

SCREENING-LEVEL HAZARD CHARACTERIZATION

Resin Oils and Cyclodiene Dimer Concentrates Category

SPONSORED CHEMICALS

(See Table 1)

SUPPORTING CHEMICAL

Dicyclopentadiene CASRN 77-73-6

The High Production Volume (HPV) Challenge Program¹ 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 based on their being of high quality, highly relevant to hazard characterization, and publicly available.

OPPT does not develop HCs for those HPV chemicals which have already been assessed internationally through the HPV program of the Organization for Economic Cooperation and

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>.

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.

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.

<p>Chemical Abstract Service Registry Number (CASRN)</p>	<p><u>Sponsored Chemical</u> See Table 1</p> <p><u>Supporting Chemical</u> 77-73-6</p>
<p>Chemical Abstract Index Name</p>	<p><u>Sponsored Chemical</u> See Table 1</p> <p><u>Supporting Chemical</u> 4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydro-</p>
<p>Structural Formula</p>	<p>See Appendix</p>
<p style="text-align: center;">Summary</p> <p>The resin oils and cyclodiene dimer concentrates category consists of nine related petrochemical process streams derived from pyrolysis gasoline by the ethylene manufacturing process. The streams that form this category are complex mixtures comprised primarily of C8 to C12 aliphatic cycloalkenes, and aromatic hydrocarbons of which CASRN 77-73-6 is a key chemical constituent in the majority of streams. The substances of this category are typically liquids possessing high vapor pressure and low to moderate water solubility. All category members are expected to possess moderate mobility in soil. Volatilization is expected to be high. The rate of hydrolysis is negligible. The rate of atmospheric photooxidation is moderate to rapid. The members of the resin oils and cyclodiene dimer concentrates category are expected to possess moderate persistence (P2) and low to high bioaccumulation potential (B1-B3).</p> <p>Human Health Hazard</p> <p><i>Subcategory I: DCPD High Purity and related streams</i></p> <p>The acute toxicity of DCPD, High Purity (CASRN 77-73-6) is moderate via the oral route in rats, high via the inhalation route in rats and mice, and low via the dermal route in rabbits. The acute toxicity of High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) is low via the oral and dermal routes in rats and rabbits respectively, and low via the inhalation route in rats. In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with DCPD, High Purity (CASRN 77-73-6) male rats exhibited an increase in single cell necrosis in the liver and hyaline droplets and tubular changes in the kidneys at 20 mg/kg-day while female rats exhibited histopathological change in the adrenals and mortality at 100 mg/kg-day; the NOAEL for systemic toxicity is 4 mg/kg-day. In a 90-day inhalation repeated-dose toxicity study with DCPD, High Purity (CASRN 77-73-6), male rats exhibited histopathological changes in the kidney at 0.0054 mg/L while female rats did not exhibit any significant adverse effects; the NOAEC is not established in male rats and is 0.28 mg/L (highest concentration tested) in female rats. In a 90-day inhalation repeated-dose toxicity study with DCPD, High Purity (CASRN 77-73-6) in mice, mortality was observed at 0.28 mg/L (highest concentration tested); the NOAEC is 0.028 mg/L. In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with DCPD/Codimer Concentrate (CASRN 68478-10-4) male rats exhibited an increase in renal tubular hyaline droplets at 5 mg/kg-day while female rats exhibited</p>	

