SCREENING-LEVEL HAZARD CHARACTERIZATION OF HIGH PRODUCTION VOLUME CHEMICALS

CHEMICAL CATEGORY NAME
Heavy Fuel Oils

SPONSORED CHEMICALS
(See Table 1)

SUPPORTING CHEMICALS
(See Table 1)

The High Production Volume (HPV) Challenge Program[1] was conceived as a voluntary initiative aimed at developing and making publicly available screening-level health and environmental effects information on chemicals manufactured in or imported into the United States in quantities greater than one million pounds per year. In the Challenge Program, producers and importers of HPV chemicals voluntarily sponsored chemicals; sponsorship entailed the identification and initial assessment of the adequacy of existing toxicity data/information, conducting new testing if adequate data did not exist, and making both new and existing data and information available to the public. Each complete data submission contains data on 18 internationally agreed to "SIDS" (Screening Information Data Set[1,2]) endpoints that are screening-level indicators of potential hazards (toxicity) for humans or the environment.

The Environmental Protection Agency's Office of Pollution Prevention and Toxics (OPPT) is evaluating the data submitted in the HPV Challenge Program on approximately 1400 sponsored chemicals by developing hazard characterizations (HCs). These HCs consist of an evaluation of the quality and completeness of the data set provided in the Challenge Program submissions. They are not intended to be definitive statements regarding the possibility of unreasonable risk of injury to health or the environment.

The evaluation is performed according to established EPA guidance[2,3] and is based primarily on hazard data provided by sponsors; however, in preparing the hazard characterization, EPA considered its own comments and public comments on the original submission as well as the sponsor's responses to comments and revisions made to the submission. In order to determine whether any new hazard information was developed since the time of the HPV submission, a search of the following databases was made from one year prior to the date of the HPV Challenge submission to the present: (ChemID to locate available data sources including Medline/PubMed, Toxline, HSDB, IRIS, NTP, ATSDR, IARC, EXTOXNET, EPA SRS, etc.), STN/CAS online databases (Registry file for locators, ChemAbs for toxicology data, RTECS, Merck, etc.) and Science Direct. OPPT's focus on these specific sources is

[1] U.S. EPA. High Production Volume (HPV) Challenge Program; http://www.epa.gov/chemrtk/index.htm.
[2] U.S. EPA. HPV Challenge Program – Information Sources; http://www.epa.gov/chemrtk/pubs/general/guidocs.htm.
[3] U.S. EPA. Risk Assessment Guidelines; http://cfpub.epa.gov/ncea/raf/rafguid.cfm.

based on their being of high quality, highly relevant to hazard characterization, and publicly available.

OPPT may not develop HCs for those HPV chemicals which have recently been assessed and published internationally through the HPV program of the Organization for Economic Cooperation and Development (OECD) and for which Screening Initial Data Set (SIDS) Initial Assessment Reports (SIAR) and SIDS Initial Assessment Profiles (SIAP) are available. These documents are presented in an international forum that involves review and endorsement by governmental authorities around the world. OPPT is an active participant in these meetings and accepts these documents as reliable screening-level hazard assessments. HCs may be created if new data suggest a need to update the case work where the OECD document will be used as key support documentation.

These hazard characterizations are technical documents intended to inform subsequent decisions and actions by OPPT. Accordingly, the documents are not written with the goal of informing the general public. However, they do provide a vehicle for public access to a concise assessment of the raw technical data on HPV chemicals and provide information previously not readily available to the public.

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Summary

Heavy fuel oils are viscous liquid blends of the residues and distillates that are derived from various refinery distillations, cracking, and reforming processes. These heavy fuel oils are complex mixtures which may boil in the range of 121 to 600°C and consist of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50, together with asphaltenes and smaller amounts of heterocyclic compounds containing sulfur, nitrogen, and oxygen. The lower molecular weight components of these complex mixtures possess low to moderate water solubility while higher molecular weight fractions have negligible solubility in water. The lower molecular weight components of the heavy fuel oil category have moderate to high vapor pressure while higher molecular weight fractions tend to possess negligible to low vapor pressure. The components of the heavy fuel oils category will have low mobility in soil. Volatilization is expected to be moderate to high for most constituents of the heavy fuel oils. The rate of hydrolysis is negligible since paraffins, naphthenes, and the aromatic hydrocarbons contained in this category do not possess functional groups that hydrolyze under environmental conditions. The rate of atmospheric photooxidation is expected to be slow to rapid for most components of the heavy fuel oils. The components of heavy fuel oils are expected to possess low (P1) to high (P3) persistence and low (B1) to high (B3) bioaccumulation potential.

Human Health Hazard

Subcategory I: Residual Fuel Oils

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 68553-00-4 is low, while the acute inhalation toxicity to rats for CASRN 68476-33-5 is moderate. In a 28-day repeated-dose dermal toxicity study in rats with CASRN 68476-33-5, the following systemic effects were observed at the highest tested dose of 480 mg/kg-day: increased liver and spleen weights and decreased hemoglobin and hematocrit values. The NOAEL is not established. No data are available for reproductive and developmental toxicity. CASRN 68553-00- 4 was not mutagenic in bacteria but was mutagenic in mammalian cells *in vitro*. CASRN 68553-00-4 induced chromosomal aberrations in rat bone marrow cells *in vivo*. CASRN 68553-00-4 was irritating to rabbit skin and eyes and sensitizing to guinea pigs skin.

For Subcategory I, the reproductive and developmental toxicity endpoints were identified as data gaps under the HPV Challenge Program.

Subcategory II: Atmospheric Residual

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-45-3 is low. Following a 4-week dermal exposure of rats to CASRN 64741-45-3, no systemic effects were noted. The NOAEL is 940 mg/kg-day (highest dose tested). Data for reproductive toxicity are not available. The prenatal developmental toxicity study in rats, via the dermal route with CASRN 64741-45-3, was conducted with a lesser number of rats (10-15/dose) than recommended by the guidelines; but the study is acceptable. The study provided LOAELs of 1000 mg/kg-day and NOAELs of 333 mg/kg-day for both maternal and developmental toxicity. The maternal effects include a significant decrease in gestational body weights and significantly increased gestational length. The developmental effects include significantly decreased pup body weights. No data are available for gene mutation or chromosomal aberrations endpoints. CASRN 64741-45-3 was irritating to rabbit skin, not irritating to rabbit eyes and not-sensitizing to guinea pig skin.

For Subcategory II, the reproductive toxicity, gene mutation and chromosomal aberrations endpoints were identified as data gaps under the HPV Challenge Program.

Subcategory III: Atmospheric Distillate

The acute dermal toxicity of CASRN 68476-34-6 (supporting chemical stream) to rabbits is low. A 13-week dermal toxicity study conducted in rats with CASRN 68915-97-9 (supporting chemical stream), showed a LOAEL of 125 mg/kg-day based on effects on clinical chemistry (increased BUN, cholesterol, sorbitol dehydrogenase, total protein, globulin and decreased A/G ratio) and hematology (decreased RBC, hemoglobin, hematocrit and platelets) parameters and relative organ weights (liver, thymus, adrenals, heart, kidney, spleen). The NOAEL is 30 mg/kg-day. No reproductive toxicity data are available.

A total of five pre-natal developmental toxicity studies were performed using both sponsored chemicals and on one supporting chemical; all studies used the dermal route of exposure. In a prenatal dermal developmental toxicity study of CASRN 68410-00-4 in rats (25/dose), the LOAEL for maternal toxicity is 250 mg/kg-day based on significantly decreased body weights and body weight gains; the NOAEL is 50 mg/kg-day. No developmental effects were seen in this study; the NOAEL for developmental toxicity is 500 mg/kg-day (highest dose tested). In two other prenatal dermal developmental toxicity studies with CASRN 68410-00-4 using lesser number of animals (12-19/dose) and having different compositions of polyaromatic compounds (PACs), the range for LOAELs for maternal toxicity is 250 to 500 mg/kg-day and that for developmental toxicity is 125 to 150 mg/kg-day. The maternal effects include decreased body weight, body weight gain and food consumption. The developmental effects include decreased pup weights. The NOAELs for maternal toxicity range from 125 to 150 mg/kg-day and NOAELs for developmental toxicity range from "not established" to 50 mg/kg-day. In another prenatal dermal developmental toxicity study of CASRN 68783-08-4 in rats, conducted using lesser number of animals (12-19/dose),the LOAEL for both maternal and developmental

toxicity is 250 mg/kg-day. The maternal effects include significant decreases in body weights, body weight gains and food consumption and developmental effects include significantly decreased number of total and live pups delivered, decreased pup body weights and incomplete ossification. The NOAEL for maternal and developmental toxicity is 50 mg/kg-day. For the supporting chemical stream CASRN 68915-97-9, the LOAEL for maternal and developmental toxicity is 125 mg/kg-day; the NOAEL is 30 mg/kg-day. The maternal effects include decreased body weight, body weight gains and food consumption. Developmental effects include decreased total and live pups delivered, decreased pup body weights and incomplete ossification. No data are available for gene mutation or chromosomal aberrations endpoints. CASRN 68476-34-6 (supporting chemical stream) was irritating to rabbit skin.

For Subcategory III, the reproductive toxicity, gene mutation and chromosomal aberrations endpoints were identified as data gaps under the HPV Challenge Program.

Subcategory IV: Vacuum Residual

There were no data available on either of the two sponsored chemicals. The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-56-6 (supporting chemical stream) is low; and the acute inhalation toxicity to rats is moderate. In the 4-week repeated-dose dermal toxicity study of CASRN 64741-56-6 (supporting chemical stream) in rabbits, the LOAEL of 2000 mg/kg-day is based on decreased body weight gains and decreased alkaline phosphatase activity in male rabbits. The NOAEL is 1000 mg/kg-day. No reproductive or developmental toxicity data are available. CASRN 64741-56-6 (supporting chemical stream) was mutagenic in bacteria *in vitro*. No data for chromosomal aberrations are available. CASRN 64741-56-6 (supporting chemical stream) was irritating to rabbit skin but not to rabbit eyes. CASRN 68512-62-9 was not sensitizing to guinea pig skin.

For Subcategory IV, the reproductive and developmental toxicity and chromosomal aberrations endpoints were identified as data gaps under the HPV Challenge Program.

Subcategory V: Vacuum Distillate

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-57-7 is low. A 13-week dermal toxicity study in rats with CASRN 64741-57-7 showed a LOAEL of 125 mg/kg-day based on effects on hematological parameters (decreased RBC count, hemoglobin, hematocrit and platelets). The NOAEL is 30 mg/kg-day. No reproductive toxicity data are available. A number of prenatal developmental toxicity studies were conducted via dermal exposure to CASRN 64741-57-7. In one study in rats (25/dose), CASRN 64741-57-7 showed a LOAEL of 75 mg/kg-day for maternal toxicity based on significantly decreased body weights and body weight gains; the NOAEL is not established. The developmental toxicity LOAEL is 75 mg/kg-day based on significantly decreased pup body weight, increased incidence of microphthalmia and delayed ossifications; the NOAEL is not established. In another study in rats (25/dose), CASRN 64741-57-7 showed a LOAEL of 100 mg/kg-day for maternal toxicity based on significantly decreased body weights and body weight gains; a NOAEL of 50 mg/kg-day. The developmental toxicity LOAEL is 250 mg/kg-day based on significantly decreased pup body weight, and increased variations in fetal skeletal ossifications; the NOAEL is 100 mg/kg-

day. Several similar studies with CASRN 64741-57-7 using lesser number of animals (10-20/dose) and varying compositions of PACs showed similar effects with LOAELs ranging from 150 to 500 mg/kg-day for both maternal and developmental toxicity. The range for NOAELs is 1 to 125 mg/kg-day. Additional maternal effects in these studies were vaginal red discharge, effects on thymus and decreased numbers of implantation sites. In a prenatal developmental toxicity study in rats via the dermal route with CASRN 64742-86-5 conducted with lesser number of animals (12-15/dose), the LOAEL for maternal and developmental toxicity is 333 mg/kg-day based on significantly decreased body weights and body weight gains for maternal toxicity and significantly decreased pup body weight and dead pups delivered for developmental toxicity. The NOAEL is 50 mg/kg-day. No data for gene mutation are available; CASRN 65741-57-7 did not induce micronuclei when tested *in vivo*. CASRNs 64741-57-7 and 64742-86-5 were irritating to rabbit skin and eyes and CASRN 64741-57-7 was non-sensitizing to guinea pig skin.

For Subcategory V, the reproductive toxicity and gene mutation endpoints were identified as data gaps under the HPV Challenge Program.

Subcategory VI: Cracked Residual

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-62-4 is low. There were several repeated-dose toxicity studies in rats via the dermal route with CASRN 64741-62-4. In a 13-week study, a LOAEL of 8 mg/kg-day was based on effects on the liver and thymus (increased liver weights and decreased thymus weight and histopathological findings), body weight and body weight gains, and/or effects on hematology and clinical chemistry parameters. The NOAEL was not established. Similar effects were seen in several 28-day studies with a lowest LOAEL of 10 mg/kg-day and NOAEL not established. One of the 28-day studies also showed microscopic changes in the skin (sub-acute acanthotic dermatitis, minimal to severe early multifocal papillomatosis (skin surface elevation caused by hyperplasia and enlargement of contiguous dermal papillae)) at 2000 mg/kg-day. For CASRN 64741-75-9, a 28-day dermal toxicity study in rats resulted in a NOAEL of 210 mg/kg-day, the highest dose tested. A 13-week dermal toxicity study with CASRN 64741-80-6 showed a LOAEL of 60 mg/kg-day based on effects on liver, adrenals and alanine amino transferase; the NOAEL is not established. No reproductive toxicity data are available. A dominant lethal assay in rats (treated male rats mated with untreated females) showed no effects. In a prenatal developmental toxicity study of CASRN 64741-62-4 in rats (24/dose) via the dermal route, the LOAEL for maternal toxicity is 1.0 mg/kg-day based on increased vaginal red discharge, significantly decreased body weights and food consumption; the NOAEL is 0.05 mg/kg-day. The LOAEL for developmental toxicity is 1.0 mg/kg-day; the effects include increased resorptions, decreased number of live fetuses, decreased body weights and increased incidence of fetal variations (moderate dilation of renal pelvis, slight dilation of lateral ventricle of brain, bifid thoracic vertebral centrum and decreased average number of ossified caudal vertebrae). The NOAEL for developmental toxicity is 0.05 mg/kg-day. Several other studies are conducted using lesser number of animals (10-15/dose) than recommended by guidelines. For CASRN 64741-62-4 with varying compositions of PACs, the range of LOAEL values for maternal toxicity is 4 to 100 mg/kg-day. The effects include decreased body weights and body weight gains, food consumption, increased vaginal discharge, increased gestational length, and/or thymus atrophy. The range for LOAEL values for

developmental toxicity in these studies is 4 to 250 mg/kg-day. The effects include decreased pup body weights, decreased number of pups delivered per litter, increased resorptions, decreased number of male pups, decreased crown-rump length and/or fetal alterations. The range for NOAELs for maternal toxicity and developmental toxicity is 'not established' to 10 mg/kg-day. CASRN 64741-62-4 was not mutagenic in mammalian cells *in vitro* and did not induce chromosomal aberrations *in vivo*; however, it induced sister chromatid exchanges *in vitro* and unscheduled DNA synthesis *in vitro* and *in vivo*. CASRN 64741-62-4 did not induce dominant lethal mutation in rat germ cells. CASRN 64741-62-4 was irritating to rabbit skin and eyes and was not sensitizing to guinea pigs skin. CASRNs 64741-62-4 and 68187-58-6 increased tumor incidences in mice.

For Subcategory VI, the reproductive toxicity endpoint was identified as a data gap under the HPV Challenge Program.

Subcategory VII: Cracked Distillate

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-81-7 is low. Among several 13-week repeated-dose dermal toxicity studies in rats conducted with CASRN 64741-81-7 with varying composition of PACs, the range of LOAEL values is 30 to 125 mg/kg-day. The systemic effects include decreased body weights, increased relative testes weights, decreased epididymis weights and/or decreased hematocrit and MCH values. The range of NOAEL values is 'not established' to 30 mg/kg-day. In two 28-day repeated-dose dermal toxicity studies in rats with CASRN 64741-81-7, the LOAEL range is 93 – 930 mg/kg-day based on effects on liver and hematology parameters. The NOAEL range is 9.3 to 93 mg/kg-day. A 28-day repeated-dose dermal toxicity study of CASRN 64741-61-3 in rats showed a LOAEL of 99 mg/kg-day based on effects on liver weights and hematology parameters. The NOAEL is 9.9 mg/kg-day. No data are available on reproductive toxicity. All developmental toxicity studies for this subcategory are conducted via dermal route and using lesser number of animals (10-15/dose) than that recommended by the guidelines. For CASRN 64741-81-7 with varying compositions of PACs, the range of LOAEL values for maternal toxicity is 8 to 250 mg/kg-day. The effects include decreased body weights and body weight gains, increased vaginal discharge, effects on clinical chemistry parameters, and/or increased absolute and decreased relative liver and thymus weights. The range of NOAEL values for maternal toxicity is 'not established' to 125 mg/kg-day. The range for LOAEL values for developmental toxicity is 8 to 125 mg/kg-day. The effects include decreased pup body weights, decreased number of pups delivered per litter, increased resorptions, decreased litter size and/or fetal anomalies and skeletal variations. The range of NOAEL values for developmental toxicity is 'not established' to 30 mg/kg-day. No data are available for gene mutation and chromosomal aberrations. CASRN 64741-81-7 was irritating to rabbit skin and eyes; it was not sensitizing to guinea pigs skin. CASRNs 64741-61-3 increased tumor incidences in mice.

For Subcategory VII, the reproductive toxicity, gene mutation and chromosomal aberration endpoints were identified as data gaps under the HPV Challenge Program.

Subcategory VIII: Reformer Residual

There were no data for any endpoints for this subcategory.

For Subcategory VIII, the repeated-dose, reproductive and developmental toxicity, gene mutation and chromosomal aberration endpoints were identified as data gaps under the HPV Challenge Program.

Hazard to the Environment

No adequate data are available for the sponsored substances. Based on the supporting chemicals (CASRNs 90622-56-3, 1120-36-1 and 629-73-2), the 96-h LC_{50} for fish is 0.11 mg/L, the 48-h EC_{50} for aquatic invertebrates is 0.9 mg/L, and the 72-h EC_{50} for aquatic plants is 0.4 mg/L for biomass. Based on the supporting chemical (CASRN 64742-49-0), the 21-d chronic NOEC and LOEC for aquatic invertebrates is 0.17 mg/L and 0.32 mg/L, respectively. Based on CASRNs 1120-36-1 and 629-73-2 there are no aquatic toxicity effects at saturation for chemicals in this category with a carbon chain of fourteen or greater.

No data gaps for Aquatic toxicity were identified under the HPV Challenge Program.

The sponsor, American Petroleum Institute, submitted a Test Plan and Robust Summaries to EPA for heavy fuel oils on June 17, 2004. EPA posted the submission on the ChemRTK HPV Challenge website on July 2, 2004. (http://www.epa.gov/oppt/chemrtk/pubs/summaries/heavyfos/c15368tc.htm). EPA comments on the original submission were posted to the website on December 8, 2005. Public comments were also received and posted to the website. On July 12, 2011, the sponsor submitted the interim final category analysis document and several revised robust summaries which were posted to the ChemRTK website on November 30, 2011.

Category Identification/Justification

The sponsor proposed a category that covered two groups: finished residual fuels (or, heavy fuels) that are marketed commercially (consisting of two CASRNs, 68476-33-5 and 68553-00-4) and the 30 refinery process streams from which they are blended. The 30 petroleum process streams are complex mixtures of hydrocarbons in the C7 – C50 range that boil between 121 and 600 °C. However, the more typical heavy fuel oils are mixtures of hydrocarbons in the C20 – C50 range, whereas fuel oils with lower carbon numbers and boiling temperatures are associated with lighter weight streams (CONCAWE, 1998). All of the category members are complex mixtures, containing variable amounts of alkanes, cycloalkanes, aromatics, olefins, asphaltenes and heteromolecules containing sulfur, oxygen, nitrogen and organometals. The residual fuels are low-grade fuels primarily used in industrial boilers and other direct-source heating applications (e.g., blast furnaces) and as a fuel for large marine diesel engines. The finished heavy fuels (residual fuels) consist primarily of residuum of the refining process after virtually all of the higher-quality hydrocarbons have been removed from crude oil feedstock. Residual fuels are blended from a variety of different residual and distillate materials, and the exact blend for a specific residual fuel is determined largely by the desired viscosity of the finished fuel (see figure 1). To produce a residual fuel of a specified viscosity, the high viscosity of the residual streams is reduced by adding a diluent that is typically a lower quality distillate stream. As a result, the composition of residual fuel oils can vary widely and will depend on the refinery configuration, the crude oils being processed and the overall refinery demand.

Owing to the inherent variability in petroleum materials, category members are not defined by detailed compositional information, but rather by process history, physical properties and product use specifications. The category includes both residual fuel oils and seven refinery streams divided into eight subcategories: Subcategory I, Residual Fuel Oils; Subcategory II, Atmospheric Residual; Subcategory III, Atmospheric Distillate; Subcategory IV, Vacuum Residual; Subcategory V, Vacuum Distillate; Subcategory VI, Cracked Residual; Subcategory VII, Cracked Distillate; and Subcategory VIII, Reformer Residual (see Table 1)..

The sponsor justified the grouping of the category members on the basis of production streams. EPA agreed with the rationale for the heavy fuel oils category and subdivision of the refinery streams into seven subcategories, reflecting their processing history. EPA accepted the sponsor's category definition and justification. The read-across approach is acceptable within subcategories, but not between subcategories.

For aquatic toxicity, subcategorizing these substances is not necessary. Categorizing these substances in one single category is justified because they have similar structure profiles, and therefore they have similarities in physico-chemical and environmental fate properties. A read-across approach to treat all sponsored substances as one broad category is adequate.

Furthermore, high-molecular-weight organometallic and other heteroatom compounds in some of the higher-boiling category members are not expected to interfere with the chemicals' toxicity to aquatic organisms because they are not expected to be bioavailable based on their extremely high molecular weights and low water solubility.

Justification for Supporting Chemicals

For health effects endpoints, the sponsor proposed the use of data from other HPV categories (i.e., Gas Oils, Asphalt and Aromatic Extracts) to read across to the lightest heavy fuel oil streams. Petroleum streams in the heavy fuel oil category generally consist of hydrocarbon molecules having 20 – 50 carbon atoms, although some streams in this category have low-end carbon atoms from 7 – 15. Heavy fuel oils also may be blended with gas oils or similar low viscosity fuels to meet market specifications. Although not explicitly stated, for the vacuum distillate subcategory (subcategory III), the sponsor proposed the use of diesel fuel No. 2 (fuel oil No. 2-D; CASRN 68476-34-6) (to address acute dermal toxicity, skin and eye irritation endpoints). In addition, heavy atmospheric gas oil, CASRN 68915-97-9 (also included in the Gas Oils Category) which is compositionally similar to the CASRN 68783-08-4 is also used as a supporting chemical for subcategory III (to address repeated-dose and developmental toxicity endpoints). For the vacuum residues subcategory (subcategory IV) the sponsor proposed, although not explicitly stated, the use of residues (petroleum), vacuum (CASRN 64741-56-6) (to address acute oral, dermal and inhalation and repeated-dose toxicity and gene mutation, skin and eye irritation endpoints). EPA agrees that these substances adequately support their respective subcategories for the evaluation of human health effects endpoints.

For aquatic toxicity endpoints, EPA is using the following supporting chemicals to address this category:

Naphtha (petroleum) hydrotreated light (CASRN 64742-49-0),
C7-C10 iso-alkanes (CASRN 90622-56-3),
1-tetradecene (CASRN 1120-36-1) and
1-hexadecene (CASRN 629-73-2)

These chemicals have similar structures, and physical/chemical properties, and they have the same mode of toxic action (non-polar narcosis).

The C7-C9 aliphatic hydrocarbons (CASRNs 64742-49-0 and 90622-56-3) have been assessed in the OECD HPV program (SIAM 30; http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=d3906311-a0e0-4fe8-a66b-7159b864a557&idx=0).

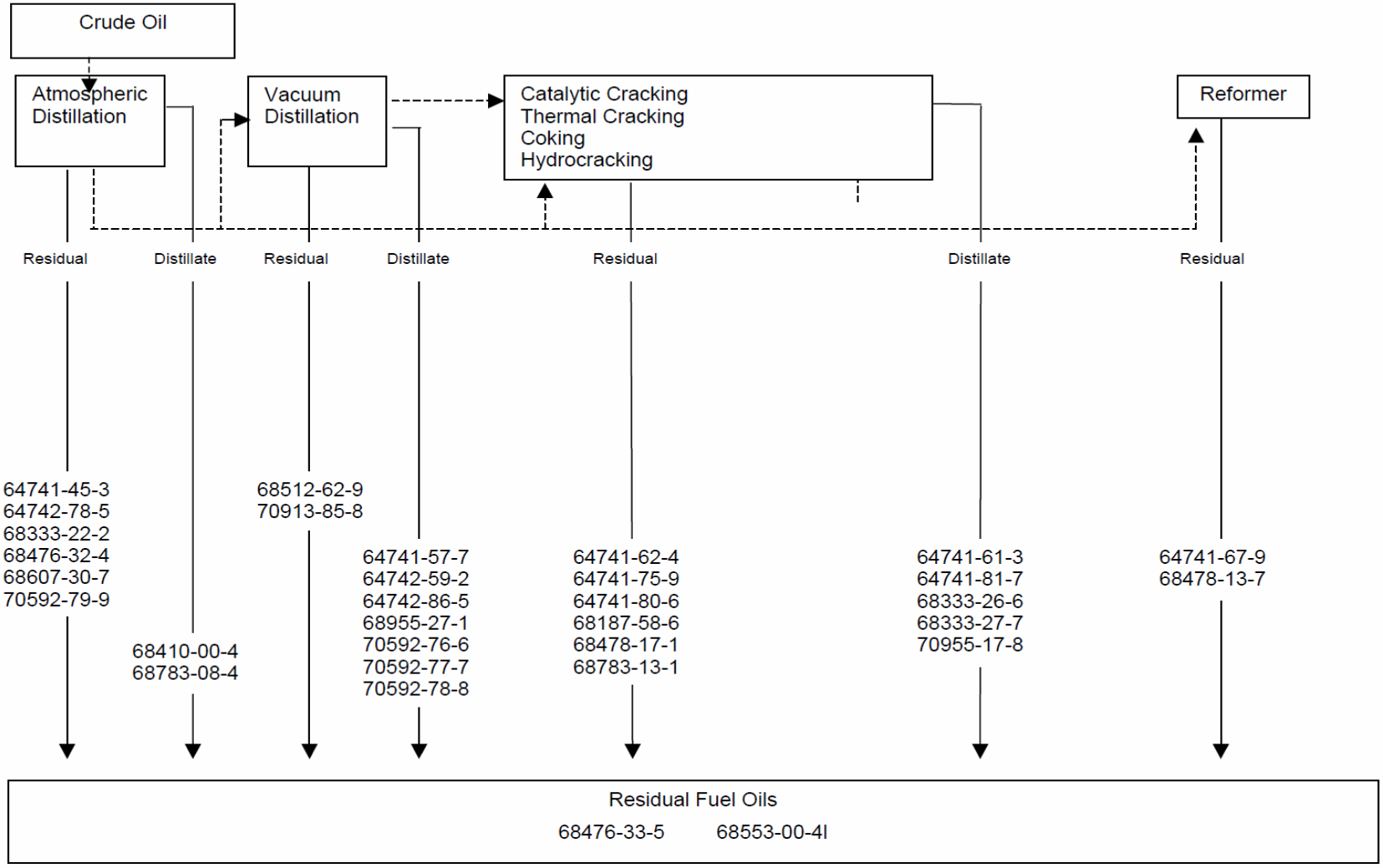
1-Tetradecene (CASRN 1120-36-1: SIAM 11) has been assessed in the OECD HPV program as a member of the alpha olefins category (http://www.chem.unep.ch/irptc/sids/OECDSIDS/AOalfaolefins.pdf).

1-Hexadecene (CASRN 629-73-2: SIAM 19) has been assessed in the OECD HPV program as a member of the higher olefins category (http://www.chem.unep.ch/irptc/sids/OECDSIDS/HigherOlefins.pdf).

Table 1. CA Index Names and CASRNs for Heavy Fuel Oils Subcategories for Human Health Effects Endpoints	
CASRN	**CA Index Name**
Subcategory I. Residual Fuel Oils	
68476-33-5	Fuel Oil, residual
68553-00-4	Fuel oil, No. 6
Subcategory II. Atmospheric Residual	
64741-45-3	Residues (petroleum), atm. tower
64742-78-5	Residues (petroleum), hydrosulfurized atmospheric
68333-22-2	Residues (petroleum), atmospheric
68607-30-7	Residues (petroleum), topping plant, low-sulfur
70592-79-9	Residues (petroleum), atm. tower, light
68476-32-4	Fuel oil, residues-straight-run gas oils, high sulfur
Subcategory III. Atmospheric Distillate	
68410-00-4	Distillates (petroleum) crude oil
68783-08-4	Gas oils (petroleum), heavy atmospheric
Subcategory III. Supporting Chemicals	
68476-34-6	Diesel fuels No.2 (*used to support acute dermal toxicity, skin irritation endpoints*)
68915-97-9	Gas oils (petroleum), heavy atmospheric (*used to support repeated-dose and developmental toxicity endpoints*)
Subcategory IV. Vacuum Residual	
68512-62-9	Residues (petroleum), light vacuum
70913-85-8	Residues (petroleum), solvent-extd. Vacuum distilled
Subcategory IV. Supporting Chemical	
64741-56-6	Residues (peteroleum), vacuum (*used to support acute oral, dermal and inhalation and repeated-dose toxicity, gene mutation, skin and eye irritation endpoints*)
Subcategory V. Vacuum Distillates	
64741-57-7	Residues (petroleum), heavy vacuum
64742-59-2	Gas oils (petroleum), hydrotreated vacuum

64742-86-5	Gas oil (petroleum), hydrosulfurized heavy vacuum
68955-27-1	Distillates (petroleum), petroleum residues vacuum
70592-76-6	Distillates (petroleum), internmediate vacuum
70592-77-7	Distillates (petroleum), light vacuum
70592-78-8	Distillates (petroleum), vacuum
Subcategory VI. Cracked Residual	
64741-62-4	Clarified oils(petroleum), catalytic cracked
64741-75-9	Residues (petroleum), hydrocracked
64741-80-6	Residues (petroleum), thermal cracked
68187-58-6	Pitch, petroleum, arom
68478-17-1	Residues (petroleum), heavy coker gas oil and vacuum gas oil
68783-13-1	Residues (petroleum), coker scrubber condensed-ring-aromatic-containing
Subcategory VII. Cracked Distillate	
64741-61-3	Distillates (petroleum), heavy catalytic cracked
64741-81-7	Distillates (petroleum), heavy thermal cracked
68333-26-6	Distillates (petroleum), hydrosulfurized catalytic cracked
68333-27-7	Distillates (petroleum), hydrosulfurized intermediate catalytic cracked
70955-17-8	Aromatic hydrocarbons, C12 - 20
Subcategory VIII. Reformer Residual	
64741-67-9	Residues (petroleum), catalytic reformer fractionator
68478-13-7	Residues (petroleum), catalytic reformer fractionators residue distn.

Figure 1. HFO Process Diagram



1. Chemical Identity

1.1 Identification and Purity

The chemicals in this category are refinery streams containing the same classes of hydrocarbon and heterocyclic compounds. The proportion of these compounds vary with boiling temperature range of a stream; the higher the molecular weight of the oil's components, the higher the levels of Polyaromatic content (PAC), polycycloparaffins and hetero-atoms (N, O, S and metals) and the lower the levels of paraffins. The cracking processes further modify the composition of the streams. Composition of extractable PAC contents in the samples that were tested are provided in sponsor's the category assessment document and in robust summary where appropriate. The composition of extractable PAC contents is also provided in Appendix E.

1.2 Physical-Chemical Properties

The physical-chemical properties of the sponsored substances and supporting chemicals in the Heavy Fuel Oils category are summarized in Table 2. The representative chemical structures of the sponsored chemicals and supporting chemicals are provided in the Appendix.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1]		
	Subcategory I: Residual Fuel Oils	
Property	**Fuel oil, residual**	**Fuel oil, No. 6**
CASRN	68476-33-5	68553-00-4
Molecular Weight	Complex mixture of aromatic, aliphatic and naphthenic hydrocarbons	
Physical State	Liquid	
Melting Point	-1°C (measured pour point)	-1°C (measured pour point)
Boiling Point	160–600°C (measured)	204–649°C (measured)[2]
Vapor Pressure	<0.75 mm Hg at 37.8°C (measured)	$<1\times10^{-10}$ to 0.0001 mm Hg (estimated)[3,4]
Dissociation Constant (pK_a)	Not applicable	
Henry's Law Constant	7.0×10^{-5} to 90.2 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 90.2 atm-m^3/mol (estimated)[3,4]
Water Solubility	6.25 mg/L at 20°C (measured)	6.26 mg/L at 22°C (measured)
Log K_{ow}	8.7–19.3 (estimated)[3,4]	8.7–19.3 (estimated)[3,4]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Marathon Petroleum Company LLC. 2006. Material Safety Data Sheet (MSDS) for Marathon No. 6 Fuel Oil. Available online at http://www.marathonpetroleum.com/MSDS/0159MAR019.pdf as of December 14, 2010.
[3] Data range presented for representative structures provided the Appendix.
[4] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory II: Atmospheric Residual					
Property	**Residues (petroleum), atm. tower**	**Residues (petroleum), hydrodesulfurized atmospheric**	**Residues (petroleum), atmospheric**	**Residues (petroleum), topping plant, low-sulfur**	**Residues (petroleum), atm. tower, light**	**Fuel oil, residues-straight-run gas oils, high sulfur**
CASRN	64741-45-3	64742-78-5	68333-22-2	68607-30-7	70592-79-9	68476-32-4
Molecular Weight	Complex mixture of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50					
Physical State	Liquid					
Melting Point	18°C (measured pour point)	No data. Typical pour point values for heavy fuel oils are <30°C.				
Boiling Point	>350°C (measured)[2]	>350°C (measured)[2]	>200°C (measured)[2]	181.2–266.7°C (estimated)[4,5]	>200°C (measured)[2]	181.2–266.7 (estimated)[3,4]
Vapor Pressure	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 1.2 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 1.2 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 1.2 mm Hg (estimated)[3,4]	0.0035 to 1.2 mm Hg (estimated)[3,4]
Dissociation Constant (pK_a)	Not applicable					
Henry's Law Constant	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 9.35 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 9.35 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 9.35 atm-m^3/mol (estimated)[3,4]	0.00035 to 9.35 atm-m^3/mol (estimated)[3,4]
Water Solubility	$<1.0\times10^{-10}$ to 2.9×10^{-5} mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 2.9×10^{-5} mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 12.9 mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 12.9 mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 12.9 mg/L at 25°C (estimated)[3,4]	0.11 to 12.9 mg/L at 25°C (estimated)[3,4]
Log K_{ow}	9.6–19.3 (estimated)[4,5]	9.6–19.3 (estimated)[4,5]	4.26–19.3 (estimated)[3,4]	4.26–19.3 (estimated)[3,4]	4.26–19.3 (estimated)[3,4]	4.26–6.73 (estimated)[3,4]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Boiling ranges obtained from the TSCA CAS definition.
[3] Data range presented for representative structures provided the Appendix.
[4] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory III: Atmospheric Distillate					
Property	**Distillates (petroleum), crude oil**	**Gas oils (petroleum), heavy atmospheric**	**Fuels, diesel (supporting chemical)**	**Fuel oil no. 2 (supporting chemical)**	**Fuel oil no. 4 (supporting chemical)**	**Fuels, diesel, no. 2 (supporting chemical)**
CASRN	68410-00-4	68783-08-4	68334-30-5	68476-30-2	68476-31-3	68476-34-6
Molecular Weight	Complex mixture of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50					
Physical State	Liquid					
Melting Point	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	-5°C (measured pour point)[2]; 0°C (measured pour point)[3]; -6°C (measured pour point)[4]; -50 to -14°C (measured pour point)[5]	No data. Typical pour point values for heavy fuel oils are <30°C.	-5°C (measured pour point)[2]; 0°C (measured pour point)[3]; -6°C (measured pour point)[4]; -50 to -14°C (measured pour point)[5]	-5°C (measured pour point)[2]; 0°C (measured pour point)[3]; -6°C (measured pour point)[4]; -50 to -14°C (measured pour point)[5]
Boiling Point	205–495°C (measured)[6]	121–510°C (measured)[6]	160–390°C (measured)[2]; 160–400°C (measured)[3]; 141–388°C (measured)[5]	160–390°C (measured)[2]; 160–400°C (measured)[3]; 141–388°C (measured)[5]	160–390°C (measured)[2]; 160–400°C (measured)[3]; 141–388°C (measured)[5]	160–390°C (measured)[2]; 160–400°C (measured)[3]; 141–388°C (measured)[5]
Vapor Pressure	$<1.0\times10^{-10}$ to 3.3 mm Hg (estimated)[7,8]	$<1.0\times10^{-10}$ to 62.2 mm Hg (estimated)[7,8]	3.0 mm Hg (measured)[2,3]; 15.0 mm Hg (measured)[5]	15.0 mm Hg (measured); 2.12–26.4 mm Hg (measured)[9]	3.0 mm Hg (measured)[2,3]; 15.0 mm Hg (measured)[5]	3.0 mm Hg (measured)[2,3]; 15.0 mm Hg (measured)[5]; 2.12–26.4 mm Hg (measured)[9]
Dissociation Constant (pK_a)	Not applicable					
Henry's Law Constant	7.0×10^{-5} to 7.4 atm-m^3/mol (estimated)[7,8]	1.9×10^{-7} to 2.8 atm-m^3/mol (estimated)[7,8]	0.14 to 90.2 atm-m^3/mol (estimated)[7,8]	0.14 to 90.2 atm-m^3/mol (estimated)[7,8]	2.8×10^{-8} to 90.2 atm-m^3/mol (estimated)[7,8]	0.14 to 90.2 atm-m^3/mol (estimated)[7,8]

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory III: Atmospheric Distillate					
Property	**Distillates (petroleum), crude oil**	**Gas oils (petroleum), heavy atmospheric**	**Fuels, diesel (supporting chemical)**	**Fuel oil no. 2 (supporting chemical)**	**Fuel oil no. 4 (supporting chemical)**	**Fuels, diesel, no. 2 (supporting chemical)**
Water Solubility	$<1.0\times10^{-10}$ to 2.5 mg/L at 25°C (estimated)[7,8]	3.7×10^{-9} to 28.4 mg/L at 25°C (estimated)[7,8]	1.9×10^{-5} to 3.9 mg/L at 25°C (estimated)[7,8]	1.9×10^{-5} to 3.9 mg/L at 25°C (estimated)[7,8]	1.0×10^{-6} to 3.9 mg/L at 25°C (estimated)[7,8]	1.9×10^{-5} to 3.9 mg/L at 25°C (estimated)[7,8]
Log K_{ow}	4.6–19.3 (estimated)[7,8]	3.6–12.3 (estimated)[7,8]	4.5–9.9 (estimated)[7,8]	4.5–9.9 (estimated)[7,8]	4.5–9.9 (estimated)[7,8]	4.5–9.9 (estimated)[7,8]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Measured value obtained for an automotive gas oil.
[3] Measured value for a heating oil.
[4] Measured value for a marine oil.
[5] Measured values obtained for diesel fuel oil from various locations.
[6] Boiling ranges obtained from the TSCA CAS definition.
[7] Data range presented for representative structures provided the Appendix.
[8] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[9] Agency for Toxic Substances and Disease Registry. 2005. Toxicological Profile for Fuel Oils/Kerosene. Available online at http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=516&tid=91 as of December 15, 2010.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)			
	Subcategory IV: Vacuum Residual		
Property	**Residues (petroleum), light vacuum**	**Residues (petroleum), solvent-extd. vacuum distilled residuum**	**Residues (petroleum), vacuum (supporting chemical)**
CASRN	68512-62-9	70913-85-8	64741-56-6
Molecular Weight	Complex mixture of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50		
Physical State	Liquid		
Melting Point	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.
Boiling Point	>230°C (measured)[2]	>300°C (estimated)[3,4]	>495°C (measured)[2]
Vapor Pressure	$<1.0\times10^{-10}$ to 0.16 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.16 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 4.2×10^{-7} mm Hg (estimated)[3,4]
Dissociation Constant (pK_a)	Not applicable		
Henry's Law Constant	7.0×10^{-5} to 38.5 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 38.5 atm-m^3/mol (estimated)[3,4]	0.001 to 6,320 atm-m^3/mol (estimated)[3,4]
Water Solubility	$<1.0\times10^{-10}$ to 0.02 mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.02 mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ mg/L at 25°C (estimated)[3,4]
Log K_{ow}	6.8–19.3 (estimated)[3,4]	6.8–19.3 (estimated)[3,4]	13.6–16.9 (estimated)[3,4]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Boiling ranges obtained from the TSCA CAS definition.
[3] Data range presented for representative structures provided the Appendix.
[4] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)							
	Subcategory V: Atmospheric Distillate						
Property	**Residues (petroleum), heavy vacuum**	**Gas oils (petroleum), hydrotreated vacuum**	**Gas oils (petroleum), hydrodesulfurized heavy vacuum**	**Distillates (petroleum), petroleum residues vacuum**	**Distillates (petroleum), intermediate vacuum**	**Distillates (petroleum), light vacuum**	**Distillates (petroleum), vacuum**
CASRN	64741-57-7	64742-59-2	64742-86-5	68955-27-1	70592-76-6	70592-77-7	70592-78-8
Molecular Weight	Complex mixture of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50.						
Physical State	Liquid						
Melting Point	31–35°C (measured pour point)	No data. Typical pour point values for heavy fuel oils are <30°C.	13°C (measured pour point)	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	27°C (measured pour point)
Boiling Point	350–600°C (measured)[2]	230–600°C (measured)[2]	350–600°C (measured)[2]	>300°C (estimated)[3,4]	250–545°C (measured)[2]	250–545°C (measured)[2]	270–600°C (measured)[2]
Vapor Pressure	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.48 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.19 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 3.3 mm Hg (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.13 mm Hg (estimated)[3,4]
Dissociation Constant (pK_a)	Not applicable						
Henry's Law Constant	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[3,4]	2.6×10^{-6} to 372 atm-m^3/mol (estimated)[3,4]	1.9×10^{-7} to 372 atm-m^3/mol (estimated)[3,4]	7.0×10^{-5} to 21.9 atm-m^3/mol (estimated)[3,4]
Water Solubility	$<1.0\times10^{-10}$ to 1.4×10^{-4} mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.26 mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 1.4×10^{-4} mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 1.4×10^{-4} mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.10 mg/L at 25°C (estimated)[3,4]	3.6×10^{-9} to 2.5 mg/L at 25°C (estimated)[3,4]	$<1.0\times10^{-10}$ to 0.04 mg/L at 25°C (estimated)[3,4]
Log K_{ow}	8.8–19.3 (estimated)[3,4]	5.6–19.3 (estimated)[3,4]	8.8–19.3 (estimated)[3,4]	8.8–19.3 (estimated)[3,4]	6.0–15.6 (estimated)[3,4]	5.6–12.6 (estimated)[3,4]	6.4–19.3 (estimated)[3,4]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Boiling ranges obtained from the TSCA CAS definition.
[3] Data range presented for representative structures provided the Appendix.
[4] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory VI: Cracked Residual					
Property	**Clarified oils (petroleum), catalytic cracked**	**Residues (petroleum), hydrocracked**	**Residues (petroleum), thermal cracked**	**Pitch, petroleum, arom.**	**Residues (petroleum), heavy coker gas oil and vacuum gas oil**	**Residues (petroleum), coker scrubber condensed-ring-armoatic-containing**
CASRN	64741-62-4	64741-75-9	64741-80-6	68187-58-6	68478-17-1	68783-13-1
Molecular Weight	Complex mixture of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50					
Physical State	Liquid					
Melting Point	1.7°C (measured pour point); -13 to -1°C (measured pour point)[2]	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.
Boiling Point	150–600°C (measured)[2]; 202–511°C (measured)[2]	>350°C (measured)[3]	>350°C (measured)[3]	>300°C (estimated)[4,5]	>230°C (measured)[3]	>350°C (measured)[3]
Vapor Pressure	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 1.7×10^{-5} mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.16 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]
Dissociation Constant (pK_a)	Not applicable					
Henry's Law Constant	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 5.9×10^{-5} atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]
Water Solubility	<100 mg/L at 20°C (measured)[2]	$<1.0\times10^{-10}$ to 2.9×10^{-5} mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 2.9×10^{-5} mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.03 mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.02 mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 2.9×10^{-5} mg/L at 25°C (estimated)[4,5]

