composition and application.

In the case of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category, the three CAS RNs are assigned to commercial hydrocarbon solvents, whose composition and commercial applications provide the primary justification for evaluating these substances as a category. Further, the existing toxicology data show that substances in this category follow a similar mode of action (non-polar narcosis) and have similar orders of aquatic and mammalian toxicity, which further supports the grouping of these substances into a category. The toxicity studies representing the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category were conducted on products in commerce that are multi-constituent substances. Most of the studies used to characterize the toxicity of this category are taken from the Dossier for CAS RN 64742-94-5. Although the substance studied, (hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene) contains a lower percentage of C_{14} to C_{16} constituents than the low naphthalene substance (hydrocarbons, C_{10}-C_{13}, aromatics, <1% naphthalene), water solubility limitations of these constituents will minimize their bioavailability and ability to cause additional adverse effects. Therefore, the results of the studies reported should adequately characterize the potential acute aquatic toxicity of this carbon number range.

Additionally, data from the C_9 Aromatic Hydrocarbon Solvents Category for a C_9 aromatic UVCB has been included, where appropriate, to further support the conclusions of this submission for select human health and physical-chemical endpoints. The use of C_9 Hydrocarbon Solvent category data is justified since some of the UVCB substances in the C_{10}-C_{13} Hydrocarbon Solvents Category may contain as much as 22% C_9 aromatic hydrocarbons.

Data has also been used from the 2-Methylnaphthalene (CAS RN 91-57-6) submission, where appropriate, to further support the conclusions with regard to methylnaphthalene (CAS RN 1321-94-4).

Category Member Conventional Naming

The naming convention used to identify category members is based on their general compositions (predominant carbon number range and hydrocarbon type, specifically aromatics) and is intended to identify hydrocarbon solvent substances manufactured by various companies that are sufficiently similar with regard to composition such that their physical and biological properties would exhibit similar if not identical values. The naming convention as applied to hydrocarbon solvents was seen as a means to provide an immediate understanding of the type of solvent and its composition to allow for an accurate grouping of hydrocarbon substances within categories. As UVCBs, some of the hydrocarbon solvent category members share CAS RNs with some petroleum process streams, which have broader boiling ranges and consequently are compositionally more complex.

Production of C_{10}-C_{13} aromatics hydrocarbon solvents is differentiated from other refinery streams such as gasoline and diesel fuel by additional processing steps leading to finished substances with narrower distillation ranges, removal of sulfur- and nitrogen-containing compounds, and low color. Category members (CAS RN 64742-94-5 and CAS RN 70693-06-0) meet the criteria for UVCB substances because they contain a relatively large number of discrete chemical constituents and the exact composition of some of the constituent chemicals may be unknown. However, Methyl Naphthalene(s) (CAS Registry Number (RN) 1321-94-4 is recognized by TSCA as a Class 1 substance with a specific molecular formula and so it is not a UVCB. It should also be noted

that CAS RN 1321-94-4 is no longer offered commercially as a hydrocarbon solvent by those manufacturers represented in the group sponsoring this category. The general naming convention guidance was developed and used for category members as follows:

"Hydrocarbons", the first part of the name, recognizes the specific chemical class.

The carbon number range typically identifies at least 80% of the chemical constituents in the substance.

The structures are identified by the types of hydrocarbons present: n-paraffins (n-alkanes), iso-paraffins (isoalkanes), cyclic-paraffins or naphthenics (cyclics), and aromatics. The first three are mentioned when present in the substance at a level between 10 and 80%. Aromatics will be indicated as per HPV category and when present as a smaller fraction, identified at levels less than or greater than 2%.

Components with specific toxicology or classification will be mentioned, using the classification cut-off as an indication level (according to EU DSD (Dangerous Substances Directive) and GHS (Global Harmonized System of Classification and Labeling of Chemicals) guidance).

Applying this guidance results in the following names for UVCB members that could be considered as members of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category (not all of these substances may have data available but are otherwise characterized with data for at least one category member or analog):

Hydrocarbons, C_{10}, aromatics, >1% naphthalene
Hydrocarbons, C_{10}, aromatics, <1% naphthalene
Aromatic Hydrocarbons, C_9-C_{11}
Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene
Hydrocarbons, C_{10}-C_{13}, aromatics, <1% naphthalene
Hydrocarbons, C_{11}, aromatics

Analog Identification

In addition to the available physical and biological data for substances in this category, data for the following analogs are also presented, as necessary, to support the characterization of selected endpoints:

CAS RN 90-12-0; 1-methylnaphthalene
CAS RN 91-57-6; 2-methylnaphthalene
CAS RN 95-63-6; 1,2,4-trimethylbenzene
CAS RN 25550-14-5; 1-ethyl-3-methylbenzene
CAS RN 64742-95-6; Hydrocarbons, C_9, aromatics

The five analog substances represent specific isomers of the more complex stream. The analog substances are hydrocarbon constituents that fall within the carbon range of the category members. By a similar mode of toxic action, non-polar narcosis, data from these substances can be considered as read across when assessing the potential toxicity of the category members. Indeed, when the acute aquatic toxicity data for the read-across candidates are compared to toxicities of all category members, they fall within a similar range of toxicity, which supports their use in the overall assessment of category members.

Substances in the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category can be composed of a single chemical or a range of hydrocarbons that can include aromatic structures that fall predominantly within a C number range of 10 to 13. As a result, some category member's physicochemical properties can be characterized by a range of values as a function of composition because a single value is not possible. For example, a multi-constituent hydrocarbon substance will not exhibit a single P_{ow} value, but rather a range based on its composition. This would be the case regardless of whether the data were measured using a standard testing procedure or calculated based on the individual constituent chemicals.

For some properties, the value range is based on a series of representative hydrocarbons that were selected by industry, based on hydrocarbon process (distillation) knowledge, to accurately characterize category members. The hydrocarbons selected (see the following list) include alkylated benzenes and alkylated naphthalenes from C_{10}-C_{16}. Alkylated benzenes and alkylated naphthalenes were selected as representative chemicals since this is the compositional make-up of the UVCB substances in this category. Chemicals with single multi-carbon chains and/or multiple methyl groups were chosen to provide the most comprehensive range of expected values.