an increase in liver weight and hepatocellular hypertrophy at 100 mg/kg-day; the NOAEL for systemic toxicity is not established in males and is 25 mg/kg-day in females. There were no treatment-related effects in dams or pups in the reproductive/developmental portion of the study; the NOAEL for reproductive/developmental toxicity is 100 mg/kg-day (highest dose tested); the NOAEL for maternal toxicity is 25 mg/kg-day. In the combined repeated-dose/reproductive/developmental toxicity screening test with DCPD, High Purity (CASRN 77-73-6) described above, mortality and litter loss were observed in dams and low viability index, low birth weight and decreased weight gain were observed in pups at 100 mg/kg-day; the NOAEL for reproductive/maternal/developmental toxicity is 20 mg/kg-day. In a dietary, three-generation reproductive toxicity study with DCPD, High Purity (CASRN 77-73-6), excepting decreased pup weight at 34.7 mg/kg-day, no significant effects on reproduction were observed; the NOAEL for reproductive toxicity is 34.7 mg/kg-day (highest concentration tested). The NOAELs for maternal and developmental toxicity are 34.7 mg/kg-day (highest concentration tested) and 3.45 mg/kg-day, respectively. In an oral gavage prenatal developmental toxicity study in rats with DCPD, High Purity (CASRN 77-73-6) dams exhibited decreased body weight and decreased body weight gain at 50 mg/kg-day and pups exhibited decreased fetal weight at 200 mg/kg-day; the NOAEL is not established for maternal toxicity and is 50 mg/kg-day for developmental toxicity. In an oral gavage prenatal developmental toxicity study with DCPD, High Purity (CASRN 77-73-6) in rabbits, bloody vaginal discharge and abortion were observed at 100 mg/kg-day and signs of developmental toxicity consisted of increased non-live implants/litter, decreased fetuses, and gross deformities at 400 mg/kg-day; the NOAELs for maternal and developmental toxicity are 25 mg/kg-day and 300 mg/kg-day, respectively. In a dietary prenatal developmental toxicity study with DCPD, High Purity (CASRN 77-73-6) in rats, no effects were observed at 37.5 mg/kg-day; the NOAEL for maternal/developmental toxicity is 37.5 mg/kg-day (highest concentration tested). DCPD, High Purity (CASRN 77-73-6) was not mutagenic in bacteria *in vitro* but induced chromosomal aberrations in mammalian cells *in vitro*. DCPD/Codimer Concentrate (CASRN 68478-10-4) and High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) were not mutagenic in bacteria *in vitro* and did not induce chromosomal aberrations in mammalian cells *in vivo*. High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) did not induce unscheduled DNA synthesis in mammalian cells *in vitro*. DCPD, High Purity (CASRN 77-73-6) is irritating to rabbit skin and eyes. DCPD, High Purity (CASRN 77-73-6) and High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) are neurotoxic to rats and DCPD, High Purity (CASRN 77-73-6) is neurotoxic to mice.

No data gaps were identified under the HPV Challenge Program.

Subcategory II: Low DCPD Resin Oil and Resin Former

The acute toxicity of Low DCPD Resin Oil (CASRNs 68516-20-1 and 68477-54-3) is low via the oral route (rats) and high via the inhalation route (rats). In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with Low DCPD Resin Oil (CASRNs 68516-20-1 and 68477-54-3) male rats exhibited histopathological changes in the kidney at 35 mg/kg-day and female rats exhibited an increase in liver weight and hepatocellular hypertrophy at 125 mg/kg-day; the NOAEL for systemic toxicity is not established in males and is 35 mg/kg-day in females. There were no treatment-related effects in dams, while low pup weight was observed at 375 mg/kg-day; the NOAEL for reproductive toxicity is 375 mg/kg-day

(highest dose tested) and the NOAEL for developmental toxicity is 125 mg/kg-day; the NOAEL for maternal toxicity is 35 mg/kg-day. Low DCPD Resin Oil (CASRN 68516-20-1 and 68477-54-3) is not mutagenic in bacteria *in vitro* and did not induce chromosomal aberrations in mammalian cells *in vivo*. Low DCPD Resin Oil (CASRN 68516-20-1 and 68477-54-3) is irritating to rabbit skin and eyes and is not neurotoxic in rats.

No data gaps were identified under the HPV Challenge Program.

Subcategory III: MCPD Dimer

The acute toxicity of MCPD Dimer (CASRN 26472-00-4) is low via the oral and dermal routes in rats and rabbits, respectively and moderate via the inhalation route in rats and mice. In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with MCPD Dimer (CASRN 26472-0-4) in rats, males exhibited histopathological changes in the kidney at 20 mg/kg-day while female rats exhibited an increase in liver weight and hepatocellular hypertrophy at 100 mg/kg-day; the NOAEL for systemic toxicity is not established in males and is 20 mg/kg-day in females. There were no treatment-related effects in dams, while low pup weight and decreased weight gain were observed in pups; the NOAEL for reproductive toxicity is 300 mg/kg-day (highest dose tested) and for developmental toxicity is 20 mg/kg-day; the NOAEL for maternal toxicity is 20 mg/kg-day. MCPD Dimer (CASRN 26472-00-4) is not mutagenic in bacteria *in vitro* but did induce micronuclei in erythrocytes *in vivo*. MCPD Dimer (CASRN 26472-00-4) is neurotoxic in rats.

No data gaps were identified under the HPV Challenge Program.