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory VI: Cracked Residual					
Property	**Clarified oils (petroleum), catalytic cracked**	**Residues (petroleum), hydrocracked**	**Residues (petroleum), thermal cracked**	**Pitch, petroleum, arom.**	**Residues (petroleum), heavy coker gas oil and vacuum gas oil**	**Residues (petroleum), coker scrubber condensed-ring-armoatic-containing**
Log K_{ow}	9.6–19.3 (estimated)[4,5]	9.6–19.3 (estimated)[4,5]	9.6–19.3 (estimated)[4,5]	5.8–19.3 (estimated)[4,5]	6.8–19.3 (estimated)[4,5]	9.6–19.3 (estimated)[4,5]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] ECB. 2000. European Chemical Substances Information System (ESIS), IUCLID Dataset, Residual Fuel Oils (CAS No. 64741-62-4). Available online at http://ecb.jrc.ec.europa.eu/esis/ as of January 12, 2011.
[3] Boiling ranges obtained from the TSCA CAS definition.
[4] Data range presented for representative structures provided the Appendix.
[5] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)							
	Subcategory VII: Cracked Distillate					Subcategory VIII: Reformer Residual	
Property	**Distillates (petroleum), heavy catalytic cracked**	**Distillates (petroleum), heavy thermal cracked**	**Clarified oils (petroleum), hydro-desulfurized catalytic cracked**	**Distillates (petroleum), hydro-desulfurized intermediate catalytic cracked**	**Aromatic hydrocarbons, C12 – 20**	**Residues (petroleum), catalytic reformer fractionator**	**Residues (petroleum), catalytic reformer fractionator residue distn.**
CASRN	64741-61-3	64741-81-7	68333-26-6	68333-27-7	70955-17-8	64741-67-9	68478-13-7
Molecular Weight	Complex mixture of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50						
Physical State	Liquid						
Melting Point	No data. Typical pour point values for heavy fuel oils are <30°C.	16–35°C (measured pour point)	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.	No data. Typical pour point values for heavy fuel oils are <30°C.
Boiling Point	260–500°C (measured)[2]	260–480°C (measured)[2]	>350°C (measured)[2]	205–405°C (measured)[2]	282–427°C (measured)[2]	160–400°C (measured)[2]	>399°C (measured)[2]
Vapor Pressure	$<1.0\times10^{-10}$ to 0.13 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.13 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 1.24 mm Hg (estimated)[4,5]	2.3×10^{-6} to 0.26 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 3.2 mm Hg (estimated)[4,5]	$<1.0\times10^{-10}$ to 0.003 mm Hg (estimated)[4,5]
Dissociation Constant (pK_a)	Not applicable						
Henry's Law Constant	1.9×10^{-7} to 372 atm-m^3/mol (estimated)[4,5]	2.6×10^{-7} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]	2.8×10^{-7} to 372 atm-m^3/mol (estimated)[4,5]	2.4×10^{-4} to 0.05 atm-m^3/mol (estimated)[4,5]	2.2×10^{-7} to 372 atm-m^3/mol (estimated)[4,5]	7.0×10^{-5} to 372 atm-m^3/mol (estimated)[4,5]
Water Solubility	3.7×10^{-9} to 0.04 to mg/L at 25°C (estimated)[4,5]	1.3×10^{-9} to 0. mg/L at 25°C (estimated)[4,5]	$<1.0\times10^{-10}$ to 2.9×10^{-5} mg/L at 25°C (estimated)[4,5]	2.9×10^{-8} to 0.94 mg/L at 25°C (estimated)[4,5]	0.001 to 12.9 mg/L at 25°C at 25°C (estimated)[4,5]	2.9×10^{-8} to 6.5 mg/L (estimated)[4,5]	$<1.0\times10^{-10}$ to 1.4×10^{-4} mg/L at 25°C (estimated)[4,5]

Table 2. Physical-Chemical Properties of the Heavy Fuel Oils Category[1] (continued)							
	Subcategory VII: Cracked Distillate					Subcategory VIII: Reformer Residual	
Property	**Distillates (petroleum), heavy catalytic cracked**	**Distillates (petroleum), heavy thermal cracked**	**Clarified oils (petroleum), hydro-desulfurized catalytic cracked**	**Distillates (petroleum), hydro-desulfurized intermediate catalytic cracked**	**Aromatic hydrocarbons, C12 – 20**	**Residues (petroleum), catalytic reformer fractionator**	**Residues (petroleum), catalytic reformer fractionator residue distn.**
Log K_{ow}	6.4–12.3 (estimated)[3,4]	6.4–12.7 (estimated)[3,4]	9.6–19.3 (estimated)[4,5]	5.0–12.6 (estimated)[4,5]	4.3–7.2 (estimated)[4,5]	4.2–12.6 (estimated)[4,5]	8.8–19.3 (estimated)[4,5]

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Boiling ranges obtained from the TSCA CAS definition.
[3] Data range presented for representative structures provided the Appendix.
[4] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

Physical-Chemical Properties Characterization

Heavy fuel oils are viscous liquid blends of the residues and distillates that are derived from various refinery distillations, cracking, and reforming processes. These heavy fuel oils are complex mixtures which may boil in the range of 121 to 600°C and consist of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50, together with asphaltenes and smaller amounts of heterocyclic compounds containing sulfur, nitrogen, and oxygen. The lower molecular weight components of these complex mixtures possess low to moderate water solubility while higher molecular weight fractions have negligible solubility in water. The lower molecular weight components of the heavy fuel oil category have moderate to high vapor pressure while higher molecular weight fractions tend to possess negligible to low vapor pressure.

2. General Information on Exposure

2.1 Production Volume and Use Pattern

The C Heavy Fuel Oils category chemicals had an aggregated production and/or import volume in the United States greater than 24 billion 200 million pounds in calendar year 2005.

- CASRN 68476-33-5: 1 billion pounds and greater;
- CASRN 68553-00-4: 1 billion pounds and greater;
- CASRN 64741-45-3: 1 billion pounds and greater;
- CASRN 68333-22-2: 1 billion pounds and greater;
- CASRN 68607-30-7: 1 billion pounds and greater;
- CASRN 70592-79-9: 1 billion pounds and greater;
- CASRN 68410-00-4: 1 billion pounds and greater;
- CASRN 68783-08-4: 1 billion pounds and greater;
- CASRN 68512-62-9: 1 billion pounds and greater;
- CASRN 70913-85-8: 100 million to < 500 million
- CASRN 64741-57-7: 1 billion pounds and greater;
- CASRN 64742-59-2: 1 billion pounds and greater;
- CASRN 64742-86-5: 1 billion pounds and greater;
- CASRN 68955-27-1: 1 billion pounds and greater;
- CASRN 70592-76-6: 1 billion pounds and greater;
- CASRN 70592-77-7: 1 billion pounds and greater;
- CASRN 70592-78-8: 1 billion pounds and greater;
- CASRN 64741-62-4: 1 billion pounds and greater;
- CASRN 64741-75-9: 1 billion pounds and greater;
- CASRN 64741-80-6: 1 billion pounds and greater;
- CASRN 68187-58-6: 1 billion pounds and greater;
- CASRN 68478-17-1: 1 billion pounds and greater;
- CASRN 64741-61-3: 1 billion pounds and greater;

- CASRN 64741-81-7: 1 billion pounds and greater;
- CASRN 64741-67-9: 1 billion pounds and greater;
- CASRN 68478-13-7: 100 million to < 500 million

CASRNs 64742-78-5, 68476-32-4, 68783-13-1, 68333-26-6, 68333-27-7 and 70955-17-8 were not reported in the 2006 IUR.

CASRNs 68476-33-5, 64741-45-3, 68333-22-2, 68607-30-7, 70592-79-9, 68410-00-4, 68512-62-9, 70913-85-8, 64742-59-2, 64742-86-5, 68955-27-1, 70592-76-6, 70592-77-7, 70592-78-8, 64741-75-9, 64741-80-6, 68187-58-6, 64741-61-3, 64741-81-7, 64741-67-9 and 68478-13-7:
No industrial processing and uses, and commercial and consumer uses were reported for these chemicals.

CASRN 68553-00-4:
Non-confidential information in the IUR indicated that the industrial processing and uses for the chemical include pulp mills as fuels. Commercial and consumer uses of this chemical are claimed confidential.

CASRN 68783-08-4 and 68478-17-1:
Non-confidential information in the IUR indicated that the industrial processing and uses for the chemicals include petroleum refineries as fuels. Non-confidential commercial and consumer uses of these chemicals include "other."

CASRN 64741-57-7:
Industrial processing and uses, and commercial and consumer uses of this chemical are claimed confidential.

CASRN 64741-62-4:
Non-confidential information in the IUR indicated that the industrial processing and uses for the chemical include other basic organic chemical manufacturing as other; and petroleum refineries as fuels. Non-confidential commercial and consumer uses of this chemical include "other."

2.2 Environmental Exposure and Fate

The environmental fate properties are provided in Table 3.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1]

Property	Subcategory I: Residual Fuel Oils	
	Fuel oil, residual	**Fuel oil, No. 6**
CASRN	68476-33-5	68553-00-4
Photodegradation Half-life	0.7–5.0 hours (estimated)[2,3]	0.7–5.0 hours (estimated)[2,3]
Hydrolysis Half-life	Stable	
Biodegradation	No data	No data
Bioaccumulation Factor	0.9 to 1.7×10^6 (estimated)[2,3]	0.9 to 1.7×10^6 (estimated)[2,3]
Log K_{oc}	5.6–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]
Fugacity (Level III Model)[2,3]		
Air (%)	<0.1–6.1	<0.1–6.1
Water (%)	6.2–84.1	6.2–84.1
Soil (%)	7.6–93.8	7.6–93.8
Sediment (%)	<0.1–31.6	<0.1–31.6
Persistence[4]	P1 (low) to P3 (high)	P1 (low) to P3 (high)
Bioaccumulation[4]	B1 (low) to B3 (high)	B1 (low) to B3 (high)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Data range presented for representative structures provided the Appendix.
[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[4] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory II: Atmospheric Residual					
Property	**Residues (petroleum), atm. tower**	**Residues (petroleum), hydrodesulfurized atmospheric**	**Residues (petroleum), atmospheric**	**Residues (petroleum), topping plant, low-sulfur**	**Residues (petroleum), atm. tower, light**	**Fuel oil, residues-straight-run gas oils, high sulfur**
CASRN	64741-45-3	64742-78-5	68333-22-2	68607-30-7	70592-79-9	68476-32-4
Photodegradation Half-life	0.7–4.8 hours (estimated)[2,3]	0.7–4.8 hours (estimated)[2,3]	0.7–8.9 hours (estimated)[2,3]	0.7–8.9 hours (estimated)[2,3]	0.7–8.9 hours (estimated)[2,3]	0.7–8.9 hours (estimated)[2,3]
Hydrolysis Half-life	Stable					
Biodegradation	No data	No data	No data	No data	No data	No data
Bioaccumulation Factor	0.9 to 1.2×10^5 (estimated)[2,3]	0.9 to 1.2×10^5 (estimated)[2,3]	0.9 to 3.9×10^4 (estimated)[2,3]	0.9 to 3.9×10^4 (estimated)[2,3]	0.9 to 3.9×10^4 (estimated)[2,3]	0.9 to 3.9×10^4 (estimated)[2,3]
Log K_{oc}	5.6–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]	3.6 – 13.2 (estimated)[2,3]	3.6 – 13.2 (estimated)[2,3]	3.6 – 13.2 (estimated)[2,3]	3.6 – 13.2 (estimated)[2,3]
Fugacity (Level III Model)[2,3]						
Air (%)	<0.1–3.9	<0.1–3.9	<0.1–18.8	<0.1–18.8	<0.1–18.8	<0.1–18.8
Water (%)	6.2–89.2	6.2–89.2	6.2–71.6	6.2–71.6	6.2–71.6	6.2–71.6
Soil (%)	4.3–93.8	4.3–93.8	1.6–93.8	1.6–93.8	1.6–93.8	1.6–93.8
Sediment (%)	<0.1–31.6	<0.1–31.6	<0.1–8.6	<0.1–8.6	<0.1–8.6	<0.1–8.6
Persistence[4]	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)
Bioaccumulation[4]	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Data range presented for representative structures provided the Appendix.
[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[4] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)

Property	Subcategory III: Atmospheric Distillate					
	Distillates (petroleum), crude oil	**Gas oils (petroleum), heavy atmospheric**	**Fuels, diesel (supporting chemical)**	**Fuel oil, no. 2 (supporting chemical)**	**Fuel oil, no. 4 (supporting chemical)**	**Fuels, diesel, no. 2 (Fuel oil No. 2-D) (supporting chemical)**
CASRN	68410-00-4	68783-08-4	68334-30-5	68476-30-2	68476-31-3	68476-34-6
Photodegradation Half-life	0.7–9.8 hours (estimated)[2,3]	0.8–18.0 hours (estimated)[2,3]	5.0–9.4 hours (estimated)[2,3]	5.0–9.4 hours (estimated)[2,3]	1.0–9.4 hours (estimated)[2,3]	5.0–9.4 hours (estimated)[2,3]
Hydrolysis Half-life	Stable					
Biodegradation	No data	No data	60% in 28 days (not readily biodedegradable)[4]; 57.5% in 28 days (not readily biodegradable)[4]	60% in 28 days (not readily biodedegradable)[4]; 57.5% in 28 days (not readily biodegradable)[4]; A mixed culture of estuarine bacteria was observed to degrade fuel oil no. 2 by 55% in 28 days[5]; 86–90% degradation in 1 year[5]	60% in 28 days (not readily biodedegradable)[4]; 57.5% in 28 days (not readily biodegradable)[4]	60% in 28 days (not readily biodedegradable)[4]; 57.5% in 28 days (not readily biodegradable)[4]
Bioaccumulation Factor	0.9 to 3.9×10^4 (estimated)[2,3]	39.4 to 3.9×10^4 (estimated)[2,3]	867 to 3.9×10^4 (estimated)[2,3]	867 to 3.9×10^4 (estimated)[2,3]	867 to 3.9×10^4 (estimated)[2,3]	867 to 3.9×10^4 (estimated)[2,3]
Log K_{oc}	3.3–13.2 (estimated)[2,3]	2.3–9.5 (estimated)[2,3]	2.9–5.6 (estimated)[2,3]	2.9–5.6 (estimated)[2,3]	2.9–8.3 (estimated)[2,3]	2.9–5.6 (estimated)[2,3]
Fugacity (Level III Model)[2,3]						
Air (%)	<0.1–21.2	<0.1–30.7	3.4–20.8	3.4–20.8	<0.1–20.8	3.4–20.8
Water (%)	6.2–72.6	4.6–72.0	19.7–87.4	19.7–87.4	2.5–87.4	19.7–87.4
Soil (%)	1.5–93.8	1.0–77.8	3.6–54.1	3.6–54.1	3.6–54.1	3.6–54.1
Sediment (%)	<0.1–8.6	0.7–17.7	2.0–22.7	2.0–22.7	2.0–61.3	2.0–22.7
Persistence[6]	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) – P2 (moderate)	P1 (low) – P2 (moderate)	P1 (low) – P2 (moderate)	P1 (low) – P2 (moderate)
Bioaccumulation[6]	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3	B1 (low) to B3	B1 (low) to B3

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)						
	Subcategory III: Atmospheric Distillate					
Property	**Distillates (petroleum), crude oil**	**Gas oils (petroleum), heavy atmospheric**	**Fuels, diesel (supporting chemical)**	**Fuel oil, no. 2 (supporting chemical)**	**Fuel oil, no. 4 (supporting chemical)**	**Fuels, diesel, no. 2 (Fuel oil No. 2-D) (supporting chemical)**
				(high)	(high)	(high)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Data range presented for representative structures provided the Appendix.
[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[4] American Petroleum Institute. Revised Robust Summary and Test Plan for the Gas Oils Category available online at http://www.epa.gov/oppt/chemrtk/pubs/summaries/gasoilct/c14835tc.htm as of December 15, 2010.
[5] Agency for Toxic Substances and Disease Registry. 2005. Toxicological Profile for Fuel Oils/Kerosene. Available online at http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=516&tid=91 as of December 15, 2010.
[6] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)			
	Subcategory IV: Vacuum Residual		
Property	**Residues (petroleum), light vacuum**	**Residues (petroleum), solvent-extd. vacuum distilled residuum**	**Residues (petroleum), vacuum (supporting chemical)**
CASRN	68512-62-9	70913-85-8	64741-56-6
Photodegradation Half-life	0.7–7.5 hours (estimated)[2,3]	0.7–7.5 hours (estimated)[2,3]	0.7–2.2 hours (estimated)[2,3]
Hydrolysis Half-life	Stable		
Biodegradation	No data	No data	No data
Bioaccumulation Factor	0.9–6.5×10^4 (estimated)[2,3]	0.9–6.5×10^4 (estimated)[2,3]	0.9–20.9 (estimated)[2,3]
Log K_{oc}	4.0–13.2 (estimated)[2,3]	4.0–13.2 (estimated)[2,3]	9.2–9.3 (estimated)[2,3]
Fugacity (Level III Model)[2,3]			
Air (%)	<0.1–11.1	<0.1–11.1	<0.1–0.6
Water (%)	6.2–78.4	6.2–78.4	6.1–36.7
Soil (%)	2.1–93.8	2.1–93.8	62.6–93.0
Sediment (%)	<0.1–16.9	<0.1–16.9	<0.1–0.9
Persistence[4]	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)
Bioaccumulation[4]	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Data range presented for representative structures provided the Appendix.
[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[4] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)

Property	Subcategory V: Atmospheric Distillate						
	Residues (petroleum), heavy vacuum	**Gas oils (petroleum), hydrotreated vacuum**	**Gas oils (petroleum), hydrodesulfurized heavy vacuum**	**Distillates (petroleum), petroleum residues vacuum**	**Distillates (petroleum), intermediate vacuum**	**Distillates (petroleum), light vacuum**	**Distillates (petroleum), vacuum**
CASRN	64741-57-7	64742-59-2	64742-86-5	68955-27-1	70592-76-6	70592-77-7	70592-78-8
Photodegradation Half-life	0.7–4.8 hours (estimated)[2,3]	0.7–8.0 hours (estimated)[2,3]	0.7–5.0 hours (estimated)[2,3]	0.7–4.8 hours (estimated)[2,3]	0.7–7.4 hours (estimated)[2,3]	0.8–9.8 hours (estimated)[2,3]	0.7–6.8 hours (estimated)[2,3]
Hydrolysis Half-life	Stable						
Biodegradation	No data	No data	No data	No data	No data	No data	No data
Bioaccumulation Factor	0.9 to 1.2×10^5 (estimated)[2,3]	0.9 to 3.9×10^4 (estimated)[2,3]	0.9 to 1.7×10^6 (estimated)[2,3]	0.9 to 1.2×10^5 (estimated)[2,3]	1.2 to 2.5×10^5 (estimated)[2,3]	39.4 to 2,719 (estimated)[2,3]	0.9 to 8.1×10^5 (estimated)[2,3]
Log K_{oc}	5.6–13.2 (estimated)[2,3]	3.8–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]	4.1–11.2 (estimated)[2,3]	3.3–9.4 (estimated)[2,3]	4.3–13.2 (estimated)[2,3]
Fugacity (Level III Model)[2,3]							
Air (%)	<0.1–3.9	<0.1–16.1	<0.1–6.1	<0.1–3.9	<0.1–12.9	<0.1–21.2	<0.1–6.9
Water (%)	6.2–89.2	6.2–70.0	6.2–84.1	6.2–89.2	6.2–69.0	4.6–72.6	6.2–65.5
Soil (%)	4.3–93.8	1.8–93.8	7.6–93.8	4.3–93.8	2.0–93.7	1.5–77.7	1.3–93.8
Sediment (%)	<0.1–31.6	<0.1–14.6	<0.1–31.6	<0.1–31.6	<0.1–20.6	0.1–17.7	<0.1–43.1
Persistence[4]	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)
Bioaccumulation[4]	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B2 (moderate)	B1 (low) to B3 (high)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Data range presented for representative structures provided the Appendix.
[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[4] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)

Property	Subcategory VI: Cracked Residual					
	Clarified oils (petroleum), catalytic cracked	**Residues (petroleum), hydrocracked**	**Residues (petroleum), thermal cracked**	**Pitch, petroleum, arom.**	**Residues (petroleum), heavy coker gas oil and vacuum gas oil**	**Residues (petroleum), coker scrubber condensed-ring-armoatic-containing**
CASRN	64741-62-4	64741-75-9	64741-80-6	68187-58-6	68478-17-1	68783-13-1
Photodegradation Half-life	0.7–4.8 hours (estimated)[2,3]	0.7–4.8 hours (estimated)[2,3]	0.7–4.8 hours (estimated)[2,3]	0.7–1.3 hours (estimated)[2,3]	0.7–7.5 hours (estimated)[2,3]	0.7–4.8 hours (estimated)[2,3]
Hydrolysis Half-life	Stable					
Biodegradation	<20% degradation in soil after 1 year[4]	No data	No data	No data	No data	No data
Bioaccumulation Factor	0.9 to 1.2×10^5 (estimated)[2,3]	0.9 to 1.2×10^5 (estimated)[2,3]	0.9 to 1.2×10^5 (estimated)[2,3]	0.9 to 1,727 (estimated)[2,3]	0.9 to 6.5×10^4 (estimated)[2,3]	0.9 to 1.2×10^5 (estimated)[2,3]
Log K_{oc}	5.6–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]	5.9–13.2 (estimated)[2,3]	4.0–13.2 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]
Fugacity (Level III Model)[2,3]						
Air (%)	<0.1–3.9	<0.1–3.9	<0.1–3.9	<0.1–0.1	<0.1–11.1	<0.1–3.9
Water (%)	6.2–89.2	6.2–89.2	6.2–89.2	6.2–8.4	6.2–68.4	6.2–89.2
Soil (%)	4.3–93.8	4.3–93.8	4.3–93.8	56.9–93.8	2.1–93.8	4.3–93.8
Sediment (%)	<0.1–31.6	<0.1–31.6	<0.1–31.6	<0.1–34.6	<0.1–16.9	<0.1–31.6
Persistence[5]	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)
Bioaccumulation[5]	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B2 (moderate)	B1 (low) to B3 (high)	B1 (low) to B3 (high)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.

[2] Data range presented for representative structures provided the Appendix.

[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.

[4] ECB. 2000. European Chemical Substances Information System (ESIS), IUCLID Dataset, Residual Fuel Oils (CAS No. 64741-62-4). Available online at http://ecb.jrc.ec.europa.eu/esis/

[5] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Table 3. Environmental Fate Characteristics of the Heavy Fuel Oils Category[1] (continued)							
	Subcategory VII: Cracked Distillate					Subcategory VIII: Reformer Residual	
Property	**Distillates (petroleum), heavy catalytic cracked**	**Distillates (petroleum), heavy thermal cracked**	**Clarified oils (petroleum), hydro-desulfurized catalytic cracked**	**Distillates (petroleum), hydro-desulfurized intermediate catalytic cracked**	**Aromatic hydrocarbons, C12 – 20**	**Residues (petroleum), catalytic reformer fractionator**	**Residues (petroleum), catalytic reformer fractionator residue distn.**
CASRN	64741-61-3	64741-81-7	68333-26-6	68333-27-7	70955-17-8	64741-67-9	68478-13-7
Photodegradation Half-life	0.8–6.8 hours (estimated)[2,3]	0.8–6.8 hours (estimated)[2,3]	0.7–4.8 hours (estimated)[2,3]	1.0–8.9 hours (estimated)[2,3]	1.2–10.9 hours (estimated)[2,3]	0.8–11.0 hours (estimated)[2,3]	0.7–5.0 hours (estimated)[2,3]
Hydrolysis Half-life	Stable						
Biodegradation	No data	No data	No data	No data	No data	No data	No data
Bioaccumulation Factor	39 to 8×10^5 (estimated)[2,3]	39 to 8×10^5 (estimated)[2,3]	0.9 to 1.2×10^5 (estimated)[2,3]	368.6 to 1.0×10^4 (estimated)[2,3]	425 to 2.9×10^4 (estimated)[2,3]	368.6 to 1,881 (estimated)[2,3]	0.9 to 1.7×10^6 (estimated)[2,3]
Log K_{oc}	4.3–9.4 (estimated)[2,3]	4.3–9.7 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]	3.6–8.3 (estimated)[2,3]	3.6–5.6 (estimated)[2,3]	3.0–7.1 (estimated)[2,3]	5.6–13.2 (estimated)[2,3]
Fugacity (Level III Model)[2,3]							
Air (%)	<0.1–6.9	<0.1–6.9	<0.1–3.9	<0.1–18.8	<0.1–9.2	<0.1–23.3	<0.1–6.1
Water (%)	4.6–65.5	5.0–65.5	6.2–89.2	2.5–71.6	5.0–32.8	1.0–73.0	6.2–84.1
Soil (%)	1.3–77.7	1.3–82.3	4.3–93.8	1.6–36.3	43.1–86.4	1.3–43.7	7.6–93.8
Sediment (%)	0.1–43.0	0.1–43.0	<0.1–31.6	7.9–61.1	2.6–51.9	0.1–55.2	<0.1–31.6
Persistence[4]	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)	P1 (low) to P3 (high)
Bioaccumulation[4]	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B3 (high)	B1 (low) to B2 (moderate)	B1 (low) to B3 (high)

[1] American Petroleum Institute, Petroleum HPV Testing Group. 2004. Robust Summary and Test Plan for the Heavy Fuel Oils. Available online at http://www.epa.gov/chemrtk/pubs/summaries/heavyfos/c15368tc.htm as of December 15, 2010.
[2] Data range presented for representative structures provided the Appendix.
[3] U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm as of December 15, 2010.
[4] Federal Register. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) pp. 60194–60204.

Environmental Fate Characterization

The components of the heavy fuel oils category are expected to possess low mobility in soil. Microbial degradation in soils is expected to be greatest for the lower molecular weight aromatic fractions, while the biodegradation of the aliphatic and naphthenic hydrocarbons decreases with increasing carbon chain length and degree of branching. Aromatics with one, two or three aromatic rings are efficiently biodegraded; however, those with four or more aromatic rings and the high molecular weight asphaltenes are quite resistant to biodegradation. A single application of approximately 21, 14, or 13 g/kg soil of home fuel oil, no. 2 to outdoor plots in Pennsylvania (silt loam), Oklahoma (sandy loam), and Texas (clay loam) was degraded by 86, 90, and 86%, respectively, after 1 year, with degradation being independent of temperature differences. The degradation of hydrocarbons fractions of fuel oil, no. 2 was studied using a marine microcosm under different temperature, light and biological activity regimes. Levels of heavy fuel oils were found to decrease exponentially under all conditions, with temperature having the greatest effect on the half-lives of the component hydrocarbons. In cold water, the half-life for total hydrocarbons was greater than 10 days, while in warmer water (17–21°C), the half-life decreased to approximately 30 hours. In cold water, saturated hydrocarbons were removed more rapidly than aromatic hydrocarbons, but in warmer water, the half-lives of the fractions were similar. For the saturated hydrocarbons, the half-life increased with increasing molecular weight or with branched or cyclic moieties, i.e., small *n*-alkanes (C-12) had the shortest half-life in both warm and cold water. A Bunker C fuel oil biodegraded 11% in 28 days using an inoculum of a mixed culture of bacteria obtained from a estuarine creek known to be exposed to low levels of oil contamination. Volatilization of the components of heavy fuel oils is expected to be moderate to high. The rate of hydrolysis is expected to be negligible since the substances in this category do not possess functional groups that hydrolyze under environmental conditions. The components of the heavy fuel oils category are expected to possess low (P1) to high (P3) persistence and low (B1) to high (B3) bioaccumulation potential.

Conclusion: Heavy fuel oils are viscous liquid blends of the residues and distillates that are derived from various refinery distillations, cracking, and reforming processes. These heavy fuel oils are complex mixtures which may boil in the range of 121 to 600°C and consist of aromatic, aliphatic, and naphthenic hydrocarbons, generally having carbon numbers in the range of C7 to C50, together with asphaltenes and smaller amounts of heterocyclic compounds containing sulfur, nitrogen, and oxygen. The lower molecular weight components of these complex mixtures possess low to moderate water solubility while higher molecular weight fractions have negligible solubility in water. The lower molecular weight components of the heavy fuel oil category have moderate to high vapor pressure while higher molecular weight fractions tend to possess negligible to low vapor pressure. The components of the heavy fuel oils category will have low mobility in soil. Volatilization is expected to be moderate to high for most constituents of the heavy fuel oils. The rate of hydrolysis is negligible since paraffins, naphthenes, and the aromatic hydrocarbons contained in this category do not possess functional groups that hydrolyze under environmental conditions. The rate of atmospheric photooxidation is expected to be slow to rapid for most components of the heavy fuel oils. The components of heavy fuel oils are expected to possess low (P1) to high (P3) persistence and low (B1) to high (B3) bioaccumulation potential.

3. Human Health Hazard

A summary of health effects data submitted for SIDS endpoints is provided in Table 4. The table also indicates where data for tested category members are read-across (RA) to untested members of the category.

Acute Oral Toxicity

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)
(1) In four separate studies, Sprague-Dawley rats (5/sex/dose) were administered CASRN 68553-00-4 (Fuel oil, No. 6, API 78-6, API-78-7, API 78-8 and API 79-2) via gavage at 25 mL/kg (23,750 mg/kg based on density of 950 kg/m^3 [or mg/mL] reported in CONCAWE, 1998) and observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 23,750 mg/kg

(2) Male Wistar rats (5/dose) were administered CASRN 68553-00-4 (Residual Fuel oil, No. 6) via the oral route at 1.0, 1.47, 2.15, 3.16, 4.64, 6.81 and 10 g/kg and were observed for 14 days. Mortality was seen at ≥ 3160 mg/kg as follows: 1/5 each at 3.16 and 4.64 g/kg, 3/5 at 6.81 g/kg and 5/5 at 10 g/kg. Additional details are from TSCATS (OTS0536024).
LD_{50} = 5880 mg/kg

Subcategory II: Atmospheric Residual

Residues (petroleum), atm. tower (CASRN 64741-45-3)
Sprague-Dawley rats (5/sex) were administered CASRN 64741-45-3 (residues (petroleum), atm. tower sample F-132) via gavage at 5000 mg/kg and were observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 5000 mg/kg

Subcategory III: Atmospheric Distillate

No data.

Subcategory IV: Vacuum Residual

Residues (petroleum), vacuum (CASRN 64741-56-6, supporting chemical)
Sprague-Dawley rats (5/sex) were administered CASRN 64741-56-6 (residues (petroleum) vacuum (API sample 81-13)) in corn oil via gavage at 5000 mg/kg. No mortalities were observed. This study summary was reported in the HPV Hazard Characterization for Gas Oils.
LD_{50} > 5000 mg/kg

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CAS No. 64741-57-7)

Sprague-Dawley rats were administered residues (petroleum), heavy vacuum via gavage at 5000 mg/kg-bw and were observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 5000 mg/kg-bw

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CASRN 64741-62-4)
(1) Sprague-Dawley rats (10/sex/dose) were administered CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (API 81-15))) via gavage at 3.2, 4.0, 5.0, 6.25 or 7.81 g/kg and were observed for 14 days after dosing. Mortality was seen at all doses as follows: 1 male and 1 female at 3.2 g/kg, 1 male and 3 females at 4.0 g/kg, 2 males and 2 females at 5.0 g/kg, 3 males and 5 females at 6.25 g/kg and 10 males and 10 females at 7.81 g/kg.
LD_{50} (males) **= 5270 mg/kg**
LD_{50} (females) **= 4320 mg/kg**

(2) Sprague-Dawley rats (10/sex/dose) were administered CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked; Cracked residual Carbon Black Oil; F-73-01)) via gavage at 4.0, 5.1, 6.2 or 8.4 g/kg and were observed for 14 days. Mortality was seen at ≥ 5.1 g/kg as follows: 2 males and 0 female at 4.0 g/kg, 3 males and 3 females at 5.1 g/kg, 9 males and 7 females at 6.2 g/kg, and 10 males and 10 females at 8.4 g/kg. Additional details are from TSCATS (OTS0546268).
LD_{50} (males) **= 5230 mg/kg**
LD_{50} (females) **= 5820 mg/kg**

Subcategory VII: Cracked Distillate

Distillates (petroleum), heavy thermal cracked (CASRN 64741-81-7)
(1) Sprague-Dawley rats (5/sex) were administered CASRN 64741-81-7 (Distillates (petroleum), heavy thermal cracked (Coker heavy gas oil, sample F-97))) via gavage at 5000 mg/kg and were observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 5000 mg/kg

(2) Sprague-Dawley rats (5/sex) were administered four samples of CASRN 64741-81-7 separately (residues (petroleum), heavy vacuum—F-97-01, Visbreaker HGO, Vis gas oil VIBRA, and VB Mittelol) via gavage at 5000 mg/kg and were observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 5000 mg/kg

Subcategory VIII: Reformer Residual

No data.

Acute Inhalation Toxicity

Subcategory I: Residual Fuel Oils

***Fuel oil, residual* (*CASRN 68476-33-5*)**
Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 68476-33-5 (Fuel oil, residual; Heavy Fuel Oil; F-74-01) as an aerosol via whole-body inhalation at 2.1, 3.3 or 4.8 mg/L for 4 hours and were observed for 14 days. Mortality was seen at the highest exposure concentration (9 males and 6 females). Additional details are from TSCATS (OTS0544092).
LC_{50} (males) **= 4.1 mg/L**
LC_{50} (females) **= 4.5 mg/L**

Subcategory IV: Vacuum Residual

Residues (petroleum), vacuum (CASRN 64741-56-6), supporting chemical
Wistar rats (5/sex/dose) were exposed to CASRN 64741-56-6 (Residues (petroleum), vacuum) aerosol via inhalation at 2.3 mg/L (94.4 mg/m^3) for 4.5 hours and were observed for 14 days. No mortalities were observed.
LC_{50} > 2.3 mg/L (converted from 94.4 mg/m^3 based on molecular weight of 600 [Asphalt MSDS]). These data are from the HPV submission for Asphalt.

Acute Dermal Toxicity

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)
New Zealand White rabbits (4/sex) were administered undiluted CASRN 68553-00-4 (Fuel oil, No. 6 (API 78-6)) via the dermal route at 5 mL/kg (4874 mg/kg based on density of 950 mg/mL reported in CONCAWE, 1998) under occluded conditions for 24 hours and were observed for 14 days after dosing. In three other studies using the same protocol, the Fuel oil, No. 6 blends tested included API-78-7, API 78-8 and API 79-2. No mortalities were observed.
LD_{50} > 4874 mg/kg

Subcategory II: Atmospheric Residual

Residues (petroleum), atm. tower (CASRN 64741-45-3)
New Zealand White rabbits (5/sex/dose) were administered undiluted CASRN 64741-45-3 (Residues (petroleum), atm. tower (F-132)) via the dermal route at 2 g/kg under occluded conditions for 24 hours and were observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 2000 mg/kg

Subcategory III: Atmospheric Distillate

Diesel fuel No. 2 (CASRN 68476-34-6, supporting chemical)
In a 4-week study, Sprague-Dawley rats (10/sex/dose) were administered undiluted CASRN 68476-34-6 (Diesel fuel No. 2 (F-75-01) via the dermal route under occluded conditions at 0, 0.5, 2 or 5 mL/kg-day (0, ~500, 2000 or 5000 mg/kg-day) once daily, 5 days/week. No mortalities were observed. This study summary was reported in the HPV Hazard Characterization for Gas Oils.
LD_{50} (estimated) **> 5000 mg/kg**

Subcategory IV: Vacuum Residual

Residues (petroleum), vacuum (CASRN 64741-56-6, supporting chemical)
New Zealand White rabbits (5/sex) were administered undiluted CASRN 64741-56-6 (Residues (petroleum), vacuum) via the dermal route at 2 g/kg under occluded conditions for 24 hours and were observed for 14 days after dosing. No mortalities were observed. This study summary was reported in the HPV Hazard Characterization for Gas Oils.
LD_{50} > 2000 mg/kg

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CASRN 64741-57-7)
New Zealand White rabbits (3/sex) were administered undiluted CASRN 64741-57-7 (Residues (petroleum), heavy vacuum; Vacuum distillate HVGO)) via the dermal route at 2000 mg/kg under occluded conditions for 24 hours and were observed for 14 days after dosing. In three other studies using the same protocol, tested substances included Visbreaker HGO, Vis gas oil VIBRA, and VB Mittelol. No mortalities were observed.
LD_{50} > 2000 mg/kg

Subcategory VI: Cracked Residual

***Clarified oils (petroleum), catalytic cracked* (*CASRN 64741-62-4*)**
New Zealand White rabbits (4/sex) were administered undiluted CASRN 64741-62-4 (Cracked clarified oils (petroleum), catalytic cracked; Cracked residue (API 81-15)) via the dermal route at 2000 mg/kg under occluded conditions for 24 hours and were observed for 14 days after dosing. No mortalities were observed.
LD_{50} > 2000 mg/kg

Subcategory VII: Cracked Distillate

Distillates (petroleum), heavy thermal cracked (CASRN 64741-81-7)
(1) New Zealand White rabbits (5/sex) were administered undiluted CASRN 64741-81-7 (distillates (petroleum), heavy thermal cracked;F-97-01; Coker heavy gas oil) via the dermal route at 2000 mg/kg under occluded conditions for 24 hours and were observed for 13 days after dosing. No mortalities occurred.
LD_{50} > 2000 mg/kg

(2) New Zealand White rabbits (3/sex) were administered undiluted CASRN 64741-81-7 (distillates (petroleum), heavy thermal cracked; Visbreaker Gas Oils) via the dermal route at 2000 mg/kg under occluded conditions for 24 hours and were observed for 13 days after dosing. In three other studies using the same protocol, tested substances included Vis gas oil VIBRA, and VB Mittelol and Heavy Vacuum Gas Oil. No mortalities occurred.
LD_{50} > 2000 mg/kg

Repeated-Dose Toxicity

All repeated-dose toxicity studies were conducted by a dermal route since the sponsor claims it is the primary route of human exposure. The sponsor conducted a study on clarified slurry oil (CASRN 64741-62-4; Subcategory VI)) in male mice to compare dermal and oral routes of exposure. The conclusion is: "Based on mortality, body weights, liver weights, and liver and bone marrow pathology, CSO is more toxic to mice when it is administered subchronically by the dermal route than by the oral route. After 10 weeks of oral administration, mice exhibited only slight morphologic changes in the liver. The observed liver changes were suggestive of the healing of an earlier toxicological insult rather than of on-going toxicity. It would therefore appear that mice exposed orally to CSO developed or manifested, in fewer than 10 weeks, a form of acclimation or adaptation that was profoundly effective in repairing or protecting the liver from the hepatotoxic effects of CSO. Mice exposed dermally to CSO at a dose of 1000 mg/kg/day for 10 weeks had a mortality of 50%, severe skin irritation, slightly decreased body weights, significantly increased liver and reduced thymus weights, reduced megakaryocytes in sterna bone marrow, and severe liver necrosis and fibrosis. Based on a previous study in rats it appears that mice are less sensitive to the skin effects of CSO than rats".

Subcategory I: Residual Fuel Oils

Fuel oil, residual (CASRN 68476-33-5)

(1) In a 28-day study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 68476-33-5 (F-92-01) via the dermal route at 0 (sham-exposed), 0.5, 1.0 or 2.0 mL/kg-day (0, 480, 960 or 1920 mg/kg-day 6 hour/day,5 days/week on to the previously clipped backs of the animals. The application sites were occluded during the exposure period; the skin was then wiped to remove residual test substance. Clinical signs and dermal irritation observations, hematology and clinical chemistry evaluations, organ weights (liver, kidneys, testes, ovaries, spleen, brain and adrenals), necropsy observations and histopathological examination (control and high-dose groups) were performed.

There were no mortalities and treatment-related clinical signs. A significant decrease ($p<0.05$) in body weight gains was seen in males at 1920 mg/kg-day and at 960 mg/kg-day (not significant). No dermal irritation was seen. Liver weights (absolute and relative to body and brain weights) were significantly increased ($p<0.05$) at all doses in both sexes (except for the males at 960 mg/kg-day for absolute liver weights). The absolute and relative spleen weights were significantly increased at all doses. Hematological parameters showed changes suggestive of

anemia (significantly lower ($p<0.05$) erythrocytes count and hematocrit and hemoglobin levels) at all doses. Absolute kidney weights were significantly lower ($p<0.05$) than controls in males at1920 mg/kg-day; however, they were within the normal ranges. No treatment-related changes were seen during histopathology examination. Testes and ovaries were normal. Dermal lesions (acanthosis and hyperkeratosis—trace or mild severity) were noted at the application sites in two rats animals at 1920 mg/kg-day. Additional details are from TSCATS (OTS0534754).
LOAEL = 480 mg/kg-day (based on increased liver and spleen weights and decreased erythrocytes, hemoglobin and hematocrit values)
NOAEL = Not established

(2) In a 28-day study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 68476-33-5 (F-92-01) via the dermal route at 0 (sham-exposed), 0.5, 1.0 or 2.5 mL/kg-day (0, 496, 992 or 2480 mg/kg-day, respectively, 6 hours/day,5 days/week on to the shorn dorsal skin of the animals. The application sites were occluded during the exposure period; the skin was then wiped to remove the residual test substance. Clinical signs and dermal irritation observations, hematology and clinical chemistry evaluations, body weights, organ weights (liver, kidneys, testes, ovaries, brain and spleen), necropsy observations and histopathological examination (control and high-dose groups) were performed.