Chemical Name	CAS RN
1,2,3,5-tetra-methylbenzene	527-53-7
1-methyl-2-n-propylbenzene	1074-17-5
1,2-dimethyl-4-ethylbenzene	934-80-5
naphthalene	91-20-3
2-ethyl-naphthalene	939-27-5
1,3-dimethyl-naphthalene	575-41-7
2,6-dimethyl-naphthalene	581-42-0
4-methyl biphenyl	644-08-6
2-butyl-naphthalene	1134-62-9
1,2,3,4-tetramethyl-naphthalene	n/a
1-pentyl-naphthalene	n/a
1,2,3,4,5-pentamethyl-naphthalene	n/a
1-hexyl-naphthalene	2876-53-1
1,2,3,4,5,7-hexamethyl-naphthalene	n/a

n/a = not available

Physico-chemical Properties

The members of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category are liquids at room temperature. Value ranges are based on a series of 14 representative hydrocarbons that were selected by industry, based on hydrocarbon process (distillation) knowledge, to accurately characterize category members. The melting point values range from -66.9 to 112 ^{o}C (measured; this applies to constituents in the C_{10}-C_{13} range; as well as category members with constituents ranging up to C_{16}). The boiling points range from ~182°C to ~288°C (359°F to 554°F) (measured; for category members with constituents in the C_{16} range the boiling point range could extend to 326°C). The vapor pressure values range from 0.003 to 1.33 hPa at 25 ^{o}C (calculated; this applies to constituents in the C_{10}-C_{13} range; for category members with constituents ranging up to C_{16} the vapor pressure range could extend down to 0.0003 hPa). Water solubility values range from 1.7 to 31.9 mg/L (calculated; this applies to constituents in the C_{10}-C_{13} range; for category members with constituents ranging up to C_{16} the water solubility range could extend down to 0.12 mg/L) with a relative density range of 0.68 to 0.78 g/cm^3 (measured; this applies to constituents in the C_9-C_{16} range). The log P_{ow} values for the category members range from 3.2 to 4.5 (calculated; this applies to constituents in the C_{10}-C_{13} range; for category members with constituents ranging up to C_{16} the log P_{ow} values range could extend to 6.45).

Human Health

Toxicokinetics, Metabolism, and Distribution

There are no metabolism studies specifically for the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category. However, several short chain alkyl naphthalene analog hydrocarbon constituents (1-methylnaphthalene, 2-methylnaphthalene) and naphthalene fall within the carbon number range of this category. Due to the structural similarity of these molecules to other constituents of the C_{10}-C_{13} Aromatics Hydrocarbon Solvents, it seems reasonable to assume that the solvents would have toxicokinetic properties similar to those of these constituents. Absorption rates were studied for naphthalene and the methyl naphthalenes components (1-methyl naphthalene and 2-methylnaphthalene) in a study using human volunteers and were reported to be approximately 300-500 ng/cm^2/hr. The potential for systemic doses from inhalation exposures is unknown.

C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category products are typically metabolized by side chain oxidation to alcohol and carboxylic acid derivatives. In guinea pigs dosed orally, the methylnaphthalenes are preferentially metabolized by side chain oxidation to form naphthoic acids, although ring oxidation can also occur. These metabolites can be glucuronidated and excreted in the urine or further metabolized before being excreted. The majority of the metabolites are excreted in the urine and to a lower extent, in the feces. Excretion is rapid with the majority of the elimination occurring within the first 24 hours of exposure. Even though the material has the potential to be rapidly excreted, it may not be excluded that the substance may have a slight potential to bioaccumulate in the tissues (e.g., brain, liver, kidney and fat tissues).

Acute Toxicity

The available acute toxicity data demonstrate that hydrocarbon solvent substances tested in the C_{10}-C_{13} Aromatics Hydrocarbon Solvents Category, containing alkylbenzenes and alkylnaphthalenes, show toxicity by the single dose oral route in rats ranged from 2.7 (CAS RN 1321-94-4; mixed methyl naphthalenes) to 7.0 g/kg bwt (CAS RN

64742-94-5; C10-13 aromatics, >1% naphthalene). For the CAS RN 1321-94-4; mixed methyl naphthalenes product, a single oral dose of undiluted test material at 3162 mg/kg bw resulted in death for 5 of 5 male rats and death for 4 of 5 females; at 5000 mg/kg bw, death for 4 of 5 male rats (3 on day 1 and 1 on day 3) and death for 4 of 5 females (4 on day 1). At the 2000 mg/kg bw, 0 of 5 males and 1 of 5 females died (2 days after dosing). The surviving animals were observed for 14 days after the day of dosing. Common signs of systemic toxicity noted in all dose groups were hunched posture, lethargy, pilo-erection and decreased respiratory rate with additional signs of ataxia and labored respiration. Isolated incidents of red/brown stains around the eyes and/or snout, increased salivation, and loss of righting reflex were noted. Common abnormalities noted at necropsy of animals that died during the study were hemorrhagic lungs, dark liver, dark kidneys, sloughing of the non-glandular epithelium of the stomach and hemorrhage or severe hemorrhage of the gastric mucosa. No organ abnormalities were noted at necropsy of animals that were killed at the end of the study,

For the CAS RN 64742-94-5; C10-13 aromatics, >1% naphthalene study, five rats per sex per dose were given a single dose of 0.5, 1.5, 5.0 g/kg bwt. All animals in the 0.5 g/kg and 1.5 g/kg bwt dose groups survived to study termination and displayed an increase in body weight over their Day 0 values. No observable abnormalities were noted for the majority of the animals. Single incidences of dry red material around the penis, urine and ano-genital staining, and oral and ocular discharge were noted. Soft stool was noted in 1 female in the 0.5 g/kg dose group at 6 hours and in 1 male animal in the 1.5 g/kg dose group from 1 hour to day 1. There were no observable abnormalities for all animals at postmortem examination. For the 5.0 g/kg bwt dose group, 5 animals died prior to scheduled termination (2 males on Day 2, 2 females on Day 3 and 1 female on Day 4). Surviving animals displayed an increase in body weight over their Day 0 values. The most frequently noted clinical observation included ano-genital and urine staining, oral and nasal discharges, small amount of stool, soft stool, hypoactivity and decrease in food consumption. Postmortem examination of animals which succumbed revealed a high incidence of distension and abnormal contents of the stomach and small intestines, staining of the fur and lung discoloration. Also noted at a lower incidence were liver discoloration, distension and abnormal contents of the cecum and urinary bladder. Four of the 5 survivors in this group displayed no observable abnormalities, while the remaining animal exhibited alopecia.