Hazard to the Environment

The 96-h LC₅₀ of CASRN 77-73-6 ranges from 14.2 to 86.3 mg/L for fish. The 96-h LC₅₀ of high DCPD resin oil (CASRN 68477-40-7 and 68477-54-3) for fish ranges from 10.6 to 13.5 mg/L. The 96-h LC₅₀ of low DCPD resin oil (CASRN 68477-54-3) for fish is 6.1 mg/L. The 96-h LC₅₀ of DCPD/codimer concentrate (CASRN 68478-10-4) for fish is 0.53 mg/L. The 48-h EC₅₀ of CASRN 77-73-6 for aquatic invertebrates ranges from 8.0 to 10.5 mg/L. The 48-h EC₅₀ of low DCPD resin oil (CASRN 68516-20-1 and 68477-54-3) for aquatic invertebrates is 3.0 mg/L. The 48-h EC₅₀ of DCPD/codimer concentrate (CASRN 6878-10-4) for aquatic invertebrates is 0.76 mg/L. The 72-h EC₅₀ of CASRN 77-73-6 for aquatic plants is 27.0 mg/L for growth rate. The 96-h EC₅₀ of low DCPD resin oil (CASRN 68516-20-1 and 68477-54-3) for aquatic plants is 0.94 and <0.27 mg/L for biomass and growth rate, respectively. The 96-h EC₅₀ of DCPD/codimer concentrate (CASRN 68478-10-4) for aquatic plants is 1.0 and 1.2 mg/L for biomass and growth rate, respectively. The 96-h EC₅₀ of MCPD dimer (CASRN 26472-00-4) for aquatic plants is 0.42 and 0.83 mg/L for biomass and growth rate, respectively. The 21-d chronic toxicity of CASRN 77-73-6 for aquatic invertebrates is 3.2 mg/L.

Chronic toxicity to aquatic invertebrates is identified as a data gap for low DCPD resin oil (CASRN 68516-20-1 and 68477-54-3), DCPD/codimer concentrate (CASRN 68478-10-4), and MCPD dimer (CASRN 26472-00-4) under the HPV Challenge Program.

The sponsor, The American Chemistry Council Olefins Panel, submitted a Test Plan and Robust Summaries to EPA for resin oils and cyclodiene dimer concentrates category on December 18, 2001. EPA posted the submission on the ChemRTK HPV Challenge website on December 27, 2001 (<http://www.epa.gov/chemrtk/pubs/summaries/resinoil/c13434tc.htm>). EPA comments on the original submission were posted to the website on August 1, 2002. Public comments were also received and posted to the website. The sponsor submitted updated/revised documents on September 19, 2002, February 18, 2004, December 6, 2004 and March 30, 2005 which were posted to the ChemRTK website on September 30, 2002, April 7, 2004, January 26, 2005 and May 18, 2005, respectively.

Category Justification

The resin oils and cyclodiene dimer concentrates category consists of nine related complex mixtures which are petroleum process streams that are derived from the pyrolysis gasoline stream (Table 1). The pyrolysis gasoline stream is derived from the ethylene process, and this fraction is subjected to various processes including distillation, thermal processing and purification steps to isolate the process streams included in the proposed category. All of these streams are complex mixtures of aromatic and aliphatic C4 – C12 hydrocarbons of various compositions. Dicyclopentadiene (DCPD; CASRN 77-73-6) is a major constituent (i.e. greater than 40%) of four streams. Methylcyclopentadiene (MCPD; CASRN 26472-00-4) dimer is a major constituent of one stream and a minor constituent (i.e. less than 20%) of four streams. In some cases, more than a single CASRN is used to represent a specific stream.

The proposed category is generally supported on the basis of similar environmental fate and transport behavior among the sponsored process streams. The streams have been subcategorized according to their physical and chemical properties. Subcategory I contains the streams with high levels of dimers and codimers of DCPD and MCPD (Table 2). Subcategory II contains the two streams with lesser amounts of dimers and codimers of DCPD and MCPD and higher levels of aromatic monomers. Subcategory III is comprised of one stream with a high level of aromatics and less than 5% aliphatics. Measured biodegradation data have been provided to support three of the sponsored streams (MCPD dimer, DCPD codimer concentrate and low DCPD resin oil) and show a pattern that supports the grouping.

For the purposes of human health, EPA has grouped the sponsored streams into three subcategories (Table 2) based on the chemical composition information provided by the sponsor. Exact composition data were not provided; instead, the range of compositional characteristics was provided and used to determine the subcategories. Subcategory I consists of streams that contain ~20% DCPD or greater either as a monomer or as a codimer. Subcategory II consists of the streams that contain less than 7% DCPD and have a more varied chemical profile that includes substituted benzene, toluene and styrene compounds. Subcategory III contains the stream that is low in DCPD and contains ~ 90% MCPD.