No mortality or treatment-related clinical signs were noted. A minimal, reversible dermal irritation was seen at all doses. Several statistically significant parameters for hematology (lower eosinophil count in mid- and high-dose males, lower hemoglobin concentration in high-dose males) and clinical chemistry (lower SGOT levels in low- and high-dose females and high-dose males, higher glucose levels in mid- and high-dose females and high-dose males and lower total protein levels in low dose males) were within normal limits and did not exhibit any clear dose-related trends. Relative liver weights were higher for females in all dose groups and for males in the high-dose group. Liver/body weight and liver/brain weight ratios were higher at all doses. Higher spleen/body weight ratios (in low and mid-dose females and high-dose males) and higher spleen/brain weight (in low-dose females and high-dose males) ratios were not considered to be treatment-related by the study director. Treatment-related histopathology results were eosinophil casts in the kidneys of control and high-dose rats (considered to be spontaneous in the Sprague-Dawley rats by the study director), hepatic inflammation in a high-dose male and hyperkeratosis at the application site in the high-dose rats (minimal severity).
LOAEL = 496 mg/kg-day (based on effects on liver weight, spleen weight and liver/body weight ratio and liver/brain weight ratio)
NOAEL = Not established

Subcategory II: Atmospheric Residual

Residues (petroleum), atm. tower (CASRN 64741-45-3)
In a 4-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-45-3 (residues (petroleum), atm. tower; Atmospheric Tower Bottoms (F-132)) via the dermal route at 0, 0.01, 0.25 or 1.0 mL/kg-day (0, 9.4, 235 or 940 mg/kg-day, respectively) 6 hours/day, 5 days/week, on to the previously clipped backs of the animals, under occluded conditions. Mortality, clinical signs, dermal irritation, body weights were recorded. Hematology and clinical chemistry parameters were evaluated. Necropsy observations, organ weights and histopathology

(control and high dose animals) examination were conducted. There were no treatment-related effects on body weights, organ weights, organ/body weight ratios, hematological changes, clinical chemistry or clinical observations or histopathology. Testes and ovaries were normal. Skin irritation was none to very minimal at all doses.
NOAEL = 940 mg/kg-day (highest dose tested)

Subcategory III: Atmospheric Distillate

Gas oils (petroleum), heavy atmospheric (CASRN 68915-97-9)
The study is conducted on *heavy atmospheric gas oil*, CASRN 68915-97-9, which is compositionally similar to heavy fuel CASRN 68783-08-4, and also included in the Gas oils category.

In a 13-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CARN 68915-97-9 (heavy atmospheric gas oil) via the dermal route at 0, 30, 125 or 500 mg/kg-day once daily, 5 days/week. The application sites were not occluded during the exposure period; the animals were fitted with Elizabethan collars to prevent oral ingestion of the test substance. At the end of each week, any residual test substance was removed by wiping the skin. Mortality, clinical signs, dermal irritation, body weights were recorded. Hematology, clinical chemistry and urinalysis parameters were evaluated. At necropsy, organ weights were recorded and histopathology examination was conducted.

Two animals became moribund and were sacrificed. One of the animals was a male from the 500 mg/kg-day group and the effects were considered to be treatment related. The other was a male at 30 mg/kg-day and it death was considered incidental. Except for a slight skin irritation (due to Elizabethan collars) there were no other treatment-related clinical signs. Body weight gains were significantly (10%, significance not indicated) decreased in the males of the high-dose group. Serum chemistry values were different from controls in the at 125 and 500 mg/kg-day (increased BUN (27-35%), cholesterol (39-117%), sorbitol dehydrogenase (68-106%)) and at 500 mg/kg-day (increased total protein (11%) and globulin (27%) and decreased A/G ratio (20%)). Hematological parameters indicated differences from controls in males at 125 and 500 mg/kg-day males and in females at 500 mg/kg-day (decreased RBC count 8-30%), hemoglobin (9-31%) and hematocrit (8-30%) and platelets (23-48%). At necropsy, treatment-related effects included increased liver size, decreased thymus size, thickening of the limiting ridge between the non-glandular and glandular sections of the stomach and enlarged and reddened lymph nodes. There were some relative organ weight differences at ≥ 125 mg/kg-day (adrenals, heart, kidney, liver, spleen and thymus). Treatment-related effects observed at histopathological examination in the 500 mg/kg-day dose group included severe reduction in hematopoiesis in the bone marrow, liver hypertrophy and connective tissue formation. There were also increased areas of hematopoiesis, focal necrosis and cell death in the liver and a reduction in the numbers of lymphocytes in the thymus glands. There were no treatment-related effects on the epididymal sperm or testicular spermatid parameters (weight of cauda epididymis, number of sperms/gram of cauda, testes weight, number of spermatid/gram of testis, and number of sperm/testis.
LOAEL = 125 mg/kg-day (based effects on serum chemistry and hematological parameters, organ weight)
NOAEL = 30 mg/kg-day

Subcategory IV: Vacuum Residual

Residues (petroleum), vacuum (CASRN 64741-56-6, supporting chemical)
In a 4-week study, New Zealand White rabbits (5/sex/dose) were administered residues (petroleum), vacuum (API sample 81-13) via the dermal route at 0, 200, 1000 or 2000 mg/kg-day to clipped dorsal skin under occluded conditions for 6 hours/day, 3 days/week, for total of 12 applications. The application sites were occluded. The residual test substance was then wiped off the skin. All animals were observed for signs of toxicity and dermal irritation; body weights and food consumption were recorded; clinical chemistry and hematology parameters were evaluated and at necropsy, organ weights were taken. Histopathology examination was conducted on tissues and organs from the control and high-dose groups.

Two animals died and two were sacrificed moribund during the study – the identity of the dose groups for these mortalities were not reported in the robust summary; however the full report is available in TSCATS (OTS 0000186-1) and shows that one control female and one high dose male were found dead, and one control male and a mid-dose female were sacrificed in moribund condition during the study. This supports the conclusion that these deaths were not likely treatment-related. Treatment-related clinical signs observed in survivors included thin appearance, decreased food intake, flaking skin and wheezing (doses not stated). All animals treated with residues (petroleum), vacuum exhibited slight edema. Decreased body weight gain was observed in males at 2000 mg/kg-day. There were no treatment-related changes in the hematology parameters. Alkaline phosphatase was reduced by 50% in males at 2000 mg/kg-day. Changes in absolute and/or relative organ weights were observed at 2000 mg/kg-day (adrenals, kidney, pituitary and spleen), but were not considered to be treatment-related. Treatment-related gross necropsy and microscopic findings were confined to the skin. The skin of females appeared to be more severely affected. Effects in females were limited to the point of contact with the test substance. Incidental findings were observed and were consistent with *Encephalitozoon* infection. Additional details are from the HPV test submission for asphalt category and TSCATS OTS0000186-1.
LOAEL (systemic) = 2000 mg/kg-day (based on decreased body weight gain and reduced alkaline phosphatase in males)
NOAEL (systemic) = 1000 mg/kg-day

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum *(CASRN 64741-57-7)*
(1)

Sample CRU No.	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
85244	0.00	0.06	2.48	1.86	1.24	0.50	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-57-7 (Heavy Vacuum Gas Oil (CRU No. 85244)) daily via the dermal route at 0, 30, 125, 500 or 2000 mg/kg-day, 6hr/day, 5 days/week, on to previously clipped sites on the trunk of the animals. The application sites were not occluded; the animals were fitted with Elizabethan collars to minimize ingestion of the test substance. At 24 hours after the 5th dose, the residual test substance was wiped off. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical

chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose groups. Sperm head morphology was evaluated in the control and at 2000 mg/kg-day.

Two males and one female at 2000 mg/kg-day died during the study. The male deaths were considered to be treatment-related but the female death was incidental. Body-weight gains in both sexes were reduced at 2000 mg/kg-day (males weighed 20% less and females weighed 15% less than controls). Erythrocytes and platelets were reduced in males and females at 2000 mg/kg-day and in females at 500 mg/kg-day during weeks 5 and 13. At 125 mg/kg-day, erythrocytes count, hemoglobin, hematocrit and platelets were decreased in both sexes. Clinical chemistry changes included increased sorbitol dehydrogenase (two fold increase), increased cholesterol (two fold) and decreased uric acid (50%) in males and females at 2000 mg/kg-day and decreased glucose in females and increased cholesterol in males at 500 mg/kg-day. At gross necropsy, relative thymus weights and relative liver weights were reduced in both sexes at ≥ 500 mg/kg-day. Histopathological examination revealed decreased erythropoeisis and fibrosis of the bone marrow in males at 2000 mg/kg-day and a marked reduction in thymic lymphocytes in males and moderate decrease in females at 2000 mg/kg-day and slightly in both sexes at 500 mg/kg-bw/day. No effects were seen on sperm morphology.
LOAEL = 125 mg/kg-day (based on decreased hematological parameters)
NOAEL = 30 mg/kg-day

(2) In a 28-day study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-57-7 (heavy paraffinic vacuum distillate, F-128) via the dermal route at 0, 0.1, 1.0 or 2.5 mL/kg-day (0, 94, 940 or 2350 mg/kg-day) 6 hours/day, 5 days/week on to the previously clipped sites on the back of animals. The application sites were occluded and after the exposure period, the residual test substance was wiped off.. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose groups.

No mortality or treatment-related clinical signs were observed. There were no significant differences in body weights between control and treatment groups. Very slight and sporadic dermal irritation (slight erythema, slight eschar and slightly dried skin) was seen at all doses. The severity was not dose dependent. A significantly lower ($p<0.01$) and dose dependent decrease ($p<0.05$) in mean hematocrit and hemoglobin values were seen in females at 2350 mg/kg-day. A significant increase ($p<0.01$) in cholesterol values was seen females of the high-dose. Treatment-related increase in mean absolute and/or relative (to body weight and brain weight) liver weight were noted in males and females at 940 and 2350 mg/kg-day. At necropsy, multiple red foci in thymus and yellow discoloration of kidney were seen in females at 2350 mg/kg-day. No treatment-related changes were observed during the histopathlogical examination. No effects were seen on testes and ovaries. Additional details are also from TSCATS (OTS0555147).
$LOAEL_{females}$ = 940 mg/kg-day (based on effects on hematocrit, hemoglobin, cholesterol values and increased absolute and relative liver weights)
$NOAEL_{females}$ = 94 mg/kg-day
$NOAEL_{males}$ = 2350 mg/kg-day (highest dose tested)

(3) In a 28-day study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-57-7 (heavy vacuum gas oil stock, F-113-01) via the dermal route at 0, 0.01, 0.1 or 1.0 mL/kg-day (0, 9.3, 93 or 930 mg/kg-day, respectively) 6 hours/day, 5 days/week on to previously clipped sites. The application sites were occluded during the exposure period. The skin was then wiped off to remove residual test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose groups.

No mortality or treatment-related clinical signs were observed. Slight skin irritation was observed in females at 930 mg/kg-day. Body weight and body weight gain were decreased in females at 930 mg/kg-day. Increased liver weight (relative to body weight (10-16%) and brain weight (8%)) and decreased absolute and relative kidney weights (14 and 10%, respectively) in females at 930 mg/kg-day were not considered treatment related or biologically relevant by the study director. Treatment-related decreases in hematocrit (8-10%) and hemoglobin (5-6%) were seen at 930 mg/kg-day in both sexes. A significant increase in cholesterol values (47%) was seen in females at 930 mg/kg-day. No treatment-related changes were observed during the histopathlogical examination. No effects were seen on testes and ovaries.
LOAEL = 930 mg/kg-day (based on effects on hematocrit, hemoglobin in both sexes and cholesterol values and increased liver weights in females)
NOAEL = 93 mg/kg-day

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CASRN 64741-62-4)
(1)

Sample CRU No.	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
86484	0.0	0.98	9.76	19.52	9.76	4.88	0.98
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-62-4 (clarified oils (petroleum), catalytic cracked; Clarified Slurry Oil, (CSO)) via the dermal route at 0, 8, 30, 125 or 500 mg/kg-day daily, 5 days/week under non-occluded conditions. There were two groups of untreated control animals. Animals were fitted with Elizabethan collars to minimize ingestion of he test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and 125 and 500 mg/kg-day dose groups.

All rats in the highest dose group and males treated at 125 mg/kg-day, died or were sacrificed in a moribund condition prior to necropsy. In addition, 8 females treated at 125 mg/kg-day and 2 males at 30 mg/kg-day died or were sacrificed prior to scheduled necropsy. Body weight gains were reduced at ≥ 30 mg/kg-day. Erythema (slight) and thickened, leathery skin were observed in four rats at 500 mg/kg-day. Hematological parameters were changed in comparison to the controls at dose levels ≥ 30 mg/kg-day (decreased hematocrit, hemoglobin, RBC count, and platelets). Serum chemistry was also changed at dose levels ≥ 30 mg/kg-day (increased BUN,

decreased uric acid, increased alkaline phosphatase, decreased LDH). Increased frequency of elevated glucose levels were seen urine of rats at ≥ 30 mg/kg-day. Liver weights were increased at all dose levels. There was a dose-related decrease in thymus weights. At necropsy, epidermal hyperplasia and trace to slight chronic inflammation in the superficial dermis. In the liver, microsystes, cholangiolitis/cell degeneration/disarray and altered focus of hepatocytes was observed at doses ≥ 8 mg/kg-day. Necrosis and fibrosis were also observed in liver at doses ≥ 30 mg/kg-day. Hepatocellular degeneration, hypertrophy of hepatocytes, multinucleated large hepatocytes and vacuolation were observed at doses ≥ 125 mg/kg-day. Erythroid hypoplasia of the bone marrow was observed at doses ≥ 125 mg/kg-day with slight changes found at 30 mg/kg-day. Hypoplasia and atrophy of thymus was seen at ≥ 8 mg/kg-day.
LOAEL = 8 mg/kg-day (based on effects on liver and thymus)
NOAEL = Not established

(2)

Sample CRU No.	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
86001	0.0	2.57	25.68	19.26	6.42	3.21	0.64
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-62-4 (clarified oils (petroleum), catalytic cracked; Clarified Slurry Oil, (CSO)) via the dermal route at 0, 8, 30, 125, 500 or 2000 mg/kg-bw/day daily, 5 days/week on to previously clipped sites on the back of animals. The application sites were not occluded; the animals were fitted with Elizabethan collars to minimize ingestion of the test substance. At 24 hour after the fifth dose of the week, the residual test substance was wiped off. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on selected tissues and gross lesions.

All rats at 2000 and 85% rats at 500 mg/kg-day died or sacrificed in moribund condition. At 125 mg/kg-day, 5/10 males and 1/10 females died or sacrificed in moribund condition prior to scheduled necropsy. Body weight gains were reduced at ≥ 30 mg/kg-day. Skin irritation was not seen at 8, 30 or 125 mg/kg-day. Hematological parameters were decreased compared control values in both sexes at 125 mg/kg-day (decreased hematocrit, hemoglobin, and RBC count). Hematocrit values were also decreased at 30 mg/kg/day in both sexes. Several clinical chemistry values were changed compared to controls. At 125 mg/kg-day, males showed increased glucose (26%), A/G ratio (14%), total bilirubin (146%), aspartate aminotrasferase (200%), alkaline phosphatase (72%), and calcium (7%) values. Males at 30 mg/kg/day showed decreased uric acid (33%) and LDH (52%) values. In females, at 125 mg/kg-day, increased A/G ratio (18%), and decreased LDH (79%) values were seen. Females at 30 mg/mg-day showed increased alkaline phosphatase (58%) values and those at 8 mg/kg-day showed increased cholesterol (43%) values. Absolute liver weights were increased (21%)in females at 8 mg/kg-day and relative liver weight were increased in both sexes (13 and 23%, respectively for males and females. In males, absolute (43%) and relative (39%) thymus weights at 30 mg/kg-day and relative spleen weight (25%) were increased at 30 mg/kg-day. In females at 125 mg/kg-day, absolute (67%) and relative (38%) thymus weights were decreased. Histopathology showed microcysts, cholangiolitis/cell degeneration and altered focus of hepatocytes at ≥8 mg/kg-day. Necrosis was

observed at ≥ 30 mg/kg-day. Erythroid hypoplasia of bone marrow was observed at ≥ 30 mg/kg-day. Hypoplasia and atrophy of thymus was seen at ≥ 8 mg/kg-day. No treatment-related effects were seen on testes and ovaries.
LOAEL = 8 mg/kg-day (based on effects on liver and thymus)
NOAEL = Not established

(3) In a 13-week study, Fisher 344 rats (10/sex/dose) were exposed to CASRN 64741-62-4 (clarified oils (petroleum), catalytic cracked (API 81-15)) via the dermal route at 0 (sham-exposed), 40, 200 or 400 mg/kg-day, 6 hours/day, 5 days/week for a total of 65 applications. The application sites were not occluded; the rats were fitted with Elizabethan collars to prevent ingestion of the test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and low- and mid-dose animals.

All rats at 400 mg/kg-day died or were killed in a moribund condition. Seven rats in the 200 mg/kg-day group died or were killed in a moribund condition. One male died at 40 mg/kg-day; however, the death was not considered treatment related. Clinical signs observed in the 200 and 400 mg/kg-day groups included thinness, hunched posture, lethargy and prostration. No erythema or edema was observed. Dose-related and statistically significant ($p<0.05$) decreases were observed in body weights throughout the study duration. Statistically significant ($p<0.05$) hematological changes (decreased RBC, hemoglobin and hematocrit) occurred in both sexes at 40 and 200 mg/kg-day. Serum chemistry evaluation showed statistically significant changes in both sexes (increases in BUN, SGOT, SGPT, and ALP values and decreases in total protein values) at 200 mg/kg-day and at increased alkaline phosphatase values in both sexes at 40 mg/kg-day. A statistically significant increase in absolute and relative liver weights were seen in males and females at 40 mg/kg-day and in females at 200 mg/kg-day. At necropsy, gross findings in males of the 200 mg/kg-day group included small thymus, reddened and/or enlarged lymph nodes, discoloration of the liver and congested and/or dark testes. Histological changes in rats from the 200 mg/kg-day group included minimal to severe multifocal centrilobular degeneration of hepatic lobules, vacuolation, pigmentation and/or accumulations of neutrophils and absent thymic tissue (severe atrophy). In many of the female rats at 200 mg/kg-day, the hepatic changes were accompanied by secondary treatment-related changes in the kidneys (, adrenals, ovaries and uterus. Similarly, in male rats at this dose level, secondary changes were present in the kidneys and adrenals. Skin lesions characterized by hyperplasia and/or hyperkeratosis were observed in all of the dose groups. Additional details are from TSCATS (OTS0539134).
LOAEL = 40 mg/kg-day (based on changes in hematology, clinical chemistry parameters, decreased body weight and organ weights)
NOAEL = Not established

(4)

Sample 091645 (F-179)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.70	10.00	30.00	20.00	6.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, Sprague-Dawley rats (20/sex/dose) were exposed to CASRN 64741-62-4 (Catalytic-Cracked Slurry Oil, F-179) via the dermal route at 0, 0.001, 0.01, 0.05, 0.1 or 0.5 mL/kg-day (0, 1.06, 10.6, 53, 106, and 530 mg/kg-day, respectively) daily, 6 hours/day, 5 days/week under occluded conditions. The skin was then wiped to remove residual material. Mortality, clinical signs, skin irritation, body weights and food consumption were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

Mortality occurred at 530 mg/kg-day; in males (35%) and females (10%). At 530 mg/kg-day, a decrease (12%) in terminal body weights was seen in males. At ≥53 mg/kg-day, hematology parameters showed decreases in RBC count (9-30%), hematocrit (9-36%), hemoglobin (7-28%) and at ≥10.6 mg/kg-day, in platelets (20-43%). The affected serum chemistry parameters at ≥ 53included increased BUN (31-85%), creatinine (8-14%), SGOT (9-111%), cholesterol (61-87%), and alkaline phosphatase ((93% in females only at 530 mg/kg-day). Absolute liver weights were significantly increased in males and females at ≥53 mg/kg-day (19-45%) and relative liver weights (to body weight) were increased (11-37%) at all doses in both sexes except at 1.06 mg/kg-day. Kidney, spleen, thymus, lungs and heart weights were also affected by treatment. The decreases (43-56%) in absolute and relative thymus weights at 530 mg/kg-day and increases (12-23%) in absolute and relative lungs weights at 53, 106 and 530 mg/kg-day were treatment-related. Histopathological examination revealed the following changes: increased incidence of bone marrow cellular depletion at ≥ 106 mg/kg-day in both sexes; liver congestion/necrosis/vacuolar changes at ≥ 53 mg/kg-day in both sexes; thymus atrophy in males at ≥ 10.6 mg/kg-day and at ≥106 mg/kg-day in females and thyroid chronic inflammation (lymphocytic thyroiditis) at≥ 53 mg/kg-day in both sexes.
LOAEL = 10.6 mg/kg-day (based on increased absolute and relative liver weight, lungs weight, decreased platelets, thymic atrophy)
NOAEL = 1.06 mg/kg-day

(5) In a 28-day study, albino Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-62-4 (clarified oils (petroleum), catalytic cracked (Carbon Black Oil (CBO) F-115-01), FCCU Clarified Oil) via the dermal route at 0 (untreated), 1, 10 or 50 mg/kg-day (neat) and 0 (acetone), 0.1, 1.0, 10 or 50 mg/kg-day as a 10% solution in acetone 6 hours/day, 5 days/week on to previously clipped sites under occluded conditions. Following a 6-hour exposure period, the test sites were wiped to remove residual test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

A statistically significant decrease in RBC counts (males), hematocrit and hemoglobin values (both sexes) were seen at 50 mg/kg-day groups and in males receiving 10 mg/kg-day CBO in acetone. Clinical chemistry parameters showed significantly higher BUN in both sexes at 50

mg/kg-day, higher cholesterol and glucose levels than controls. Higher cholesterol values were seen in females at 10 mg/kg-day. Absolute and relative liver weights were elevated over controls in the high-dose acetone group and in the neat 10 mg/kg-day groups. Absolute and relative thymus weights and absolute kidney weights were lower than controls among high-dose rats. Except for changes in skin (acanthosis and hyperkeratosis) in both sexes at 50 mg/kg-day, there were no other treatment-related histopathological findings. Additional details are from TSCATS (OTS0546268).
LOAEL = 10 mg/kg-day (based on increased liver weights and changes in hematology and clinical chemistry)
NOAEL = 1 mg/kg-day

(6) In a 28-day study, Sprague-Dawley rats (10/se/dose) received CASRN 64741-62-4 (clarified oils (petroleum), catalytic cracked (carbon Black Oil, F-73-01) via the dermal route at 0, 0.5, 1.0, or 2.5 mL/kg-day (0, 542, 1084 or 2710 mg/kg-day, 6 hours/day, 5 days/week onto previously clipped backs of the animals. The application sites were occluded during the exposure period. The application sites were then wiped to remove residual test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

Body weights were decreased statistically ($p<0.05$) at all doses for males and in the high-dose group for females. Body weight gain was also affected in all animals; to the lesser extent in females. Absolute and relative liver weights were higher than controls at all doses and kidney and ovary weights were significantly ($p<0.05$) lower in the mid- and high-dose groups. Changes in hematological (decreased eosinophils, hemoglobin and hematocrit in both sexes at all doses) and biochemical (decreased SGPT in males, increased alkaline phosphatase in females, increased glucose in both sexes and decreased total protein in females) parameters were observed. All these changes were not considered to be treatment-related and/or biologically relevant by the study director. Histopathology revealed no treatment-related effects except acanthosis and hyperkeratosis in high-dose animals. Additional details are from TSCATS (OTS0534753).
LOAEL = 542 mg/kg-day (based on decreased body weights body weight gains, and increased liver weights, effect on hematology parameters)
NOAEL = Not established

(7) In a 28-day study, New Zealand White rabbits (5/sex/dose) were exposed to CASRN 64741-62-4 (clarified oils (petroleum), catalytic cracked (API 81-15)) via the dermal route at 0, 200, 1000 or 2000 mg/kg-day, 6 hours/day, 3 times/week on to previously clipped backs of the animals for a total of 12 applications under occluded conditions. At the end of the exposure period, the application sites were wiped off to remove residual test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

Treatment-related deaths occurred in mid-dose (1 male) and high-dose rabbits (two males and one female) during the exposure period. Clinical signs in surviving rabbits included cracked or flaking skin, thin appearance, necrotic tissue around the dosing area, decreased food intake,

moderate to severe erythema outside of the dosed area, edema and skin ulceration at the test site. Statistically significant ($p<0.05$) decreases in were observed among males from all doses and high-dose females. Overall body weight gains were lower in males of the mid- and high-dose groups and high-dose females. No treatment-related trends were seen in hematology parameter. Statistically significant ($p<0.05$) serum chemistry changes (increase in SGOT activity in high-dose males and females, decreased total protein in mid-and high-dose females and mid-dose males) were observed. Absolute and relative liver weights were increased significantly ($p<0.05$) over controls in females of all dose groups and males of the mid- and high-dose groups. Gross examination revealed thickened skin among all treatment groups. Microscopic changes in high-dose animals included skin (sub-acute acanthotic dermatitis, minimal to severe early multifocal papillomatosis (skin surface elevation caused by hyperplasia and enlargement of contiguous dermal papillae) in high-dose males and females), hepatic (slight to moderate diffuse mid-zonal hepatocellular hypertrophy, minimal to severe necrosis), thymus (involution of the thymus) and mesenteric lymph nodes (slight to moderate lymphoid depletion). Additional details are from TSCATS (OTS0000901H7).
LOAEL = 200 mg/kg-bw/day (based on decreased body weights, increased liver weights and microscopic changes in skin)
NOAEL = Not established

Residues (petroleum), hydrocracked (CASRN 64741-75-9)
In a 28-day study, Sprague-Dawley rats (10/se/dose) received CASRN 64741-75-9 (Hydrocracker Recycle Oil (F-127)) via the dermal route at 0, 0.01, 0.05, or 0.25 mL/kg-day (0, 8.4, 42 or 210 mg/kg-day, respectively) 6 hours/day, 5 days/week on previously clipped sites on the backs of the animals under occluded conditions. The skin was wiped to remove residual test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals. There was no mortality. Very slight to moderate skin irritation was observed. There were no effects on body weights, organ weights, hematology or conical chemistry parameters. There were no treatment-related changes observed during the histopathological examination.
NOAEL = 210 mg/kg-day (highest dose tested)

Residues (petroleum), thermal cracked (CASRN 64741-80-6)
In a 13-week study, male and female Sprague-Dawley rats (number/dose not stated) were exposed to 67% mix of CASRN 64741-80-6 (67% mix of Visbreaker residue in Stock 141) via the dermal route at 0 (sham exposed), 0 (vehicle, Stock 141) 60, 250 or 1000 mg/kg-day daily, 5 days/week onto previously clipped sites on the backs of the animals. The animals were fitted with Elizabethan collars to minimize ingestion of the test substance. At 24 hours after the fifth dose, residual test substance was wiped off as thoroughly as possible. Mortality, clinical signs, skin irritation, body weights and food consumption were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals. Sperm morphology and count were also performed.

There were no treatment-related clinical signs or skin irritation. Decreased body weight gain (17%) was seen in males at 1000 mg/kg-day. Decreased RBC count (8%), hemoglobin (11%)

and hematocrit (9%) were noted in males at 1000 mg/kg-day. Decreased BUN, total protein and albumin and increased sorbitol dehydrogenase in males and increased BUN, sorbitol dehydrogenase and cholesterol values in females were seen at 1000 mg/kg-day. At 250 mg/kg-day, increased sorbitol dehydrogenase in females and decreased alanine amino transferase in males were seen. At 60 mg/kg-day, a decrease in ALT activity (12%) was seen in males. Absolute and relative liver weights were increased in both sexes at 1000 mg/kg-day; at 250 mg/kg-day, increased absolute liver weight in males and a slight increase in relative liver weights in females were noted. At 60 mg/kg-day, increase (2-12%) in absolute liver weights in both sexes were noted. In males, relative spleen weight, absolute and relative adrenals weights and relative kidney weights were increased at 1000 mg/kg-day. Absolute adrenals weights were also increased in males at 250 and 60 mg/kg-day (26%). No treatment-related effects were seen during the histopathological examination or sperm evaluation.
LOAEL = 60 mg/kg-day (based on effects on ALT, absolute and relative liver weight and absolute adrenals weights)
NOAEL = not established

Subcategory VII: Cracked Distillate

Distillates (petroleum), heavy thermal cracked (CASRN 64741-81-7)
(1)

Sample 86181	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.25	2.48	12.40	7.44	2.48	0.500	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, male and female Sprague-Dawley rats (number/dose not indicated) were exposed to CASRN 64741-81-7 (Distillates (petroleum), heavy thermal cracked, (Joliet Heavy Coker Gas Oil, CRU 86181)) via the dermal route at 0 (sham-exposed), 8, 30 or 125 mg/kg-day, 5 days/week. The test substance was applied to previously clipped sites on the backs of the animals. The application sites were not occluded; the rats were fitted with Elizabethan collars to prevent ingestion of the test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals. Sperm morphology and sperm count were evaluated.

No mortality was reported. Skin irritation was moderate in all treated groups. Body weight gain was decreased in males at 125 mg/kg-day (17%). Absolute and relative liver weights were increased (24-36%) in both sexes at 125 mg/kg-day and relative liver weights were increased (9-16%) in both sexes at 30 mg/kg-day. Absolute thymus weights were decreased (52-56%) in males and females at 125 mg/kg-day. Relative heart weights were increased (14%) in males at 125 mg/kg-day. Absolute weights for epididymis were decreased (13%) in males at 30 mg/kg-day. Hematology changes included decreased RBC count (12%), hemoglobin (15-16%), and platelets (30-31%) in both sexes at 125 mg/kg-day. Hematocrit and MCH were decreased (13 and 4%, respectively) in females at 125 mg/kg-day and in males (5 and 4%, respectively) at 30 mg/kg-day; MCV was decreased in males (4%) and MCHC was decreased in females at 125 mg/kg-day. Clinical chemistry changes included increased BUN in the mid-dose males, sorbitol dehydrogenase glucose, creatinine, cholesterol, triglycerides in females at 125 mg/kg-day; decreased calcium at 30 mg/kg-day in males and potassium in females at 125 mg/kg-day.

Histopathology examination revealed decreased lymphoid tissue in thymus of males and females at 125 mg/kg-day.
LOAEL = 30 mg/kg-day (based on decreased epididymes weights, decreased hematocrit, MCH, calcium and increased BUN values.)
NOAEL = 8 mg/kg-day

(2)

Sample 83366	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	2.50	5.10	2.50	1.30	0.90	0.10
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-81-7 (Distillates (petroleum), heavy thermal cracked, (Paulsboro Heavy Coker Gas Oil, CRU 83366) via the dermal route at 0 (sham-exposed), 30, 125, 500 or 2000 mg/kg-day, 5 days/week. The test substance was applied to previously clipped sites on the backs of the animals. The application sites were not occluded; the rats were fitted with Elizabethan collars to prevent ingestion of the test substance. At 24 hours after the fifth dose each week, the residual test substance was wiped off. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose (125 mg/kg-day) animals. Sperm count and morphology was evaluated.

All animals from 500 and 2000 mg/kg-day groups were terminated early. One male and one female died at 125 mg/kg-day. Skin irritation was moderate in all treatment groups. Body weights were decreased in males and females at 30 mg/kg-day and at in males at 125 mg/kg-day. Decreases in RBC count (9-13%), hemoglobin (10-11%), and hematocrit (10-12%) were seen in males and females at 125 mg/kg-day and platelets were decreased in females (25%) at 125 mg/kg-day. Sorbitol dehydrogenase activity was decreased (38%) in males and BUN was increased (44%) in females at 125 mg/kg-day. Absolute and relative thymus weights were decreased (42-48%) and liver weights were increased (24-50%) in males and females and relative spleen weights were increased (36%) in males at 125 mg/kg-day. Relative testes weights were increased at 30 (6%) and 125 mg/kg-day (16%). Histopathology examination revealed lymphoid reduction in thymus in both sexes at 125 mg/kg-day; fibrous foci in spleens of males and focal fibrosis in bone marrow in one male and in 2 females at 125 mg/kg-day. Sperm morphology was unremarkable.
LOAEL = 30 mg/kg-day (based on decreased body weights in both sexes and increased relative testes weights in males)
NOAEL = not established

(3)

Sample 86272	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.32	4.86	8.10	1.62	0.32	0.16	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-81-7 (Distillates (petroleum), heavy thermal cracked, (Heavy Coker Gas Oil, Sample 86272) via the dermal route at 0 (sham-exposed), 8, 30, or 125 mg/kg-day, 5 days/week. The test substance was applied to previously clipped sites on the backs of the animals. The application sites were not occluded; the rats were fitted with Elizabethan collars to prevent ingestion of the test substance. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals. Sperm count and morphology was evaluated.

Limited signs of intoxication were seen in several animals (dose not indicated). Moderate to severe skin irritation was seen. Body weights were decreased ((20%) in males at 125 mg/kg-day. Decreases in RBC count (13%), hemoglobin (11%), hematocrit (10%) and platelets (32%) were seen in males and hemoglobin ((8%), platelets ((18%) and lymphocytes (13%) were in females at 125 mg/kg-day. WBC count (31%) and a number of segmented neutrophils (94%) were increased in females at 125 mg/kg-day. Increased BUN (43-57%) in both sexes and sorbitol dehydrogenase (60%) in females and decreased potassium (13%) were seen in females at 125 mg/kg-day. Absolute and relative liver weights in females (18 and 26%) and relative liver weights in males (24%) were increased at 125 mg/kg-day. Absolute and relative thymus weights in females (36 and 32% respectively) and absolute thymus weights in males (35%) were decreased at 125 mg/kg-day. Histopathology examination revealed reduction in thymocytes in thymus and increased granulocytes in bone marrow at 125 mg/kg-day. Sperm morphology was unremarkable.
LOAEL = 125 mg/kg-day (based on decreased body weights, effect on hematology and clinical chemistry parameters, organ weights and histopathology findings in thymus and bone marrow)
NOAEL = 30 mg/kg-day

(4)

Sample 86193	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.84	2.94	0.38	0.00	0.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a 13-week study, male and female Sprague-Dawley rats (number/dose not indicated) were exposed to CASRN 64741-81-7 (Distillates (petroleum), heavy thermal cracked, (Visbreaker Gas Oil, CRU 86193 (V.B. Mittelol) via the dermal route at 0 (sham-exposed), 8, 30, or 125 mg/kg-day, 5 days/week. The test substance was applied to previously clipped sites on the backs of the animals. The application sites were not occluded; however, the rats were fitted with Elizabethan collars to minimize ingestion of the test substance. AT 24 hours after the fifth dose each week, residual test substance was wiped off. Mortality, clinical signs, skin irritation and body weights were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathology examinations were conducted on tissues from the control and high-dose animals. Sperm morphology and count were evaluated.

There was no mortality. No other treatment-related clinical signs were seen except for skin irritation (erythema , edema and chronic deterioration of the skin) at all doses. There were no effects on body weights, hematology, clinical chemistry, urinalysis. There was a reduction in uterus weight at 30 mg/kg-day—this was not observed in any other group. Histopathology findings pertained to skin (thickening of epidermis with parakeratosis, chronic inflammation, ulcers and increased mitosis in the epidermal basal cells). The skin changes were more severe in females. Lymph nodes were enlarged predominantly in the high-dose animals and microscopic examination revealed non-specific reactive hyperplasia in lymph nodes in most instances. There were no effects on sperm morphology.
NOAEL = 125 mg/kg-day (highest dose tested)

(5) In a 4-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-81-7 (Distillated (petroleum), heavy thermal cracked (Cocker Heavy Gas Oil (F-97-01) via dermal route at 0 (acetone), 0.001, 0.1 or 1.0 mL/kg-day (0, 0.93, 93 or 930 mg/kg-day, respectively) 6 hours/day, 5 days/week for under occluded conditions. The test substance was applied to previously clipped sites on the backs of the animals. Following the 6-hour exposure period, the skin was wiped to remove residual test substance. Mortality, clinical signs, skin irritation, body weights and food consumption were monitored. Clinical chemistry and hematology parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

No treatment-related mortality was seen. The terminal body weight was decreased (9%) in females at 930 mg/kg-day. At 930 mg/kg-day, there was an increase in absolute spleen weights in males (24%), relative spleen weights (to body weight) in both sexes (21 and 17% respectively, for males and females), absolute liver weights in males (24%) and relative liver weights in both sexes (12-23%). Relative liver weights (to body weight) were increased (8%) in males at 93 mg/kg-day. Hematology changes included decreased RBC count (6-9%, males and females at 930 mg/kg-day and females at 93 mg/kg-day), hematocrit (5-11%) and hemoglobin (7-13%) (males and females at 930 mg/kg-day and males at 93 mg/kg-day). Clinical chemistry was unremarkable. Histopathology on two control groups and high-dose animals revealed no treatment-related changes. Testes and ovaries showed no treatment-related effects.
LOAEL = 93 mg/kg-day (based on increased relative liver weights and decreased RBC count, hemoglobin and hematocrit)
NOAEL = 9.3 mg/kg-day

(6) In a 4-week study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-81-7 (Distillated (petroleum), heavy thermal cracked (Cocker Heavy Gas Oil (F-136)) via dermal route at 0, 0.01, 0.1 or 1 mL/kg-day (0, 9.3, 93 or 930 mg/kg-day 6 hours/day, 5 days/week under occluded conditions. The test substance was applied to previously clipped sites on the backs of the animals. Following the 6-hour exposure period, the skin was wiped to remove residual test substance. Mortality, clinical signs, skin irritation, body weights and food consumption were monitored. Clinical chemistry and hematology urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

There was no treatment-related mortality during this study. Dose-related increased incidence with very slight to slight dermal irritation was seen. Body weights were not affected by treatment. Hematology changes were noted in males and females at 930 mg/kg-day (slightly decreased hematocrit, 4%) and females (9%) and hemoglobin in females (6%). BUN was increased at all doses in males (18, 21, and 19%, respectively). Cholesterol levels were elevated in females at 930 mg/kg-day (59%). Absolute and relative liver weights were increased elevated in both sexes at 930 mg/kg-day (30-32%) and in females at 93 mg/kg-day (11%). Histopathology on control and high-dose rats revealed no treatment-related changes. Additional details are from TSCATS (OTS0544095).
LOAEL = 930 mg/kg-day (based on increased liver weights, hematology parameters and increased cholesterol and BUN)
NOAEL = 93 mg/kg-day

Distillates (petroleum), heavy catalytic cracked (CASRN 64741-61-3)
(1) In a 28-day study, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-61-3 (distillates (petroleum), heavy catalytic cracked or Heavy Cycle Oil or Heavy Thermo-cracked Distillate (F-134)) via the dermal route at 0, 0.01, 0.1 or 1 mL/kg-day (0, 9.9, 99 or 990 mg/kg-day) for 6 hours/day, 5 days/week under occluded conditions. The test substance was applied to previously clipped sites on the backs of the animals. Following the 6-hour exposure period, the skin was wiped to remove residual test substance. Mortality, clinical signs, skin irritation, body weights and food consumption were monitored. Clinical chemistry, hematology and urinalysis parameters were evaluated. At necropsy, organ weights were taken. Histopathological examinations were conducted on tissues from the control and high-dose animals.

Dose-related and very slight to moderate irritation was observed. Body weight was decreased (11%) and relative brain weight (11%) was increased in males at 990 mg/kg-day. Absolute liver weights were increased (28%) in females at 990 mg/kg-day and relative liver weights (to body weight) were increased in both sexes (19 and 33% in males and females, respectively). Relative liver weight (to brain) was increased in females at 99 and 990 mg/kg-day, 11 and 30%, respectively. Hematology changes included decreases in RBC count, hemoglobin hematocrit in males at 990 mg/kg-day and in females at 99 and 990 mg/kg-day at 99 and 990 mg/kg-day. Platelets were decreased (33%) in females at 990 mg/kg-day. At this dose, females also showed increased SGOT (24%) and cholesterol (60%) levels. Histopathological examination revealed no treatment-related changes. No treatment-related effects were seen on testes and ovaries.
$LOAEL_{males}$ = 990 mg/kg-day (based on decreased body weight, liver weights RBC count, hematocrit and hemoglobin levels)
$NOAEL_{males}$ = 99 mg/kg-bw/day
$LOAEL_{females}$ = 99 mg/kg-day (based on decreased liver weights, RBC count, hematocrit and hemoglobin)
$NOAEL_{females}$ = 9.9 mg/kg-day

Subcategory VIII: Reformer Residual

No data.

Reproductive Toxicity

Subcategories I to V and VII and VIII

No data.

Developmental Toxicity

Subcategory I: Residual Fuel Oils

No data.