A single dose acute dermal toxicity study resulted in an LD_{50} of 2.0 g/kg for CAS RN 1321-94-4 mixed methyl naphthalenes (14 day observation duration). The study consisted of a group of ten fasted rats (five males and five females) given a single 24-hour, semi-occluded dermal application of undiluted material to intact skin at a dose level of 2000 mg/kg bw. No deaths occurred in this study. No signs of systemic toxicity or skin irritation were noted. Body weight changes were not impacted significantly. No abnormalities were noted at necropsy. A single dose acute dermal toxicity study resulted in an LD_{50} of 2.0 g/kg for the CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene product. A group of rabbits (5 animals per sex) were given a single dermal application of test material. The exposure site was occluded for 24 hours. All animals survived to study termination. There were no treatment-related clinical signs. All animals gained weight over their initial Day 0 values. Topical application of test material elicited dermal irritation in all animals. Erythema, ranging from well-defined to moderate/severe were noted in all animals on Day 1. Edema ranging from very slight to moderate was observed on all animals on Day. 1. Edema was not observed in any animal on Day 7. At postmortem examination, there was no evidence of macroscopic abnormalities. Four males and 2 females were noted with desquamation and/or eschar on the dose site which was consistent with their inlife dermal observations.

The available acute toxicity data demonstrate that hydrocarbon solvent substances tested in the C_{10}-C_{13} Aromatics Hydrocarbon Solvents Category, containing alkylbenzenes and alkylnaphthalenes, show toxicity by the oral route of in rats ranged from 2.7 (CAS RN 1321-94-4; mixed methyl naphthalenes) to 7.0 g/kg (CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene). Single dose 14 day duration acute dermal toxicity results were LD_{50}s of 2.0 g/kg for CAS RN 1321-94-4 mixed methyl naphthalenes and CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene.

Acute single 4- hour exposure, inhalation LC_{50} values ranged from >169 to >4688 mg/m^3. In most cases the values were dependent on the inherent physiochemical properties of the test material, e.g., volatility, thus limiting the study design to the maximum achievable saturated vapor concentration. In rats, exposed to CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene, the value was > 169 and 4778 mg/m^3. Even under conditions that resulted in exposure of aerosols and vapor, e.g., exceeding the saturated vapor concentration of C_{10}-C_{13} aromatics, >1% naphthalene, the LC_{50} was >1073 mg/m^3 in mice.

Irritation

Irritation studies were conducted in rabbits with commercial $C_{10} - C_{13}$ Aromatic Hydrocarbon Solvents Category products (CAS RN 64742-94-5; C_{10} aromatics >1% naphthalene and CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene) and the Primary Irritation Index results ranged from 1.08 to 1.83 out of a possible score of 8,

respectively. However, if the irritation scores are interpreted according to newer OECD testing guidelines (24, 48, 72 hour averages for erythema and for edema), the values are 0.94 (erythema) and 0.06 (edema), and 1.5 (erythema) and 0.33 (edema), respectively for the same tests.

Eye irritation studies were conducted in rabbits on a commercial $C_{10} - C_{13}$ Aromatic Hydrocarbon Solvents Category product with CAS RN 64742-94-5; C_{10} aromatics, >1% naphthalene and results indicated a maximum Draize score of 12 on a scale of 0 - 110, indicating the test material was minimally irritating to the eyes of rabbits.

A single respiratory irritation study conducted in mice with a representative $C_{10} - C_{13}$ Aromatic Hydrocarbon Solvents Category product showed an RD_{50} of 20.3 mg/m^3 indicating that CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene has the potential to moderately irritate the respiratory tract and cause depression in respiratory rates in mice.

Sensitization

No experimental animal studies were made available by members of the C_{10}-C_{13} aromatic hydrocarbon solvents consortium for sensitization.

Human Dermal Irritation and Sensitization

Two studies evaluated the skin irritating and sensitizing capabilities of two commercial $C_{10} - C_{13}$ Aromatic Hydrocarbon Solvents Category products on humans. These studies were conducted with and without UV irradiation of the contact sites with 26 volunteer subjects examined and screened by the physician-author of the report(s). The studies were conducted according to the same protocol, briefly described here. The first study was conducted with commercial product CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene (Boiling Point Range 185-205°C and ~ 91% within C10-C13 carbon range); the second was conducted with commercial product CAS RN 64742-94-5; C_{10}-C_{13} aromatics, >1% naphthalene (Boiling Point Range 230-285°C and ~ 89% within C10-C13 carbon range). Each study had 3 phases.

In Phase I, the MED (Minimum Erythemogenic Dose - UVB light produced Erythemogenic Effects) was determined to set the exposure for combined UVB exposure and dermal application of the test material. Five sites on the back and 5 sites on the arm were exposed to UVB light for 10, 20, 30, 40 or 50 seconds at 10 cm from the exposure site. Sites were examined at 18 and 24 hours. In Phase II, determination of phototoxicity and primary irritancy was measured. On each arm, 4 test sites were used with a 5th site serving as a control (no test material applied). On Day 1, each testing site had 0.3 g of a 50% w/w test material in U.S.P. Petrolatum applied to it and held in contact with the skin for 24 hours under a semi-occlusive dressing. On day 2, after 24 hours, participants returned and had 0.3 ml of a neat solution of test material (or water if control) applied to the same sites. The right arm was exposed to UVA (phototoxicity) and the left arm was not (primary irritant study); both arms were examined for irritation. Participants returned at 24, 48, and 72 hours for an examination for dermal irritation. In Phase III, determination of photocontact and contact allergenic capabilities were assessed. On each side of the back, 9 test sites were used for experimental purposes with a 10th site serving as a control (no test material applied). The left side of the back was used to evaluate the irritant and contact allergenic propensities with the evaluation of photocontact allergenic propensities were performed on the right side. 0.3 g of a 30% w/w test material:vehicle solution was used at each experimental site for the evaluation of the propensities. Dermal irritation and damage was assessed and scored according to a modified Draize scale.

The assessments of the two studies showed the following results: Phase II test materials did not elicit any effects which could be construed as a characteristic of a phototoxic propensity or of a primary irritant. Skin patches exposed to test material displayed no signs of skin irritation. The dermal irritation scores were 0 (Draize Score) for all subjects (26 people), on all days (5 days) of exposure to test material. A faint erythema (score of 1) was observed in skin patches exposed to test material and UV light for most subjects; however, subjects exposed to only UV light displayed a similar erythema (score of 1). In Phase III, the test materials showed no evidence of being a photocontact allergen and no evidence of being either a primary irritant or a contact allergen. No erythema was observed during the rechallenge phase of exposure (score of 0 for all subjects).