For the purposes of aquatic toxicity, EPA has grouped all of the sponsored streams into one category. All of the sponsored process streams are composed of hydrocarbons. The dominant mechanism of action for these compounds is expected to be hydrocarbon-induced narcosis, and the level of toxicity observed for each stream will depend on the water solubility and partition

coefficients of the components. The proposed category is supported by measured data for representative compounds from each of the three subcategories. The available data vary over approximately one order of magnitude for the tested streams, indicating a similarity of response.

Table 1. Sponsored Chemicals in the Resin Oils and Cyclodiene Dimer Concentrates Category		
Sponsored Stream	CASRN	Chemical Abstract Index Name
DCPD, High Purity	77-73-6	4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydro-
DCPD Concentrate		
	68478-08-0	Naphtha, petroleum, light steam-cracked, C5 –fraction, oligomer conc.
	68527-26-4	Naphtha, petroleum, light steam-cracked debenzenized
	68603-02-1	Distillates, petroleum, thermal cracked naphtha and gas oil, dimerized
DCPD/Codimer Concentrate	68478-10-4	Naphtha, petroleum, light steam-cracked, debenzenized, C8 – 16-cycloalkadiene conc.
DCPD, Purge Stream	68527-24-2	Naphtha, petroleum, light steam-cracked arom., C5-12 cycloalkadiene fraction, polymers
DCPD Stream	68477-53-2	Distillates, petroleum, steam-cracked, C5 – 12 fraction
High DCPD Resin Oil		
	68477-54-3	Distillates, petroleum, steam-cracked, C8 – 12 fraction
	68477-40-7	Distillates, petroleum, cracked stripped steam-cracked petroleum distillates C10-12 fraction
Low DCPD Resin Oil		
	68477-54-3	Distillates, petroleum, steam-cracked, C8 – 12 fraction
	68516-20-1	Naphtha, petroleum, steam-cracked middle arom.
Resin Former	68477-54-3	Distillates, petroleum, steam-cracked, C8 – 12 fraction
MCPD Dimer	26472-00-4	4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydrodimethyl-

Note 1: The CAS numbers associated with the corresponding production streams are shown in the above table. In some cases, more than a single CAS number is used to represent a specific stream. The Olefins Industry or others may use these same CAS numbers to represent substances that may, in various degrees, be dissimilar to the category streams. CAS numbers, other than those shown in this table may be used to describe these streams in future reporting.

Table 2. Subcategories in the Resin Oils and Cyclodiene Dimer Concentrates Category	
<i>Physical-Chemical Properties and Fate</i>	<i>Human Health Hazard</i>
<i>Subcategory I</i>	
<ul style="list-style-type: none"> • DCPD High Purity • DCPD Concentrate • DCPD/Codimer Concentrate • DCPD Purge Stream • DCPD Stream • MCPD Dimer 	<ul style="list-style-type: none"> • DCPD High Purity • DCPD Concentrate • DCPD/Codimer Concentrate • DCPD Purge Stream • DCPD Stream • High DCPD Resin Oil
<i>Subcategory II</i>	
<ul style="list-style-type: none"> • High DCPD Resin Oil • Resin Former 	<ul style="list-style-type: none"> • Low DCPD Resin Oil • Resin Former
<i>Subcategory III</i>	
<ul style="list-style-type: none"> • Low DCPD Resin Oil 	<ul style="list-style-type: none"> • MCPD Dimer

Supporting Chemical Justification

Dicyclopentadiene (DCPD, CASRN 77-73-6) is a major component (>94%; see below) of the DCPD high purity stream. It has been assessed at SIAM 7 under the OECD HPV program and the data can be viewed at the following link:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0. References to data for DPCD are made in this hazard characterization for completeness, and used, where appropriate, to characterize the toxicity of the DCPD high purity stream.

1. Chemical Identity

1.1 Identification and Purity

The following description is taken from the 2005 Test Plan and Robust Summary. The resin oils and cyclodiene dimer concentrates category was developed by grouping nine related petrochemical process streams derived from distillation and in some cases thermal processing and further purification of the pyrolysis gasoline stream from the ethylene process unit. The streams that form this category are complex mixtures of C4-C12 hydrocarbons, comprised primarily of C8 to C12 aliphatic cycloalkenes, and aromatic hydrocarbons of which DCPD is a major component in the majority of the streams. DCPD high purity was 94% pure or greater, DCPD resin grade was 75% pure and MCPD dimer was 90% pure or greater when noted in the robust summaries. The following are the chemical compositions of the complex mixtures, when given in the robust summaries:

DCPD/Codimer Concentrate (CASRN 68478-10-4)

The sample tested consisted of DCPD (29%), MCPD dimer (13%), DCPD/MCPD dimer (13%), other codimers of cyclopentadiene – e.g. with 1,3-butadiene or isoprene (7%), other similar codimers of MCPD (22%), and balance (16%).