Subcategory II: Atmospheric Residual

Residues (petroleum), atm. tower (CASRN 64741-45-3)

Sample 091691; (F-228)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	0.30	2.00	2.00	2.00	0.60	0.10
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered CASRN 64741-45-3 (residues (petroleum), atm. Tower; Atmospheric Tower Bottom (ATB); F-228) at 0, 50, 333 or 1000 mg/kg-day for 6 hours/day on shaved backs on gestation days 0 – 20. There were 15, 12, 10 and 11 pregnant females in the control, 50, 333 and 1000 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after the 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

Treatment related mortalities were not observed among dams. Body weights were significantly decreased ($p<0.05$) at 1000 mg/kg-day between gestation days 16 – 20. There were no treatment-related effects on either absolute or relative food consumption in dams. The gestation length was significantly increased ($p<0.01$) at 1000 mg/kg-day. At necropsy, no lesions related to treatment were observed in dams of any of the dose groups. Significantly decreased ($p<0.05$) pup body weights were observed at 1000 mg/kg-day. A Significantly decreased ($p<0.05$) number of implantation sites was observed only at 333 mg/kg-day, but not at the higher dose and was not considered to be treatment related. No significant difference was noted for the total pups per litter, proportion dead on lactation day 0, proportion surviving on lactation day 4, fetal sex ratio, or external pup alterations.
LOAEL (maternal toxicity) = 1000 mg/kg-day (based on decreased gestational body weights and increased gestational length)
NOAEL (maternal toxicity) = 333 mg/kg-day
LOAEL (developmental toxicity) = 1000 mg/kg-day (based on decreased pup body weights)

NOAEL (developmental toxicity) = 333 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

Subcategory III: Atmospheric Distillate

Distillates, Crude Oil (DCO); VDF Diesel (CASRN 68410-00-4)
(1)

Sample 091681 (F-215)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.20	4.00	4.00	0.00	0.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (25/dose) were administered CASRN 68410-00-4 (Distillate Crude Oil (DCO; VDF Diesel (DCO, F-215)) at 0 (acetone), 50, 250 or 500 mg/kg-day for 6 hours/day on shaved backs of the animals on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after the 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no treatment-related mortalities. Slight to extreme irritation was noted at all doses at the application sites. Body weights and body weight gains were significantly lower ($p<0.05$ and/or $p<0.01$) at 250 and 500 mg/kg-day at various points during gestation and postnatal periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 500 mg/kg-day during gestation and lactation. All litter parameters were unaffected by treatment. Implantation sites and sex ratio were comparable to controls. The number of dams with viable fetuses was comparable among the four dose groups. There were no biologically significant effects on corpora lutea, implantations, litter sizes, live fetuses, early and late resorptions, fetal body weights, percent resorbed conceptuses and sex ratio. No treatment-related gross external soft tissue or skeletal alterations in fetuses were seen.
LOAEL (maternal toxicity) = 250 mg/kg-day (based on decreased body weights, body weight gains)
NOAEL (maternal toxicity) = 50 mg/kg-day
NOAEL (developmental toxicity) = 500 mg/kg-day (highest dose tested)

(2)

Sample 091647 (F-194)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.1	4.0	4.0	0.0	0.0	0.0	0.0
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered CASRN 68410-004 (Distillates Crude Oil (DCO); F-194)) at 0, 125, 250 or 1000 mg/kg-day for 6 hours/day on shaved backs of the animals. Animals from the 125 and 250 mg/kg-day groups were administered the test substance during gestation days 0-20; and those from the 1000 mg/kg-day were administered the test substance during gestation days 5-9 (due to severe skin irritation). There were , 19, 15, 15, and 14 pregnant females in the control, 125, 250 and 1000 mg/kg-day groups, respectively. The control group was shared with another study, possibly conducted simultaneously (ATX-91-0129). The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after the 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Slight to extreme irritation was noted at all doses at the application sites. Alopecia and yellow staining in the perineal region were seen at 1000 mg/kg-day. Body weights were significantly decreased ($p<0.05$) at 250 and 1000 mg/kg-day at various time points during gestation and postnatal periods. Absolute food consumption in dams was significantly ($p<0.05$) lower at 250 mg/kg-day and absolute and relative food consumption was significantly ($p<0.01$) lower at 1000 mg/kg-day. There were no effects on gestation length, number of implantation sites, a number of dead pups on lactation day 0 and proportion of surviving pups to lactation day 4 or sex ratio. At necropsy, no treatment-related lesions were observed in dams of any of the dose groups. Significantly decreased ($p<0.05$ to $p<0.01$) pup body weights were observed at 250 and 1000 mg/kg-day on lactation days 0 and 4. A significant decrease ($p<0.05$) in pup body weights were also observed at 125 mg/kg-day on lactation days 0. There were no external pup alterations at any dose.

LOAEL (maternal toxicity) = 250 mg/kg-day (based on decreased body weights, body weight changes and food consumption)

NOAEL (maternal toxicity) = 125 mg/kg-day

LOAEL (developmental toxicity) = 125 mg/kg-day (based on decreased pup body weights)

NOAEL (developmental toxicity) = not established

[*Note: Although in this study, lesser number of animals/dose are used than those recommended by the guidelines, and the dosing period for the 1000 mg/kg-day group animals is shorter (due to skin irritation, gestation days 5-9 instead of 0-20), the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(3)

Sample 091681 (F-215)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.20	4.00	4.00	0.00	0.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered CASRN 68410-00-4 (Distillates Crude Oil (DCO); F-215)) at 0, 50, 150 or 500 mg/kg-day for 6 hours/day on shaved backs on gestation days 0 – 20. There were 15, 12, 12, and 12 pregnant females in the control, 50, 150 and 500 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Slight to extreme irritation was noted at all doses at the application sites. Alopecia, yellow, yellow/brown, yellow/red staining in the perineal and abdominal regions were seen at 500 mg/kg-day. Body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 500 mg/kg-day at various time points during gestation and postnatal periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) higher at 150 mg/kg-day and 500 mg/kg-day during gestation and lactation. Pup body weights at 150 and 500 mg/kg-day were lower (not significant) than that of the controls on lactation day 0 (6.10 and 5.56 grams, respectively, versus 6.55 grams in the control group) and day 4 (8.41 and 6.94 grams, respective, versus 9.89 grams in the control group). At 500 mg/kg-day, the proportion of pups surviving to lactation day 4 was significantly decreased ($p<0.01$) than controls. There were no effects on gestation length, number of implantation sites, a number of total and live pups on lactation day 0 and proportion of dead pups on lactation day 0 or sex ratio. There were no external pup alterations at any dose.

LOAEL (maternal toxicity) = 500 mg/kg-day (based on decreased body weights, body weight gains)

NOAEL (maternal toxicity) = 150 mg/kg-day

LOAEL (developmental toxicity) = 150 mg/kg-day (based on decreased pup body weights on lactation days 0 and 4)

NOAEL (developmental toxicity) = 50 mg/kg-day

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

Gas oils (petroleum), heavy atmospheric (CASRN 68783-08-4)

(1)

Sample 094626 (F-275)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.70	4.00	1.00	0.70	0.50	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (12/dose; 15/control) were administered CASRN 68783-08-4 (Full Range Gas Oil (FRGO, F-275)) at 0, 50, 250 or 500 mg/kg-day for 6 hours/day on shaved backs of the animals on gestation days 0 – 20. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Slight to extreme irritation was noted at all doses at the application sites. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 250 and 500 mg/kg-day at various time points during gestation and postnatal periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 250 and 500 mg/kg-day during gestation and lactation. Slight dermal irritation was noted at all doses. Early resorption sites were seen in uteri of two females at 500 mg/kg-day. Total number of pups per litter and live pups per litter were significantly decreased ($p<0.05$ to $p<0.01$) at 250 and 500 mg/kg-day. Four females at 500 mg/kg-day did not deliver litters. Two of these females delivered only one pup each that were found dead on lactation day 0. The third female that delivered only two pups was noted to have very small nipples on lactation day 3. On lactation day 4, these two pups were found dead with no milk in their stomach. The proportion of dead pups in the 500 mg/kg-day group was significantly greater than that of the control. The proportion of male pups in the 500 mg/kg-day group was significantly greater than in the control group. Pup body weights at 250 and 500 mg/kg-day were significantly lower than that of the controls on lactation days 0 and 4. External examination of pups revealed sporadic occurrances of hematoma, tip of tail black, left eye slightly swollen and dark red, eschar, missing tail--considered to be incidental in nature.

LOAEL (maternal toxicity) = 250 mg/kg-day (based on decreased body weights, body weight changes and food consumption)

NOAEL (maternal toxicity) = 50 mg/kg-day

LOAEL (developmental toxicity) = 250 mg/kg-day (based on decreased number of total and live pups delivered and pups body weights on lactation days 0 and 4)

NOAEL (developmental toxicity) = 50 mg/kg-day

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(2) The following study was conducted on *heavy atmospheric gas oil*, CASRN 68915-97-9, which is compositionally similar to heavy fuel CASRN 68783-08-4, and also included in the Gas oils category.
Pregnant Sprague-Dawley rats (12/dose) were administered CASRN 68915-97-9 (Heavy Atmospheric Gas Oil that is compositionally similar to Heavy Fuel; 68783-08-4) at 0 (sham control), 8, 30, 125, and 500 mg/kg-day for 6 hours/day on shorn dorsal skin on gestation days 0–19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. Two additional groups (postnatal groups) at 0 (sham control) and 125 mg/kg-day were included in the study--dams and their litters were observed on post partum days 0 to 4 for clinical signs. Body weights and food consumption were recorded. Offspring were weighed according to gender. The pups were examined for external malformations and daily for the presence/absence of milk in the stomach. For each female, reproductive organs were examined; liver and thymus were weighed; the number of corpora lutea per ovary and number of implantations for each dam were recorded. At necropsy, blood samples were collected for hematology and clinical chemistry evaluations. Fetuses were examined for soft tissue abnormalities and skeletal examination.

Skin irritation which ranged from slight to moderate was noted at all doses. A red vaginal discharge was seen in 7/11 animals at 500 mg/kg-day and 1/12 animals at 125 mg/kg-day. Body weight, weight gain ($p<0.05$ to $p<0.01$) and food consumption ($p<0.01$) were significantly reduced at 125 and 500 mg/kg-day. At 500 mg/kg-day, other statistically significant changes ($p<0.05$ to $p<0.01$) included decreased absolute and relative thymus weight, increased relative liver weight, decreased platelets, segmented neutrophils, decreased triglycerides, and increased total protein, albumin, calcium, BUN and alkaline phosphatase. Pre-implantation losses were seen at 125 and 500 mg/kg-day. There was a significant increase in the mean number/percent resorptions in the 500 mg/kg-day group. Mean fetal body weights were significant decreased (significance not provided) for all viable fetuses at 500 mg/kg-day and in male pups at 125 mg/kg-day. A significant increase (significance not provided) in incomplete ossification of a number of skeletal structures (nasal bones, thoracic centra, caudal centra, sternebrae, metatarsal and pubis) at 125 and 500 mg/kg-day. No treatment-related abnormalities were seen in the soft tissues.
LOAEL (maternal toxicity) = 125 mg/kg-day (based on decreased body weights, body weight changes and food consumption)
NOAEL (maternal toxicity) = 30 mg/kg-day
LOAEL (developmental toxicity) = 125 mg/kg-day (based on decreased number of total and live pups delivered and pups body weights, incomplete ossification)
NOAEL (developmental toxicity) = 30 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

Subcategory IV: Vacuum Residual

No data.

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CASRN 64741-57-7)
(1)

Sample 091650 (F-197)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.40	4.00	2.00	0.60	0.20	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a prenatal developmental toxicity study, pregnant Sprague-Dawley rats (25/dose) were administered 64741-57-7 (Heavy Vacuum Gas Oil (VDF Gas Oil, F-197) at 0, 50, 100 or 250 mg/kg-day in acetone, for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored; body weight and food consumption were measured and the number of corpora lutea, implantation sites, early/late resorptions, and live and dead fetuses were recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. Gross observations were made and external examinations of pups were conducted.

No mortality occurred. Body weights and body weight gains were decreased (significant for body weight gain, $p<0.01$) at 100 and 250 mg/kg-day. Absolute and/or relative food consumption in dams was significantly ($p<0.05$ to $p<0.01$) lower at 50, 100 and 250 mg/kg-day during gestation at various time points. Slight irritation was noted at all doses at the application sites. At 250 mg/kg-day, litter sizes and the mean number of live fetuses were significantly reduced ($p<0.05$); litter averages for total resorptions, early resorptions and percent resorbed conceptuses and the number of dams with resorptions were increased. Live fetal body weights and female fetal body weight were significantly reduced ($p<0.01$) at 250 mg/kg-day. There were no significant or biologically relevant differences in the litter averages for corpora lutes, implantations and sex ratios. There were no late resorptions and no dam resorbed all conceptuses; the number of dams with viable fetuses was comparable among the four dose groups. Skeletal observations at 250 mg/kg-day showed significantly reduced ($p<0.01$) the average number of caudal vertebral ossification sites per fetus. There was an increased tendency toward fetal and litter incidences of bifid thoracic vertebral centra and incompletely ossified sternebrae at 250 mg/kg-day.
LOAEL (maternal toxicity) = 100 mg/kg-day (based on decreased body weights, body weight gains)
NOAEL (maternal toxicity) = 50 mg/kg-day
LOAEL (developmental toxicity) = 250 mg/kg-day (based on decreased fetal body weights, increased variations in fetal skeletal ossifications)
NOAEL (developmental toxicity) = 100 mg/kg-day

(2)

Sample 091649 (F-196)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	0.30	3.00	2.00	2.00	0.70	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (25/dose) were administered 64741-57-7 (Heavy Vacuum Gas Oil (VDF Gas Oil, F-196) at 0 (acetone), 75, 150 or 300 mg/kg-day (in acetone), for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored; body weight and food consumption were measured and the number of corpora lutea, implantation sites, early/late resorptions, and live and dead fetuses were recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. Gross observations were made and external examinations (soft tissue and skeletal alterations) of pups were conducted.

No mortality occurred. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at all doses at various time points during dosing period. Absolute and/or relative food consumption in dams was significantly ($p<0.05$ to $p<0.01$) lower at all doses during dosing period. At 150 and 300 mg/kg-day, significant reductions ($p<0.01$) in litter sizes and live fetuses and increases ($p<0.01$) in resorptions (total and/or early resorptions) were seen. The number of dams with any resorptions was also significantly increased ($p<0.01$) at 300 mg/kg-day. There was an increased tendency for the percentage of resorbed conceptuses per litter at 150 mg/kg-day and a significant increase ($p<0.01$) at 300 mg/kg-day. Fetal body weights were decreased at 75 mg/kg-day achieving a statistical significance ($p<0.01$) at 150 and 300 mg/kg-day. No biologically significant differences were seen in litter averages for corpora lutea, implantations, late resorptions and sex ratio. The number of dams with viable fetuses was comparable among all groups. The fetal incidences of microphthalmia and bifid thoracic vertebral centra were significantly increased ($p<0.01$) at all doses. There was a reduction in average number of ossified caudal vertebrae per fetus at 300 mg/kg-day (significance not provided).
LOAEL (maternal toxicity) = 75 mg/kg-day (based on decreased body weights, body weight gains and food consumption)
NOAEL (maternal toxicity) = not established
LOAEL (developmental toxicity) = 75 mg/kg-day (based on decreased fetal body weights, increased incidences of microphthalmia and delayed ossification)
NOAEL (developmental toxicity) = not established

(3)

Sample 091689 (F-225)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.0	0.4	4.0	1.0	0.4	0.1	0.0
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered CASRN 64741-57-7 (Heavy Vacuum Gas Oil (HVGO F-225)) at 0, 50, 150 or 500 mg/kg-day for 6 hours/day on previously clipped backs (intrascapular and lumbar regions) on gestation days 0 – 20. There were 15, 12, 12, and 12 pregnant females in the control, 50, 150 and 500 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the

exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Slight to extreme irritation was noted at all doses at the application sites. At 500 mg/kg-day, the incidence of vaginal discharge was higher than that of the control group. Gestation length was significantly increased ($p<0.01$) at 500 mg/kg-day compared to controls. Body weights were significantly lower ($p<0.01$) at 500 mg/kg-day at various time points during gestation and lactation periods. Body weight gains were significantly lower at 150 mg/kg-day ($p<0.05$) and 500 mg/kg-day ($p<0.01$). Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 150 mg/kg-day and 500 mg/kg-day during gestation and lactation except for females at 500 mg/kg-day during gestation days 16-20. At necropsy, one female at 500 mg/kg-day had red vaginal discharge and a dead fetus in the uterus. Another female in this group had thickened uterine walls and one early resorption in the uterus. Pup body weights at 150 and 500 mg/kg-day were significantly lower ($p<0.01$) than that of the controls on lactation days 0 and 4. At 500 mg/kg-day, the proportion of pups surviving to lactation day 4 was significantly decreased ($p<0.01$) than controls. There were no effects on gestation length, number of implantation sites, a number of total and live pups on lactation day 0 and proportion of dead pups on lactation day 0 or sex ratio. There were no external pup alterations at any dose.
LOAEL (maternal toxicity) = 150 mg/kg-day (based on decreased body weights, body weight gains and food consumption)
NOAEL (maternal toxicity) = 50 mg/kg-day
LOAEL (developmental toxicity) = 150 mg/kg-day (based on decreased pup body weights on lactation days 0 and 4)
NOAEL (developmental toxicity) = 50 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(4)

Sample 094627 (F-276)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	9.00	9.00	0.20	0.00	0.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered 64741-57-7 (Heavy Vacuum Gas Oil; Hydrocracker Feed Oil (F-276)) at 0 (sham control), 1.0, 250 or 500 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs on gestation days 0 – 20. (Actual administration of the test substance was from day -7 (premating) to gestation day 20.) There were 15, 11, 12, and 11 pregnant females in the control, 1.0, 250 and 500 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in

pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 250 and 500 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 250 and 500 mg/kg-day during gestation and lactation. Slight to moderate irritation was noted at all doses at the application sites. The enlargement of axillary lymph nodes at 250 and 500 mg/kg-day and the cervical lymph nodes at 500 mg/kg-day were considered to be secondary to the dermal irritation. The number of implantation sites for the 250 and 500 mg/kg-day groups was significantly lower ($p<0.05$) than that of the control group. Total number of pups per litter and live pups per litter were significantly reduced at 250 ($P<0.05$) and 500 mg/kg-day ($p<0.01$). The number of pups surviving to lactation day 4 was significantly decreased ($p<0.05$) at 500 mg/kg-day. Average pup body weights at 250 mg/kg-day on lactation day 0 and at 500 mg/kg-day on lactation days 0 to 4 were decreased significantly ($p<0.01$).
LOAEL (maternal toxicity) = 250 mg/kg-day (based on decreased body weights, body weight changes and food consumption)
NOAEL (maternal toxicity) = 1 mg/kg-day
LOAEL (developmental toxicity) = 250 mg/kg-day (based on decreased number of implantation sites, total and live pups and decreased pup body weights on lactation day 0)
NOAEL (developmental toxicity) = 1 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(5)

Sample 091649 (F-196)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	0.30	3.00	2.00	2.00	0.70	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (15/dose; 20/control) were administered 64741-57-7 (Heavy Vacuum Gas Oil (F-196) at 0 (sham control), 1.0, 250 or 1000 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs on gestation days 0 – 20. (Actual administration of the test substance was from day -7 (pre-mating) to gestation day 20.) The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after the 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

One female at 1000 mg/kg-day died on gestation day 22. Treatment-related increased incidence of vaginal discharge was seen at 250 and 1000 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 250 and 1000 mg/kg-day at various time points

during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 250 and 1000 mg/kg-day during gestation and/or lactation periods. Slight and sporadic irritation was noted at all doses at the application sites. At necropsy, decreased thymus size was noted in 1, 2, 3, and 6 females at 0, 1, 250 and 1000 mg/kg-day, respectively. At 1000 mg/kg-day, none of the pregnant females delivered a litter; although the implantation sites at this dose were comparable to the control group. At 250 mg/kg-day, the number of total and live pups at lactation day 0 were significantly lower ($p<0.01$) than those for the control group. Average pup body weights at 250 mg/kg-day on lactation day 0 and 4 were decreased significantly ($p<0.05$ and $p<0.01$, respectively). There were no significant differences in gestation length, number of implantation sites, external pup alterations, proportion of pups dead on lactation day 0, proportion of pups surviving on lactation day 4 or proportion of male pups on lactation days 0 and 4, compared to controls.
LOAEL (maternal toxicity) = 250 mg/kg-day (based on vaginal discharge, decreased body weights, body weight gains, food consumption and decreased thymus size)
NOAEL (maternal toxicity) = 1 mg/kg-day
LOAEL (developmental toxicity) = 250 mg/kg-day (based on decreased total and live pups on lactation day 0 and decreased pup body weights on lactation day 0 and 4)
NOAEL (developmental toxicity) = 1 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(6)

Sample 091650 (F-197)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.40	4.00	2.00	0.60	0.20	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (15/dose; 20/control) were administered CASRN 64741-57-7 (Heavy Vacuum Gas Oil (VDF Gas Oil, F-197) at 0 (sham control), 1.0, 250 (241 corrected dose) or 1000 (965 corrected dose) mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 20. (Actual administration of the test substance was from day -7 pre-mating, mating through gestation day 20.) The control group was shared with another study possibly conducted simultaneously (ATX-91-0127). The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after the 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Treatment-related increased in the incidence of vaginal discharge was seen at 250 and 1000 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 241 and 965 mg/kg-day at various points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.01$) lower at 241 and 965 mg/kg-day during gestation and/or lactation periods. Slight to moderate irritation

was noted at all doses at the application sites. At necropsy, a late resorption was noted in one female at 965 mg/kg-day. At 965 mg/kg-day, none of the pregnant females delivered a litter; although the implantation sites at this dose were comparable to the control group. A statistically significant decrease was noted in the number of total and live pups ($p<0.05$); the proportion of pups surviving to lactation day 4 ($p<0.01$) and pup body weights on lactation day 0 and 4 ($p<0.05$) at 241 mg/kg-day. There were no significant differences in gestation length, number of implantation sites, external pup alterations, or proportion of male pups on lactation days 0 and 4 among all groups.

LOAEL (maternal toxicity) = 241 mg/kg-day (based on vaginal discharge, decreased body weights, body weight gains and food consumption)

NOAEL (maternal toxicity) = 1 mg/kg-day

LOAEL (developmental toxicity) = 241 mg/kg-day (based on decreased total and live pups, proportion of pups surviving to lactation day 4 and decreased pup body weights on lactation day 0 and 4)

NOAEL (developmental toxicity) = 1 mg/kg-day

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(7)

Sample 091654 (F-201)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	0.40	4.00	3.00	0.90	0.40	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (15/dose; 20/control) were administered 64741-57-7 (Heavy Vacuum Gas Oil (hydrocracker Fresh Feed, F-201) at 0 (sham control), 1.0, 250 or 1000 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 20. (Actual administration of the test substance was from day -7 (pre-mating) to gestation day 20.) There were 16, 10, 9 and 12 pregnant females in the control, 1.0, 250 and 500 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

One female at 1000 mg/kg-day was sacrificed in a moribund condition. Treatment-related increased incidence of vaginal discharge was seen at 250 and 1000 mg/kg-day. Ocular and nasal discharge was also seen at 1000 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 250 and 1000 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 250 and 1000 mg/kg-day during gestation and/or lactation periods. Slight irritation was noted at all doses at the application sites. At necropsy, decreased thymus size (significance not provided) was noted at 250 and 1000 mg/kg-day. At 250 mg/kg-day, six out of nine females delivered. At 1000 mg/kg-day, none of the pregnant females

delivered a litter and the number of implantation sites at this dose were decreased (significance not provided) compared to the control group. At 250 mg/kg-day, the number of implantation sites was significantly lower ($p<0.01$) than that of the control group suggesting increased pre-implantation loss. At this dose, the number of total and live pups on lactation day 0 were significantly lower ($p<0.01$) than those for the control group. Average pup body weights at 250 mg/kg-day on lactation day 0 and 4 were decreased significantly (significance not provided). There were no significant differences at 250 mg/kg-day in gestation length, external pup alterations, proportion of dead pups on lactation day 0, proportion of pups surviving on lactation day 4 or proportion of male pups on lactation days 0 and 4.
LOAEL (maternal toxicity) = 250 mg/kg-day (based on decreased body weights, body weight gains and decreased thymus size)
NOAEL (maternal toxicity) = 1 mg/kg-day
LOAEL (developmental toxicity) = 250 mg/kg-day (based on decreased implantation sites, total and live pups on lactation day 0 and decreased pup body weights on lactation days 0 and 4)
NOAEL (developmental toxicity) = 1 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(8)

Sample 85244	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.06	2.48	1.86	1.24	0.50	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a developmental toxicity screen, pregnant Sprague-Dawley rats (10/dose) were administered CASRN 64741-57-7 (Heavy Vacuum Gas Oil (CRU No. 85244) at 0, 30, 125, 500 or 1000 mg/kg-day, for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored; body weight and food consumption were measured and the number of corpora lutea, implantation sites, early/late resorptions, and live and dead fetuses were recorded. At necropsy, blood samples were collected for evaluation of clinical chemistry parameters. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. Gross observations were made and external examinations of pups were conducted.

No mortality occurred. Dose-related decrease in mean body weights and body weight gains was seen at ≥ 500 mg/kg-day at various time points during gestation period. Absolute and/or relative food consumption in dams was lower at ≥500. Thymus was smaller in dams at 1000 mg/kg-day. Lungs were pale in color in the treated groups; however, the significance of this finding is not known. Relative liver weights were significantly increased ($p<0.05$) at ≥500 mg/kg-day. The number of implantation sites and percent pre-implantation loss were not affected by treatment. The number of dams with resorptions was significantly increased ($p<0.05$ to $p<0.01$) and the litter size was significantly decreased ($p<0.05$ to $p<0.01$) at ≥ 500 mg/kg-day. No significant differences were seen in serum chemistry parameters. At the time of necropsy all fetuses were viable. Fetal body weights were significantly reduced ($p<0.05$) at ≥ 500 mg/kg-day. External examination showed one fetus at 1000 mg/kg-day was edematous (accumulation of serum in

cellular tissues) and pale in color; both hind paws were malformed; digits were reduced in size with subcutaneous hematoma located at the distal most aspect of each the digits. Skeletal variations included increased incidence of mostly unossified or incompletely ossified bones at ≥500 mg/kg-day. Fetuses with vertebral malformations were seen among the litters of dams given 500 mg/kg-day. Visceral malformations were restricted to two fetuses from the 500 mg/kg-day—one fetus had microphthalmia and another one had a diaphragmatic hernia (protrusion of liver into the thoracic cavity).

LOAEL (maternal toxicity) = 500 mg/kg-day (based on decreased body weights, body weight gains and food consumption)

NOAEL (maternal toxicity) = 125 mg/kg-day

LOAEL (developmental toxicity) = 500 mg/kg-day (based on decreased fetal body weights, increased resorptions, unossified/incomplete ossification, vertebral/visceral malformations)

NOAEL (developmental toxicity) = 125 mg/kg-day

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

Gas Oils (peteroleum), hydrodesulfurized heavy vacuum (CASRN 64742-86-5)

Sample 091690 (F-227)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	0.70	3.00	2.00	1.00	0.30	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (12/dose; 15/control) were administered CASRN 64742-86-5 (Hydrodesulfurized Heavy Vacuum Gas Oil (HHVGO, F-227) at 0, 50, 33 or 1000 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 20. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

One female at 1000 mg/kg-day died on gestation day 16. Treatment-related increased incidence of vaginal discharge was seen at 333 and 1000 mg/kg-day. Red-black stained coat in the perineal region was noted for two females at 1000 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 333 and 1000 mg/kg-day at various time points during gestation period. Absolute and relative food consumption in dams was significantly ($p<0.05$ to $p<0.01$) lower at 333 and 1000 mg/kg-day during gestation period. Slight to extreme skin irritation was noted at 333 and 1000 mg/kg-day. At 1000 mg/kg-day, none of the pregnant females delivered a litter; however, the number of implantation sites at this dose were comparable to the control group. One female delivered dead pups at 333 mg/kg-day. At 333 mg/kg-day, the number of total and live pups on lactation day 0 were significantly lower ($p<0.01$) than those for the control group. Average pup body weights at 333 mg/kg-day were decreased significantly on lactation day 0 ($p<0.05$) and 4 ($p<0.01$). There were no significant

differences in gestation length, a number of implantation sites, proportion of dead pups on lactation day 0, proportion of pups surviving on lactation day 4 or proportion of male pups on lactation day 4 and external pup alterations.
LOAEL (maternal toxicity) = 333 mg/kg-day (based on decreased body weights, body weight gains and food consumption)
NOAEL (maternal toxicity) = 50 mg/kg-day
LOAEL (developmental toxicity) = 333 mg/kg-day (based on decreased total and live pups on lactation day 0 and decreased pup body weights on lactation days 0 and 4 and dead pups delivered by one female)
NOAEL (developmental toxicity) = 50 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CASRN 64741-62-4)
(1) In a study described above, separate groups of pregnant Sprague-Dawley rats (24/dose) were administered CASRN 64741-62-4 (Clarified Slurry Oil) daily at 0 (sham control), 0.05, 1.0, 50 or 250 mg/kg-day, for 6 hours/day, on to previously shaved backs of the animals during gestation days 0-19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Animals were sacrificed on GD 20. At necropsy, gravid uterus was weighed, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations were conducted. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio.

There were no mortalities. Red vaginal discharge was seen at all doses ($p<0.05$ and /or $p<0.01$). Body weights and food consumption was reduced ≥ 1.0 mg/kg-day. Gravid uterine weights were also significantly reduced in a dose -related manner. Early resorptions and total resorptions were significantly increased ($p<0.05$) in a dose related manner at ≥1.0 mg/kg-day. The number of live fetuses were also significantly decreased ($p<0.05$) in a dose-related manner at ≥1.0 mg/kg-day; all fetuses died at 250 mg/kg-day. A percent of dead or resorbed conceptuses per litter was increased significantly ($p<0.05$) at 1.0 to 50 mg/kg-day. Fetal body weights were significantly decreased ($p<0.05$) at 1to 50 mg/kg-day. Increased incidences of fetal variations were noted in fetuses from 1 to 50 mg/kg-day and included moderate dilation of the renal pelvis, slight dilation of lateral ventricle of brain, bifid thoracic vertebral centrum and decreased average numbers of ossified caudal vertebrae.
LOAEL (maternal toxicity) = 1.0 mg/kg-day (based on increased red vaginal discharge, decreased body weight, food consumption)
NOAEL (maternal toxicity) = 0.05 mg/kg-day
LOAEL (developmental toxicity) = 1.0 mg/kg-day (based on increased resorptions, decreased live fetuses, decreased body weights and increased incidence of fetal variation)
NOAEL (developmental toxicity) = 0.05 mg/kg-day

(2)

Sample 091645 (F-179)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.70	10.00	30.00	20.00	6.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a developmental toxicity study, pregnant Sprague-Dawley rats (15/dose; 20/control) were administered CASRN 64741-62-4 (Clarified Slurry Oil; CSO; F-179)) at 0 (sham control) , 0.05, 10, or 250 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs, on gestation days 0 – 20. (Actual administration of the test substance was from day -7 (pre-mating) to gestation day 20.) The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. A higher incidence of vaginal discharge was noted in females at 250 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 10 and 250 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.05$) lower at 10 and 250 mg/kg-day during gestation and lactation. Thymus size was decreased at 250 mg/kg-day. None of the females in the 250 mg/kg-day group delivered a litter. There were no differences between the dose groups that delivered a litter and the control group with respect to gestation length, total and live pups delivered, external pup alterations, pup body weights and proportion of dead pups on lactation day 0, proportion of pups surviving to lactation day 4 or the proportion of males on days 0 and 4. There was no significant difference in the number of implantation sites between the control and the dosed groups.

LOAEL (maternal toxicity) = 10 mg/kg-day (based on decreased body weights, body weight gains and food consumption)

NOAEL (maternal toxicity) = 0.05 mg/kg-day

LOAEL (developmental toxicity) = 250 mg/kg-day (based on100% resorption rate—none of females delivered)

NOAEL (developmental toxicity) = 10 mg/kg-day

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(3)

Sample 091692 F-229	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	3.00	20.00	30.00	10.00	4.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a developmental toxicity study, pregnant Sprague-Dawley rats (12/dose; 15/control) were administered CASRN 64741-62-4 (FCCU Clarified Oil; Carbon Black Oil (CBO-F-229)) at 0 (sham control), 0.05, 10, or 50 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs on gestation days 0 – 20. There were 15, 8, 11, and 10 pregnant females in the control, 0.05, 10 and 50 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. A higher incidence of vaginal discharge was noted in females at 50 mg/kg-day. The gestation length was significantly longer ($p<0.01$) than that of the control group. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at 50 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.01$) lower at 50 mg/kg-day during gestation. At 50 mg/kg-day, the total number of pups delivered per litter on day 0 and the total number of live pups delivered/litter were significantly lower ($p<0.01$) than the control group. The proportion of male pups was significantly lower ($p<0.05$) on lactation day 0 and 4 than the control group. On day 0, the body weight of live pups from was significantly lower ($p<0.01$) at 50 mg/kg-day on lactation day 0. There were no significant differences for the number of implantation sites, proportion of surviving pups on lactation day 0 or external pup alterations.
LOAEL (maternal toxicity) = 50 mg/kg-day (based on decreased body weights, body weight changes increased incidence of vaginal discharge and increase in gestation length)
NOAEL (maternal toxicity) = 10 mg/kg-day
LOAEL (developmental toxicity) = 50 mg/kg-day (based decreased total and live puips per litter, increased proportion of dead pups on lactation day 0, decreased proportion of males on lactation days 0 and 4 and decrease in pup body weights on lactation day 0)
NOAEL (developmental toxicity) = 10 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(4)

Sample 86001	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.0	2.57	25.68	19.26	6.42	3.21	0.64
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a developmental toxicity study, pregnant Sprague-Dawley rats were administered CASRN 64741-62-4 (Clarified Slurry Oil (CRU No. 86001)) at 0 (sham control), 10, 100 or 1000 mg/kg-day daily on to shaved intact sites on the backs on gestation days 9 – 12. There were 20, 20, 15, and 15 pregnant females in the control (sham), 10, 100 and 1000 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Blood was collected at necropsy for evaluation of clinical chemistry parameters. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. In dams, there was a dose-related decrease in mean body weights and body weight gains in the treated groups achieving a statistical significance ($p<0.05$ to $P<0.01$) at 100 and 1000 mg/kg-day. Liver weights were significantly increased ($p<0.01$) and thymus weights were significantly decreased ($p<0.01$) at 1000 mg/kg-day. At 1000 mg/kg-day, a number of resorptions and dams with resorptions were increased ($p<0.01$) and litter size was decreased ($p<0.01$). All fetuses were viable at necropsy; however, there was an increase in *in utero* death at 1000 mg/kg-day. Fetal body weights were significantly reduced ($p<0.01$) at 1000 mg/kg-day. Edema and paw malformations were increased at ≥100 mg/kg-day, achieving a statistical significance at 1000 mg/kg-day. Cleft palate was observed at 1000 mg/kg-day at a litter incidence of 40% and a fetal incidence of 14%.
LOAEL (maternal toxicity) = 100 mg/kg-day (based on decreased body weights, body weight changes and food consumption)
NOAEL (maternal toxicity) = 10 mg/kg-day
LOAEL (developmental toxicity) = 100 mg/kg-day (based on external fetal alterations)
NOAEL (developmental toxicity) = 10 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, and the dosing period for the 1000 mg/kg-day group animals is shorter (due to irritation, gestation days 9 - 12 instead of 0-20), the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(5)

Sample 86484	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.0	0.98	9.76	19.52	9.76	4.88	0.98
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a developmental toxicity study, pregnant Sprague-Dawley rats (15/dose) were administered CASRN 64741-62-4 (Syntower Bottom (STB, CRU No. 86484)) at 0 (sham control), "4", 8, 30, 125, 500 mg/kg-day daily on to shaved intact sites on shaved backs on gestation days 0 – 19.

The "4" mg/kg-day group animals were administered the test substance at 8 mg/kg-day on alternate days during gestation. The 500 mg/kg-day group animals were exposed to the test substance only during gestation days 10-12. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Blood samples were collected for evaluation of clinical chemistry parameters. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Vaginal bleeding was noted in animals at ≥8 mg/kg-day. The mean body weight for the 30 and 125 mg/kg-day groups were significantly reduced ($p<0.01$) throughout most of the gestation period and at 500 mg/kg-day during gestation days 10-12. Body weight gain was also reduced at these doses. Food consumption was lower at all doses. At all doses, thymus weights were lower achieving a statistical significance ($p<0.01$) at 125 and 500 mg/kg-day. Absolute liver weights were significantly ($p<0.01$) reduced at 125 mg/kg-day The number and percent resorptions were increased ≥8 mg/kg-day, statistically significant ($p<0.01$) at ≥30 mg/kg-day. Liter size was significantly decreased at ≥ 8 mg/kg-day. A significant decrease in mean fetal body weight was seen in male fetuses at ≥4 mg/kg-day. Two fetuses at 500 mg/kg-day (GD 10-12) were edematous and one fetus had a kinked tail. The total number of affected fetuses in this group was significantly greater than that from the control group. One fetus at 30 mg/kg-day had hyper flexion of both forelimbs. A significant increase in total rib malformation was seen at 500 mg/kg-day (GD 10-12). A dose-related increase in the incidence of incomplete ossifications of the nasal bones, vertebrae and sternebrae was seen. At 500 mg/kg-day, there was a significant ($p<0.01$) increase in fetuses having cleft palate.

LOAEL (maternal toxicity) = 4 mg/kg-day (based on decreased body weights, body weight changes)

NOAEL (maternal toxicity) = not established

LOAEL (developmental toxicity) = 4 mg/kg-day (based on decreased body weights, increased mean percent resorptions and decreased in litter size)

NOAEL (developmental toxicity) = not established

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(6)

Sample 091645 (F-179)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.70	10.00	30.00	20.00	6.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

In a developmental toxicity study, pregnant Sprague-Dawley rats were administered CASRN 64741-62-4 (Clarified Slurry Oil; CSO; Cat Cracked Clarified Oil; F-179) at 0 (acetone), 0.05, 1.0, 50 or 250 mg/kg-day, for 6 hours/day, on to previously shaved backs. The test substance was administered to animals (25/dose) from control and 0.05 mg/kg-day groups on gestation days 0 – 19. The remaining three groups were divided into seven subgroups (10/dose/duration) and received the test substance according to their assigned seven subgroups each on GD 0-2, GD

3-5, GD 6-8, GD 9-11, GD 12-14, GD 15-17 and GD 18-19. The study was designed to determine the critical period effect of dermal administration of CSO (F-179) on major organogenesis in the developing rat conceptus. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Body weights, body weight gains and absolute and relative food consumption were not affected at 0.05 mg/kg-day. Body weights for the 1, 50 and 250 mg/kg-day groups were unaffected. However, the body weight gain was significantly lower ($p<0.05$ to $p<0.01$) in these group s during their assigned gestation periods compared to controls. Absolute and relative food consumption in dams for these groups was also significantly lower ($p<0.05$ to $p<0.01$). At 50 and 250 mg/kg-day, early resorptions were increased during gestation days 6 through 8. At 250 mg/kg-day, increased early resorptions were occurred during gestation days 9 through 11. There was an increased tendency of percent of resorbed conceptuses per litter at 50 mg/kg-day achieving a statistical significance ($p<0.05$) at 250 mg/kg-day. Fetal alterations were not considered to be treatment-related (not significant compared to controls, no dose response, or were within the historical control ranges). Fetal sex ratio, body weights, gross external, soft tissue or skeletal morphology were not affected by the treatment when administered on days 0 through 19 or gestation or days 0-2, 3-5, 6-8, 9-11, 12-14, 15-17 or 18 and 19. At 0.05 mg/kg-day, the test substance did not adversely affect the offspring (embryo- fetal viability, sex, body weight or external soft and skeletal morphology).
[The study did not follow the full dosing regimen; therefore, NOAEL/LOAEL values were not determined for this hazard characterization.]

(7)

Sample 86001	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.0	2.57	25.68	19.26	6.42	3.21	0.64
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (10/dose) were administered CASRN 64741-62-4 (Clarified Slurry Oil; CSO; Cat Cracked Clarified Oil; CRU No. 86001) at 0 (sham control), "4", 8, 30, 125, 250 mg/kg-day daily on to shaved intact sites on shaved backs on gestation days 0 – 19. The "4" mg/kg-day group animals were administered the test substance at 8 mg/kg-day on alternate days during gestation. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Blood samples were collected for evaluation of clinical chemistry parameters. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0-4 and sex. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations were conducted.

Two dams exposed to 4 mg/kg-day showed skin irritation. One dam exposed to 125 mg/mg-day was found dead on GD 18. Vaginal bleeding was noted in animals at ≥8 mg/kg-day. The mean body weights and body weight gains were significantly reduced ($p<0.01$) throughout most of the gestation period at ≥8 mg/kg-day. Food consumption was lower at ≥ 8 mg/kg-day. Thymus weights were lower than control at ≥ 8 mg/kg-day, achieving a statistical significance ($p<0.05$) at 250 mg/kg-day. Absolute and relative liver weights were increased ($p<0.05$) at 250 mg/kg-day. Treatment-related seven clinical chemistry parameters (not stated in the robust summary) were affected in a dose-related manner and those associated with liver toxicity (cholesterol and alkaline phosphatase) were increased. The number of implantation sites and percent preimplantation losses was not affected by the treatment. At ≥ 30 mg/kg-day, the number of dams with all resorptions and number of resorptions were increased ($p<0.01$) and litter size was decreased. Fetuses at 30 and 125 mg/kg-day were smaller (decreased body weight and crown-rump length) than those from the control groups. Abnormal external fetal development (microganthia, kinked tail and edema) was observed in fetuses at ≥ 8 mg/kg-day. Visceral anomalies included enlarged ventricles of the brain, displacement of esophagus and development of heart.

LOAEL (maternal toxicity) = 8 mg/kg-day (based on vaginal discharge, decreased body weights, body weight changes, decreased food consumption and atrophy of thymus)

NOAEL (maternal toxicity) = not established

LOAEL (developmental toxicity) = 8 mg/kg-day (based on increased number and percent resorptions and decreased fetal body weight, crown-rump length and litter size, and increased fetal anomalies)

NOAEL (developmental toxicity) = not established

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment. Since "4" mg/kg-day group did not receive the full regimen of doses and it did not show any maternal or developmental effects, it was not considered when assigning the NOAEL/LOAEL values.*]

(8)

Sample 86001	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	2.57	25.68	19.26	6.42	3.21	0.64
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (12/dose) were administered single doses of CASRN 64741-62-4 (Clarified Slurry Oil; CSO; Cat Cracked Clarified Oil; CRU No. 86001) **via gavage** at 0 (water), 125, 500 or 2000 mg/kg on a designated day during specific periods of organogenesis (see below), during which the developing conceptus is believed to be sensitive to the teratogenic insult of a chemical.
Group 1: tap water (control) dosed through GD 11 to 14
Group 2: at 2000 mg/kg on GD 11
Group 3: at 125 mg/kg on GD 12
Group 4: at 500 mg/kg on GD 12
Group 5: at 2000 mg/kg on GD 12.
Group 6: at 2000 mg/kg on GD 13
Group 7: at 2000 mg/kg on GD 14
For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Each dam was sacrificed on day 20 of its presumed gestation. Thoracic and abdominal organs were examined and reproductive organs were examined grossly. Thymus and liver weights were taken. The number of corpora lutea and uterus weights was recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 at necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

No treatment-related mortality was seen. Treatment-related clinical signs included vaginal bleeding, perinanal staining and decreased stool. One female at 2000 mg/kg (GD 14) had severe red vaginal discharge and was sacrificed moribund on GD 19; her entire litter was found to be dead. The mean body weights for dams at 500 and 2000 mg/kg were significantly reduced ($p<0.01$) during the later part of gestation. A significant reduction in overall maternal body weight (GD 0-20) and net body weight change was also seen in these groups. There was a dose-response on GD 12. Food consumption was reduced at 500 and 2000 mg/kg. At these doses, the absolute and relative thymus weights were significantly lower ($p<0.01$) than controls. Relative liver weights were significantly increased at 2000 mg/kg (GD 13). The number of percent resorptions was increased at 2000 mg/kg on GD 11, 12 and 13; achieving a statistical significance on GD 11 and 12. Litter size at 2000 mg/kg (GD 11 and 12) was decreased significantly ($p<0.01$) and the fetal sex ratio was significantly altered at 2000 mg/kg (GD 11). Mean male fetal body weight was significantly decreased at ≥500 mg/kg and in all viable fetuses in the 2000 mg/kg groups. A significant increase in fetal malformations was observed for all 2000 mg/kg groups. The most common malformations were cleft palate, hind and forepaws brachydactyly (short and stubby toes) and tail (kinked, fleshy tab at the tip). One fetus at 500 mg/kg (GD 12) had hind-paw malformations; one fetus had syndactyly (fused toes) and one fetus had brachydactyly. A significant increase in skeletal malformations was noted at ≥500 mg/kg and included misshapen cervical and caudal vertebrae, misshapen clavicle and costal cartilage and fore- and hind paw phalanges absent, misshapen or fused and incompletely ossified skeletal structures. In 2000 mg/kg groups, significant increase was seen cleft palate. This malformation

was seen at 125 and 500 mg/kg. In addition, diaphragmatic hernia was seen at 2000 mg/kg (GD 11, 12¸and 13) and ectopic esophagus at 2000 mg/kg (GD 13).
[The study did not follow the full dosing regimen (single doses administered), therefore, NOAEL/LOAEL values were not determined for this hazard characterization.]