The data above should be analyzed using a weight of evidence approach. The human data should be given more weight since human exposure data is more relevant to the general populace. Since no irritation was noted in the human volunteer studies, and only minimal irritation was noted in the rabbit studies, the conclusion is that the $C_{10} - C_{13}$ Aromatic Hydrocarbon Solvents Category pose a minimal skin irritation risk to humans. Based on eye irritation data, the $C_{10} - C_{13}$ Aromatic Hydrocarbon Solvents Category pose a minimal eye irritation risk. These chemicals may possess properties indicating hazard for human health for irritation of the respiratory tract.

Repeated Dose Toxicity

A 90-day subchronic, repeated-dose, oral gavage study conducted on a C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category substance (CAS RN. 64742-94-5) showed a low order of systemic toxicity.

Rats (10/sex/dose group) were dosed with 0, 300, 600, or 1200 mg/kg bw/day (including a 28-day satellite recovery high-dose group) for three days. The high dose for the satellite and main study animals was adjusted to 1000 mg/kg bw/day from the 4th day on (in this 90-day study) due to the clinical response displayed in the first 3 days (ano-genital staining, emaciation and hypoactivity) in several animals. During the first week of the study, food consumption in male rats was significantly decreased compared to controls and the male body weights in the high dose group were significantly reduced compared to controls at all intervals throughout the study. However, all male groups gained weight at a rate similar to the control group. This effect was not seen in females. There were ten early deaths, 1 female low-dose group, 1 female mid-dose group, 3 male and 4 female high-dose group (includes 1 female moribund euthanasia), and 1female satellite group. Based on gross postmortem results and/or pathology findings, 1 female mid-dose group, 2 male high-dose group, and 1female satellite group deaths were the result of dosing trauma or aspiration of test material.

The majority of animals in the 300 and 600 mg/kg bw/day groups displayed no observable abnormalities during the test period. The high dose group and satellite animals were dosed initially at 1200 mg/kg bw/day for 3 days and then doses were adjusted to 1000 mg/kg bw/day due to the response displayed by the animals. In the 1000 mg/kg bw/day group and satellite recovery groups, clinical signs included ano-genital staining, alopecia and emaciation in both sexes. There were no signs of toxicity with the exception of emaciation and related observations. Hypothermia and hypoactivity were noted in several animals primarily just prior to their deaths. Male body weights in the high dose group were significantly reduced compared to controls at all intervals throughout the study beginning in the first week of the study. After this interval, the groups gained weight at a rate similar to the control group. This effect was not seen in females. During the first week of the study, food consumption in male rats was significantly decreased compared to controls.

Changes in the liver were noted and include hypertrophy – predominantly centrilobular seen in the females at all dose levels and sporadically in the males along with a low incidence of periportal hepatocelular hypertrophy was seen in the high dose males and/or female rats. The changes corresponded to the significant increase in the mean liver weights (absolute and relative) and an increase in the gamma-glutamyl transferase and cholesterol values seen at termination in the females. An increased incidence and/or severity of thyroid follicular epthilium hypertrophy and/or hyperplasia (not distinguished in the report), was observed in the male rats at all dose levels and in the mid and high dose group females. A low, sporadic incidence of submucosal edema and inflammation, focal mucosal necrosis and hemorrhage was noted involving the glandular and/or non-glandular areas of the stomach. Inflammation and necrosis in the stomach of some treated animals were attributed to the effects of intubation of a locally irritating substance on the gastrointestinal tract. A significant increase in the mean kidney weights (absolute and relative) was noted at termination but no corresponding changes in the kidneys were observed by the pathologist. Although the absolute testes weights at the highest dose level were not statistically different from control weights, the relative testes weights (relative to final body weight) were significantly increased only in the highest dose level due to the significantly decreased final body weights. These effects are considered to be an adaptive response. There were no treatment-related histopathological changes in any testes examined.

Increased hemosiderosis in the splenic red pulp was seen in the male and female rats of the 600 and 1000 mg/kg bw/day dose levels. While several hematological parameters were statistically significantly altered, the effects were not considered to be biologically relevant and were not considered to be the cause of the noted hemosiderosis. The following results were noted:

Bone Marrow – There were no adverse pathology findings of the bone marrow in any animal at any dose.

Hematocrit - There was no dose response for male rats. The hematocrit count was statistically affected at all dose levels; however, all treated male rats had hematocrit counts that were 95% of control. Hematocrit counts were only statistically affected for the female rats at 600 mg/kg bw/day (96% of control). Hematocrit counts were not different from controls in the recovery group that was initially dosed with 1000 mg/kg bw/day. Hematocrit levels returned to normal in the recovery group (initially dosed with 1000 mg/kg bw/day). Since only the male rats were statistically affected, no dose response was observed, and experimental values were within 10% of controls (normal physiological range), these changes are not considered to be an adverse effect.

MCHC – Only male rats in the 1000 mg/kg bw/day group were statistically affected; however, the MCHC level was 97.5% of control. Female rats were statistically affected at all doses, however, no dose response was observed. The values (% of control) for MCHC were 96.7%, 96.9%, 96% for the 300, 600, and 1000 mg/kg

bw/day treated female rats respectively. MCHC levels returned to normal in the recovery group (initially dosed with 1000 mg/kg bw/day). Since only the female rats were statistically affected, no dose response was observed, and experimental values were within 10% of controls (normal physiological range), these changes are not considered to be an adverse effect.

RBC– Only male rats in the 600 and 1000 mg/kg bw/day groups were statistically affected. The values for RBC levels (% of control) were 95% and 91.5% for the 600 and 1000 mg/kg bw/day groups, respectively. Female rat RBC levels were not significantly decreased at any test dose. RBC levels returned to normal in the recovery group (initially dosed with 1000 mg/kg bw/day). Since only the male rats showed a significant decrease in RBC counts, it is unlikely that this change is an adverse effect or is related to the splenic hemosiderosis observed in both sexes of rats. The decrease observed in the male rats was less than 10% of control (normal physiological range) and these changes are not considered to be an adverse effect.

Hemoglobin – Male rats exposed to 300, 600, and 1000 mg/kg bw/day had decreased hemoglobin counts of 95%, 95%, and 92.5% of control, respectively. Female rat hemoglobin count was 93% of control at the 600 and 1000 mg/kg bw/day doses. Hemoglobin concentrations returned to normal in the recovery group (initially dosed with 1000 mg/kg bw/day). Since no dose response was observed in either the male or female rats, and experimental values were within 10% of controls (normal physiological range), these changes are not considered to be an adverse effect.