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7; Resin-Former Feedstock)

The sample tested consisted of DCPD (50-60%), cyclopentadiene (CPD)/methyl CPD dimer (15-20%), butadiene (BD)/CPD dimer (<2%), styrene (10-12%), xylene (<2%) and CPD (<2%).

Low DCPD Resin Oil (CASRNs 68477-54-3 & 68516-20-1; C9 Resin Oil)

The samples tested consisted of indene (14-21.2%), vinyltoluenes (13.9-17%), trimethylbenzenes (0-9%), styrene and methyl styrenes (3-7.9%), methyl indene (3.9 - 8%) and naphthalene (0-1%).

1.2 Physical-Chemical Properties

The physical-chemical properties of the resin oils and cyclodiene dimer concentrates category members are summarized in Table 3. The components of this category are liquids that possess high vapor pressure and low to moderate water solubility.

Table 3. Physical-Chemical Properties of the Resin and Oils and Cyclodiene Dimer Category¹									
Property	Subcategory I					Subcategory II			Subcategory III
	SPONSORED CHEMICAL DCPD High Purity Stream	SPONSORED CHEMICAL DCPD Purge Stream	SPONSORED CHEMICAL DCPD/Codimer Concentrate	SPONSORED CHEMICAL MCPD Dimer Stream	SPONSORED CHEMICAL DCPD Concentrate Stream	SPONSORED CHEMICAL DCPD Stream	SPONSORED CHEMICAL High DCPD Resin Oil Stream	SPONSORED CHEMICAL Resin Former Stream	SPONSORED CHEMICAL Low DCPD Resin Oil Stream
CASRN	77-73-6	68527-24-2	68478-10-4	26472-00-4	68478-08-0; 68527-26-4; 68603-02-1	26472-00-4; 68477-53-2	68477-54-3; 68477-40-7	68477-54-3	68477-54-3; 68516-20-1
Molecular Weight	132.21	Complex mixture	Complex mixture	160.13	Complex mixture	Complex mixture	Complex mixture	Complex mixture	Complex mixture
Physical State	Clear, colorless liquid or stable solid at room temperature ²	Liquid	Colorless liquid	Clear, colorless liquid	Clear, colorless liquid or stable solid at room temperature ²	Clear, colorless liquid or stable solid at room temperature ²	Amber colored, clear aromatic liquid	Amber colored, clear aromatic liquid	Colorless- light yellow liquid
Melting Point	32°C (measured) ³ ; 33.6°C (measured) ⁴	<25°C (liquid)	<25°C (liquid)	-50°C (measured) ⁵	32°C (measured) ³ ; 33.6°C (measured) ⁴	32°C (measured) ³ ; 33.6°C (measured) ⁴	<25°C (liquid)	<25°C (liquid)	<25°C (liquid)
Boiling Point	170.7°C (measured) ⁴	150–197°C (measured)	150–197°C (measured)	191°C (measured)	170.7°C (measured) ⁴	170.7°C (measured) ⁴	170.7–193°C (measured)	174–193°C (measured)	174–193°C (measured)
Vapor Pressure	2.29 mm Hg at 25°C (measured); 9.8 mm Hg at 37.7°C (measured) ⁴	8.2 mm Hg at 30°C (measured); 6 mm Hg at 25°C (extrapolated)	8.2 mm Hg at 30°C (measured); 6 mm Hg at 25°C (extrapolated)	18.75 mm Hg at 30°C (measured); 14.2 mm Hg at 25°C (extrapolated)	2.29 mm Hg at 25°C (measured); 9.8 mm Hg at 37.7°C (measured) ⁴	2.29 mm Hg at 25°C (measured); 9.8 mm Hg at 37.7°C (measured) ⁴	2.29–30.8 mm Hg at 25°C (measured)	30.8 mm Hg at 25°C (measured)	30.8 mm Hg at 25°C (measured)

Table 3. Physical-Chemical Properties of the Resin and Oils and Cyclodiene Dimer Category¹