(9)

Sample 86484	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.0	0.98	9.76	19.52	9.76	4.88	0.98
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (11/dose) were administered single doses of CASRN 64741-62-4 (Syntower Bottoms CRU No. 86484) **via gavage** at 0 (water), 125, 500 or 2000 mg/kg on designated day (see below) during specific periods of organogenesis (GD 11-15) during which the developing conceptus is believed to be sensitive to the teratogenic insult of a chemical.
Group 1: tap water (control) dosed through GD 11 to 15
Group 2: at 2000 mg/kg on GD 11
Group 3: at 125 mg/kg on GD 12
Group 4: at 500 mg/kg on GD 12
Group 5: at 2000 mg/kg on GD 12.
Group 6: at 2000 mg/kg on GD 13
Group 7: at 2000 mg/kg on GD 14
Group 8: at 2000 mg/kg on GD 15
For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Each dam was sacrificed on day 20 of its presumed gestation. Thoracic and abdominal organs were examined and reproductive organs were examined grossly. Thymus and liver weights were taken. The number of corpora lutea and uterus weights were recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0-4 at necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations were conducted.

No treatment-related mortality was seen. Treatment-related clinical signs included vaginal bleeding, perineal staining and decreased stool. The females with red vaginal discharge had large numbers of resorptions. The mean body weights for dams at 2000 mg/kg were significantly reduced ($p<0.01$) during the later part of gestation. A significant reduction ($p<0.01$) in overall maternal body weight (GD 0-20) and net body weight change were seen at 2000 mg/kg. Food consumption was significantly reduced at 2000 mg/kg. Gravid uterine weights were significantly less ($p<0.01$) at $\geq$ 500 mg/kg. At these doses, the absolute and relative thymus weights were significantly reduced ($p<0.01$) than controls. There was no adverse effect on liver weight. The number of percent resorptions was increased at 2000 mg/kg on GD 11, 12 and 15. The litter size was reduced and correspondingly resorptions were increased in all treatment groups achieving a statistical significance ($p<0.01$) at 125 and 2000 mg/kg (GD 11 and 12). The number of dams with resorptions were significantly ($p<0.01$) increased at 500 and 2000 mg/kg (GD 11 and 12). A decrease in fetal body weights was seen at $\geq$ 500 mg/kg; significant ($p<0.01$) at 2000 mg/kg. Fetal external malformations were significantly increased at 2000 mg/kg and generally included cleft palate, brachydactyly (shortness of fingers or toes) and adactyly (one or more fingers or toes missing) and fleshy tab at the tip of the tail and shortened tail. The brachydactyly and adactyly was also seen at 500 mg/kg.

Other fetal variations such as edema and malrotated hindlimb also occurred in fetuses of exposed dams. Skeletal malformations were observed ≥500 mg/kg (GD 11-14) and included misshapen cervical transverse process, shortened tail, hind-paw phalanges fused, misshapen or missing. In complete ossification was noted in many skeletal structures at 2000 mg/kg (GD 11-15). A significant increase in visceral malformations was seen at 2000 mg/kg regardless of the gestation day of test substance administration. Among the findings were small and/or lobular lungs (GD 11, 12, 13), small spleen (GD 11, 15), ectopic and small kidneys (GD 11 and 14), cleft palate (GD 12, 13, 14), right-sided esophagus (GD 12 and 13), heart abnormalities (GD 12 13) and diaphragmatic hernia (GD 12, 13). Some of these findings were also seen at 500 mg/kg. Variations of the urinary tract (dilation of renal pelvis and distended ureters) were seen significantly more often at 125, 500 and 2000 (GD15) mg/kg than in the controls.
[The study did not follow the full dosing regimen (single doses administered); therefore, NOAEL/LOAEL values were not determined for this hazard characterization.]

Subcategory VII: Cracked Distillate

Distillates (petroleum), heavy catalytic cracked (CASRN 64741-61-3)

Sample 091686 (F-222)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	4.00	40.00	4.00	0.60	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered CASRN 64741-61-3 (FCCU Heavy Cycle Oil(HCO);(F-222)) at 0 (sham control), 50, 150 or 500 mg/kg-day for 6 hours/day on to previously clipped intact sites on the backs to alternating sites (intrascapular and lumbar regions) of the animals on gestation days 0 – 20. There were 14, 10, 12, and 10 pregnant females in the control, 50, 150 and 500 mg/kg-day groups, respectively. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

One female from the 150 mg/kg-day group was found dead on GD 16 and two other females from this group were sacrificed in a moribund condition on GD 15 or 16. Slight to moderate skin irritation was seen at all doses. A higher incidence of vaginal discharge was noted in females at all doses. Red, red/black or yellow staining in the perineal region was seen in several females at ≥150 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at ≥50 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly ($p<0.01$) lower at ≥50 mg/kg-day during gestation. At 50 mg/kg-day, the gestation length was significantly longer ($p<0.01$). The number of total and live pups on lactation day 0 was significantly lower ($p<0.01$) and adjusted mean pup weight on lactation day 0 was significantly decreased ($p<0.05$) compared to the control group. At this dose, seven of 10 pregnant females delivered a litter. At 150 mg/kg-day, one of 12 pregnant females delivered a litter. The number of total and live pups on lactation day 0 was significantly lower ($p<0.01$) and although not statistically significant, the

adjusted mean pup weight on lactation day 0 was decreased compared to the control group. At 500 mg/kg-day, none of the 10 pregnant females delivered a litter. At this dose, the number of implantation sites was significantly lower ($p<0.01$) than controls, suggesting increased pre-implantation loss. At 50 and 150 mg/kg-day, there were no significant differences in number of implantation sites, proportion of dead pups on lactation day 0, proportion of pups surviving to lactation day 4, proportion of male pups on lactation days 0 and 4 or external pup alterations.
LOAEL (maternal toxicity) = 50 mg/kg-day (based on decreased body weights, body weight changes and food consumption, increased incidence of vaginal discharge)
NOAEL (maternal toxicity) = not established
LOAEL (developmental toxicity) = 50 mg/kg-day (based decreased number of total and live pups on lactation day 0, decreased pup body weights on lactation day 0)
NOAEL (developmental toxicity) = not established
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

Distillates (petroleum), heavy thermal cracked (CAS No. 64741-81-7)
(1)

Sample 094625 (F-274)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	7.00	9.00	7.00	5.00	2.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats were administered CASRN 64741-81-7 (Heavy Coker Gas Oil, Heavy Thermal Cracked Distillate (HGCO (F274)) at 0 (sham control), 1.0, 50 or 250 mg/kg-day, for 6 hours/day, on to previously clipped intact site on the backs on gestation days 0 – 20. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. There were 15, 10, 12, and 10 pregnant females in the control, 1, 50 and 250 mg/kg-day groups, respectively. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0-4 and sex. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Slight skin irritation was seen at ≥50 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) than controls at ≥1 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption in dams was significantly reduced ($p<0.05$ to $p<0.01$) at ≥1 mg/kg-day during gestation. At necropsy, early resorption sites were noted in two females at 250 mg/kg-day with a red fluid filling the uterus; the uterus of another female was filled with a clear fluid. The gestation length at 50 mg/kg-day was significantly longer ($p<0.01$) than that of the sham controls. No females from the 250 mg/kg-day group delivered a litter. The number of implantation sites were significantly less ($p<0.01$) at 250 mg/kg-day than controls. Total pups per litter and live pups per litter were significantly less ($p<0.05$) at 50 mg/kg-day than the

controls. Average pup body weights were not significantly different at 1 and 50 mg/kg-day compared to controls.
LOAEL (maternal toxicity) = 50 mg/kg-day (based on decreased body weight gain, food consumption)
NOAEL (maternal toxicity) = 1 mg/kg-day
LOAEL (developmental toxicity) = 50 mg/kg-day (based on decreased number of total and live pups delivered per litter)
NOAEL (developmental toxicity) = 1 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(2)

Sample 091653 (F-200)	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.00	0.90	20.00	5.00	0.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (15/dose; 20/control) were administered CASRN 64741-81-7 (Heavy Coker Gas Oil, Heavy Thermal Cracked Distillate (HGCO (F200)) at 0 (sham control), 0.1(diluted in acetone), 50 (neat) or 250 (neat) mg/kg-day, for 6 hours/day, on to previously clipped intact site on the backs on gestation days 0 – 20. (Actual administration of the test substance was from day -7 (pre-mating) to gestation day 20.) The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. The excess test substance was wiped from the application sites after 6-hour exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

One female in the 250 mg/kg-day group was found dead on GD 18. Slight to severe skin irritation was seen at all doses. There was an increased incidence of vaginal discharge in females at 250 mg/kg-day. Body weights and body weight gains were significantly lower ($p<0.05$ to $p<0.01$) at ≥50 mg/kg-day at various time points during gestation and lactation periods. Absolute and/or relative food consumption was significantly lower ($p<0.05$ to $p<0.01$) than controls at 250 mg/kg-day during gestation and pre-mating periods. At necropsy, thymus size was decreased at 250 mg/kg-day (weight data not included). Two females showed resorptions. The total number of live pups and pup body weights were significantly lower ($p<0.01$) at 50 mg/kg-day. At 250 mg/kg-day, only one female delivered a litter. The number of implantation sites in females of this group were significantly lower ($p<0.01$) than the controls suggesting increased pre-implantation loss. At 50 mg/kg-day, the number of total and live pups on lactation day 0 was decreased ($p<0.01$) and pup body weights were lower ($p<0.05$) than that of the controls on lactation days 0 and 4. None of the pups from the only litter that was delivered, survived to lactation day 4 at 250 mg/kg-day. There were no differences in gestation length,

external pup alterations or the proportion of males on lactation day 0 and 4 among all doses and the controls.
LOAEL (maternal toxicity) = 50 mg/kg-day (based on decreased body weights and body weight changes)
NOAEL (maternal toxicity) = 0.1 mg/kg-day
LOAEL (developmental toxicity) = 50 mg/kg-day (based on decreased number of total and live pups and decreased pup body weights)
NOAEL (developmental toxicity) = 0.1 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(3)

Sample 83366	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.10	2.50	5.10	2.50	1.30	0.90	0.10
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (10/dose) were administered CASRN 64741-81-7 (Heavy Coker Gas Oil (HCGO); Heavy Thermal Cracked Distillate (CRU No. 83366)) at 0, 8, 30, 125, 250 mg/kg-day daily on to shaved intact sites on clipped backs on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. Each female was sacrificed on day 20. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Blood samples were collected for evaluation of clinical chemistry parameters. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Moderate to severe skin irritation was seen at all doses. Vaginal bleeding was noted in animals at ≥30 mg/kg-day. Mean body weights, body weight gains, uterine weights and net body weights were decreased in a dose-related manner at ≥ 30 mg/kg-day throughout most of the gestation period. Food consumption was decreased at ≥ 125 mg/kg-day. At ≥ 125 mg/kg-day, thymus weights were lower achieving a statistical significance ($p<0.05$). Pale lungs were seen in treated animals. Absolute liver weights were significantly ($p<0.05$) reduced at 250 mg/kg-day. The relative liver weights were higher ($p<0.01$) at ≥ 125 mg/kg-day. The gravid uterine weights were decreased in a dose-related manner at ≥ 30 mg/kg-day achieving a statistical significance at >125 mg/kg-day. The number of dams with all resorptions, the number of resorptions and litter size were adversely affected in a dose-related manner at ≥125 mg/kg-day. There was an indication of dose-related hepatotoxicity as characterized by increases in serum aspartate amino transferase and sorbitol dehydrogenase activities. A significant decrease ($p<0.05$ to $p<0.01$) in mean fetal body weight was seen at ≥125 mg/kg-day. At these doses, crown-rump length was significantly reduced in female fetuses. External fetal examination showed a slight increase in anomalies at ≥125 mg/kg-day on a fetal basis only (one fetus with edema, one fetus with a slightly reduced lower jaw and one dead fetus with microganthia). The soft tissue examination did not reveal any statistically significant

increase in anomalies. Some skeletal variations, mostly unossified or incompletely ossified bones, were seen at a higher incidence at ≥125 mg/kg-day.
LOAEL (maternal toxicity) = 30 mg/kg-day (based on vaginal bleeding, decreased body weights and food consumption)
NOAEL (maternal toxicity) = 8 mg/kg-day
LOAEL (developmental toxicity) = 125 mg/kg-day (based on increased number and percent resorptions, decreased fetal body weight and crown-rump length, increased fetal anomalies)
NOAEL (developmental toxicity) = 30 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(4)

Sample CRU No.	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
86181	0.25	2.48	12.4	7.44	2.48	0.50	0.0
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (15/dose) were administered CASRN 64741-81-7 (Heavy Coker Gas Oil (HCGO); Heavy (CRU No. 86181)) at 0, 8, 30, 125, 250 mg/kg-day daily on to shaved intact sites on clipped backs on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Each female was sacrificed on day 20. Blood samples were collected for evaluation of clinical chemistry and hematology parameters. Gross examination of organs was conducted; thymus and liver were weighed; the number of corpora lutea per ovary and gravid uterus weight were recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations of pups were conducted.

There were no mortalities. Slight to severe skin irritation was seen at all doses. Vaginal red discharge was noted in animals at ≥30 mg/kg-day with increasing incidence. One female dosed at 250 mg/kg-day was sacrificed in a moribund condition on GD 16 with severe vaginal red discharge. Mean body weights (at all doses), body weight gains and net body weights were decreased in a dose-related manner throughout most of the gestation period achieving a statistical significance at ≥30 mg/kg-day. Food consumption was decreased at all doses with the amount of reduction increased with the increasing dose. Absolute thymus weights were significantly decreased at all doses achieving a statistical significance at ≥ 30 mg/kg-day ($p<0.05$ to $p<0.01$) and relative thymus weights were decreased in a dose-related manner; achieving a statistical significance at ≥125 mg/kg-day. Absolute liver weights were significantly decreased ($p<0.01$) at 250 mg/kg-day; mean relative liver weights were significantly increased ($p<0.05$ to $p<0.01$) at ≥125 mg/kg-day. The gravid uterine weights were decreased in a dose-related manner at ≥ 30 mg/kg-day achieving a statistical significance at >125 mg/kg-day. The number of dams with resorptions, the mean percent resorptions and litter size were adversely affected at all doses, significantly ($p<0.01$) at ≥125 mg/kg-day. Some of the hematological parameters were affected (segmented neutrophils, lymphocytes and monocytes). The changes in clinical chemistry

parameters were comparable with the normal range of non-pregnant animals. Fetal body weights were significantly decreased ($p<0.05$ to $p<0.01$) at ≥125 mg/kg-day. There were no significant findings following the gross examinations of fetuses. Fetal skeletal examinations showed a statistically significant increase in incompletely ossified or unossified sternebrae at 8 mg/kg-day. Isolated incidences of variations and malformations—not dose-related—were seen during the fetal visceral evaluations.

LOAEL (maternal toxicity) = 8 mg/kg-day (based on decreased body weights, body weight gain and food consumption)

NOAEL (maternal toxicity) = not established

LOAEL (developmental toxicity) = 8 mg/kg-day (based on increased mean number and percent resorptions, skeletal variations)

NOAEL (developmental toxicity) = not established

[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(5)

Sample 86193	1-ARC (%)	2-ARC (%)	3-ARC (%)	4-ARC (%)	5-ARC (%)	6-ARC (%)	7-ARC (%)
	0.84	2.94	0.38	0.00	0.00	0.00	0.00
Wt. % of PACs (polyaromatic compounds) that have 1-7 aromatic rings in the Aromatic Ring Class							

Pregnant Sprague-Dawley rats (15/dose; 14/control) were administered CASRN 64741-81-7 (Heavy Coker Gas Oil; Visbreaker Gas Oil (VGO); V B Mittelol (CRU No. 86193)) at 0, 30, 125, 250 mg/kg-day daily on to shaved intact sites on clipped backs on gestation days 0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Each female was sacrificed on day 20. Gross examination of organs was conducted; the number of corpora lutea per ovary and gravid uterus weight were recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. At necropsy, gross observations were made; numbers of resorptions and implantation sites were recorded; and external examinations were conducted.

There were no mortalities. Slight to severe skin irritation was seen at all doses. Mean body weights were not affected by treatment; however, body weight gains were significantly decreased ($p<0.05$) at 250 mg/kg-day. No significant differences in food consumption values at any dose and there were no treatment-related, significant findings at necropsy of females. Although not statistically significant, there was a dose-related increase in resorptions. Dams with resorptions and percent pre-implantation loss were higher at 250 mg/kg-day when compared with controls. There were no differences in fetal body weights from the exposed animals and the controls. There were isolated incidence of variations and malformations during external examination of fetuses; Fleshy tab tip of tail (in one fetus at 125 and one at 250 mg/kg-day,

protruding tongue in one fetus at 250 mg/kg-day). Based on low incidence and no dose response, these observations were considered not to be treatment related.
LOAEL (maternal toxicity) = 250 mg/kg-day (based on decreased body weight gains)
NOAEL (maternal toxicity) = 125 mg/kg-day
NOAEL (developmental toxicity) = 250 mg/kg-day (highest dose tested)
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.*]

(6) Pregnant Sprague-Dawley rats (15/dose) were administered CASRN 64741-81-7 (Coker Heavy Gas Oil) at 0 (sham control), 8, 30, 125, 250 mg/kg-day daily on to the shorn sites on gestation days
0 – 19. The application sites were not occluded; the animals were fitted with Elizabethan collars during the exposure period. For each dam, viability and clinical signs of toxicity were monitored and body weight and food consumption measurements were taken. Each female was sacrificed on day 20. Blood samples were collected for evaluation of clinical chemistry parameters. Gross examination of organs was conducted; thymus and liver were weighed; the number of corpora lutea per ovary and gravid uterus weight were recorded. The number and location of implantations and live and dead fetuses were recorded. Observations in pups included signs of toxicity, mortality, body weight on lactation days 0 and 4 and sex ratio. Skeletal examinations and examination of soft tissue abnormalities for pups were conducted.

There were no mortalities. Slight to severe skin irritation was seen at all doses. Vaginal red discharge was noted in animals at ≥30 mg/kg-day with increasing incidence. The net body weights were decreased at ≥30 mg/kg-day achieving a statistical significance at ≥125 mg/kg-day. Food consumption was decreased at ≥125 mg/kg-day. Clinical chemistry parameters were affected only at 250 mg/kg-day as follows: decreased triglycerides (52%), increase albumin, (36%), A/G ratio (33%), inorganic phosphorus (43%) and iron (2.5 times the control). At necropsy, absolute thymus weights were significantly decreased at all doses achieving a statistical significance at ≥ 125 mg/kg-day. Absolute liver weights were increased and relative liver weights were decreased. The number of dams with all resorptions were increased (50%) at 250 mg/kg-day (50%) and the number of resorptions were increased at 125 mg/kg-day. There were decreases in litter size, fetal body weights and crown-rump length at ≥125 mg/kg-day. The external examinations of pups showed anomalies at ≥125 mg/kg-day. The anomalies included reduced (shortened) lower jaw and edema. Displacement of esophagus and distension of the uterus were also observed. Isolated incidences of variations and malformations were seen during the fetal visceral evaluations.
LOAEL (maternal toxicity) = 125 mg/kg-day (based on decreased body weights, body weight gain, decreased liver and thymus weights and effects on clinical chemistry parameters)
NOAEL (maternal toxicity) = 30 mg/kg-day
LOAEL (developmental toxicity) = 125 mg/kg-day (based on decreased pup body weight, litter size; increased number and percent resorptions, external anomalies)
NOAEL (developmental toxicity) = 30 mg/kg-day
[*Note: In this study, although lesser number of animals/dose are used than those recommended by the guidelines, the study generated sufficient information to assess maternal and*

developmental toxicity. Therefore, it is considered adequate to include in this hazard assessment.]

Subcategory VIII: Reformer Residual

No data.

Genetic Toxicity – Gene Mutation

In vitro

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)

(1) In an Ames assay, *Salmonella typhimurium* strains TA1535, TA1537, TA1538, TA98 and TA100 were exposed to CASRN 68553-00-4 (Fuel Oil No.6; also called as Jet Fuel A) at concentrations of 20,000 and 40,000 µg/plate with and without metabolic activation. Both positive and negative controls were included in the assay. Controls responded appropriately. Cytotoxicity information is unclear. Under the conditions of the assay, Jet Fuel A did not exhibit a positive response in any strain with or without metabolic activation. Additional details are from TSCATS (OTS0536509).
CASRN 68553-00-4 was not mutagenic in this assay.

(2) In a forward mutation assay, mouse lymphoma cells (L5178Y) were exposed to CASRN 68553-00-4 (Fuel Oil No.6; also called as Jet Fuel A) at concentrations ranging from 25 to 200 µg/mL with metabolic activation and from 100 to 2400 µg/mL without metabolic activation. Positive controls responded appropriately. Cytotoxicity information is unclear. Fuel oil No. 6 or Jet Fuel A was mutagenic with metabolic activation. Additional details are from TSCATS (OTS0536509).
CASRN 68553-00-4 was mutagenic in this assay.

Subcategory II: Atmospheric Residual

No data.

Subcategory III: Atmospheric Distillate

No data.

Subcategory IV: Vacuum Residual

Residues (petroleum), vacuum (CASRN 64741-56-6, supporting chemical)
(1) In an *in vitro* gene mutation test, Mouse lymphoma cells (L5178Y) were exposed to CASRN 64741-56-6 (Residues (petroleum), vacuum) was tested in at concentrations of 0, 62.5, 125, 250,

500 or 1000 nL/mL with and without metabolic activation. There was no evidence of mutagenic activity under non-activation conditions. However, with metabolic activation there was an indication of weak activity. This study summary was reported in the HPV Hazard Characterization for the Asphalt Category.
CASRN 64741-56-6 was mutagenic in this assay.

Subcategory V: Vacuum Distillate

No data.

Subcategory VI: Cracked Residual

***Clarified oils (petroleum), catalytic cracked* (*CASRN 64741-62-4*)**
(1) In an *in vitro* gene mutation test, Mouse lymphoma L5178Y cells were exposed to CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (API 81-15)) n at concentrations of 0.061 – 1000 nL/mL. The test substance appeared miscible in the assay medium without activation from 0.061 – 31.3 nL/mL but a brown precipitate was noted at the top concentrations from 62.5 to 100 nL/mL. Under non-activation conditions, weak mutagenic activity was noted. In the presence of metabolic activation, a dose-dependent increase in the mutant frequency was observed at concentrations > 0.977 nL/mL. Both positive and negative controls responded appropriately.
CASRN 64741-62-4 was mutagenic in this assay.

(2) In a forward mutation assay, Chinese hamster ovary cells were exposed to CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (Clarified slurry oil)) at concentrations of 0.1, 1, 3, 10 and 30 µg/mL without S-9 activation and 0.1, 1, 10, 100 and 200 µg/mL with S-9 activation. No dose-dependent increase in the mutant frequencies was noted. Both positive and negative controls responded appropriately.
CASRN 64741-62-4 was not mutagenic in this assay.

Subcategory VII: Cracked Distillate

No data.

Subcategory VIII: Reformer Residual

No data.

In vivo

Subcategory VI: Cracked Residual
No data.

Genetic Toxicity – Chromosomal Aberrations

In vitro

Subcategory I to VIII

No data.

In vivo

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)
In a bone marrow cytogenetic assay, male albino Sprague-Dawley rats (5/dose) were exposed to CASRN 68553-00-4 (Fuel Oil No.6; also called as Jet Fuel A) via inhalation at 0, 400 or 1000 ppm 6 hours/day, 5 days/week for up to a total of 20 exposures (only 5 exposures for the 400 ppm group). Under the conditions of the study, Jet Fuel A showed the ability to produce structural aberrations in bone marrow cells in rats. Additional details are from TSCATS (OTS0536509).
CASRN 68553-00-4 induced chromosomal aberrations in this assay.

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CASRN 64741-57-7)
In a micronucleus assay, rats (10/sex, train not specified) were exposed to CASRN 64741-57-7 (Residues (petroleum), heavy vacuum; Heavy Vacuum Gas Oil) via the dermal route at 30, 125, 500 or 2000 mg/kg-bw/day daily, 5 days/week for 13 weeks. At the end of 14 weeks exposure, the animals were killed and bone marrow cells from femurs were taken from 5 animals/sex/dose (except for females treated at 125 mg/kg-day and males treated at 2000 mg/kg-day). There were no difference between the control values and the treated groups for polychromatic erythrocytes (PCEs)/normochromatic erythrocytes (NCEs) ratios, percent micronucleated PCEs or percent micronucleated NCEs.
CASRN 64741-57-7 did not induce micronuclei in this assay.

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CASRN 64741-62-4)
In mammalian bone marrow chromosome aberration test, Sprague-Dawley rats (10/sex/dose) were exposed to CASRN 64741-62-4 (Clarified oils (petroleum) catalytic cracked (API 81-15)) via gavage at 0.1, 0.3 or 1 g/kg-day for 5 days. After the exposure and an intraperitoneal injection of colchicine, the animals were killed, bone marrow smears were prepared, stained and chromosomal aberrations were scored. At all doses the number of bone marrow cells with chromosomal aberrations did not differ from those for the negative control. The positive control responded appropriately.
CASRN 64741-62-4 did not induce chromosomal aberrations in this assay.

Other Information

Subcategory VI: Cracked Residual

***Clarified oils (petroleum), catalytic* cracked (CAS No. 64741-62-4)**
(1) In a sister chromatid exchange assay, mouse embryo cells were exposed to CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (API 81-15)) at 1, 2, 6 or 9 µg/mL without metabolic activation and 10, 30, 100 or 300 µg/mL with metabolic activation. Both positive and negative controls were run. Positive controls responded appropriately. Sister chromatid exchanges were increased in the presence of metabolic activation, but not in the absence of activation.
CASRN 64741-62-4 induced sister chromatid exchange in this assay.

(2) In an *in vitro* unscheduled DNA synthesis (UDS) assay, primary hepatocytes cultures (from F-344 rats) were exposed to CASRN 64741-62-4 (Clarified Slurry Oil; Clarified oils (petroleum), catalytic cracked)) at 0.5 to 100 µg/mL. Cytotoxicity was seen at 500 and 1000 µg/mL. Unscheduled DNA synthesis was elevated compared to that in the solvent control.
CASRN 64741-62-4 induced UDS in this assay.

(3) In another *in vitro* UDS assay, primary rat hepatocyte cultures were exposed to CASRN 64741-62-4 (Clarified Slurry Oil; Clarified oils (petroleum), catalytic cracked)) at concentrations ranging from 1×10^{-6} to 1000 µg/mL. Both positive and negative controls were run. Positive controls responded appropriately. The presence of a dose-response, positive net grain count and increased number of cells in repair indicate that the test substance is genotoxic.
CASRN 64741-62-4 induced UDS in this assay.

(4) In an unscheduled DNA synthesis assay, Fischer 344 male rats were exposed to CASRN 64741-62-4(clarified oils (petroleum), catalytic cracked) via gavage at 50, 200 or 1000 mg/kg at 2 and 12 hours prior to sacrifice. Primary hepatocyte cultures were obtained from the livers of treated rats. Unscheduled DNA synthesis was elevated above that in the solvent control.
CASRN 64741-62-4 induced UDS in this assay.

In the dominant lethal assay, male Crl:CD(SD)BR VAF/Plus rats (10/dose) were administered percutaneous doses of CASRN 64741-62-4 (Clarified slurry oil) at 0, 0.1, 1.0, 10, 50 and 250 mg/kg-day for 70days before a seven-day cohabitation period with untreated virgin female rats. Two female rats were assigned with each male rat. The female rats were not administered the test substance. The male rats were observed for viability and clinical signs of toxicity, signs of irritation; and body weight and food consumption were recorded. The male rats were sacrificed after completion of the cohabitation period. The testes, epididymides, seminal vesicles, prostate gland, pituitary gland and brain were weighed. The left testis and epididymis were used for evaluation of the spermatozoa, testicular spermatid count and concentration, and cauda epididymal spermatozoa count, concentration and motility, and evaluation of the epididymal fluid for debris and unexpected cell types. The right testis, epididymis, seminal vesicle, prostate gland, pituitary gland and gross lesions were processed for histopathological examination. The females were examined for viability and clinical signs of toxicity. Body weight and food consumption were recorded. On day 14 of gestation, the females were sacrificed and a gross necropsy was performed; the uterus was examined for pregnancy, number and distribution of implantations, early resorptions and live and dead embryos. The number of corpora lutea in each ovary was recorded for the non-pregnant females.

No deaths and no skin reactions were caused by the test substance. An increase in a number of pale rats was seen a 50 and 250 mg/kg-day. One rat at 250 mg/kg-day had small, pale seminal vesicles and prostate and small pituitary. Decreased absolute prostate weights were seen at ≥10 mg/kg-day. There was a reduced body weight gain at ≥10 mg/kg-day. Absolute and relative food consumption was reduced ($p<0.05$ to $p<0.01$) at ≥50 mg/kg-day. Mating and fertility parameters were unaffected by the treatment. The females assigned to cohabitation with male rats were unaffected by treatment in relation to clinical signs, necropsy observations or average body weights, body weight gains or food consumption values. Litter averages for corpora lutea, implantations and live embryos; resorptions were not significantly different among the dose groups. There were no dead embryos and no dams resorbed all conceptuses. .
CASRN 64741-62-4 did not induce dominant lethal mutation in this assay.

Additional Information

Skin Irritation

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)
New Zealand White rabbits (3/sex) were administered four different samples of undiluted (0.5 mL each) CASRN 68553-00-4 (Heavy Fuel oil, No. 6 (API 78-6, 78-7, 78-8, 79-2;) to the intact and abraded skin of each rabbit under occluded conditions for 24 hours. After 24 hours, any excess test substance was removed by wiping. Erythema and edema was minimal for three samples (API 78-6, 78-7 and 78-8). Sample API 79-2 caused severe erythema in one rabbit that was resolved by 72 hours. In another animal, API 79-2 caused minimal erythema at 24 hours but its severity increased by 72 hours. The average primary irritation scores were 0.35, 0.73, 0.27 and 1.54 for API 78-6, 78-7, 78-8 and 79-2, respectively.

CASRN 68553-00-4 was irritating to rabbit skin in this study.

Subcategory II: Atmospheric Residual

Residues (petroleum), atm. tower (CASRN 64741-45-3)
New Zealand rabbits (6, sex not indicated) were administered 0.5 mL of undiluted CASRN 64741-45-3 (Residues (petroleum), atm. Tower; Atmospheric residue) to the intact skin under occluded conditions for 24 hours and observed for 7 days after application. After 24 hours, any excess test substance was removed by wiping. Edema was observed in all animals after 24 hours. Erythema was observed after 72 hours; however, it could not be assessed properly due to the staining nature of the test substance. The primary irritation score was 3.5.
CASRN 64741-45-3 was irritating to rabbit skin in this study.

Subcategory III: Atmospheric Distillate

Diesel fuel No. 2 (CASrN 68476-34-6, supporting chemical)
In the 4-week study in Sprague-Dawley rats, described previously in the acute dermal toxicity section, skin irritation occurred at ≥0.5 mL/kg-day.
CASRN 68476-34-6 was irritating to rat skin in this study.

Subcategory IV: Vacuum Residual

Residues (petroleum) vacuum (CASRN 64741-56-6, supporting chemical)
Six New Zealand rabbits (sex not reported) were administered 0.5 mL for undiluted CASRN 64741-56-6 (Residues (petroleum) vacuum) to intact and abraded skin under occluded conditions for 24 hours and observed for 7 days. At 24 and 72 hours after application, erythema was seen. However, due to dark staining of the skin at the application site, it was difficult to assess erythema properly. The primary irritation index was 0.18. Edema was not observed at either abraded or intact skin sites. Signs of irritation had resolved by day 4.
CASRN 64741-56-6 was irritating to rabbit skin in this study.

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CASRN 64741-57- 7)
Rabbits (3/sex, unspecified strain) were administered 0.5 mL of undiluted CASRN 64741-57-7 (Residues (petroleum), heavy vacuum gas oil) to six sites on the right and left flanks of each under occluded (4 hours and 24 hours) and non-occluded (24 hours) conditions. After 24 hours, any excess test substance was removed by wiping. Animals were observed for 7 days after application. At 24 hours, irritation scores ranged from 2.2 for occluded sites and 2.7 for non-occluded sites.
CASRN 64741-57-7 was irritating to rabbit skin in this study.

Gas oils (petroleum), hydrodesulfurized heavy vacuum (CASRN 64742-86-5)
New Zealand White rabbits (3/sex) were administered 0.5 mL of undiluted CASRN 64742-86-5 (Hydrosulfurized heavy vacuum gas oil) to the intact and abraded skin of each rabbit under occluded conditions for 24 hours. Animals were observed for up to 6 days after application.

Very slight to well-defined erythema was observed during the course of the study. By day 6, all irritation scores were zero. The average primary irritation index was 0.17. Additional details are from TSCATS (OTS0513402).
CASRN 64742-86-5 was irritating to rabbit skin in this study.

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CASRN 64741-62-4)
Six rabbits (unspecified strain) were administered 0.5 mL of undiluted CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (API 81-15)) to intact and abraded skin of each rabbit under occluded conditions for 24 hours; animals were observed for 7 days after application. After 24 hours the treated skin was wiped to remove any residue of the test substance. The primary irritation index based on 24 and 72 hours scores was 0.2. The irritation increased gradually on the later observation days. It is concluded in the robust summary that the tar-like nature of the test substance, it was not all removed from the application sites following the 24-hour exposure period. The remaining test substance was probably responsible for the increased dermal irritation observed at the 7 day observation period.
CASRN 64741-62-4 was irritating to rabbit skin in this study.

Subcategory VII: Cracked Distillate

Cracked distillate (CASRN 64741-81-7)
(1) Six New Zealand White rabbits (sex not reported) were administered 0.5 mL of undiluted CASRN 64741-81-7 (Cracked distillates) to intact and abraded skin of each rabbit under occluded conditions for 24 hours. After 24 hours the treated skin was wiped to remove any residue of the test substance. The primary irritation index was 5.1 for intact skin and 5.6 for abraded skin. Erythema and edema were observed for both intact and abraded skin immediately following exposure.
CASRN 64741-81-7 was irritating to rabbit skin in this study.

(2) Six rabbits (3/sex; strain not reported) were administered 0.5 mL of undiluted CASRN 64741-81-7 (Visbreaker Gas Oils, 3 samples—Visbreaker HGO, Vis gas oil VIBRA and VB Mittelol) to intact and abraded skin sites (total six sites on each rabbit). The three sites on the right flank were abraded and the three sites on the left flank remained intact. The anterior and middle test sites were occluded and the posterior sites were left unoccluded. Following a 4-hour exposure period, the anterior sites were wiped to remove excess test substance and after 24 hours, the middle and posterior sites were wiped of excess test substance and were evaluated for irritation. Average 4-hour (occluded) erythema and edema scores were 1.3 to 1.9 and 1.0 to 1.2, respectively. Average 24-hour (occluded) primary irritation index was 2.4 to 3.6.
CASRN 64741-81-7 was irritating to rabbit skin in this study.

(3) Six New Zealand White rabbits (sex not reported) were administered 0.5 mL of undiluted CASRN 64741-81-7 (Vacuum tower bottoms) to intact and abraded skin of each rabbit under occluded conditions for 24 hours. After 24 hours the treated skin was wiped to remove any residue of the test substance. It was difficult to read erythema due to the staining of the skin at

the application sites; the erythema was scored adjacent to the patch test site. The primary irritation index was 0.18.
CASRN 64741-81-7 was not irritating to rabbit skin in this study.

Eye Irritation

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)
Nine New Zealand rabbits were instilled 0.1 mL of undiluted CASRN 68553-00-4 (Heavy fuel oil) on the everted lower eyelid of the right eye. The test eyes of three rabbits were rinsed with warm distilled water for 1minutes following 30 seconds exposure. The test eyes of other rabbits remained unwashed. Ocular irritation was observed at 24, 48 and 72 hours after treatment. Four different samples (API 78-6, 78-7, 78-8 and 79-2) were tested following the same protocol; for two samples the observation period was extended until no irritation was seen. Irritation was scored by the method of Draize. The average 24-hour irritation scores ranged from 2.67 to 7.67 for washed eyes and 4.0 to 7.33 for unwashed eyes.
CASRN 68553-00-4 was irritating to rabbit eyes in this study.

Subcategory II: Atmospheric Residual

Residues (petroleum), atmospheric (CASRN 64741-45-3)
Three male New Zealand White rabbits were instilled undiluted (0.1 mL) CASRN64741-45-3 (Residues (petroleum), atmospheric) in the conjunctival sac of the right eye and ocular irritation was observed at 1, 24, 48 and 72 hours. There was no evidence of damage to the iris. Average eye irritation scores at 24 and 72 hours were 0.
CASRN64741-45-3 was not irritating to rabbit eyes in this study.

Subcategory IV: Vacuum Residual

Residues (petroleum), vacuum (CASN 64741-56-6)
Twelve New Zealand White rabbits were instilled undiluted (0.1 mL) CASRN 64641-56-6 (Residues (petroleum), vacuum) onto the corneal surface of the right eye and ocular irritation was observed at 1, 24, 48 and 72 hours after treatment and again at 4, 7, 10 and 14 days after treatment. Half of the treated eyes were flushed with water 20 – 30 seconds after instillation of the test substance. Irritation was scored by the method of Draize. Conjunctival redness and swelling were observed. No corneal opacity or iritis was observed. The test substance was non-irritating in unrinsed eyes and minimally irritating in rinsed eyes.
64641-56-6 was not irritating to rabbit eyes in this study.

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CASRN 64741-57-7)
Six rabbits (3/sex; strain not reported) were instilled 0.1 mL of undiluted CASRN 64741-57-7 (Heavy vacuum gas oil)) into the conjunctival sac of the left eye and ocular irritation was

observed at 1, 24, 48 and 72 hours after treatment. Irritation was scored by the method of Draize. Conjunctival redness and swelling were observed. No corneal opacity or iritis was seen. The Irritation score for heavy vacuum gas oil at 24 hours was 10.3.
CASRN 64741-57-7 was irritating to rabbit eyes in this study.

Gas oils (petroleum), hydrodesulfurized heavy vacuum (CASRN 64742-86-5)
Six New Zealand White rabbits were instilled 0.1 mL of CASRN 64742-86-5 (Hydrosulfurized heavy vacuum gas oil) in to the right eyes; the left eyes served as controls. Test eyes remained unwashed and rabbits were observed for up to 7 days. Positive ocular responses were observed at 1 and 24 hours, but all symptoms resolved by 72 hours. The average Draize score at 24 hours was 12.6. Additional details are from TSCATS (OTS0513402).
CASRN 64742-86-5 was irritating to rabbit eyes in this study.

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CASRN 64741-62-4)
Nine rabbits (sex and strain not noted) were instilled 0.1 mL of undiluted CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (API 81-15)) to the corneal surface of one eye and ocular irritation was observed at 1, 24, 48 and 72 hours and 7 days after treatment. After 30 seconds, the treated eyes of three rabbits were washed with water for 1 minute. Eyes of the other 6 rabbits were not washed. Irritation was scored by the method of Draize. The presence of brown or light brown test material was noticeable at the observation and scoring. Signs of irritation abated by 24 hours, after which time, eyes were normal.
CASRN 64741-62-4 was irritating to rabbit eyes in this study.

Subcategory VII: Cracked Distillate

Cracked distillate (CASRN 64741-81-7)
(1) Twelve New Zealand White rabbits (sex not noted) were instilled 0.1 mL of undiluted CASRN 64741-81-7 (Cracked distillates; F97-01) onto the corneal surface of the right eye and ocular irritation was observed at 1, 24, 48 and 72 hours and 7 days after treatment. In half of the rabbits, the treated eyes were flushed for 1 minute with lukewarm water. Conjunctival redness and swelling were observed. All signs of irritation cleared by 72 hours.
CASRN 64741-81-7 was not irritating to rabbit eyes in this study.

(2) Six rabbits (3/sex; strain not reported) were instilled 0.1 mL of undiluted CASRN 64741-81-7 (Visbreaker gas oils, 3 samples--Visbreaker heavy gas oil, Vis gas oil VIBRA and VB Mittelol) into the conjunctival sac of the left eye and ocular irritation was observed at 1, 24, 48 and 72 hours after treatment. Irritation was scored by the method of Draize. Conjunctival redness and swelling were observed. No corneal opacity or iritis was seen. Irritation scores at 24 hours were 1.7 to 5.3.
CASRN 64741-81-7 was irritating to rabbit eyes in this study.

Sensitization

Subcategory I: Residual Fuel Oils

Fuel oil, No. 6 (CASRN 68553-00-4)
(1) Ten Guinea pigs (sex not indicated) were administered 0.5 mL of undiluted CASRN 68553-00-4 (four different heavy fuel oil samples (API 78-6, API 78-7, API 78-8 and API 79-2)) to shorn skin for 6 hours/day, once a week for 3 weeks under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.5 mL of undiluted heavy fuel oils on different application sites. Dinitrochlorobenzene (DNCB) in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 hours after each dose. Three of the samples (API 78-6, API 78-8 and API 79-2) were not skin sensitizers since the degree of response to the challenge dose was less than that for the positive controls. One sample (API 78-7) was mildly sensitizing.
CASRN 68553-00-4 was sensitizing to guinea pigs in this study.