In conclusion, there were some differences which were statistically different but the differences were not large, and accordingly, were not considered to be biologically relevant and were not related to the observed hemosiderosis in the spleen. It should also be noted that while the test material contains methyl naphthalene, the minor changes to hematological parameters noted in studies with methyl naphthalene were not biologically relevant and were different than the minor changes noted in this study.

Hyperplasia of the urinary bladder mucosa was most prevalent in the male rats and was noted in all dosage groups as well as urinary bladder concretions. The concretions and bladder epithelium hyperplasia are not relevant to human health. IARC published a scientific report on rat bladder tumour formation and its relevance to human health outcomes. IARC states that "large quantitative differences in susceptibility exist among species and between the sexes… [which] must be considered…'. In the absence of bladder neoplasms, as is the case in this study, the IARC Advisory Group concluded that the production of bladder cancer in rats is not predictive of carcinogenic hazard to humans provided that certain criteria are met. The C10-C13 Aromatics satisfy the critical criteria including:

- The lack of genotoxic activity
- C10-C13 Aromatics are not known to produce tumours at any other site in the experimental animals
- Human occupational experience indicates that cancer is not a significant risk in the exposed population.

The incidence and severity of the urinary bladder correlates with increasing dose and with the noted concretions in the male rats. No concretions are noted in the male rat recovery group and the incidence and severity of the mucosa hyperplasia were trending towards reversibility; no male rats were observed with moderate hyperplasia, two male rats were observed with slight hyperplasia, and three male rats were observed with only minimal hyperplasia, indicating recovery. The slight mucosa hyperplasia observed in the female rats at the highest dose tested (two), returned to background levels in the recovery group. Second, except for two female rats at the highest dose test, the hyperplasia is only noted in male rats. α2μ-globulin nephropathy is a syndrome of renal damage that occurs only in male rats when repeatedly exposed to hydrocarbons. There are several hallmark criteria that characterize α2μ-globulin nephropathy, including the accumulation of α2μ-globulin, urotheliahyperplasia, lesions are only present in the male rat, and a lack of genotoxicity. Further α2μ-globulin concentrations in the male rat urine have been implicated in bladder hyperplasia and the tumourigenesis associated with some chemicals (e.g. saccharin). Interspecies and sex differences have been noted in rats and in strains with lower α2μ-globulin concentration, urothelial effects were not observed. These effects to the bladder were determined by IARC to be not relevant to human health. The test data and pathology report for C10-C13 Aromatics is consistent with an α2μ-globulin nephropathy.

The results indicate that the formation of urinary bladder concretions in male rats likely caused mechanical irritation of the transitional epithelium that lead to the noted non-prolific hyperplasia in the mucosa. Based on the recommendation from IARC, the hyperplasia is not considered to be relevant to human health.

The relative organ weights, clinical chemistry and hematology data indicated recovery during the 28 day recovery period. The liver, thyroid, and stomach, changes seen at the 90-day termination, appeared to be reversible findings as they were not observed or returned to background levels in the satellite recovery group after the 28-day

recovery period.

The changes seen in the spleen at the main study termination were at lower incidence and/or severity in the satellite recovery group, which indicates a trend towards reversibility. Based on the results of this study, the LOAEL for this test material is 600 mg/kg bw/day and the NOAEL for this test material is 300 mg/kg bw/day.

Sub-Chronic Studies with Methyl Naphthalene

Several studies in mice were conducted with either the test material 2-methyl naphthalene [CAS RN 91-57-6] or with a methyl naphthalene mixture [CAS RN 1321-94-4]. These study results should only be applied to the category member, mixed methyl naphthalenes [CAS RN 1321-94-4] as the toxicological findings were not observed in the other category members (see study above).

A chronic oral dietary study was conducted with 2-methyl naphthalene [CAS RN 91-57-6] in mice; average intakes were 0, 54.3 or 113.8 mg/kg bw/day for males and 0, 50.3, or 107.6 mg/kg bw/day for females. A low incidence of mortality from various causes was observed in males and females at all dose groups (including control group). A 7.5% decrease in body weight gains in males of 113.8 mg/kg bw/day group was noted. Hematology endpoints including a decrease in immature and mature neutrophils and an increase in lymphocytes counts were noted in the treated females compared with the controls, however no significant effects were observed in the treated males. It should be noted that numerical values and statistics were not reported for the hematological parameters. The most sensitive effects were a significant increase in neutral fat levels and pulmonary alveolar proteinosis observed in both treated groups. A LOAEL of 54.3 and 50.3 mg/kg bw/day 2-methylnaphthalene (0.075% in diet) was determined for male and female mice, respectively.

Three sub-chronic dermal studies were conducted with mixed methylnaphthalenes [1-methyl and 2-methylnaphthalene; CAS RN 1321-94-4] were conducted in mice.

Mixed methylnaphthalene (119 mg/kg bw/day) was applied to backs of female mice twice a week for 30 weeks. Pulmonary alveolar proteinosis was noted in all exposed mice; the implication is that mixed methyl naphthalene can be absorbed through the dermis and elicit pulmonary toxicity via blood flow. Pulmonary alveoli which had proteinosis were filled with cholesterol crystals, an amorphous eosinophilic material, and myelinoid structures of various dimensions and mononucleated giant cells with foamy cytoplasm. The LOAEL for repeated dose dermal toxicity of mixed methyl naphthalene was considered to be 119 mg/kg bw/application.

In a second dermal sub-chronic study, mixed methylnaphthalene was dissolved in acetone and applied to the shaved backs of mice at 0, 118.8 or 237.6 mg/kg bw/twice a week for 50 weeks. Mixed methylnaphthalene exposure induced cholesterol ester and increased levels of lung triglyceride, phospholipid, cholesterol, and dipalmitoyl-glycerophosphocholine in the lungs of treated mice. The LOAEL for repeated dose dermal toxicity was 118.8 mg/kg bw/application in mice based on changes observed in the lungs.

Mixed methylnaphthalene (0, 29.7 or 118.8 mg/kg bw) was applied on the shaved skin of mice backs twice weekly for 30 weeks in another dermal study. The dermal exposure to methylnaphthalene resulted in a 97 % increase in lipid pneumonia. The LOAEL for repeated dose dermal toxicity of methylnaphthalene was 29.7 mg/kg bw/application in female mice**.**

Conclusion for Mixed Methyl Naphthalenes [CAS RN CAS RN 1321-94-4]

Repeated dose studies with mixed methylnaphthalene indicate a moderate degree of toxicity for mice exposed via oral or dermal routes. An oral LOAEL of 0.075% (equivalent to 54.3 mg/kg bw/day in males and 50.3 mg/kg bw/day in females) was determined in a dietary study of 2-methylnaphthalene. A dermal LOAEL for mixed methylnaphthalene was considered to be 29.7 mg/kg bw/application in mice. The pulmonary toxicity observed in mice for the mixed naphthalenes was not been observed in a sub-chronic oral study using rats (see above).