Property	Subcategory I						Subcategory II		Subcategory III
	SPONSORED CHEMICAL DCPD High Purity Stream	SPONSORED CHEMICAL DCPD Purge Stream	SPONSORED CHEMICAL DCPD/Codimer Concentrate	SPONSORED CHEMICAL MCPD Dimer Stream	SPONSORED CHEMICAL DCPD Concentrate Stream	SPONSORED CHEMICAL DCPD Stream	SPONSORED CHEMICAL High DCPD Resin Oil Stream	SPONSORED CHEMICAL Resin Former Stream	SPONSORED CHEMICAL Low DCPD Resin Oil Stream
Dissociation Constant (pK _a)	Not applicable								
Henry's Law Constant	0.020 atm-m ³ /mol (estimated) ⁶	0.0025–0.15 atm-m ³ /mol (estimated) ⁶	0.0025–0.15 atm-m ³ /mol (estimated) ⁶	0.15 atm-m ³ /mol (estimated) ⁶	0.0025 atm-m ³ /mol (estimated) ⁶	0.020 atm-m ³ /mol (estimated) ⁶	0.0005–0.020 atm-m ³ /mol (estimated) ⁶	0.0005–0.0020 atm-m ³ /mol (estimated) ⁶	0.0005–0.0020 atm-m ³ /mol (estimated) ⁵
Water Solubility	20 mg/L at 25°C (measured) ⁴	0.5–20 mg/L at 25°C (measured) ⁴	0.5–20 mg/L at 25°C (measured) ⁴	0.5 mg/L (estimated) ⁴	20 mg/L at 25°C (measured) ⁵	20 mg/L at 25°C (measured) ⁴	89–389 mg/L (measured/estimated) ^{3,6}	89–389 mg/L (measured/estimated) ^{3,6}	89–389 mg/L (measured/estimated) ^{3,6}
Log K _{ow}	2.78 (measured) ⁴	3.2–5.7 (measured)	3.2–5.7 (measured)	5.5–5.7 (measured)	2.78 (measured) ⁴	2.78 (measured) ⁴	2.78–4.7 (measured)	3.1–4.7 (measured)	3.1–4.7 (measured)

¹ The Petroleum HPV Testing Group. 2005. Revised Test Plan and Robust Summary for Resin Oils and Cyclodiene Dimer. Available online at <http://www.epa.gov/chemrtk/pubs/summaries/resinoil/c13434tc.htm> as of September 7, 2010.

² The Robust Summary and Test Plan state that Dicyclopentadiene (DCPD) High Purity stream (CAS #77-73-6; approximately 97% endo- and approximately 1% cyclopentadiene) is a clear, colorless liquid at room temperature; however, most other references indicate that this substance is a solid at room temperature.

³ SRC. The Physical Properties Database (PHYSPROP). Syracuse, NY: Syracuse Research Corporation. Available online at <http://www.syrres.com/esc/physprop.htm> as of August 18, 2010.

⁴ OECD SIDS Initial Assessment Report for Dicyclopentadiene (77-73-6). Available online at <http://www.chem.unep.ch/irptc/sids/OECD/SIDS/77736.pdf> as of September 28, 2010.

⁵ Alfa Aesar. 2006–2007. Research Chemicals Metals and Materials Handbook. pp. 1135.

⁶ U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC, USA. Available online at <http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm> as of September 15, 2010.

2. General Information on Exposure

2.1 Production Volume and Use Pattern

The Resin Oils and Cyclodiene Dimer Concentrates Category chemicals had an aggregated production and/or import volume in the United States greater than 2 billion 500 million pounds in calendar year 2005.

- CASRN 77-73-6: 50 to <100 million pounds;
- CASRN 68478-10-4: 1 billion pounds and greater;
- CASRN 68478-08-0: 100 to < 500 million pounds;
- CASRN 68527-26-4: 50 to <100 million pounds;
- CASRN 68603-02-1: 100 to < 500 million pounds;
- CASRN 68477-54-3: 1 billion pounds and greater;
- CASRN 68477-40-7: 100 to < 500 million pounds;
- CASRN 68516-20-1: 100 to < 500 million pounds

CASRN 77-73-6:

Non-confidential information in the IUR indicated that the industrial processing and uses of the chemical include other basic organic chemical manufacturing, and resin and synthetic rubber manufacturing as intermediates. Non-confidential commercial and consumer uses of this chemical include transportation products.

CASRN 68527-24-2 and 68477-53-2 were not reported in the 2006 IUR.

CASRN 68477-54-3, 68477-40-7, 68516-20-1, 68478-08-0, 68527-26-4, 68603-02-1 and 68478-10-4:

No industrial processing and uses, and commercial and consumer uses were reported for these chemicals.