(2) Six Guinea pigs (sex not indicated) were administered 0.5 mL of undiluted CASRN 68553-00-4 (heavy fuel oil (F-74-01) to the shaved skin, for 6 hours/day, once a week for 3 weeks, under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.5 mL of undiluted heavy fuel oils on different application sites. DNCB in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 and 48 hours after each induction and challenge dose. During the induction phase, only 4 out of 10 animals had severity of 0 - 0.4 compared to 10 out of 10 positive control animals with severity 2.3 – 3.1. Treated animals did not show any signs of irritation during the challenge phase.
CASRN 68553-00-4 was not sensitizing to guinea pigs in this study.

Subcategory II: Atmospheric Residual

Residues (petroleum), atm. tower (CASRN 64741-45-3)
Ten guinea pigs (sex not reported) were administered 0.5 mL of undiluted CASRN 64741-45-3 (Atmospheric residues (petroleum), atm. Tower, F-132) to shaved skin for 6 hours/day, once a week for 3 weeks under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.5 mL of undiluted heavy fuel oils on different application sites. DNCB in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 and 48 hours after each induction and challenge dose. None of the test animals became sensitized following treatment. A positive control responded appropriately.
CASRN 64741-45-3 was not sensitizing to guinea pigs in this study.

Subcategory IV: Vacuum Residual

Residues (petroleum), light vacuum (CASRN 68512-62-9)
Ten guinea pigs (sex not reported) were administered 0.5 mL of undiluted CASRN 68512-62-9 (vacuum tower bottoms or vacuum residues) to shaved skin for 6 hours/day, once a week for 3 weeks under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.5 mL of undiluted heavy fuel oils on different application sites.

DNCB in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 and 48 hours after each induction and challenge dose. None of the test animals became sensitized following treatment. A positive control responded appropriately.
CASRN 68512-62-9 was not sensitizing to guinea pigs in this study.

Subcategory V: Vacuum Distillate

Residues (petroleum), heavy vacuum (CASRN 64741-57-7)
Ten guinea pigs (sex not reported) were administered 0.5 mL of undiluted CASRN 64741-57-7 (Heavy Vacuum Gas Oil, HVGO) to shaved skin for 6 hours/day, once a week for 3 weeks under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.5 mL of undiluted heavy fuel oils on different application sites. DNCB in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 and 48 hours after each induction and challenge dose. None of the test animals became sensitized following treatment. A positive control responded appropriately.
CASRN 64741-57-7 was not sensitizing to guinea pigs in this study.

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CAS No. 64741-62-4)
Ten male Guinea pigs were administered 0.4 mL of undiluted CASRN 64741-62-4 (Cracked residue, API 81-15) to shaved skin for 6 hours/day, once a week for 3 weeks under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.4 mL of undiluted heavy fuel oils on different application sites. DNCB in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 and 48 hours after each induction and challenge dose. None of the test animals became sensitized following treatment. A positive control responded appropriately.
During the induction phase of the study, dermal irritation included very slight edema and very slight to well defined erythema. No dermal irritation was exhibited by either the test group or naïve controls following challenge application. A positive control responded appropriately.
CASRN 64741-62-4 was not sensitizing to guinea pigs in this study.

Subcategory VII: Cracked Distillate

Distillates (petroleum), heavy thermal cracked (CASRN 64741-81-7)
Ten male Guinea pigs were administered 0.5 mL of undiluted CASRN 64741-81-7 (Cracked distillate) to shaved skin for 6 hours/day, once a week for 3 weeks under occluded conditions (Induction phase). After a 2-week rest period, the treated animals were challenged with 0.5 mL of undiluted heavy fuel oils on different application sites. DNCB in ethanol was used a positive control. Skin reactions were graded for erythema and edema 24 and 48 hours after each induction and challenge dose. None of the test animals became sensitized following treatment. A positive control responded appropriately.
CASRN 64741-81-7 was not sensitizing to guinea pigs in this study.

Carcinogenicity

Subcategory VI: Cracked Residual

Clarified oils (petroleum), catalytic cracked (CAS No. 64741-62-4)
(1) In a Lifetime Dermal Carcinogenicity/Chronic Toxicity Screening Bioassay, 50 µL CASRN 64741-62-4 (Clarified oils (petroleum), catalytic cracked (API 81-15)), diluted in toluene, was applied to the shaved backs of C3H mice (50 males/dose) at 0, 0.1, 1 or 10% twice/week for their lifetime. Vehicle (toluene) and positive controls (benzo-a-pyrene in toluene) were also tested. By week 52, ninety-four percent of the high-dose mice died. Neoplasms occurred in all treatment groups and toluene controls. Several neoplastic legions were observed in the non-dermal tissues of mice. Six types of neoplasms were observed at the dermal test sites in mice of the treated groups. These included fibromas, papillomas, hemangiomas, fibrosarcomas, squamous cell carcinomas and malignant melanomas; the first three being benign neoplasms. Metastatic tumors (squamous cell carcinoma and fibrosarcoma) were observed at ≥ 1% groups. Additional details are from TSCATS (OTS0000426-8).
CASRN 64741-62-4 increased tumor incidence in this study.

(2) During a 28-week dermal tumorigenicity bioassay (to assess the initiation/promotion potential), 50 µL 1% (diluted in toluene) CASRN 64741-42-4 (Clarified oils (petroleum), catalytic cracked (API 81-15)) (was applied to the shaved back of 30 male CD-1 mice twice weekly for 25 weeks following a pre-treatment with 1 mg/mL dimethyl benzantahracene (DMBA) for 1 week and a 2-week rest period. Negative, vehicle and positive controls were also tested. Time to first tumor appearance was significantly reduced in treated mice, but the incidence and total number of clinically observed masses increased. However, the incidence of histologically confirmed neoplasms was comparable to controls. Additional details are from TSCATS (OTS0000547-1).
CASRN 64741-62-4 increased tumor incidence in this study.

Pitch, petroleum, arom (CAS No. 68187-58-6)
In a mouse skin-painting assay, CASRN 68187-58-6 (pitch petroleum, aromatic) was applied in toluene to the shaved backs of 40 male C3H mice at 1850 mg/kg, twice/week for 109 weeks. A group of 40 additional rats served as vehicle controls and another group of 20 rats received similar treatment with a positive control (~ 5.5 mg/kg benzo(a)pyrene /week). Based on gross pathology, treated rats exhibited a greater incidence of malignant tumors than controls. The study histopathology characterized the benign tumors primarily as papillomas and keratoacanthomas, and the malignant tumors as squamous cell carcinomas. Less predominant neoplastic lesions in the treated animals were a hemangioma, a fibrosarcoma and a basal cell carcinoma. Additional details are from TSCATS (OTS204860).
CASRN 68187-58-6 increased tumor incidence in this study.

Subcategory VII: Cracked Distillate

Distillates (petroleum), heavy catalytic cracked (CAS No. 64741-61-3)
(1) In a mouse skin painting test, one hundred female CD-1 mice received 20 mg of

CASRN 64741-61-3 (distillates (petroleum), heavy catalytic cracked) dermally 3 times/week for up to 193 days (sacrificed because moribund). Treated mice (81%) developed a greater number of skin tumors (squamous cell carcinoma, papilloma, basal cell carcinoma) than controls (0.5%). Additional details are from TSCATS (OTS200438).
CASRN 64741-61-3 increased tumor incidence in this study.

(2) In a mouse skin painting test, CD-1 mice (25/sex) received 20 mg CASRN 64741-61-3 (of distillates (petroleum), heavy catalytic cracked) dermally 3 times/week for up to 11 months sacrificed because moribund). Treated mice (80% males and females) developed a greater number of skin tumors (squamous cell carcinoma, papilloma) than controls (1.3% males, 0% females). Additional details are from TSCATS (OTS200438).
CASRN 64741-61-3 increased tumor incidence in this study.

Conclusion:

Subcategory I: Residual Fuel Oils

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 68553-00-4 is low, while the acute inhalation toxicity to rats for CASRN 68476-33-5 is moderate. In a 28-day repeated-dose dermal toxicity study in rats with CASRN 68476-33-5, the following systemic effects were observed at the highest tested dose of 480 mg/kg-day: increased liver and spleen weights and decreased hemoglobin and hematocrit values. The NOAEL is not established. No data are available for reproductive and developmental toxicity. CASRN 68553-00- 4 was not mutagenic in bacteria but was mutagenic in mammalian cells *in vitro*. CASRN 68553-00-4 induced chromosomal aberrations in rat bone marrow cells *in vivo*. CASRN 68553-00-4 was irritating to rabbit skin and eyes and sensitizing to guinea pigs skin.

Subcategory II: Atmospheric Residual

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-45-3 is low. Following a 4-week dermal exposure of rats to CASRN 64741-45-3, no systemic effects were noted. The NOAEL is 940 mg/kg-day (highest dose tested). Data for reproductive toxicity are not available. The prenatal developmental toxicity study in rats, via the dermal route with CASRN 64741-45-3, was conducted with lesserer number of rats (10-15/dose) than recommended by the guidelines; but the study is acceptable. The study provided LOAELs of 1000 mg/kg-day and NOAELs of 333 mg/kg-day for both maternal and developmental toxicity. The maternal effects include a significant decrease in gestational body weights and significantly increased gestational length. The developmental effects include significantly decreased pup body weights. No data are available for gene mutation or chromosomal aberrations endpoints. CASRN 64741-45-3 was irritating to rabbit skin, not irritating to rabbit eyes and not-sensitizing to guinea pig skin.

Subcategory III: Atmospheric Distillate

The acute dermal toxicity of CASRN 68476-34-6 (supporting chemical stream) to rabbits is low. A 13-week dermal toxicity study conducted in rats with CASRN 68915-97-9 (supporting chemical stream), showed a LOAEL of 125 mg/kg-day based on effects on clinical chemistry (increased BUN, cholesterol, sorbitol dehydrogenase, total protein, globulin and decreased A/G ratio) and hematology (decreased RBC, hemoglobin, hematocrit and platelets) parameters and relative organ weights (liver, thymus, adrenals, heart, kidney, spleen). The NOAEL is 30 mg/kg-day. No reproductive toxicity data are available.

A total of five pre-natal developmental toxicity studies were performed using both sponsored chemicals on one supporting chemical; all studies used the dermal route of exposure. In a prenatal dermal developmental toxicity study of CASRN 68410-00-4 in rats (25/dose), the LOAEL for maternal toxicity is 250 mg/kg-day based on significantly decreased body weights and body weight gains; the NOAEL is 50 mg/kg-day. No developmental effects were seen in this study; the NOAEL for developmental toxicity is 500 mg/kg-day (highest dose tested). In two other prenatal dermal developmental toxicity studies with CASRN 68410-00-4 using lesser number of animals (12-19/dose) and having different compositions of polyaromatic compounds (PACs), the range for LOAELs for maternal toxicity is 250 to 500 mg/kg-day and that for developmental toxicity is 125 to 150 mg/kg-day. The maternal effects include decreased body weight, body weight gain and food consumption. The developmental effects include decreased pup weights. The NOAELs for maternal toxicity range from 125 to 150 mg/kg-day and NOAELs for developmental toxicity range from "not established" to 50 mg/kg-day. In another prenatal dermal developmental toxicity study of CASRN 68783-08-4 in rats, conducted using lesser number of animals (12-19/dose),the LOAEL for both maternal and developmental toxicity is 250 mg/kg-day. The maternal effects include significant decreases in body weights, body weight gains and food consumption and developmental effects include significantly decreased number of total and live pups delivered, decreased pup body weights and incomplete ossification. The NOAEL for maternal and developmental toxicity is 50 mg/kg-day. For the supporting chemical stream CASRN 68915-97-9, the LOAEL for maternal and developmental toxicity is 125 mg/kg-day; the NOAEL is 30 mg/kg-day. The maternal effects include decreased body weight, body weight gains and food consumption. Developmental effects include decreased total and live pups delivered, decreased pup body weights and incomplete ossification. No data are available for gene mutation or chromosomal aberrations endpoints. CASRN 68476-34-6 (supporting chemical stream) was irritating to rabbit skin.

Subcategory IV: Vacuum Residual

There were no data available on either of the two sponsored chemicals. The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-56-6 (supporting chemical stream) is low; and the acute inhalation toxicity to rats is moderate. In the 4-week repeated-dose dermal toxicity study of CASRN 64741-56-6 (supporting chemical stream) in rabbits, the LOAEL of 2000 mg/kg-day is based on decreased body weight gains and decreased alkaline phosphatase activity in male rabbits. The NOAEL is 1000 mg/kg-day. No reproductive or developmental toxicity data are available. CASRN 64741-56-6 (supporting chemical stream) was mutagenic in bacteria *in vitro*. No data for chromosomal aberrations are available. CASRN 64741-56-6

(supporting chemical stream) was irritating to rabbit skin but not to rabbit eyes. CASRN 68512-62-9 was not sensitizing to guinea pig skin.

Subcategory V: Vacuum Distillate

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-57-7 is low. A 13-week dermal toxicity study in rats with CASRN 64741-57-7 showed a LOAEL of 125 mg/kg-day based on effects on hematological parameters (decreased RBC count, hemoglobin, hematocrit and platelets). The NOAEL is 30 mg/kg-day. No reproductive toxicity data are available. A number of prenatal developmental toxicity studies were conducted via dermal exposure to CASRN 64741-57-7. In one study in rats (25/dose), CASRN 64741-57-7 showed a LOAEL of 75 mg/kg-day for maternal toxicity based on significantly decreased body weights and body weight gains; the NOAEL is not established. The developmental toxicity LOAEL is 75 mg/kg-day based on significantly decreased pup body weight, increased incidence of microphthalmia and delayed ossifications; the NOAEL is not established. In another study in rats (25/dose), CASRN 64741-57-7 showed a LOAEL of 100 mg/kg-day for maternal toxicity based on significantly decreased body weights and body weight gains; a NOAEL of 50 mg/kg-day. The developmental toxicity LOAEL is 250 mg/kg-day based on significantly decreased pup body weight, and increased variations in fetal skeletal ossifications; the NOAEL is 100 mg/kg-day. Several similar studies with CASRN 64741-57-7 using lesser number of animals (10-20/dose) and varying compositions of PACs showed similar effects with LOAELs ranging from 150 to 500 mg/kg-day for both maternal and developmental toxicity. The range for NOAELs is 1 to 125 mg/kg-day. Additional maternal effects in these studies were vaginal red discharge, effects on thymus and decreased numbers of implantation sites. In a prenatal developmental toxicity study in rats via the dermal route with CASRN 64742-86-5 conducted with lesser number of animals (12-15/dose), the LOAEL for maternal and developmental toxicity is 333 mg/kg-day based on significantly decreased body weights and body weight gains for maternal toxicity and significantly decreased pup body weight and dead pups delivered for developmental toxicity. The NOAEL is 50 mg/kg-day. No data for gene mutation are available; CASRN 65741-57-7 did not induce micronuclei when tested *in vivo*. CASRNs 64741-57-7 and 64742-86-5 were irritating to rabbit skin and eyes and CASRN 64741-57-7 was non-sensitizing to guinea pig skin.

Subcategory VI: Cracked Residual

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-62-4 is low. There were several repeated-dose toxicity studies in rats via the dermal route with CASRN 64741-62-4. In a 13-week study, a LOAEL of 8 mg/kg-day was based on effects on the liver and thymus (increased liver weights and decreased thymus weight and histopathological findings), body weight and body weight gains, and/or effects on hematology and clinical chemistry parameters. The NOAEL was not established. Similar effects were seen in several 28-day studies with a lowest LOAEL of 10 mg/kg-day and NOAEL not established. One of the 28-day studies also showed microscopic changes in the skin (sub-acute acanthotic dermatitis, minimal to severe early multifocal papillomatosis (skin surface elevation caused by hyperplasia and enlargement of contiguous dermal papillae)) at 2000 mg/kg-day. For CASRN 64741-75-9, a 28-day dermal toxicity study in rats resulted in a NOAEL of 210 mg/kg-day, the highest dose tested.

A 13-week dermal toxicity study with CASRN 64741-80-6 showed a LOAEL of 60 mg/kg-day based on effects on liver, adrenals and alanine amino transferase; the NOAEL is not established. No reproductive toxicity data are available. A dominant lethal assay in rats (treated male rats mated with untreated females) showed no effects. In a prenatal developmental toxicity study of CASRN 64741-62-4 in rats (24/dose) via the dermal route, the LOAEL for maternal toxicity is 1.0 mg/kg-day based on increased vaginal red discharge, significantly decreased body weights and food consumption; the NOAEL is 0.05 mg/kg-day. The LOAEL for developmental toxicity is 1.0 mg/kg-day; the effects include increased resorptions, decreased number of live fetuses, decreased body weights and increased incidence of fetal variations (moderate dilation of renal pelvis, slight dilation of lateral ventricle of brain, bifid thoracic vertebral centrum and decreased average number of ossified caudal vertebrae). The NOAEL for developmental toxicity is 0.05 mg/kg-day. Several other studies are conducted using lesser number of animals (10-15/dsoe) than that is recommended by guidelines. For CASRN 64741-62-4 with varying compositions of PACs, the range of LOAEL values for maternal toxicity is 4 to 100 mg/kg-day. The effects include decreased body weights and body weight gains, food consumption, increased vaginal discharge, increased gestational length, and/or thymus atrophy. The range for LOAEL values for developmental toxicity in these studies is 4 to 250 mg/kg-day. The effects include decreased pup body weights, decreased number of pups delivered per litter, increased resorptions, decreased number of male pups, decreased crown-rump length and/or fetal alterations. The range for NOAELs for maternal toxicity and developmental toxicity is ‘not established’ to 10 mg/kg-day. CASRN 64741-62-4 was not mutagenic in mammalian cells *in vitro* and did not induce chromosomal aberrations *in vivo*; however, it induced sister chromatid exchanges *in vitro* and unscheduled DNA synthesis *in vitro* and *in vivo*. CASRN 64741-62-4 did not induce dominant lethal mutation in rat germ cells. CASRN 64741-62-4 was irritating to rabbit skin and eyes and was not sensitizing to guinea pigs skin. CASRNs 64741-62-4 and 68187-58-6 increased tumor incidences in mice.

Subcategory VII: Cracked Distillate

The acute oral toxicity to rats and acute dermal toxicity to rabbits of CASRN 64741-81-7 is low. Among several 13-week repeated-dose dermal toxicity studies in rats conducted with CASRN 64741-81-7 with varying composition of PACs, the range of LOAEL values is 30 to 125 mg/kg-day. The systemic effects include decreased body weights, increased relative testes weights, decreased epididymis weights and/or decreased hematocrit and MCH values. The range of NOAEL values is 'not established' to 30 mg/kg-day. In two 28-day repeated-dose dermal toxicity studies in rats with CASRN 64741-81-7, the LOAEL range is 93 – 930 mg/kg-day based on effects on liver and hematology parameters. The NOAEL range is 9.3 to 93 mg/kg-day. A 28-day repeated-dose dermal toxicity study of CASRN 64741-61-3 in rats showed a LOAEL of 99 mg/kg-day based on effects on liver weights and hematology parameters. The NOAEL is 9.9 mg/kg-day. No data are available on reproductive toxicity. All developmental toxicity studies for this subcategory are conducted via dermal route and using lesser number of animals (10-15/dose) than that recommended by the guidelines. For CASRN 64741-81-7 with varying compositions of PACs, the range of LOAEL values for maternal toxicity is 8 to 250 mg/kg-day. The effects include decreased body weights and body weight gains, increased vaginal discharge, effects on clinical chemistry parameters, and/or increased absolute and decreased relative liver and thymus weights. The range of NOAEL values for maternal toxicity is 'not established' to

125 mg/kg-day. The range for LOAEL values for developmental toxicity is 8 to 125 mg/kg-day. The effects include decreased pup body weights, decreased number of pups delivered per litter, increased resorptions, decreased litter size and/or fetal anomalies and skeletal variations. The range of NOAEL values for developmental toxicity is 'not established' to 30 mg/kg-day. No data are available for gene mutation and chromosomal aberrations. CASRN 64741-81-7 was irritating to rabbit skin and eyes; it was not sensitizing to guinea pigs skin. CASRNs 64741-61-3 increased tumor incidences in mice.

Subcategory VIII: Reformer Residual

There were no data for any endpoints for this subcategory.

Table 4. Summary of Human Health Data

Subcategory I: Residual Fuel Oils			Subcategory II: Atmospheric Residual					
Endpoints	**Fuel oil, residual (68476-33-5)**	**Fuel oil, No. 6 (68553-00-4)**	**Residues (petroleum), atm. tower (64741-45-3)**	**Residues (petroleum), hydro-desulfurized atmospheric (64742-78-5)**	**Residues (petroleum), atmospheric (68333-22-2)**	**Residues (petroleum), topping plant, low-sulfur (68607-30-7)**	**Residues (petroleum), atm. tower, light (70592-79-9)**	**Fuel oil, residues-straight-run gas oils, high sulfur (68476-32-4)**
Acute Oral Toxicity LD_{50} (mg/kg)	No Data 5880 (RA)	**5880**	**> 5000**	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)
Acute Inhalation Toxicity LC_{50} (mg/L)	**4.1 – 4.5**	No Data 4.1 - 4.5 (RA)	–	–	–	–	–	–
Acute Dermal Toxicity LD_{50} (mg/kg)	No Data > 4874 (RA)	**> 4874**	**> 2000**	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)
Repeated-Dose Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	**NOAEL = NE LOAEL = 480**	No data NOAEL = NE LOAEL = 480 (RA)	**NOAEL = 940 (hdt)**	No Data NOAEL = 940 (hdt) (RA)	No Data NOAEL = 940 (hdt) (RA)	No Data NOAEL = 940 (hdt) (RA)	No Data NOAEL = 940 (hdt) (RA)	No Data NOAEL = 940 (hdt) (RA)
Reproductive Toxicity NOAEL/LOAEL Oral (mg/kg-day)	No data.	No data	No data	No data	No data	No data	No data.	No data

Table 4. Summary of Human Health Data

	Subcategory I: Residual Fuel Oils		Subcategory II: Atmospheric Residual					
Endpoints	**Fuel oil, residual (68476-33-5)**	**Fuel oil, No. 6 (68553-00-4)**	**Residues (petroleum), atm. tower (64741-45-3)**	**Residues (petroleum), hydro-desulfurized atmospheric (64742-78-5)**	**Residues (petroleum), atmospheric (68333-22-2)**	**Residues (petroleum), topping plant, low-sulfur (68607-30-7)**	**Residues (petroleum), atm. tower, light (70592-79-9)**	**Fuel oil, residues-straight-run gas oils, high sulfur (68476-32-4)**
Developmental Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	No data	No data						
Maternal Toxicity			**NOAEL = 333[1] LOAEL= 1000**	No Data NOAEL = 333 LOAEL= 1000	No Data NOAEL = 333 LOAEL= 1000	No Data NOAEL = 333 LOAEL= 1000	No Data NOAEL = 333 LOAEL= 1000	No Data NOAEL = 333 LOAEL= 1000
Developmental Toxicity			**NOAEL = 333[1] LOAEL= 1000**	NOAEL = 333 LOAEL= 1000 (RA)	NOAEL = 333 LOAEL= 1000 (RA)	NOAEL = 333 LOAEL= 1000 (RA)	NOAEL = 333 LOAEL= 1000 (RA)	NOAEL = 333 LOAEL= 1000 (RA)
Genetic Toxicity – Gene Mutation *In vitro*	No Data Positive (RA)	**Positive**	No data	No data	No data	No data	No data	No data
Genetic Toxicity – Chromosomal Aberrations *In vitro*	No data	No data	No data	No data	No data.	No data	No data	No data
Genetic Toxicity – Chromosomal Aberrations *In vivo*	No Data Positive (RA)	**Positive**	–	–	–	–	–	–
Additional Information	No Data			No Data	No Data	No Data	No Data	No Data
Skin Irritation	Irritating	**Irritating**	**Irritating**	Irritating	Irritating	Irritating	Irritating	Irritating
Eye Irritation	Irritating	**Irritating**	**Not irritating**	Not irritating	Not irritating	Not irritating	Not irritating	Not irritating
Skin Sensitization	Sensitizing (RA)	**Sensitizing** –	**Not sensitizing**	Non-sensitizing (RA)	Non-sensitizing (RA)	Non-sensitizing (RA)	Non-sensitizing (RA)	Non-sensitizing (RA)
Carcinogenicity	–		–	–	–	–	–	–

Table 4. Summary of Human Health Data

	Subcategory III: Atmospheric Distillate				Subcategory IV: Vacuum Residual		
Endpoints	**Distillates (petroleum), crude oil (68410-00-4)**	**Gas oils (petroleum), heavy atmospheric (68783-08-4)**	**Heavy atmospheric gas oill (68915-97-9; supporting chemical)**	**Diesel fuel No. 2 (Fuel oil No. 2-D) (68476-34-6; supporting chemical)**	**Residues (petroleum), light vacuum (68512-62-9)**	**Residues (petroleum), solvent-extd. vacuum distilled atm residuum (70913-85-8)**	**Residues (petroleum), vacuum (64741-56-6; supporting chemical)**
Acute Oral Toxicity LD_{50} (mg/kg)	No data	No data	–		No Data > 5000 (RA)	No Data > 5000 (RA)	**> 5000**
Acute Inhalation Toxicity LC_{50} (mg/L)	No data	No data	–	–	No Data > 2.3 (RA)	No Data > 2.3 (RA)	**> 2.3**
Acute Dermal Toxicity LD_{50} (mg/kg)	No Data > 5000 (RA)	No Data > 5000 (RA)		**> 5000**	No Data > 2000 (RA)	No Data > 2000 (RA)	**> 2000**
Repeated-Dose Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	No Data NOAEL = 30 LOAEL = 125 (RA)	No Data NOAEL = 30 LOAEL = 125 (RA)	**NOAEL = 30[3] LOAEL = 125**	–	No Data NOAEL = 1000 LOAEL = 2000 (RA)	No Data NOAEL = 1000 LOAEL = 2000 (RA)	**NOAEL = 1000 LOAEL = 2000**
Reproductive Toxicity NOAEL/LOAEL Oral (mg/kg-day)	No data	No data	–	–	No data	No data	–

Table 4. Summary of Human Health Data

	Subcategory III: Atmospheric Distillate				Subcategory IV: Vacuum Residual		
Endpoints	**Distillates (petroleum), crude oil (68410-00-4)**	**Gas oils (petroleum), heavy atmospheric (68783-08-4)**	**Heavy atmospheric gas oill (68915-97-9; supporting chemical)**	**Diesel fuel No. 2 (Fuel oil No. 2-D) (68476-34-6; supporting chemical)**	**Residues (petroleum), light vacuum (68512-62-9)**	**Residues (petroleum), solvent-extd. vacuum distilled atm residuum (70913-85-8)**	**Residues (petroleum), vacuum (64741-56-6; supporting chemical)**
Developmental Toxicity NOAEL/LOAEL Dermal (mg/kg-day)				–	No data	No data	–
Maternal Toxicity	**NOAEL = 50[2] LOAEL = 250**	**NOAEL = 50[1] LOAEL = 250**	**NOAEL = 30[1] LOAEL = 125**				
Developmental Toxicity	**NOAEL = 500 (hdt)**	**NOAEL = –50[1] LOAEL = 125 - 250**	**NOAEL = 30[1] LOAEL = 125**				
Maternal Toxicity	**NOAEL = 125 - 150[1] LOAEL = 250 - 500**						
Developmental Toxicity	**NOAEL = NE – 50[1] LOAEL = 125 - 150**						
Genetic Toxicity – Gene Mutation *In vitro*	No data	No data	–	–	No Data Positive (RA)	No Data Positive (RA)	**Positive**
Genetic Toxicity – Chromosomal Aberrations *In vitro*	No data	No data	–	–	No data	No data	–
Additional Information	No Data		–		No data	No Data	
Skin Irritation	Irritating (RA)	–		**Irritating**	Irritating	Irritating	**Irritating**
Eye Irritation	–	–		–	Not irritating (RA)	Not irritating	**Not irritating**
Skin Sensitization	–	–		–	**Not sensitizing**	Not sensitizing (RA)	–
Carcinogenicity	–	–		–	–		

Table 4. Summary of Human Health Data							
	Subcategory III: Atmospheric Distillate				Subcategory IV: Vacuum Residual		
Endpoints	**Distillates (petroleum), crude oil (68410-00-4)**	**Gas oils (petroleum), heavy atmospheric (68783-08-4)**	**Heavy atmospheric gas oill (68915-97-9; supporting chemical)**	**Diesel fuel No. 2 (Fuel oil No. 2-D) (68476-34-6; supporting chemical)**	**Residues (petroleum), light vacuum (68512-62-9)**	**Residues (petroleum), solvent-extd. vacuum distilled atm residuum (70913-85-8)**	**Residues (petroleum), vacuum (64741-56-6; supporting chemical)**
						–	

Table 4. Summary of Human Health Data

Subcategory V: Vacuum Distillate							
Endpoints	**Residues (petroleum), heavy vacuum (64741-57-7)**	**Gas oils (petroleum), hydrotreated vacuum (64742-59-2)**	**Gas oils (petroleum), hydrodesulfurized heavy vacuum (64742-86-5)**	**Distillates (petroleum), petroleum residues vacuum (68955-27-1)**	**Distillates (petroleum), intermediate vacuum (70592-76-6)**	**Distillates (petroleum), light vacuum (70592-77-7)**	**Distillates (petroleum), vacuum (70592-78-8)**
Acute Oral Toxicity LD_{50} (mg/kg)	**> 5000**	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)
Acute Inhalation Toxicity LC_{50} (mg/L)	–	–	–	–	–	–	–
Acute Dermal Toxicity LD_{50} (mg/kg)	**> 2000**	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)
Repeated-Dose Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	**(13-wk) NOAEL = 30 LOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930**	No Data (13-wk) NOAEL = 30 NOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930 (RA)	No Data (13-wk) NOAEL = 30 NOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930 (RA)	No Data (13-wk) NOAEL = 30 NOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930 (RA)	No Data(13-wk) NOAEL = 30 NOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930 (RA)	No Data (13-wk)NOAEL = 30 NOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930 (RA)	No Data(13-wk) NOAEL = 30 NOAEL = 125 (28-d) NOAEL = 93 LOAEL = 930 (RA)
Reproductive Toxicity NOAEL/LOAEL Oral (mg/kg-day)	No data	No data	No data	No data	No data	No data	No data

Table 4. Summary of Human Health Data

Subcategory V: Vacuum Distillate							
Endpoints	**Residues (petroleum), heavy vacuum (64741-57-7)**	**Gas oils (petroleum), hydrotreated vacuum (64742-59-2)**	**Gas oils (petroleum), hydrodesulfurized heavy vacuum (64742-86-5)**	**Distillates (petroleum), petroleum residues vacuum (68955-27-1)**	**Distillates (petroleum), intermediate vacuum (70592-76-6)**	**Distillates (petroleum), light vacuum (70592-77-7)**	**Distillates (petroleum), vacuum (70592-78-8)**
Developmental Toxicity NOAEL/LOAEL Dermal (mg/kg-day) **Maternal Toxicity** **Developmental Toxicity** **Maternal Toxicity** **Developmental Toxicity**	**NOAEL = NE[2]** **LOAEL = 75** **NOAEL = NE** **LOAEL = 75** **NOAEL = 1-125[1]** **LOAEL = 150-500** **NOAEL = 1-125** **LOAEL = 150-500**	No Data NOAEL = NE LOAEL = 75 NOAEL = NE LOAEL = 75 (RA)	**NOAEL = 50[1]** **LOAEL = 333** **NOAEL = 50** **LOAEL = 333**	No Data NOAEL = NE LOAEL = 75 NOAEL = NE LOAEL = 75 (RA)	No Data NOAEL = NE LOAEL = 75 NOAEL = NE LOAEL = 75 (RA)	No Data NOAEL = NE LOAEL = 75 NOAEL = NE LOAEL = 75 (RA)	No Data NOAEL = NE LOAEL = 75 NOAEL = NE LOAEL = 75 (RA)
Genetic Toxicity – Gene Mutation ***In vitro***	No data	No data	No data	No data	No data	No data	No data
Genetic Toxicity – Chromosomal Aberrations ***In vitro***	No data	No data	No data	No data	No data	No data	No data
Genetic Toxicity – Chromosomal Aberrations ***In vivo***	**Negative**	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)
Additional Information **Skin Irritation** **Eye Irritation** **Skin Sensitization** **Carcinogenicity**	 **Irritating** **Irritating** **Not sensitizing** –	No Data Irritating Irritating Not sensitizing (RA) –	 **Irritating** **Irritating** Not sensitizing (RA) –	No Data Irritating Irritating Not sensitizing (RA) –	No Data Irritating Irritating Not sensitizing (RA) –	No Data Irritating Irritating Not sensitizing (RA) –	No Data Irritating Irritating Not sensitizing (RA) –

Table 4. Summary of Human Health Data						
Subcategory VI: Cracked Residual						
Endpoints	**Clarified oils (petroleum), catalytic cracked (64741-62-4)**	**Residues (petroleum), hydrocracked (64741-75-9)**	**Residues (petroleum), thermal cracked (64741-80-6)**	**Pitch, petroleum, arom (68187-58-6)**	**Residues (petroleum), heavy coker gas oil and vacuum gas oil (68478-17-1)**	**Residues (petroleum), coker scrubber condensed-ring-aromatic-containing (68783-13-1**
Acute Oral Toxicity LD_{50} (mg/kg)	**4320 – 5270**	No Data 4320 – 5270 (RA)	No Data 4320 – 5270 (RA)	No Data 4320 – 5270 (RA)	No Data 4320 – 5270 (RA)	No Data 4320 – 5270 (RA)
Acute Inhalation Toxicity LC_{50} (mg/L)	–	–	–	–	–	–
Acute Dermal Toxicity LD_{50} (mg/kg)	**> 2000**	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)
Repeated-Dose Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	**(13-wk) NOAEL = NE LOAEL = 8 (28-day) NOAEL = NE - 1 LOAEL = 10 - 542**	**(28-d) NOAEL = 210 (hdt)**	**(13-wk) NOAEL = NE LAOEL = 60**	No Data NOAEL = NE LOAEL = 8 (RA)	No Data NOAEL = NE LOAEL = 8 (RA)	No Data NOAEL = NE LOAEL = 8 (RA)
Reproductive Toxicity NOAEL/LOAEL Oral (mg/kg-day)	No data	No data	No data	No data	No data	No data
Reproductive Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	No data	–	–	–	–	–

Table 4. Summary of Human Health Data
Subcategory VI: Cracked Residual

Endpoints	Clarified oils (petroleum), catalytic cracked (64741-62-4)	Residues (petroleum), hydrocracked (64741-75-9)	Residues (petroleum), thermal cracked (64741-80-6)	Pitch, petroleum, arom (68187-58-6)	Residues (petroleum), heavy coker gas oil and vacuum gas oil (68478-17-1)	Residues (petroleum), coker scrubber condensed-ring-aromatic-containing (68783-13-1)
Developmental Toxicity NOAEL/LOAEL Dermal (mg/kg-day)						
Maternal Toxicity	**NOAEL = 0.05[2] LOAEL = 1.0**	No Data NOAEL = 0.05 LOAEL = 1.0	No Data NOAEL = 0.05 LOAEL = 1.0	No Data NOAEL = 0.05 LOAEL = 1.0	No Data NOAEL = 0.05 LOAEL = 1.0	No Data NOAEL = 0.05 LOAEL = 1.0
Developmental Toxicity	**NOAEL = 0.05[2] LOAEL = 1.0**	NOAEL = 0.05 LOAEL = 1.0 (RA)	NOAEL = 0.05 LOAEL = 1.0 (RA)	NOAEL = 0.05 LOAEL = 1.0 (RA)	NOAEL = 0.05 LOAEL = 1.0 (RA)	NOAEL = 0.05 LOAEL = 1.0 (RA)
Maternal Toxicity	**NOAEL = NE - 10[1] LOAEL = 4 - 100**					
Developmental Toxicity	**NOAEL = NE – 10[1] LOAEL = 4 - 250**					
Genetic Toxicity – Gene Mutation *In vitro*	**Positive**	No Data Positive (RA)	No Data Positive (RA)	No Data Positive (RA)	No Data Positive (RA)	No Data Positive (RA)
Genetic Toxicity – Gene Mutation *In vivo*	–	–	–	–	–	–
Genetic Toxicity – Chromosomal Aberrations *In vitro*	–	–	–	–	–	–
Genetic Toxicity – Chromosomal Aberrations *In vivo*	**Negative**	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)	No Data Negative (RA)
Genetic Toxicity – Other Information *In vitro*						
Sister Chromatid Exchange	**Positive**	–	–	–	–	–
Unscheduled DNA Synthesis	**Positive**	–	–	–	–	–
In vivo						

Table 4. Summary of Human Health Data

Subcategory VI: Cracked Residual						
Endpoints	**Clarified oils (petroleum), catalytic cracked (64741-62-4)**	**Residues (petroleum), hydrocracked (64741-75-9)**	**Residues (petroleum), thermal cracked (64741-80-6)**	**Pitch, petroleum, arom (68187-58-6)**	**Residues (petroleum), heavy coker gas oil and vacuum gas oil (68478-17-1)**	**Residues (petroleum), coker scrubber condensed-ring-aromatic-containing (68783-13-1**
Dominant Lethal Assay	**Negative**					
Additional Information		No Data	No Data	No Data	No Data	No Data
Skin Irritation	**Irritating**	Irritating	Irritating	Irritating	Irritating	Irritating
Eye Irritation	**Irritating**	Irritating	Irritating	Irritating	Irritating	Irritating
Skin Sensitization	**Not sensitizing**	Not sensitizing (RA)	Not sensitizing (RA)	Not sensitizing (RA)	Not sensitizing (RA)	Not sensitizing (RA)
Carcinogenicity	**Positive**	–	–	**Positive**	–	–

Table 4. Summary of Human Health Data

Endpoints	Subcategory VII: Cracked Distillate					Subcategory VIII: Reformer Residual	
	Distillates (petroleum), heavy catalytic cracked (64741-61-3)	**Distillates (petroleum), heavy thermal cracked (64741-81-7)**	**Clarified oils (petroleum), hydrodesulfurized catalytic cracked (68333-26-6)**	**Distillates (petroleum), hdyrodesulfurized intermediate catalytic cracked (68333-27-7)**	**Aromatic hydrocarbons, C12 – 20 (70955-17-8)**	**Residues (petroleum), catalytic reformer fractionator (64741-67-9)**	**Residues (petroleum), catalytic reformer fractionator residue distn. (68478-13-7)**
Acute Oral Toxicity LD_{50} (mg/kg)	No Data > 5000 (RA)	**> 5000**	No Data > 5000 (RA)	No Data > 5000 (RA)	No Data > 5000 (RA)	No data.	No data.
Acute Inhalation Toxicity LC_{50} (mg/L)	–	–	–	–	–	–	–
Acute Dermal Toxicity LD_{50} (mg/kg)	No Data > 2000 (RA)	**> 2000**	No Data > 2000 (RA)	No Data > 2000 (RA)	No Data > 2000 (RA)	–	–
Repeated-Dose Toxicity NOAEL/LOAEL Oral (mg/kg-day)	–	–	–	–	–	No data	No data
Repeated-Dose Toxicity NOAEL/LOAEL Dermal (mg/kg-day)	**(28-d) NOAEL = 9.9 LOAEL = 99**	**(13-wk) NOAEL = NE - 30 LOAEL = 30 - 125 (28-d) NOAEL = 9.3 - 93 LOAEL = 93 - 930**	No Data NOAEL = NE - 125 LOAEL = 30 - 125 (RA)	No Data NOAEL = NE - 125 LOAEL = 30 - 125 (RA)	No Data NOAEL = NE - 125 LOAEL = 30 - 125 (RA)	No data	No data

Table 4. Summary of Human Health Data

Endpoints	Subcategory VII: Cracked Distillate					Subcategory VIII: Reformer Residual	
	Distillates (petroleum), heavy catalytic cracked (64741-61-3)	**Distillates (petroleum), heavy thermal cracked (64741-81-7)**	**Clarified oils (petroleum), hydrodesulfurized catalytic cracked (68333-26-6)**	**Distillates (petroleum), hdyrodesulfurized intermediate catalytic cracked (68333-27-7)**	**Aromatic hydrocarbons, C12 – 20 (70955-17-8)**	**Residues (petroleum), catalytic reformer fractionator (64741-67-9)**	**Residues (petroleum), catalytic reformer fractionator residue distn. (68478-13-7)**
Developmental Toxicity NOAEL/LOAEL Dermal (mg/kg-day)						–	–
Maternal Toxicity	**NOAEL = NE[3] LOAEL = 50**	**NOAEL = NE-125[1] LOAEL = 8 - 250**	No data NOAEL = NE-125 LOAEL = 8-250	No data NOAEL = NE-125 LOAEL = 8-250	No data NOAEL = NE-125 LOAEL = 8-250		
Developmental Toxicity	**NOAEL = NE LOAEL = 50**	**NOAEL = NE-30[1] LOAEL = 8 - 125**	NOAEL = NE-30 LOAEL = 8-125 (RA)	NOAEL = NE-30 LOAEL = 8-125 (RA)	NOAEL = NE-30 LOAEL = 8-125 (RA)		
Genetic Toxicity – Gene Mutation *In vitro*	No data	No data	No data	No data	No data	No data	No data.
Genetic Toxicity – Chromosomal Aberrations *In vitro*	No data	No data	No data	No data	No data.	No data	No data.
Additional Information	No data		No Data	No Data	No Data		
Skin Irritation	Irritating	**Irritating**	Irritating	Irritating	Irritating	–	–
Eye Irritation	Irritating	**Irritating**	Not irritating	Not irritating	Not irritating		
Skin Sensitization	Non-sensitizing (RA)	**Non-sensitizing**	Non-sensitizing (RA)	Non-sensitizing (RA)	Non-sensitizing (RA)		
Carcinogenicity	**Positive**	–	–	–	–		

NE = not established; **Measured data in bold text**; (RA) = Read Across; – indicates that endpoint was not evaluated for this substance; hdt = highest dose tested
[1]lesser number of animals were used than that recommended by guidelines; [2]used adequate number of animals in these studies; [3]CASRN 68915-97-9 and 68783-08-4 have similar composition; [4]Male mediated reproductive toxicity (Dominant Lethal assay)

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4. Hazard to the Environment

No adequate data were submitted for the sponsored chemicals. A summary of aquatic toxicity data for supporting chemicals for SIDS endpoints is provided in Table 5. The table also indicates where test data are read-across (RA) from the supporting chemicals of the Kerosene/Jet Fuel category.