Mutagenicity

C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category substances (Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene [CAS RN 64742-94-5] and Hydrocarbons, C11, aromatics [CAS RN1321-94-4]) tested *in vitro* (Reverse Microbial Mutagenesis [Ames] Assay, Salmonella typhimurium / TA98, TA100 or TA102, TA1535, and TA1537 or TA1538, with and without activation), and Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene [CAS RN 64742-94-5] *in vivo* (mouse micronucleus test) showed no indication of genetic toxicity via increased mutation frequencies in any of the tester strains or evidence of induced cytogenetic damage in mouse bone marrow cells of mice at doses up to and including 1.0 g/kg bw. Results of these studies indicate that members of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category are unlikely to cause genetic damage in laboratory animals.

Reproductive and Developmental Toxicity

Results from the three-generation reproduction inhalation study in rats indicate limited effects from C_9 aromatic naphtha. In each of three generations (F0, F1 and F2), rats were exposed to High Flash Aromatic Naphtha (CASRN 64742-95-6) via whole body inhalation at target concentrations of 0, 100, 500, or 1500 ppm (actual mean concentrations throughout the full study period were 0, 103, 495, or 1480 ppm, equivalent to 0, 505, 2430, or 7265 mg/m^3, respectively). In each generation, both sexes were exposed for 10 weeks prior to and two weeks during mating for 6 hrs/day, 5 days/wks. Female rats in the F0, F1, and F2 generation were then exposed during gestation days 0-20 and lactation days 5-21 for 6 hrs/day, 7 days/wk. The age at exposure initiation differed among generations; F0 rats were exposed starting at 9 weeks of age, F1 exposure began at 5-7 weeks, and F2 exposure began at postnatal day (PND) 22. In the F0 and F1 parental generations, 30 rats/sex/group were exposed and mated. However, in the F2 generation, 40/sex/group were initially exposed due to concerns for toxicity, and 30/sex/group were randomly selected for mating, except that all survivors were used at 1480 ppm. F3 litters were not exposed directly and were sacrificed on lactation day 21.

Systemic Effects on Parental Generations: The F0 males showed statistically and biologically significantly decreased mean body weight by ~15% at 1480 ppm when compared with controls. Seven females died or were sacrificed *in extremis* at 1480 ppm. The F0 female rats in the 495 ppm exposed group had a 13% decrease in body weight gain when adjusted for initial body weight when compared to controls. The F1 parents at 1480 ppm had statistically significantly decreased mean body weights (by ~13% (females) and 22% (males)), and locomotor activity. F1 parents at 1480 ppm had increased ataxia and mortality (six females). Most F2 parents (70/80) exposed to 1480 ppm died within the first week. The remaining animals survived throughout the rest of the exposure period. At week 4 and continuing through the study, F2 parents at 1480 ppm had statistically significant mean body weights much lower than controls (~33% for males; ~28% for females); body weights at 495 ppm were also reduced significantly (by 13% in males and 15% in females). The male rats in the 495 ppm exposed group had a 12% decrease in body weight gain when adjusted for initial body weight when compared to controls. Based on reduced body weight observed, the overall systemic toxicity LOAEC is 495 ppm (2430 mg/m^3).

Reproductive Toxicity - Effects on Parental Generations: There were no pathological changes noted in the reproductive organs of any animal of the F0, F1, or F2 generation. No effects were reported on sperm morphology, gestational period, number of implantation sites, or post-implantation loss in any generation. Also, there were no statistically or biologically significant differences in any of the reproductive parameters, including: number of mated females, copulatory index, copulatory interval, number of females delivering a litter, number of females delivering a live litter, or male fertility in the F0 or in the F2 generation. Male fertility was statistically significantly reduced at 1480 ppm in the F1 rats. However, male fertility was not affected in the F0 or in the F2 generations; therefore, the biological significance of this change is unknown and may or may not be attributed to the test substance. No reproductive effects were observed in the F0 or F1 dams exposed to 1480 ppm (7265 mg/m^3). Due to excessive mortality at the highest concentration (1480 ppm, only six dams available) in the F2 generation, a complete evaluation is precluded. However, no clear signs of reproductive toxicity were observed in the F2 generation. Therefore, the reproductive NOAEC is considered 495 ppm (2430 mg/m^3), which excludes analysis of the highest concentration due to excessive mortality.

Developmental Toxicity - Effects on Pups: Because of significant maternal toxicity (including mortality) in dams in all generations at the highest concentration (1480 ppm), effects in offspring at 1480 ppm are not reported here. No significant effects were observed in the F1 and F2 generation offspring at 103 or 495 ppm. However, in F3 offspring, body weights and body weight gain were reduced by ~ 10-11% compared with controls at 495 ppm for approximately a week (PND 14 through 21). Maternal body weight was also depressed by ~ 12% throughout the gestational period compared with controls. The overall developmental LOAEC from this study is 495 ppm (2430 mg/m^3) based on the body weights reductions observed in the F3 offspring.

Conclusion: No effects on reproductive parameters were observed at any exposure concentration, although a confident assessment of the group exposed at the highest concentration was not possible. A potential developmental effect (reduction in mean pup weight and weight gain) was observed at a concentration that was also associated with maternal toxicity.

Neurotoxicity

Neurotoxicity and neurobehavioral endpoints were not specifically evaluated in the 90-day subchronic oral toxicity study using CAS RN. 64742-94-5, mentioned above; however, there was no evidence of pathologic changes to nervous tissue or neurobehavioral changes based on the clinical observations. No overt clinical signs of neurotoxicity were induced by the tested C_{10}–C_{13} Aromatic Hydrocarbon Solvent Category materials in the acute or repeated dose toxicity studies. In an inhalation neurobehavioral study in rats using C_{10}-C_{11} aromatic

hydrocarbons [CAS RN 64742-94-5] as the test substance, there was evidence of mild, reversible effects on gait, motor activity, and visual discrimination. Functional observation and motor activity tests as well as each of the visual discrimination performance tests, were conducted on 8 control animals and 8 animals in each of the test exposure levels. The hydrocarbon fluid tested was: $C_{10} - C_{11}$ mixed isomer aromatic solvent at dose levels of 200, 600, and 2000 mg/m^3. The highest concentration was approximately the maximally attainable vapor concentration at 20ºC. The rats were exposed for periods of 8 hours per day for 3 consecutive days. Baseline data were collected before the first exposure and the test data were collected immediately after the first and third exposure period. Separate animals for the visual discrimination testing were trained for 4 weeks, 5 days per week, prior to their exposure periods. Statistically significant effects in these domains were apparent in the high exposure group (2000 mg/m^3). Post exposure studies demonstrated the reversibility of all effects. These data, as well as evidence from previous studies, suggested that short-term exposures to levels below approximately 1000 mg/m^3) are unlikely to produce profound CNS effects.