2.2 Environmental Exposure and Fate

The environmental fate properties are provided in Table 4. The components of the resin oils and cyclodiene dimer concentrates category are expected to possess moderate mobility in soil. Three process streams, DCPD/Codimer Concentrate (CASRN 68478-10-4), methylcyclopentadiene dimer (CASRN 26472-00-4), and Low DCPD Resin Oil (CASRN 68477-54-3, 68516-20-1), were all not readily biodegradable using manometric respirometry tests (OECD 301F), achieving 0–9% biodegradation over the course of each test. In addition, dicyclopentadiene (CASRN 77-73-6), was also not readily biodegradable, achieving 0% of its theoretical biochemical oxygen demand (BOD) over a 14-day incubation period using the modified MITI test (OECD 301C). Supporting substance, benzene, ethenylmethyl- (CASRN 25013-15-4), achieved 3, 6, 13, and 32% of its theoretical BOD after 5, 10, 15, and 20 days, respectively, and was considered not readily biodegradable. These data suggest that the majority of components contained in the

process stream which comprise this category will not be readily biodegradable. Volatilization is expected to be high based on the Henry's Law constants of these substances. 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 overall weight of experimental evidence and read across from structurally similar compounds suggest that members of this category are expected to possess moderate persistence (P2). The members of the resin oils and cyclodiene dimer concentrates category are expected to possess low (B1) to high (B3) bioaccumulation potential.

Conclusion: The resin oils and cyclodiene dimer concentrates category consists of nine related petrochemical process streams derived from pyrolysis gasoline by the ethylene manufacturing process. The streams that form this category are complex mixtures comprised primarily of C8 to C12 aliphatic cycloalkenes, and aromatic hydrocarbons of which dicyclopentadiene (DCPD) is a key chemical constituent in the majority of streams. The substances of this category are typically liquids possessing high vapor pressure and low to moderate water solubility. All category members are expected to possess moderate mobility in soil. Volatilization is expected to be high. The rate of hydrolysis is negligible. The rate of atmospheric photooxidation is moderate to rapid. The members of the resin oils and cyclodiene dimer concentrates category are expected to possess moderate persistence (P2) and low to high bioaccumulation potential (B1-B3).

Table 4. Environmental Fate Characteristics of the Resin Oils and Cyclodiene Dimer Category¹

Property	Subcategory I						Subcategory II		Subcategory III
	SPONSORED CHEMICAL DCPD High Purity	SPONSORED CHEMICAL DCPD Purge Stream	SPONSORED CHEMICAL DCPD/Codimer Concentrate	SPONSORED CHEMICAL MCPD Dimer	SPONSORED CHEMICAL DCPD Concentrate	SPONSORED CHEMICAL DCPD Stream	SPONSORED CHEMICAL High DCPD Resin Oil Stream	SPONSORED CHEMICAL Resin Former Stream	SPONSORED CHEMICAL Low DCPD Resin Oil Stream
CASRN	77-73-6	68527-24-2	68478-10-4	26472-00-4	68478-08-0; 68527-26-4; 68603-02-1	26472-00-4; 68477-53-2	68477-54-3; 68477-40-7	68477-54-3	68477-54-3; 68516-20-1
Photodegradation Half-life	1.1 hours (estimated) ²	0.7–1.1 hours (estimated) ²	0.7–1.1 hours (estimated) ²	0.7 hours (estimated) ²	1.1 hours (estimated) ²	1.1 hours (estimated) ²	1.4–4.1 hours (estimated) ²	1.4–4.1 hours (estimated) ²	1.4–4.1 hours (estimated) ²
Hydrolysis Half-life	Stable								
Biodegradation	0% after 14 days (not readily biodegradable) ³	No data	0% after 28 days (not readily biodegradable)	0% after 28 days (not readily biodegradable)	0% after 14 days (not readily biodegradable) ³	0% after 14 days (not readily biodegradable) ³	No data	No data	5–9% after 41 days (not readily biodegradable)
Bioaccumulation Factor	BCF = 112–330 (measured in carp at 0.3 ppm) ³ ; BCF = 58.9–384 (measured in carp at 0.03 ppm) ³ ; BAF = 59.6 (estimated) ²	BAF = 59.6– 2.6 × 10 ⁴ (estimated) ²	BAF = 59.6–2.6 × 10 ⁴ (estimated) ²	BAF = 2.6 × 10 ⁴ (estimated) ²	BCF = 112–330 (measured in carp at 0.3 ppm) ³ ; BCF = 58.9–384 (measured in carp at 0.03 ppm) ³ ; BAF = 59.6 (estimated) ²	BCF = 112–330 (measured in carp at 0.3 ppm) ³ ; BCF = 58.9–384 (measured in carp at 0.03 ppm) ³ ; BAF = 59.6 (estimated) ²	BAF = 59.6–209.5 (estimated) ²	BAF = 79.1–481.2 (estimated) ²	BAF = 79.1–481.2 (estimated) ²
Log K _{oc}	3.2 (estimated) ²	3.2–3.6 (estimated) ²	3.2–3.6 (estimated) ²	3.6 (estimated) ²	3.2 (estimated) ²	3.2 (estimated) ²	2.9–3.2	2.9–3.1 (estimated) ²	2.9–3.1 (estimated) ²
Fugacity (Level III Model) ²									
Air (%)	0.1	0.1–0.2	0.1–0.2	0.2	0.1	0.1	0.1–1.6	0.1–0.6	0.1–0.6
Water (%)	19.2	19.2–53.2	19.2–53.2	53.2	19.2	19.2	19.2–23.8	19.5–23.8	19.5–23.8
Soil (%)	79.7	39.9–79.7	39.9–79.7	39.9	79.7	79.7	74.0–79.7	74.0–79.5	74.0–79.5