Acute Toxicity to Fish

C7-C10 Isoalkane Hydrocarbons (CASRN 90622-56-3, supporting chemical)
Rainbow trout (*Oncorhynchus mykiss*) were exposed to Water Accommodated Fractions (WAFs) of CASRN 90622-56-3 at nominal loading rates of 0, 0.9, 2.0, 10.0, 22.0 or 50.0 mg/L under static-renewal conditions for 96 hours. Corresponding time-weighted mean measured concentrations were 0, 0.05, 0.12, 0.33, 0.36 and 0.47 mg/L.
96-h LC_{50} = 0.11 mg/L

C8-C9 Cyclic Hydrocarbons (CASRN 64742-48-9, supporting chemical)
Rainbow trout (*Oncorhynchus mykiss*) were exposed to WAFs of 64742-48-9 at nominal loading rates of 1.0, 2.3, 5.1, 11.0 or 25.0 mg/L under static-renewal conditions for 96 hours. Corresponding time-weighted mean measured concentrations were 0, 0.05, 0.12, 0.33, 0.36 and 0.47 mg/L.
96-h LC_{50} = 0.3 mg/L

1-Tetradecene (CASRN 1120-36-1, supporting chemical)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/AOalfaolefins.pdf
96-h EC_{50} = No effects at saturation (0.0004 mg/L-calculated)

1-Hexadecene (CASRN 629-73-2, supporting chemical)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/HigherOlefins.pdf
96-h LC_{50} > Predicted Solubility limit (0.00144 mg/L)

Acute Toxicity to Aquatic Invertebrates

C9-C10 Hydrocarbons, n-alkanes, isoalkanes, cyclics, <2% aromatics (CASRN 64742-49-0, supporting chemical)
Water fleas (*Daphnia magna*) were exposed to CASRN 64742-49-0 at nominal loading rates of 0, 1, 2.2, 4.6, 10, 22, 46 or 100 mg/L for 48 hours under static conditions. The corresponding measured concentrations were 0, 0.11, 0.22, 0.18, 0.25, 0.44, 0.47 and 0.56 mg/L, respectively, based upon the geometric mean of the 0 and 48 hour samples.
48-h EC_{50} = 0.9 mg/L

1-Tetradecene (CASRN 1120-36-1, supporting chemical)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/AOalfaolefins.pdf
48-h EC_{50} = No effects at saturation (0.0004 mg/L-calculated)

1-Hexadecene (CASRN 629-73-2, supporting chemical)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/HigherOlefins.pdf
96-h LC_{50} > Predicted Solubility limit (0.00144 mg/L)

Toxicity to Aquatic Plants
C9-C10 Hydrocarbons, n-alkanes, isoalkanes, cyclics, <2% aromatics (CASRN 64742-49-0, supporting chemical)
Green algae (*Pseudokirchneriella subcapitata*) were exposed to CASRN 64742-49-0 at nominal loading rates of 0, 1, 3, 10, 30, 100, 300 or 1000 mg/L for 72-hours under static conditions. Corresponding mean measured concentrations were <0.02, 0.13, 0.11, 0.31, 0.33, 0.36, 0.37 and 0.40 mg/L.
72-h EC_{50} (biomass) = 0.4 mg/L
72-h EC_{50} (growth rate) > 0.4 mg/L

1-Tetradecene (CASRN 1120-36-1)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/AOalfaolefins.pdf
48-h LC_{50} = No effects at saturation (0.0004 mg/L-calculated)
1-Hexadecene (CASRN 629-73-2, supporting chemical)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/HigherOlefins.pdf
72-h EC_{50} (biomass) > Predicted Solubility limit (0.00144 mg/L)
72-h EC_{50} (growth rate) > Predicted Solubility limit (0.00144 mg/L)

Chronic Toxicity to Aquatic Invertebrates

C9-C10 Hydrocarbons, n-alkanes, isoalkanes, cyclics, <2% aromatics (CASRN 64742-49-0, supporting chemical)
Water fleas (*D. magna*) were exposed to CASRN 64742-49-0 at nominal loading rates of 0, 1, 4, 8 or 10 mg/L for 21-days under static-renewal conditions. Corresponding mean measured concentrations were 0, 0.17, 0.32, 0.79, 1.1 and 1.2 mg/L.
21-d NOEC = 0.17 mg/L
21-d LOEC = 0.32 mg/L

1-Tetradecene (CASRN 1120-36-1)
http://www.chem.unep.ch/irptc/sids/OECDSIDS/AOalfaolefins.pdf
ChV = No effects at saturation (0.0004 mg/L-calculated)

Conclusion: No adequate data are available for the sponsored substances. Based on the supporting chemicals (CASRNs 90622-56-3, 1120-36-1 and 629-73-2), the 96-h LC_{50} for fish is 0.11 mg/L, the 48-h EC_{50} for aquatic invertebrates is 0.9 mg/L, and the 72-h EC_{50} for aquatic plants is 0.4 mg/L for biomass. Based on the supporting chemical (CASRN 64742-49-0), the 21-d chronic NOEC and LOEC for aquatic invertebrates is 0.17 mg/L and 0.32 mg/L, respectively. Based on CASRNs 1120-36-1 and 629-73-2, there is no aquatic toxicity at saturation for chemicals in this category with a carbon chain of fourteen or greater.

Table 5. Summary of Environmental Effects – Aquatic Toxicity Data				
Endpoints	**SPONSORED CHEMICALS**	**SUPPORTING CHEMICAL**		
	Fuel oil, residual* **(68476-33-5)**	**C7-C10 Isoalkane Hydrocarbons** **(90622-56-3)**	**C9-C10 Hydrocarbons, n-alkanes, isoalkanes, cyclics,** **(64742-49-0)**	**1-Tetradecene, C14 (1120-36-1) 1-Hexadecene, C16 (629-73-2)**
Fish **96-h LC_{50} or LL_{50} (mg/L)**	No Adequate Data 0.11 (RA)	**0.11**	-	**NES**
Aquatic Invertebrates **48-h EC_{50} or EL_{50} (mg/L)**	No Adequate Data 0.09 (RA)	-	**0.09**	**NES**
Aquatic Plants **72-h EC_{50} or EC_{50} (mg/L)** **Growth** **Biomass**	No Adequate Data 0.4 (RA)	-	**0.4**	**NES**
Chronic Toxicity to Invertebrates **21-d EC_{50} (mg/L) 21-d NOEC/ LOEC (mg/L)**	No Data 0.17 0.32 (RA)	-	**0.17** **0.32**	**NES**

Bold = experimental data (derived from testing), RA = read across, - indicates that endpoint was not addressed for this chemical, NES = No Effects at Saturation (the water solubility limit f the substance), * represents all category substances.

REFERENCE

CONCAWE. 1998. Heavy fuel oils. Product dossier No. 98/109. Brussels. 48 pp.

APPENDIX

A Description of Process Streams

B Process Streams, CASRN, and Description of the Heavy Fuel Oils Category

C Cracking Processes

D PAC Analytical Profile of Heavy Fuel Oils

Appendix A

1.1.1 Process Streams

Because the process history of a refinery stream determines its chemical composition, it is expected that streams that have undergone similar processing will have similar physical/chemical/biologic properties and environmental fate and transport characteristics. The

streams that are produced by catalytic cracking have high levels of aromatics. In contrast, hydrocracked streams have relatively low amounts of aromatics, since hydrocracking introduces hydrogen into the cracking process resulting in saturation of aromatic compounds. As shown in Figure 1, there are eleven refinery streams in the heavy fuel oils category that are produced by cracking (five distillate and six residual streams). See Appendix A for a more detailed description of each of these streams.

Reforming

Catalytic reforming employs a catalyst to facilitate the structural rearrangement of hydrocarbon molecules in order to increase the aromatic content of a refinery stream, ultimately producing higher octane gasoline blending stocks. During reforming, olefins are saturated to form paraffins, which are then converted to shorter paraffins, isoparaffins, and naphthenes. The naphthenes are converted to aromatics by dehydrogenation (Gary and Handwerk, 1994). As shown in Figure 1, there are two refinery streams in the heavy fuel oils category that are produced as residuals of reforming. See Appendix A for a more detailed description of each of these streams.

1.1.2. Residual Fuel Oils

In addition to the process streams discussed above, the heavy fuel oil category also includes two blended residual fuel oils, Residual Fuel Oil (CAS 68476-33-5) and No. 6 Fuel Oil (CAS 68553-00-4). These two fuel oils are most often produced by blending any combination of the distillate and residual streams so that the finished fuel meets the appropriate product specifications. The residual fuels can also be blended with petroleum distillates (cutter stocks) covered in other API HPV Categories [e.g. kerosene, gas oils]. See Appendix A for a more detailed description of each of these two residual fuel oils.

In describing some of the SIDS endpoints for this category (e.g., particularly physical-chemical and environmental fate endpoints), data on Bunker C fuel oil has been cited and used as a supporting material that is representative of a no. 6 fuel oil. Bunker fuel gets its name from the containers on ships and in ports in which it is stored (i.e., "storage bunkers"). While there are several classes of bunker fuel (e.g., classes "A" and "B", etc.), Bunker C is a term that is commonly used as a generic synonym equivalent to residual fuel oil, no. 6 fuel oil, or heavy fuel oil (Irwin et al., 1997; CONCAWE, 1998). Therefore, the composition of Bunker C fuels is expected to be similar to other substances in this category, and any differences may be explained by the variability in the streams from which these products are made and the characteristics of the original crude oil. For this reason, Bunker C fuel oil is a valid supporting substance to this category that provides valuable data for characterizing SIDS endpoints. Furthermore, much of the data on the fate and effects of heavy fuel oils are derived from studies on oil spilled at sea, of which Bunker C fuel has been reported in a number of studies (Keizer et al., 1978; Jézéquel et al., 2003; Lee, et al., 2003).

Analytical data for representative materials in this category are shown in Table 1.

carbon ranges for streams in this category are directly related to physical/chemical properties and the potential for environmental effects. See Appendix A for a more detailed description of each of these streams. Knowledge of refining processes, in addition to carbon range and physical/chemical properties, coupled with tests of representative substances can be useful in evaluating human health effects. As shown in Figure 1, the major processes used to produce the refinery streams included in the heavy fuel oils category are:

Atmospheric distillation
Heavy fuel oil related streams produced by atmospheric distillation comprise fractions of crude oil separated by heating (650-700°F [346-374°C]) at atmospheric pressure. They include atmospheric distillates (heavy gas oils) and the heavier residual materials. The distillate HFO streams are similar to some of the refinery streams covered in the API HPV Gas Oils category, albeit of higher molecular weight. Some of these streams may be further hydrotreated or desulfurized to remove sulfur, nitrogen, and other impurities. Most atmospheric distillates undergo further processing in order to convert them into higher value fuels (diesel, kerosene).

Vacuum distillation
The residuum from the atmospheric distillation unit is distilled under vacuum to further separate heavier molecules without the use of high temperatures. This is done under reduced pressure to prevent thermal cracking. In addition to producing lube oils, various vacuum distillates (vacuum gas oils) and vacuum residuals are produced. Similar to the atmospheric distillates, some of the vacuum distillates may be hydrotreated or desulfurized to remove sulfur, nitrogen, and other impurities. Most vacuum distillates undergo further processing in order to convert them into higher value fuels (diesel, kerosene).

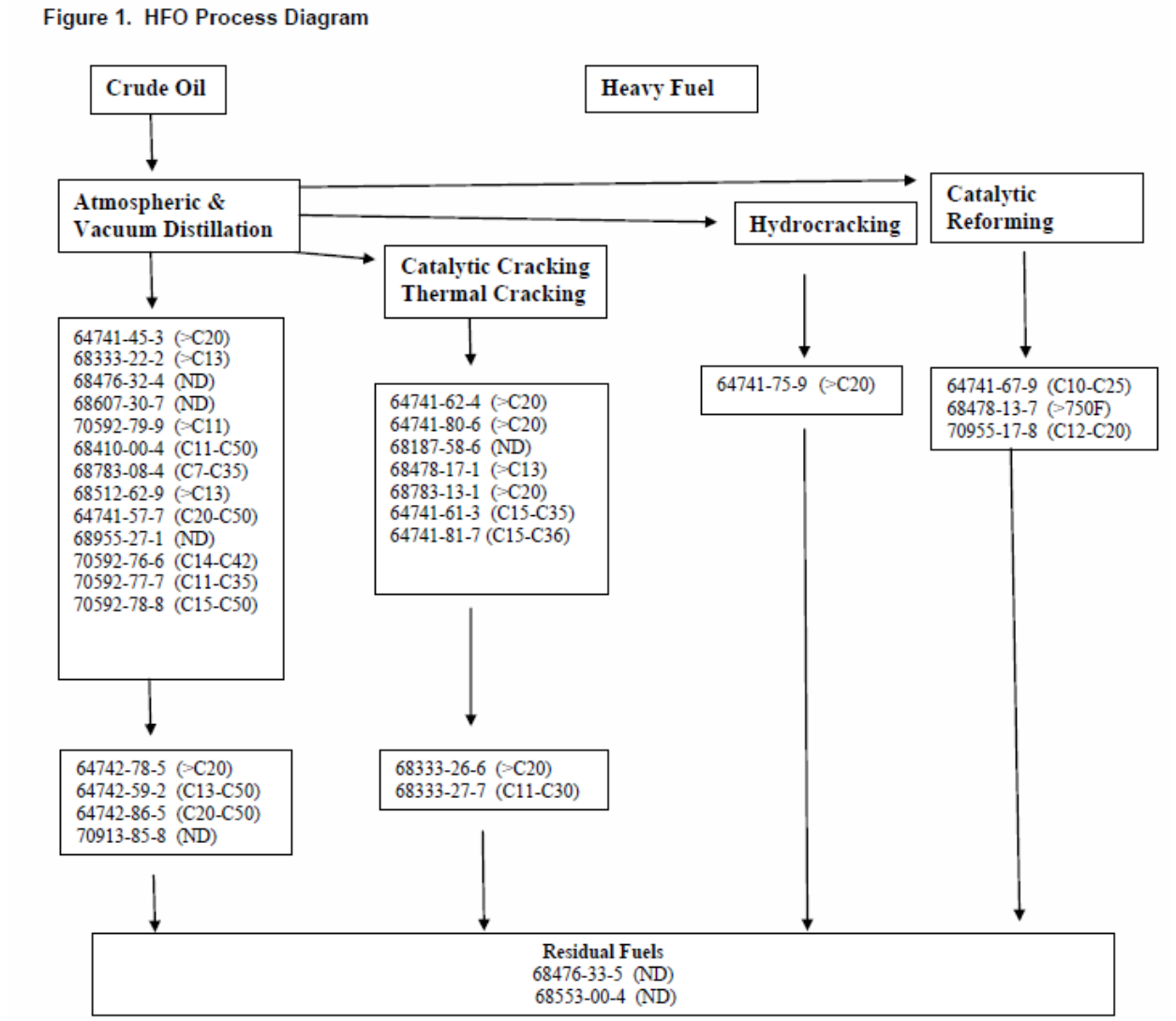
Portions of the heavier atmospheric or vacuum distillate streams may be used as blending stocks to reduce the viscosity of other residual streams. The atmospheric and vacuum residual refinery streams, each comprise a heterogeneous group of poorly defined, viscous, high boiling hydrocarbon streams that usually contain suspensions of resin/asphaltene complexes. These streams often have high levels of heterocyclic aromatic and naphthenic compounds. Varying percentages of sulfur, nitrogen, oxygen, and other elements are present as heterocyclic inclusions, primarily in the aromatics fraction. These residual streams often have a PAC content over 5%,

Cracking
Many of the distillate and residual streams used to blend heavy fuel oils are derived from cracking processes. Cracking is a process that breaks ("cracks") the heavier, higher boiling petroleum streams produced by atmospheric or vacuum distillation into lighter molecular weight materials such as gasoline, diesel fuel, jet fuel and kerosene.

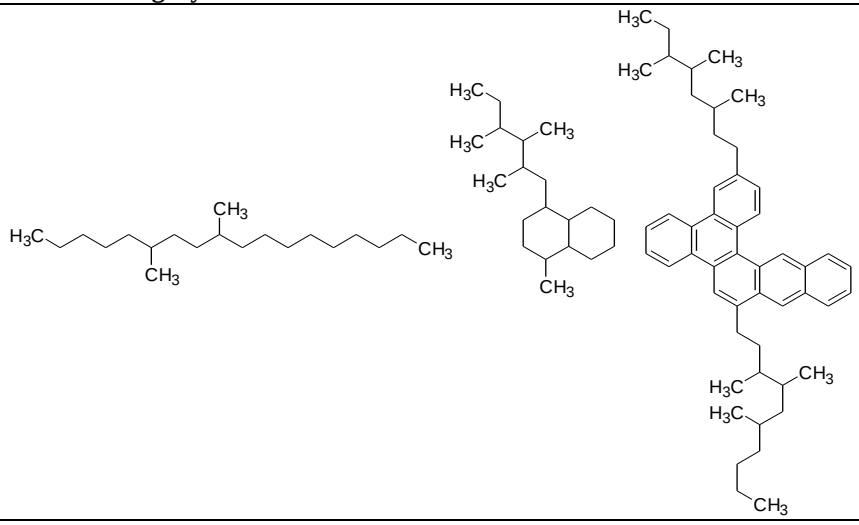
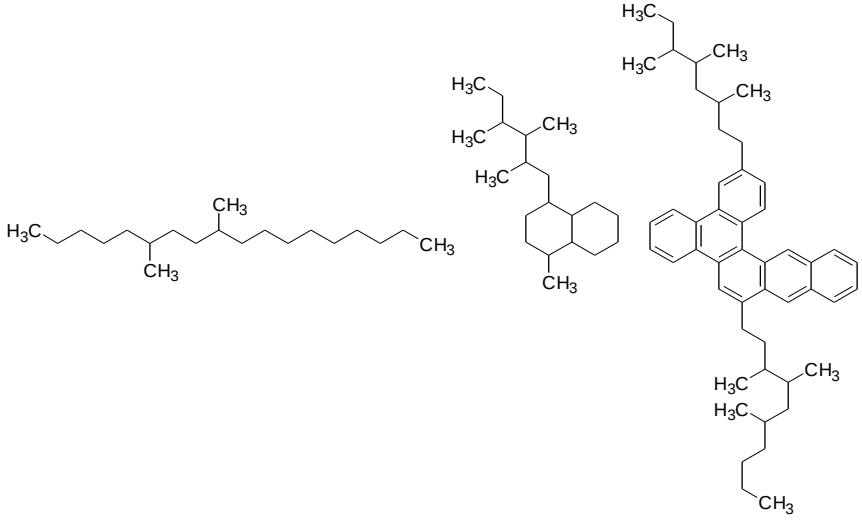
There are two basic types of cracking processes, those using heat (thermal cracking) to break molecular bonds, and those using a catalyst and heat (catalytic cracking) to facilitate the cracking process. Both thermal and catalytic cracking are used to produce refinery streams that are used for blending heavy fuel oils. Cracking processes are described in Appendix B.

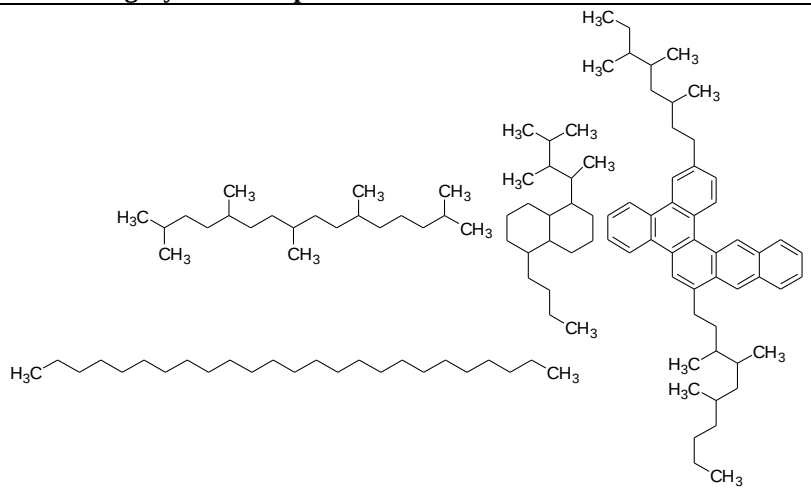
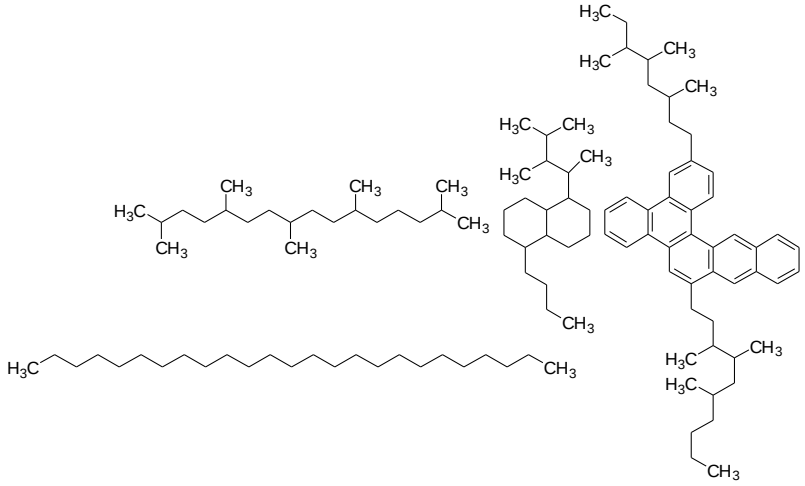
The refinery streams produced by the various cracking processes represent a continuum in the severity of the cracking process. All the cracking processes produce refinery streams that are similar from a physical-chemical perspective, being differentiated from each other primarily by the ratio of their unsaturated and saturated hydrocarbon content. The saturated and aromatic hydrocarbons species are similar but may vary in ratio between streams. For instance, refinery

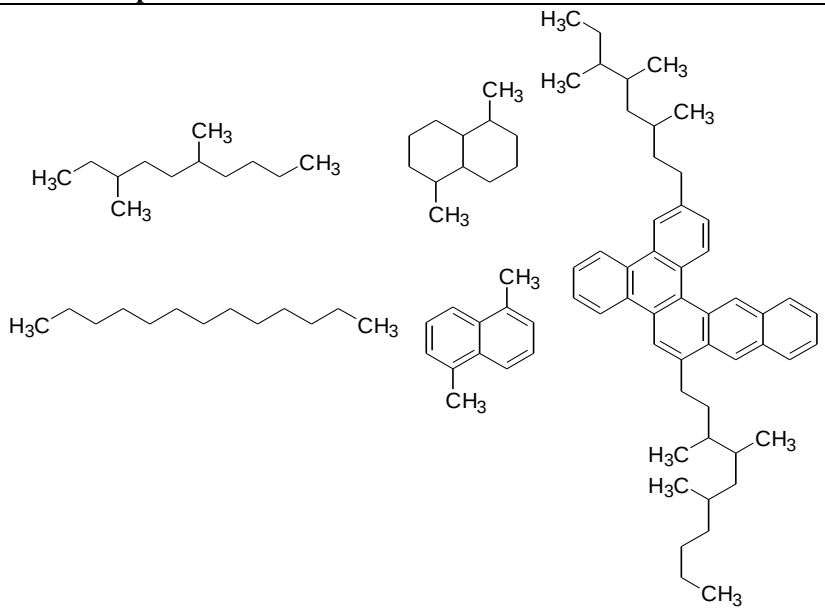
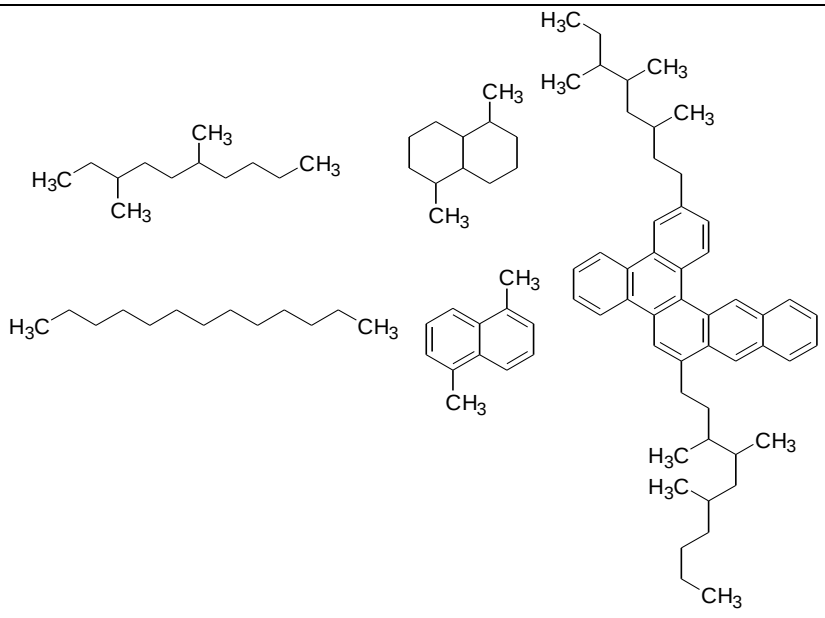
Figure 1. HFO Process Diagram

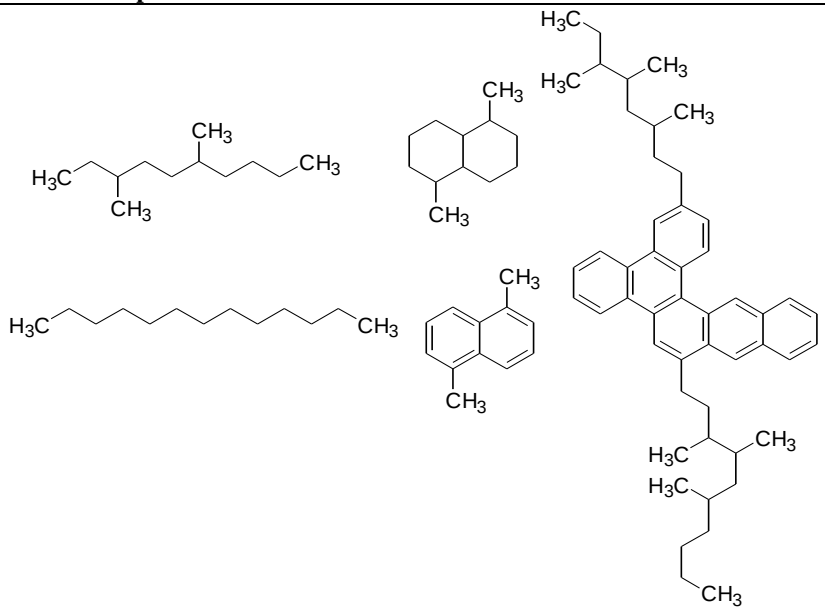
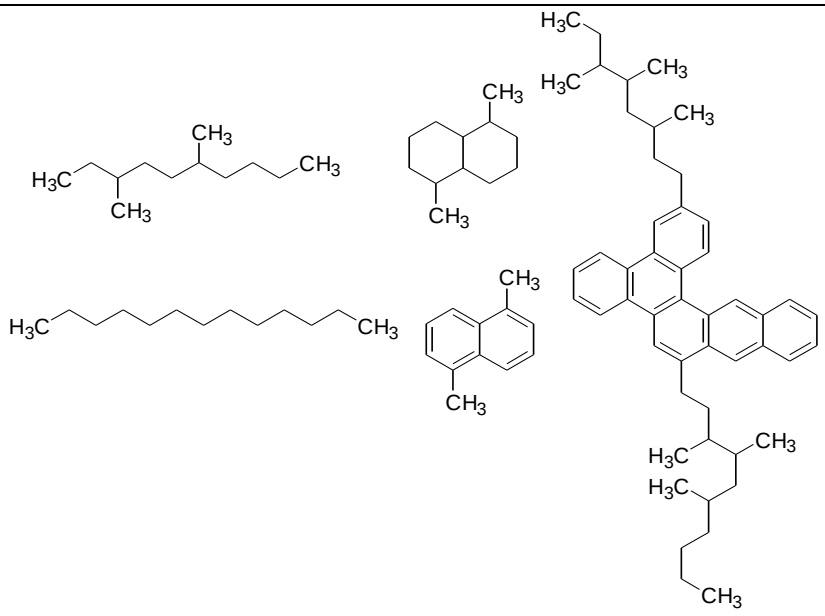


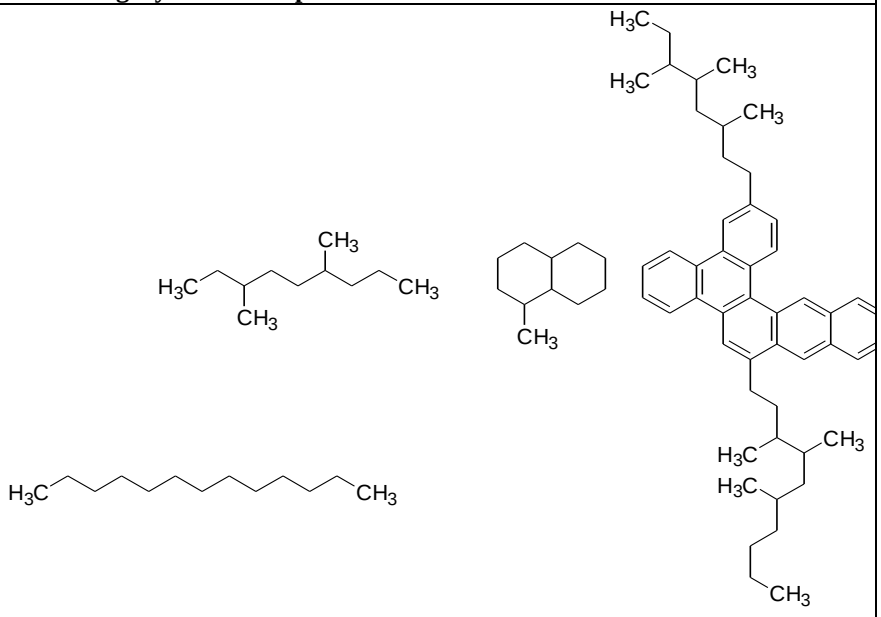
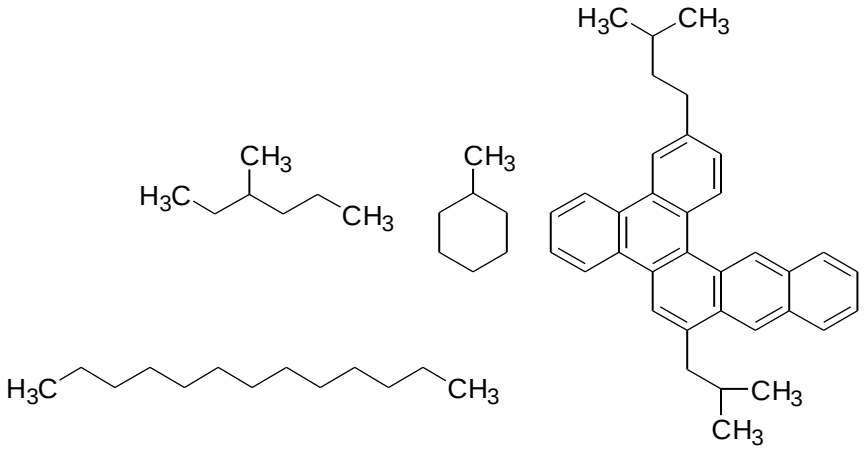
Appendix B

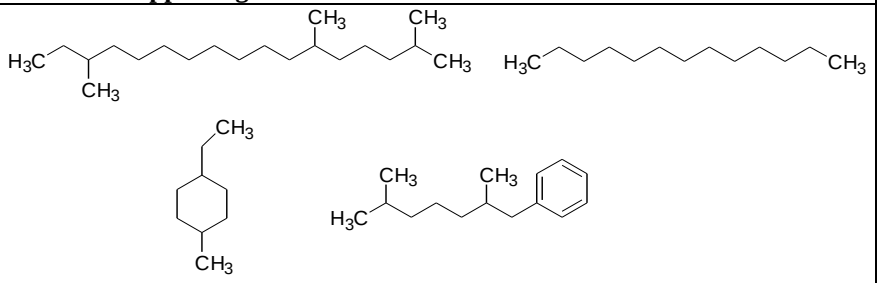
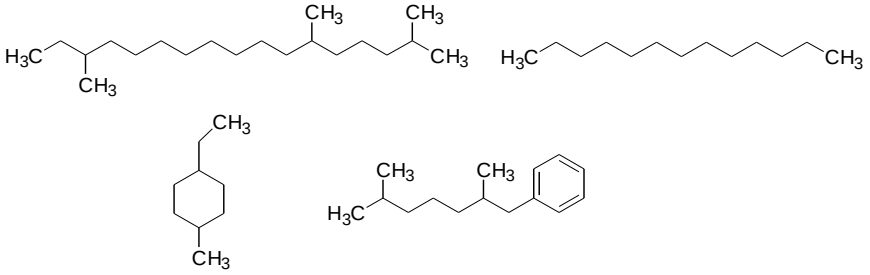
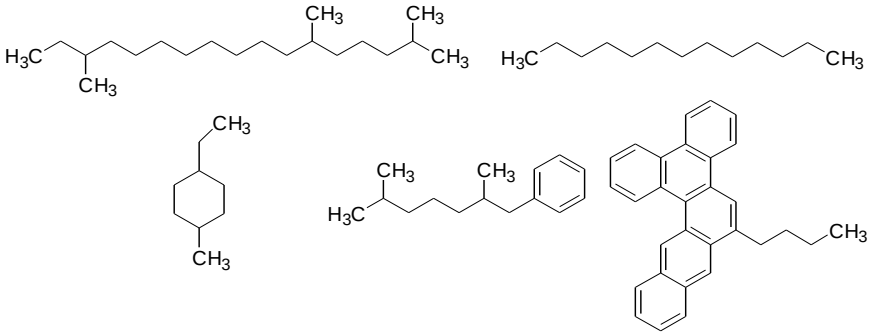
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Subcategory I: Residual Fuel Oils		
Fuel oil, residual	68476-33-5	
Fuel oil, No. 6	68553-00-4	 A distillate oil having a minimum viscosity of 900 SUS at 37.7°C (100°F) to a maximum of 9000 SUS at 37.7°C (100°F).

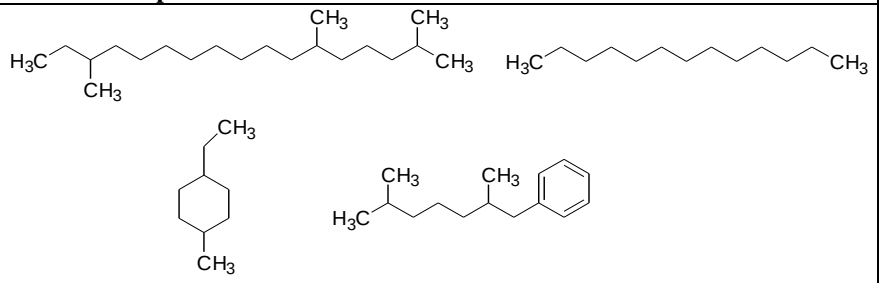
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Subcategory II: Atmospheric Residual		
Residues (petroleum), atm. tower	64741-45-3	 A complex residuum from the atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Residues (petroleum), hydrodesulfur-ized atmospheric	64742-78-5	 A complex combination of hydrocarbons obtained by treating an atmospheric tower residuum with hydrogen in the presence of a catalyst under conditions primarily to remove organic sulfur compounds. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Residues (petroleum), atmospheric	68333-22-2	

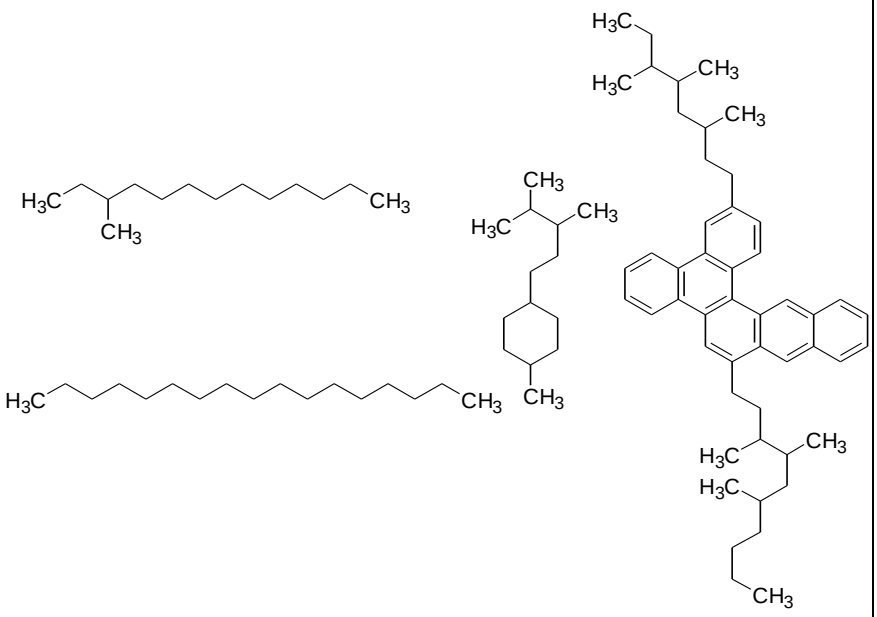
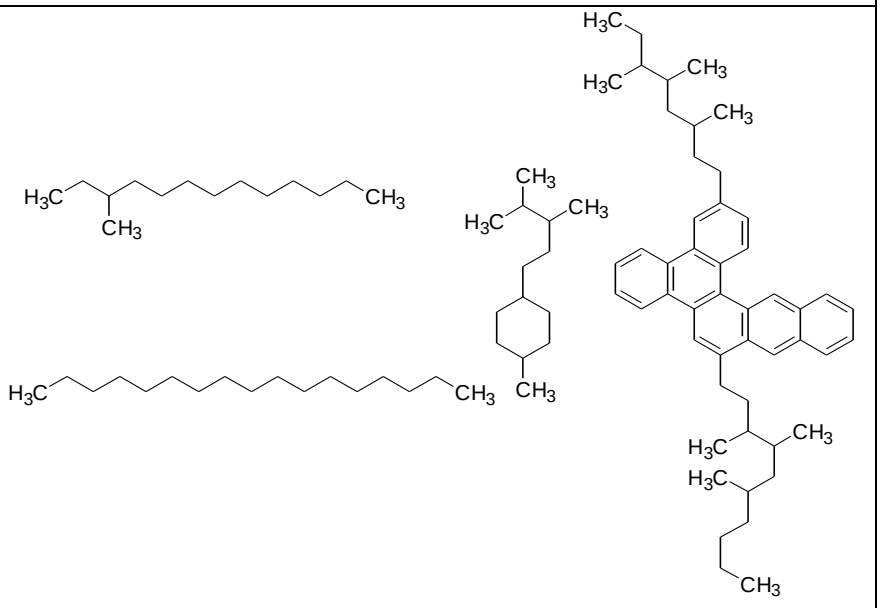
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
		 A complex residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C11 and boiling above approximately 200°C (392°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Residues (petroleum), topping plant, low-sulfur	68607-30-7	 A low-sulfur complex combination of hydrocarbons produced as the residual fraction from the topping plant distillation of crude oil. It is the residuum after the straight-run gasoline cut, kerosene cut, and gas oil cut have been removed.

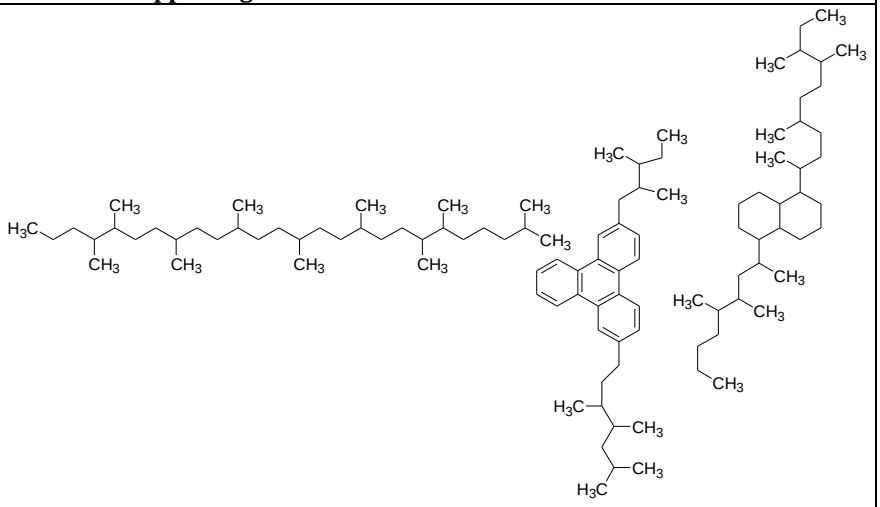
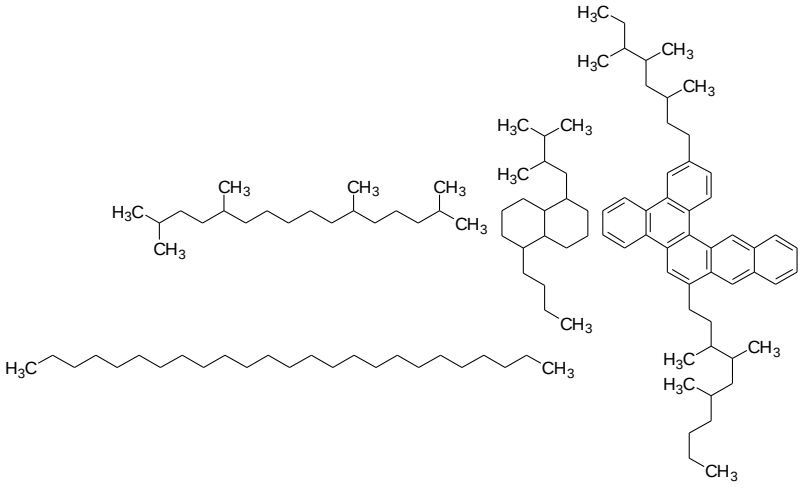
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Residues (petroleum), atm. tower, light	70592-79-9	 A complex residuum from the atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C11 and boiling above approximately 200°C (392°F). This stream is likely to contain 5 wt % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Fuel oil, residues-straight-run gas oils, high-sulfur	68476-32-4	 No description

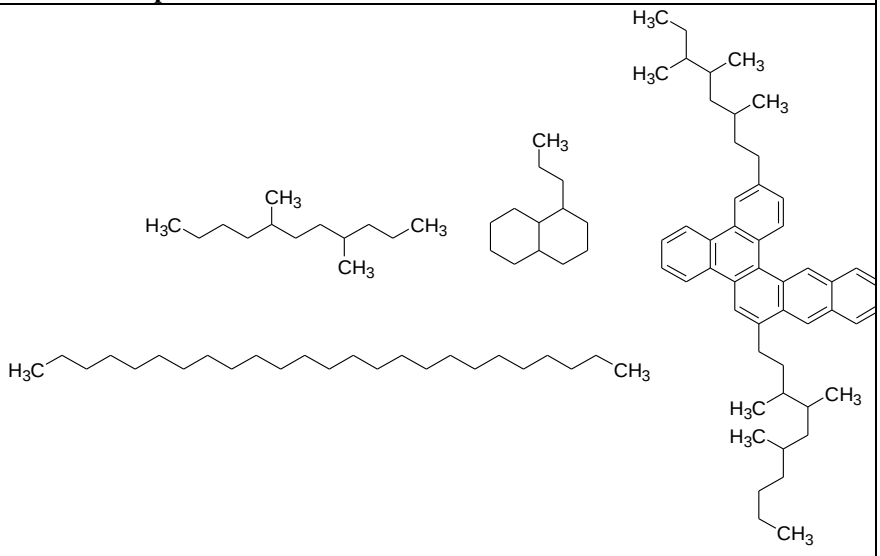
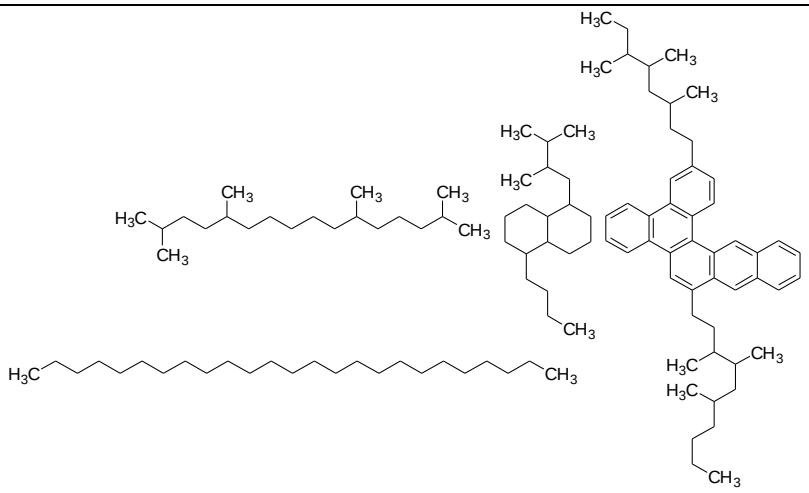
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Subcategory III: Atmospheric Distillate		
Distillates (petroleum), crude oil	68410-00-4	 A complex combination of hydrocarbons produced by distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C50 and boiling in the range of approximately 205 to >495°C (401 to >923°F).
Gas oils (petroleum), heavy atmospheric	68783-08-4	 A complex combination of hydrocarbons obtained by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C7 through C35 and boiling in the range of approximately 121 to 510°C (250 to 950°F).