These chemicals may possess properties indicating hazard for human health (irritation of the respiratory tract, eye, and skin, and transient acute CNS effects at high exposure concentrations). These hazards do not warrant further work as they are related to reversible acute toxicity which may become evident only at high exposure levels. They should nevertheless be noted by chemical safety professionals and users. Adequate screening-level data are available to characterize the human health hazard for the purposes of the OECD Cooperative Chemicals Assessment Programme.

Environment

Fate

Members of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category have the potential to volatilize from surface waters at significant rates from water (at 25°C) that range from 10 to 1403 Pa-m^3/mole, based on Henry's Law constants (HLCs). In the air, category members have the potential to degrade through indirect photolytic processes mediated primarily by hydroxyl radicals ($^{\bullet}$OH) with calculated degradation half-lives ranging from 1.9 to 14.6 hours or 0.05 to 1.4 days, based on a 12-hr day and an $^{\bullet}$OH concentration of 1.5 x 10^6 $^{\bullet}$OH/cm^3. Aqueous photolysis will not contribute to the transformation of category chemical constituents in aquatic environments because they are either poorly or not susceptible to this reaction.

Results of Mackay Level I distribution modeling, at steady state, show that category chemical constituents will partition primarily to the air (0.4 to 90.5%) and soil (9.0 to 97.3%) compartments, with a small amount partitioning to water (0.1 to 20.6%), and sediment (0.2-2.2%). Mackay Level III modeling indicates that category member constituents partition mostly to the soil (71.9 to 85.0%) and water (9.7 to 15.8%) compartments rather than air (0.1 to 2.3%) or sediment (0.8-11.2%) compartments when an equal emission rate (1000 kg/hr) to the air, water, and soil compartment is assumed. When release occurs only to either the air, water, or soil compartment, constituents are indicated in the modeling to partition primarily to the compartment to which they are released.

When released primarily to the air compartment, the primary mode of removal would be via indirect photodegradation mediated by $^{\bullet}$OH radicals. In spite of their water solubility, wet deposition of category chemical constituents is not likely to play a significant role in their atmospheric fate because of rapid photodegradation. Volatilization to the air will contribute to the loss of category chemical constituents from aqueous and terrestrial habitats.

Chemical constituents of C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category members have the potential to partition to water at significant concentrations only when emitted to this compartment. However, the levels of these constituents that may occur in aquatic environments are unlikely to degrade by hydrolysis because they lack a functional group that is hydrolytically reactive. Therefore, this degradative process will not contribute to the removal of category member constituents from the environment.

Determining the biodegradation potential of UVCBs can be challenging. The result for each multi-constituent substance (UVCB) characterizes the biodegradability of that substance as a whole, but it does not suggest that each constituent of the UVCB is equally biodegradable. As with all ready biodegradation test guidelines, the test system and study design used with these substances (OECD TG 301F) is not capable of distinguishing the relative contribution of the substances' constituents to the total biodegradation measured (constituents with higher branching/cyclic structures may degrade to a lesser extent than linear and less branched structures). Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene (CAS RN 64742-94-5), which contains chemical constituents from all category members (a UVCB), was shown to be biodegradable based on two 28-day biodegradation studies with test substance concentrations of approximately 35 to 45 mg/l that resulted in 61% biodegradation. In

another study following OECD 301F test guidelines, the analogue substance, 2-methylnaphthalene (CAS RN 91-57-6) biodegraded to an extent of 50% after 28 days. The study was extended to 67 days, at which point the percent biodegradation of 2-methylnaphthalene was 67%. C_9 components of this category were evaluated as part of the C_9 Aromatic Hydrocarbon Solvents Category (reviewed at SIAM 21). Hydrocarbons, C_9, aromatics (CAS RN 64742-95-6), 1,2,4-trimethylbenzene (CAS RN. 95-63-6), and 1-ethyl-3-methylbenzene (CAS RN 64742-95-6) were determined to be readily biodegradable (the latter substance is used as an analog to characterize the potential biodegradability of the category member, ethylmethylbenzene (CAS RN 25550-14-5). These three substances exceed 60% biodegradation in 28 days and met the 10-day window criteria for ready biodegradation.

Standardized tests to assess bioaccumulation potential are intended for single substances and are not appropriate for more complex substances (UVCB). Representative substances, or constituent chemicals, can be used to make conservative predictions of bioaccumulation potential. Results of bioconcentration factor (BCF) studies for several constituent chemicals of category members are available. BCF data range from 2 to 1416 l/kg wet weight for several constituent chemicals in the C_{10} to C_{12} range. QSARs values for BCF were estimated to range from 177 to 3932 L/kg wet for representative constituents (as listed above) in the C_{10} to C_{16} range. Values for methylnaphthalenes (CAS RN 1321-94-4) and 2-methylnaphthalene were estimated at 498 and 646 L/kg wet, respectively as well. Based on this data, category members have a potential to bioaccumulate.

Aquatic Toxicity

Sufficient data (see table below), based on both nominal and measured concentrations, are available for category substances to characterize the fish and invertebrate acute toxicity and alga toxicity of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category. These studies were conducted on the Water Accommodated Fractions (WAF) of the test substances. Acute aquatic toxicity of category members for freshwater fish and invertebrates ranged from 2 to 13.6 (96hr- LL_{50}) and 1.0 to 10 (48hr-EL_{50}) mg/l, respectively, based on nominal loadings. Results, based on measured concentrations, reportedly ranged from 0.8 to 2.3 mg/l for fish, and 0.5 to 0.95mg/l for invertebrates. Acute aquatic toxicity to freshwater algae (72-hr-EL_{50}) for category members ranged from 1 to 10.9 mg/l based on both biomass and growth rate and nominal loadings of the test substances. Measured results for toxicity to algae ranged from 0.29 to 0.43 mg/l.