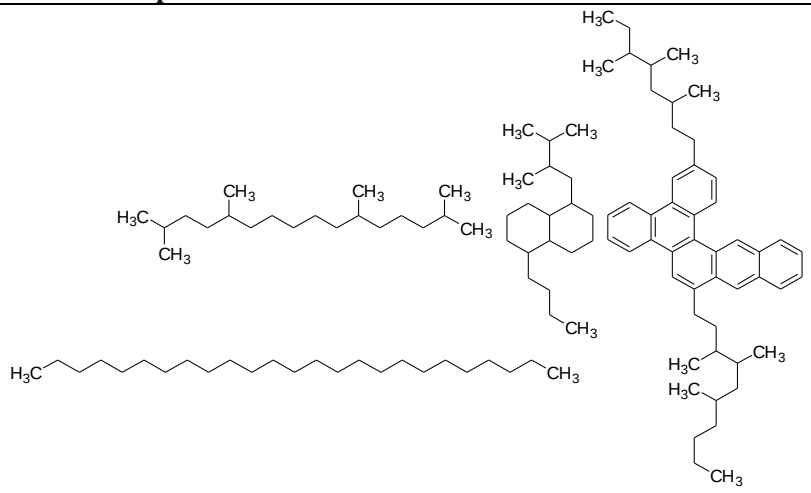
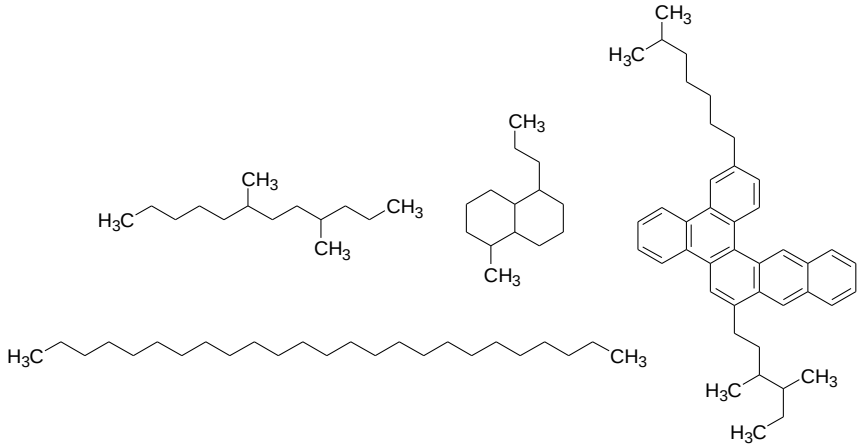
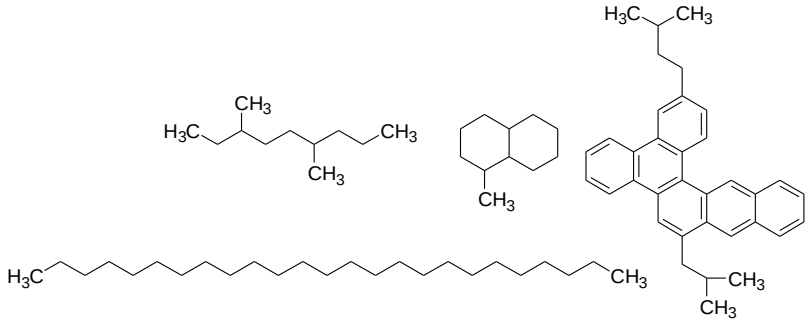
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Supporting Chemicals[1]		
Fuels, diesel	68334-30-5	 A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C20 and boiling in the range of approximately 163 to 357°C.
Fuel oil, no. 2	68476-30-2	 A distillate oil having a minimum viscosity of 32.6 SUS at 37.7°C to a maximum of 37.9 SUS at 37.7°C.
Fuel oil, no. 4	68476-31-3	 A distillate oil having a minimum viscosity of 45 SUS at 37.7°C to a maximum of 125 SUS at 37.7°C.

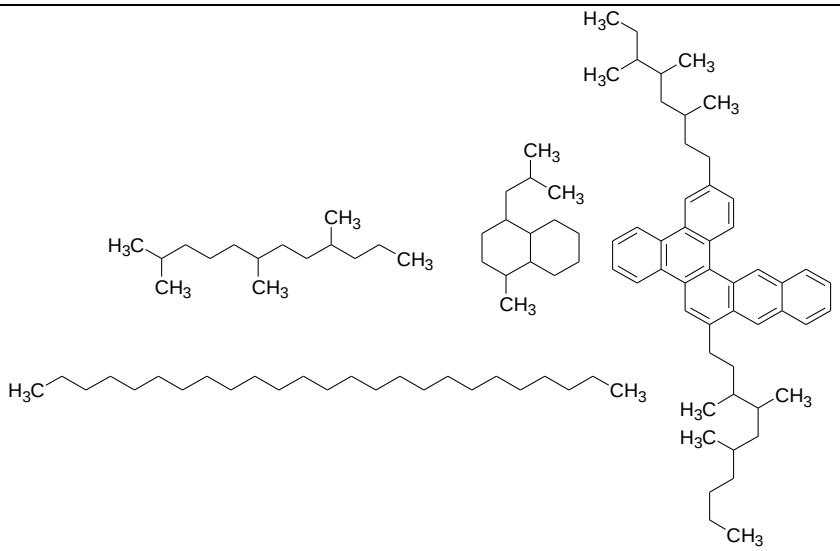
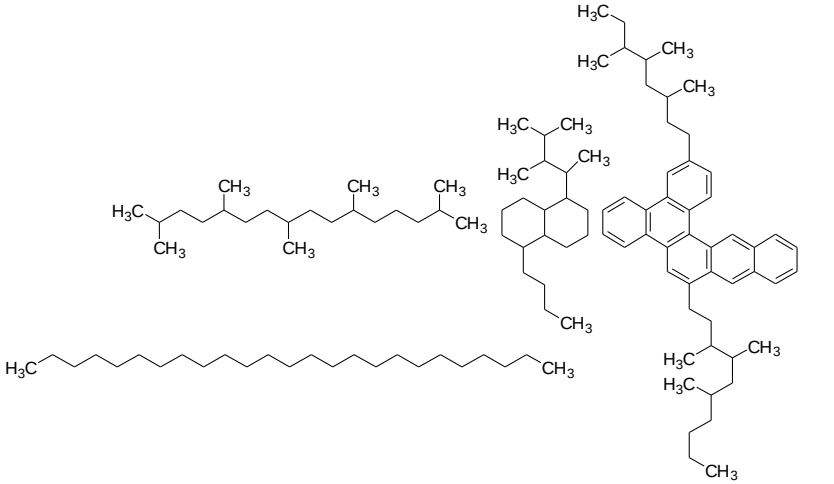
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Fuels, diesel, no. 2	68476-34-6	 A distillate oil having a minimum viscosity of 32.6 SUS at 37.7°C to a maximum of 40.1 SUS at 37.7°C.

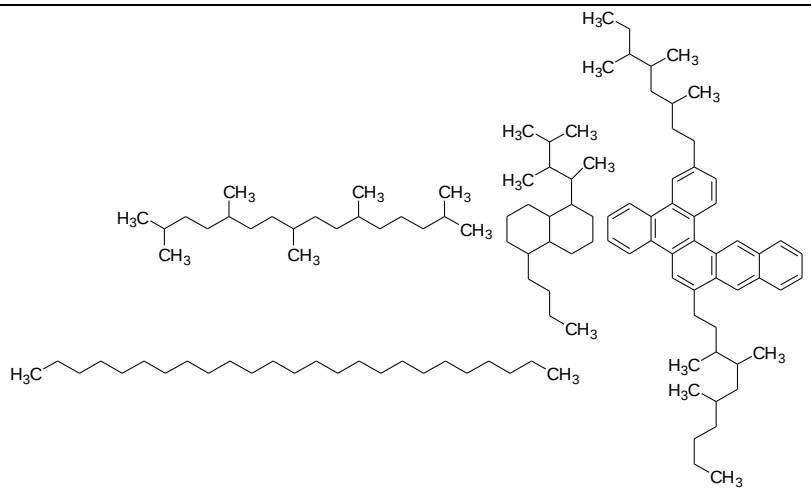
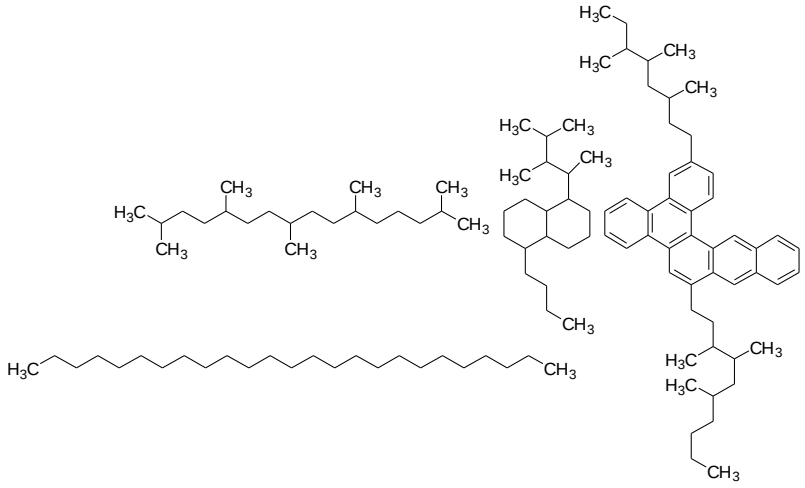
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Subcategory IV: Vacuum Residual		
Residues (petroleum), light vacuum	68512-62-9	 A complex residuum from the vacuum distillation of the residuum from the atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C13 and boiling above approximately 230°C.
Residues (petroleum), solvent-extd. vacuum distilled atm. residuum	70913-85-8	 A complex residuum produced by the solvent extraction of the vacuum distillate of the complex residuum from the atmospheric distillation of crude oil.

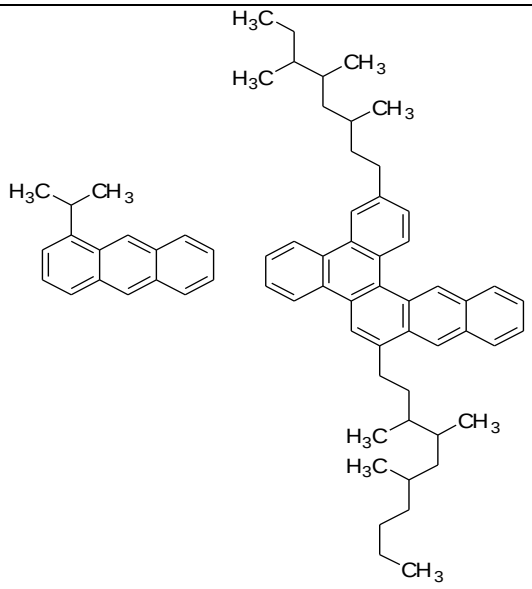
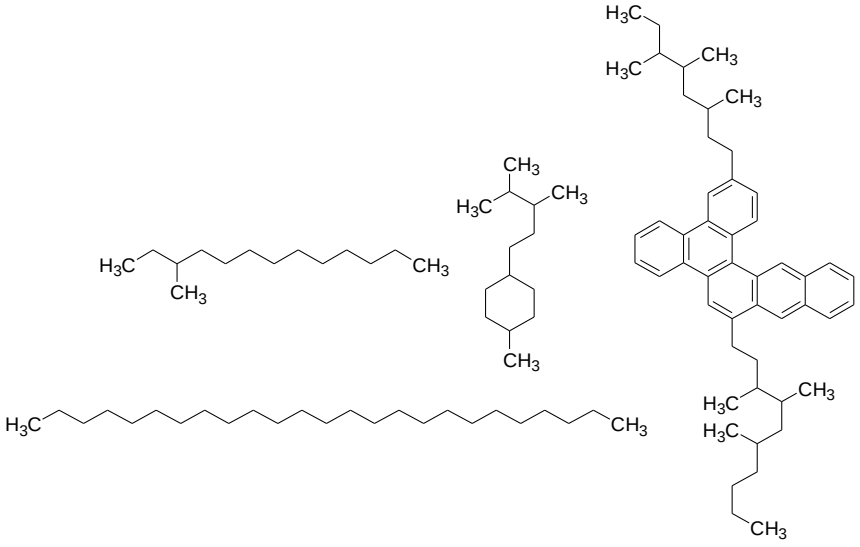
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Supporting Chemicals		
Residues (petroleum), vacuum	64741-56-6	 A complex residuum from the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C34 and boiling above approximately 495°C (923°F).
Subcategory V: Vacuum Distillate		
Gas oils (petroleum), heavy vacuum	64741-57-7	 A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and boiling in the range of approximately 350 to 600°C (662 to 1,112°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.

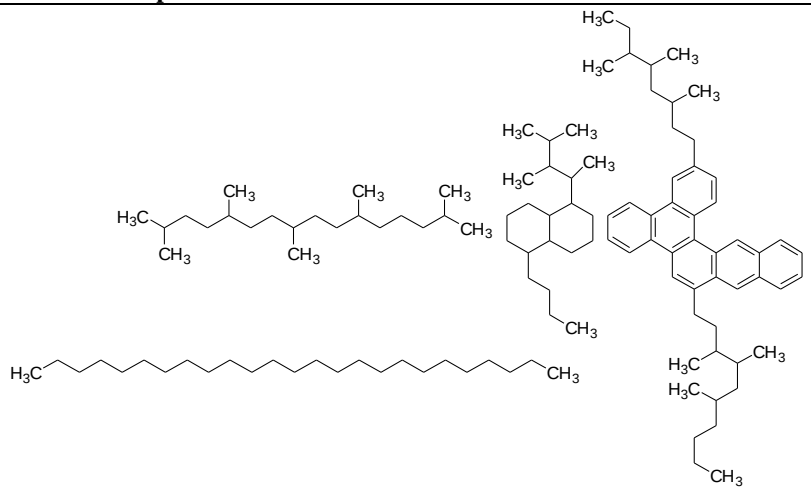
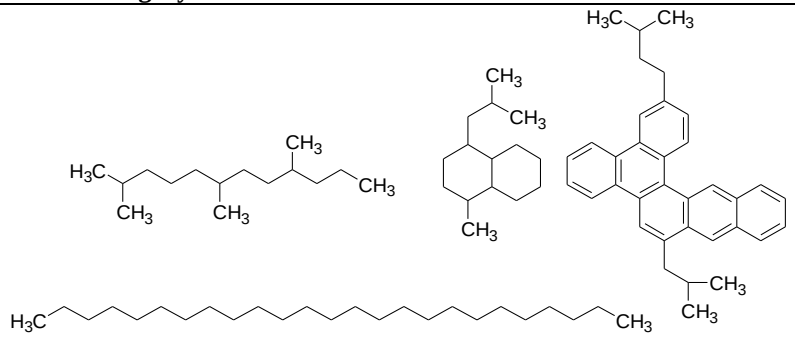
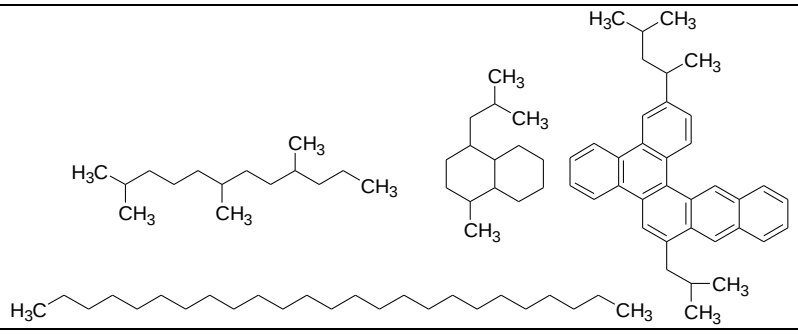
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Gas oils (petroleum), hydrotreated vacuum	64742-59-2	 A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C13 through C50 and boiling in the range of approximately 230 to 600°C (446 to 1,112°F). This stream is likely to contain 5 wt % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Gas oils (petroleum), hydrodesulfur-ized heavy vacuum	64742-86-5	 A complex combination of hydrocarbons obtained from a catalytic hydrodesulfurization process. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and boiling in the range of approximately 350 to 600°C (662 to 1,112°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Distillates (petroleum), petroleum residues vacuum	68955-27-1	

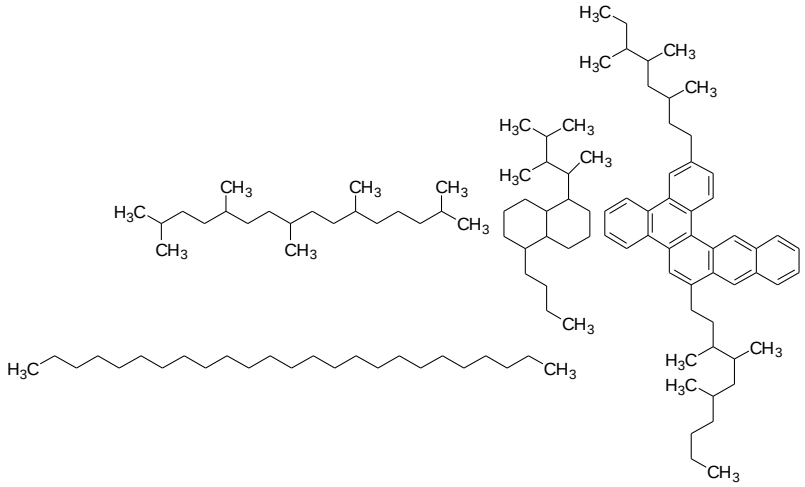
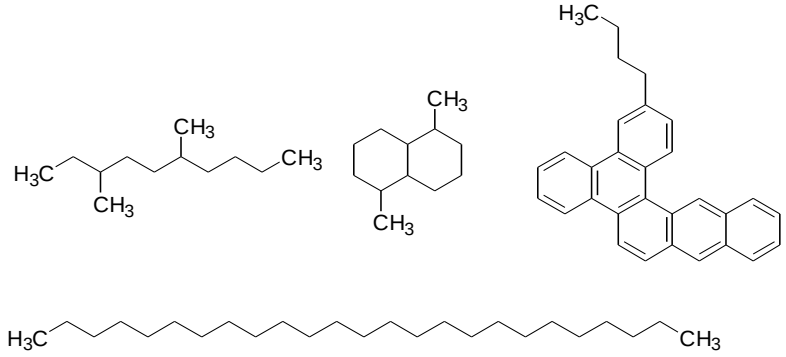
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
		 A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from the atmospheric distillation of crude oil.
Distillates (petroleum), intermediate vacuum	70592-76-6	 A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C14 through C42 and boiling in the range of approximately 250 to 545°C (482 to 1,013°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Distillates (petroleum), light vacuum	70592-77-7	

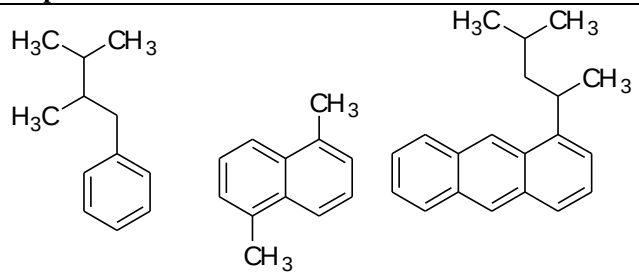
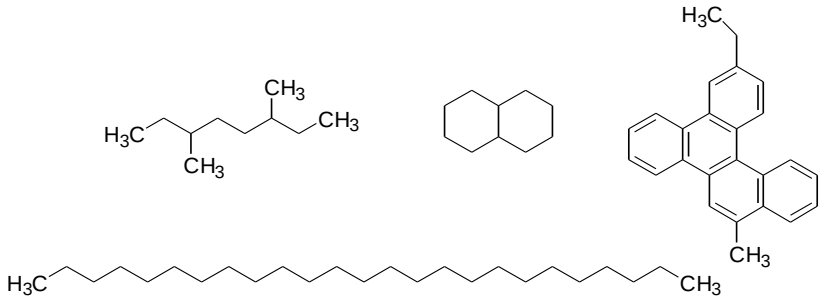
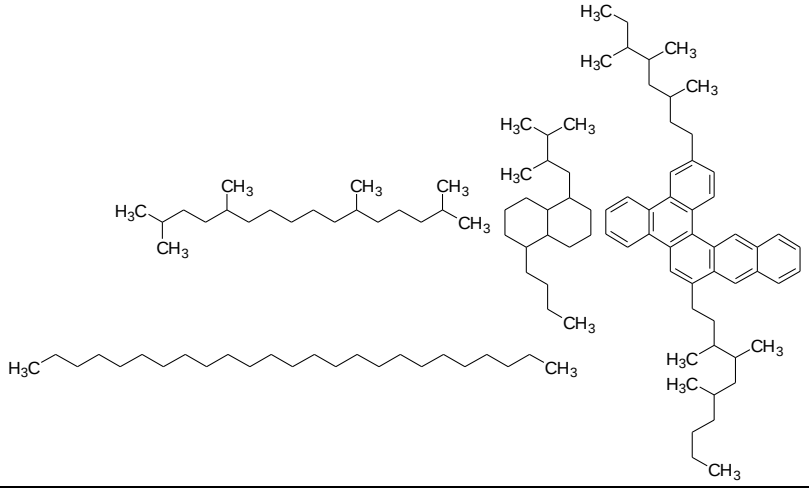
Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
		A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C35 and boiling in the range of approximately 250 to 545°C (482 to 1,013°F).
Distillates (petroleum), vacuum	70592-78-8	 A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C50 and boiling in the range of approximately 270 to 600°C (518 to 1,112°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Subcategory VI: Cracked Residual		
Clarified oils (petroleum), catalytic cracked	64741-62-4	 A complex combination of hydrocarbons produced as the residual fraction from distillation of the products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.

Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Residues (petroleum), hydrocracked	64741-75-9	 A complex combination of hydrocarbons produced as the residual fraction from distillation of the products of a hydrocracking process. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F).
Residues (petroleum), thermal cracked	64741-80-6	 A complex combination of hydrocarbons produced as the residual fraction from distillation of the product from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.

Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Pitch, petroleum, arom.	68187-58-6	 The residue from the distillation of thermal cracked or steam-cracked residuum and/or catalytic cracked clarified oil with a softening point from 40 to 180°C. Composed primarily of a complex combination of 3 or more membered condensed ring aromatic hydrocarbons.
Residues (petroleum), heavy coker gas oil and vacuum gas oil	68478-17-1	 A complex combination of hydrocarbons produced as the residual fraction from the distillation of heavy coker gas oil and vacuum gas oil. It predominantly consists of hydrocarbons having carbon numbers predominantly greater than C13 and boiling above approximately 230°C (446°F).

Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Residues (petroleum), coker scrubber, condensed-ring-arom.-contg.	68783-13-1	 A very complex combination of hydrocarbons produced as the residual fraction from the distillation of vacuum residuum and the products from a thermal cracking process. It consists predominantly of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Subcategory VII: Cracked Distillate		
Distillates (petroleum), heavy catalytic cracked	64741-61-3	 A complex combination of hydrocarbons produced by the distillation of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C35 and boiling in the range of approximately 260 to 500°C (500 to 932°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Distillates (petroleum), heavy thermal cracked	64741-81-7	

Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
		A complex combination of hydrocarbons from the distillation of the products from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly in the range of C15 through C36 and boiling in the range of approximately 260 to 480°C (500 to 896°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Clarified oils (petroleum), hydrodesulfur-ized catalytic cracked	68333-26-6	 A complex combination of hydrocarbons obtained by treating catalytic cracked clarified oil with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.
Distillates (petroleum), hydrodesulfur-ized intermediate catalytic cracked	68333-27-7	 A complex combination of hydrocarbons obtained by treating intermediate catalytic cracked distillates with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C30 and boiling in the range of approximately 205 to 450°C (401 to 842°F). It contains a relatively large proportion of tricyclic aromatic hydrocarbons.

Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
Aromatic hydrocarbons, C12-20	70955-17-8	 A complex combination of hydrocarbons obtained from the distillation of biphenyl and naphthalene feedstocks. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C12 through C20, such as alkylbenzenes, alkylnaphthalenes, indans, fluorenes, acenaphthalenes, phenanthrenes, and anthracenes, and boiling in the range of approximately 282 to 427 °C.
Subcategory VIII: Reformer Residual		
Residues (petroleum), catalytic reformer fractionator	64741-67-9	 A complex combination of hydrocarbons produced as the residual fraction from distillation of the product from a catalytic reforming process. It consists of predominantly aromatic hydrocarbons having carbon numbers predominantly in the range of C10 through C25 and boiling in the range of approximately 160 to 400°C (320 to 725°F). This stream is likely to contain 5 wt. % or more of 4- or 6-membered condensed ring aromatic hydrocarbons.
Residues (petroleum), catalytic reformer fractionator residue distn.	68478-13-7	

Process Streams, CASRN, and Description of the Heavy Fuel Oils Category		
Name	**CASRN**	**TSCA Description**
		A complex residuum from the distillation of catalytic reformer fractionator residue. It boils approximately above 399°C (750°F).

[1] Fuels, diesel (CASRN 68334-30-5), Fuel oil, no. 2 (CASRN 68476-30-2), and Fuels, diesl no. 2 (CASRN 68476-34-6) are distillate fuel oils and generally have lower molecular weight hydrocarbons than Fuel oil, residual (CASRN 68476-33-5) and Fuel oil, no 6 (CASRN 68553-00-4). Fuel oil, no. 4 is a mix of distillate and residual oils and may contain some higher molecular weight constituents as compared to the distillate fuels.

Appendix C

Cracking Processes

Thermal Cracking

Visbreaking, coking and steam cracking are types of thermal cracking. In visbreaking, the heavy feedstock is heated under pressure to crack the molecules in the stream. Coking is a severe method of thermal cracking. In steam cracking, the hydrocarbon stream is diluted with steam and then briefly heated (>900 °C) in a furnace. Light hydrocarbon feeds produce streams rich in the lighter alkenes, including ethylene, propylene and butadiene. Heavier hydrocarbon feeds give some of these, but also give products rich in aromatic hydrocarbons. Petroleum pitch, sold as a product for various applications, is a high aromatic residual material produced from either thermal cracking or catalytic cracking.

Catalytic Cracking

Catalytic cracking and hydrocracking are two types of catalytic cracking. Catalytic cracking is similar to thermal cracking except a catalyst facilitates conversion of the heavier to lighter products and requires lesser severe operating conditions than thermal cracking. Catalytic cracking converts heavy paraffins to light paraffins and olefins, heavy naphthenes to light naphthenes and olefins, and heavy aromatics to light aromatics, naphthenes and olefins. As noted above, petroleum pitch is a high aromatic residual material from either catalytic cracking or thermal cracking.

Hydrocracking

Hydrocracking is a combination of catalytic cracking and hydrogenation, using high pressure, high temperature, a catalyst, and hydrogen. It is typically used for feedstocks that are difficult to process by either catalytic cracking or reforming. When the feedstock has high paraffin content, the primary function of hydrogen is to prevent formation of PACs. Hydrocracking converts sulfur and nitrogen compounds to hydrogen sulfide and ammonia.

Appendix D

PAC Analytical Profile of Heavy Fuel Oils
(as presented in Sponsor's Category Assessment Document)

Table 12. PAC Analytical Profile of Heavy Fuel Oils

CAS RN	Sample No.	DMSO wt %[1]	ARC 1[2] (%)	ARC 2 (%)	ARC 3 (%)	ARC 4 (%)	ARC 5 (%)	ARC 6 (%)	≥ARC 7 (%)
64741-45-3 Atmospheric Tower Residuals									
64741-45-3	070904	5.6	0.0	0.5	1.1	1.1	1.1	1.1	0.5
64741-45-3	070907	1.9	0.0	0.2	0.6	0.6	0.4	0.2	0.1
64741-45-3	060905	2.6	0.0	0.0	0.5	0.8	0.5	0.5	0.1
64741-45-3	060917	3.0	0.0	0.0	0.6	1.2	0.9	0.6	0.1
64741-45-3	091691		0.1	0.3	2.0	2.0	2.0	0.6	0.1
64741-57-7 Heavy Vacuum Gas Oils									
64741-57-7	085244	6.2	0.0	0.1	2.5	1.9	1.2	0.5	0.0
64741-57-7	085289	7.1	0.0	0.0	1.4	1.4	1.4	2.1	0.7
64741-57-7	086010	6.4	0.0	0.1	1.3	1.9	1.9	1.3	0.0
64741-57-7	086269	12.6	0.0	0.6	5.0	3.8	2.5	0.9	0.0
64741-57-7	086281	11.9	0.0	0.6	6.0	3.6	1.2	0.2	0.0
64741-57-7	086289	16.6	0.0	0.7	1.0	11.6	1.7	0.8	0.0
64741-57-7	091649		0.1	0.3	3.0	2.0	2.0	0.7	0.0
64741-57-7	091650		0.0	0.4	4.0	2.0	0.6	0.2	0.0
64741-57-7	091654		0.1	0.4	4.0	3.0	0.9	0.4	0.0
64741-57-7	091689		0.0	0.4	4.0	1.0	0.4	0.1	0.0
64741-57-7	094627		9.0	9.0	0.2	0.0	0.0	0.0	0.0
64741-57-7	060906	4.3	0.0	0.0	0.4	1.3	1.3	0.9	0.3
64741-57-7	060916	3.7	0.0	0.0	0.4	1.1	1.1	0.7	0.3
64741-57-7	060922	5.4	0.0	0.1	1.6	1.6	1.1	0.5	0.1
64741-57-7	086176	8.5	0.0	0.6	0.9	2.6	1.7	0.9	1.7

CAS RN	Sample No.	DMSO wt %[1]	ARC 1[2] (%)	ARC 2 (%)	ARC 3 (%)	ARC 4 (%)	ARC 5 (%)	ARC 6 (%)	≥ARC 7 (%)
64741-57-7	086179	10.3	0.0	0.5	1.0	3.1	2.1	1.0	2.1
64741-57-7	086189-1	6.2	0.0	0.1	0.3	0.6	1.2	2.5	1.2
64741-57-7	086189-2	9.1	0.0	0.1	0.0	0.9	1.8	3.6	2.7
64741-61-3 Heavy Catalytic Cracked Distillates									
64741-61-3	070909	28.0	0.0	0.8	11.2	8.4	5.6	2.0	0.6
64741-61-3	030928	38.5	0.0	3.9	15.4	11.6	3.9	1.5	0.0
64741-61-3	060912	35.0	0.0	3.5	21.0	10.5	1.8	0.0	0.0
64741-61-3	060930	47.0	0.0	0.5	28.2	14.1	1.4	0.0	0.0
64741-61-3	091028	50.5	0.0	3.0	32.8	13.6	1.5	0.0	0.0
64741-61-3	091029	51.4	0.0	3.6	33.4	13.9	0.5	0.0	0.0
64741-61-3	091030	50.8	0.0	3.0	33.0	13.2	1.5	0.0	0.0
64741-61-3	091686		0.0	4.0	40.0	4.0	0.6	0.0	0.0
64741-62-4 Catalytic Cracked Clarified Oils									
64741-62-4	086001	64.2	0	2.6	25.7	19.3	6.4	3.2	0.6
64741-62-4	087277	19.1	0.0	0.4	3.8	5.7	5.7	3.8	0.8
64741-62-4	087278	30.3	0.0	0.9	9.1	9.1	6.1	3.0	0.9
64741-62-4	087279	20.2	0.0	0.8	6.1	6.1	4.0	2.0	0.6
64741-62-4	091645		0.0	0.7	10.0	30.0	20.0	6.0	0.0
64741-62-4	010923	43.2	0.0	1.3	13.0	13.0	8.6	4.3	1.7
64741-62-4	010924	31.0	0.0	0.3	6.2	12.4	6.2	3.1	1.6
64741-62-4	010929	52.0	0.0	1.0	15.6	15.6	10.4	5.2	2.6
64741-62-4	086002	61.7	0.0	1.9	12.3	24.7	12.3	6.2	1.2
64741-62-4	086015	31.2	0.0	0.3	6.2	12.5	9.4	6.2	1.2
64741-62-4	086066	52.6	0.0	0.5	10.5	21.0	10.5	5.3	1.6
64741-62-4	086123	13.4	0.1	4.0	4.0	2.7	2.7	1.2	0.3
64741-62-4	086180	63.5	0.0	1.3	12.7	25.4	12.7	6.4	1.3
64741-62-4	086185	63.7	0.0	1.9	25.5	19.1	12.7	5.1	0.6
64741-62-4	086196	74.9	0.0	1.5	22.5	30.0	15.0	7.5	1.5
64741-62-4	086484	48.8	0.0	1.0	9.8	19.5	9.8	4.9	1.0
64741-62-4	091692		0.0	3.0	20.0	30.0	10.0	4.0	0.0
64741-67-9 Catalytic Reformer Fractionator Residuals									
64741-67-9	060949	49.0	3.9	44.1	2.9	0.0	0.0	0.0	0.0
64741-75-9 Hydrocracked Residuals									
64741-75-9[3]	060946	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64741-80-6 Thermal Cracked Residuals									
64741-80-6	060915	4.4	0.0	0.0	1.3	2.2	0.9	0.2	0.0
64741-81-7	071021	63.0	0.0	6.3	44.1	6.3	4.4	0.0	0.0
64741-81-7	086198	9.4	5.6	2.8	0.6	0.1	0.0	0.0	0.0
64741-81-7	094625		7.0	9.0	7.0	5.0	2.0	0.0	0.0
64741-81-7 Heavy Thermal Cracked Distillates									
64741-81-7	083366	12.7	0.1	2.5	5.1	2.5	1.3	0.9	0.1
64741-81-7	086161	14.9	0.0	0.7	6.0	4.5	3.0	1.5	0.3
64741-81-7	086181	24.8	0.2	2.5	12.4	7.4	2.5	0.5	0.0
64741-81-7	086193	4.2	0.8	2.9	0.4	0.0	0.0	0.0	0.0
64741-81-7	086194	16.0	0.0	0.5	3.2	4.8	4.8	1.6	0.5
64741-81-7	086230	6.8	0.3	2.0	2.7	1.4	0.4	0.1	0.0
64741-81-7	086272	16.2	0.3	4.9	8.1	1.6	0.3	0.2	0.0
64741-81-7	091653		0.0	0.9	20.0	5.0	0.0	0.0	0.0
64742-59-2 Hydrotreated Vacuum Gas Oils									
64742-59-2	071017	2.9	0.0	0.6	0.9	0.6	0.6	0.3	0.0
64742-59-2	071026	5.8	0.0	0.5	1.7	1.7	1.2	0.6	0.1
64742-78-5 Hydrodesulfurized Atmospheric Residuals									
64742-78-5	071030	13.0	0.0	3.9	5.2	1.2	1.0	1.0	0.5
64742-86-5 Hydrodesulfurized Heavy Vacuum Gas Oils									
64742-86-5	091690		0.1	0.7	3.0	2.0	1.0	0.3	0.0

CAS RN	Sample No.	DMSO wt %[1]	ARC 1[2] (%)	ARC 2 (%)	ARC 3 (%)	ARC 4 (%)	ARC 5 (%)	ARC 6 (%)	≥ARC 7 (%)
68333-22-2 Atmospheric Residuals									
68333-22-2	071016	6.2	0.0	0.1	1.9	1.9	1.2	0.6	0.1
68410-00-4 Crude Oil Distillates									
68410-00-4	030932	3.2	0.0	1.0	1.3	0.6	0.2	0.0	0.0
68410-00-4	030933	5.5	0.1	4.4	1.1	0.0	0.0	0.0	0.0
68410-00-4	030934	5.5	0.0	1.7	1.7	1.1	0.6	0.2	0.0
68410-00-4	091647		0.1	4.0	4.0	0.0	0.0	0.0	0.0
68410-00-4	091681		0.2	4.0	4.0	0.0	0.0	0.0	0.0
68476-33-5 Residual Fuel Oils									
68476-33-5	086104	14.6	0.0	1.5	7.3	2.9	1.3	0.6	0.1
68476-33-5	086119	8.8	0.0	2.6	2.6	1.8	0.9	0.6	0.2
68476-33-5	070903	6.0	0.2	1.8	1.2	1.2	1.2	0.5	0.1
68476-33-5	086108	9.0	0.3	2.7	2.7	0.9	0.9	0.7	0.3
68478-17-1 Heavy Coker Gas Oil and Vacuum Gas Oil Residuals									
68478-17-1	071012	18.0	0.0	0.5	5.4	5.4	3.6	1.8	0.4
68478-17-1	071031	20.0	0.0	0.2	4.0	6.0	4.0	4.0	0.8
68512-62-9 Light Vacuum Residuals									
68512-62-9	092009	3.3	0.0	0.0	0.7	0.7	0.7	1.0	0.7
68512-62-9	081022	3.1	0.1	2.2	0.9	0.0	0.0	0.0	0.0
68553-00-4 Fuel Oil, No. 6									
68553-00-4	070908	21.0	0.0	2.1	8.4	6.3	2.1	1.3	0.2
68553-00-4	030936	36.1	0.0	1.8	14.4	10.8	3.6	2.9	0.7
68553-00-4	030937	32.6	0.0	2.3	13.0	9.8	6.5	3.3	1.0
68553-00-4	091034	42.4	0.0	2.5	16.1	14.0	6.8	2.5	0.0
68553-00-4	091035	42.7	0.0	3.0	17.1	13.7	6.0	2.6	0.0
68553-00-4	091036	43.3	0.0	4.3	16.5	13.9	6.1	2.6	0.0
68553-00-4	091674	13.1	0.1	2.6	5.2	1.3	1.3	1.3	0.9
68783-08-4 Heavy Atmospheric Gas Oils									
68783-08-4	071020	3.0	0.0	0.0	1.2	0.9	0.6	0.3	0.0
68783-08-4	071025	5.8	0.1	3.5	1.7	0.0	0.0	0.0	0.0
68783-08-4	081009	5.8	0.0	0.5	2.3	1.7	0.6	0.2	0.0
68783-08-4	081010	5.7	0.0	0.5	2.3	1.7	0.6	0.2	0.0
68783-08-4	081011	5.8	0.0	0.4	2.9	1.7	0.6	0.2	0.0
68783-08-4	081012	5.9	0.0	0.4	3.0	1.8	0.6	0.2	0.0
68783-08-4	081013	2.4	0.0	1.0	1.0	0.2	0.1	0.1	0.0
68783-08-4	094626		0.7	4.0	1.0	0.7	0.5	0.0	0.0
70592-76-6 Intermediate Vacuum Distillates									
70592-76-6	071011	5.8	0.0	0.1	1.7	1.7	1.2	0.6	0.2
70592-76-6	071018	5.0	0.0	2.0	3.0	0.1	0.0	0.0	0.0
70592-76-6	071029	5.8	0.0	1.2	2.9	1.2	0.5	0.2	0.0
70592-76-6	071032	6.1	0.0	0.6	2.4	1.8	1.2	0.4	0.0
70592-77-7 Light Vacuum Distillates									
70592-77-7	071015	11.0	0.0	2.2	7.7	1.1	0.0	0.0	0.0
70592-77-7	071022	6.3	0.0	0.3	2.5	1.9	0.6	0.6	0.0
70592-77-7	071023	8.2	0.0	0.8	4.1	2.5	0.8	0.5	0.0
70592-77-7	071027	8.3	0.0	1.7	5.0	1.7	0.5	0.2	0.0
70592-78-8 Vacuum Distillates									
70592-78-8	071014	9.3	0.0	0.1	0.9	3.7	2.8	1.9	0.2
70592-78-8	071019	5.2	0.0	0.1	1.0	1.0	1.0	1.0	1.0
70592-78-8	071024	7.2	0.0	0.0	1.4	2.2	2.2	1.4	0.7
70913-85-8 Solvent Extracted, Vacuum Distilled Atmospheric Residuals									
70913-85-8	070905	1.9	0.0	0.0	0.0	0.0	0.2	0.8	0.8
70913-85-8	060904	2.0	0.0	0.0	0.0	0.2	0.4	0.6	0.6

1 – Percent of DMSO-extractable PACs as determined by PAC-2 Method as described by Roth et al., 2011 [Introductory PAC paper for publication]. The DMSO wt % does not contain the total PACs for each sample; DMSO does not extract highly alkylated PACs. DMSO wt % does not correlate with modeling. PDR10 is based upon the PAC Profile only. References for individual sample PAC Profiles are presented separately

2 – ARC is "aromatic ring class". ARC 1 (%) is the weight percent of PACs that have 1 aromatic ring within the total sample; "ARC 2 (%) is the percent of PACs with 2 aromatic rings, and so forth to 7 aromatic rings determined by the PAC-2 method.