Results of computer modeling, using EPISuite v.4.0, further support the experimental results with acute aquatic toxicity (LC/EC_{50}) in the range of 0.1 to 3 mg/l for all three trophic levels. Values are based on a series of 14 representative hydrocarbons (see page 4 of this document) that were selected by industry, based on hydrocarbon process (distillation) knowledge, to accurately characterize category members.

Acute toxicity values used to characterize the C_9 components of this category come from the C_9 Aromatic Hydrocarbon Solvents Category (reviewed at SIAM 21). For fish (LL_{50}; LC_{50}) and invertebrates (EL_{50}; EC_{50}) range from 3.5 to 7.7 mg/L, based on measured data. For algae, one study for a category member (CAS No. 64742-95-6), resulted in a 72-hr EC_{50} of 2.4 (biomass) and 2.7 (growth rate) mg/L, based on the measured concentrations.

Acute toxicity values used to characterize the methylnaphthalenes of this category come from the 2-methylnaphthalene submission (CAS RN 91-57-6; reviewed at SIAM 25). For fish (LC_{50}) and invertebrates (EC_{50}) range from 1.5 to 3.0 mg/L, based on measured data. For algae, one study resulted in a 72-hr EC_{50} of 0.7 (biomass) and 2.3 (growth rate) mg/L, based on the measured concentrations.

Selected data that characterize the acute aquatic toxicity of members of the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category

Substance (CAS RN)	**Freshwater Fish 96-hr (mg/l)**	**Freshwater Invertebrate *(Daphnia magna)* 48-hr (mg/l)**	**Freshwater Alga *(Pseudokirchneriella subcapitata)* 72-hr (mg/l)**
Hydrocarbons, C_{10}-C_{13}, aromatics, >1% naphthalene (64742-94-5)	3.0 (LL_{50}) 2.3 (LC_{50}) *(Oncorhynchus mykiss)*	1.1 (EL_{50}) 0.95 (EC_{50})	7.9 (EL_{50}) (growth rate) 0.42 (EC_{50}) 3.8 (EL_{50}) (biomass) 0.29 (EC_{50}) NOELR = 0.22

			NOEC = 0.07 (growth rate and biomass)
C_{9-10} Aromatics, Predominantly C_9-C_{10} Alkylbenzenes and Naphthalene (64742-94-5)	2 - 5 (LL_{50}) *(Oncorhynchus mykiss)*	3 - 10 (EL_{50})	1 - 3 (EL_{50}) (growth rate) 1 - 3 (EL_{50}) (biomass) NOEL = 1.0 (growth rate and biomass)
Hydrocarbons, C_{10}, aromatics, >1% naphthalene (64742-94-5)	13.6 (LL_{50}) 0.84 (LC_{50}) *(Oncorhynchus mykiss)*	10.1 (EL_{50}) 0.55 (EC_{50})	10.9 (EL_{50}) (growth rate) 0.43 (EC_{50}) 8.5 (EL_{50}) (biomass) 0.34 (EC_{50}) NOELR = 2.5 NOEC = 0.09 (growth rate and biomass)

Terrestrial Toxicity

The avian acute oral LD_{50} value for one of the more chemically complex category members (Hydrocarbons, C_{10}, aromatics, >1% naphthalene; CAS RN 64742-94-5) was determined to be greater than 2,250 mg/kg body weight, the highest dose tested, based on the lack of mortality observed in all dosage groups. The avian oral LC_{50} value for the same substance was determined to be greater than 6,500 ppm (mg/kg feed), also based on the lack of mortality observed in all dosage groups. Since only one species was tested, these data represent a low potential for members of the C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category to cause toxicity to terrestrial organisms.

Chemicals in this C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category possess properties indicating a potential hazard for the environment (acute toxicity for fish, invertebrates, and algae (<1 mg/l)). Category members have a potential to bioaccumulate. Category members/substances are not readily biodegradable, but have shown the potential to biodegrade from 50% to greater than 60% in standardized tests. Adequate screening-level data are available to characterize the environmental hazard for the purposes of the OECD Cooperative Chemicals Assessment Programme.

Use/Exposure

Production

United States aggregate production capacities for the products in the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category, as indicated by their CAS RN, in the 2006 EPA IUR database, , were: >10 million to 50 million pounds (CAS RN 1321-94-4); 1 billion pounds and greater pounds (CAS RN 70993-06-0); and >1 billion pounds (CAS RN 64742-94-5) per annum. Volume Survey is overall volume for the entire individual CAS RN and includes fuels, solvents and all other uses. It is expected that the solvent portion of the volume for the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category would be significantly lower than the aggregate production volume. It should also be noted that CAS RN 1321-94-4 is no longer offered commercially by those manufacturers represented in the group sponsoring this category. This assessment only applies to CAS RNs with the constituent profiles and compositions described within this assessment. Consequently, the conclusions of this assessment do not apply to petroleum process streams with the same CAS number as those belonging to the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category.

Use

Hydrocarbon solvents in the C_{10}-C_{13} Aromatic Hydrocarbon Solvents Category are generally used in coatings, cleaning agents, agricultural chemicals, fuel additives, functional fluids, and laboratory agents.

Exposure

The sources for potential environmental exposure to C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category substances could include releases from chemical and petroleum manufacturing/processing facilities, releases from facilities that use C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category substances, releases from industrial products that include C_{10} to C_{13} aromatics, automotive sources (fuel evaporate emissions and exhaust), and possibly biogenic and combustion sources.

C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category members are used in uses in coatings, cleaning agents, agricultural chemicals, fuel additives, functional fluids, and laboratory agents. Occupational exposure includes workers exposed during the manufacture of the product stream and includes office workers. In general, occupational (manufacturing) exposure to category members is well within applicable exposure limits, and office air data are comparable to ambient residential levels.

The occupational exposure in a manufacturing facility would be expected to be relatively low because the process, storage and handling operations are confined by system containment. A comprehensive review and assessment was conducted of published occupational exposure literature published between 1960 and 1997 for industries that use hydrocarbon solvents, including painting, industrial manufacturing, printing, and construction. Approximately 350 publications were determined to have adequate information for quantitative hydrocarbon solvent exposure assessment and the data from these publications were included in a computer database. Occupational exposure data on C_{10} to C_{13} aromatic hydrocarbons were identified in this review. The review publication referenced four publications that provided data on C_{10} to C_{13} aromatic hydrocarbons. The arithmetic mean of the 96 samples was 1.8 mg/m^3 and ranged from 0 to 10 mg/m^3.

The characteristic odor of the solvents in the C_{10} to C_{13} Aromatic Hydrocarbon Solvents Category limits their use in consumer products and therefore they are not typically found in indoor air.