Table 4. Environmental Fate Characteristics of the Resin Oils and Cyclodiene Dimer Category¹

Property	Subcategory I						Subcategory II		Subcategory III
	SPONSORED CHEMICAL DCPD High Purity	SPONSORED CHEMICAL DCPD Purge Stream	SPONSORED CHEMICAL DCPD/Codimer Concentrate	SPONSORED CHEMICAL MCPD Dimer	SPONSORED CHEMICAL DCPD Concentrate	SPONSORED CHEMICAL DCPD Stream	SPONSORED CHEMICAL High DCPD Resin Oil Stream	SPONSORED CHEMICAL Resin Former Stream	SPONSORED CHEMICAL Low DCPD Resin Oil Stream
Sediment (%)	1.0	1.0–6.7	1.0–6.7	6.7	1.0	1.0	0.6–1.0	0.6–0.9	0.6–0.9
Persistence ⁴	P2 (moderate)	P2 (moderate)	P2 (moderate)	P2 (moderate)	P2 (moderate)	P2 (moderate)	P2 (moderate)	P2 (moderate)	P2 (moderate)
Bioaccumulation ⁴	B1 (low)	B1 (low) - B3 (high)	B1 (low) - B3 (high)	B3 (high)	B1 (low)	B1 (low)	B1 (low)	B1 (low)	B1 (low)

¹ The Petroleum HPV Testing Group. 2005. Revised Test Plan and Robust Summary for Resin Oils and Cyclodiene Dimer. Available online at <http://www.epa.gov/chemrtk/pubs/summaries/resinoil/c13434tc.htm> as of September 7, 2010.

² U.S. EPA. 2010. Estimation Programs Interface Suite™ for Microsoft® Windows, v4.00. U.S. Environmental Protection Agency, Washington, DC, USA. Available online at <http://www.epa.gov/opptintr/exposure/pubs/episuitedi.htm> as of September 15, 2010.

³ National Institute of Technology and Evaluation. 2002. Biodegradation and Bioaccumulation of the Existing Chemical Substances under the Chemical Substances Control Law. Available online at http://www.safe.nite.go.jp/english/kizon/KIZON_start_hazkizon.html as of October 4, 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.

3. **Human Health Hazard**

A summary of health effects data submitted for SIDS endpoints is provided in Table 5. 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: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

(1) Male Wistar rats (5/dose) were administered a single dose of CASRN 77-73-6 via gavage at unspecified concentrations and observed for 14 days. Mortality data were not reported (Smyth *et al.*, 1962).

LD₅₀ = 410 mg/kg

(2) Rats (sex/strain/number not specified) were administered a single dose of undiluted CASRN 77-73-6 via gavage at unspecified concentrations. Mortality data were not reported (Kinkead *et al.*, 1971).

LD₅₀ = 353 mg/kg

High DCPD Resin Oil (CASRN 68477-54-3 & 68477-40-7)

Fischer 344 rats (5/sex/dose) were administered CASRNs 68477-54-3 and 68477-40-7 in corn oil via gavage at 320, 560, 1000 or 1800 mg/kg and observed for 14 days. Mortality rates were 0/10, 1/10, 6/10 and 9/10 at dose levels of 320, 560, 1000 and 1800 mg/kg, respectively.

LD₅₀ (male) > 560 to < 1000 mg/kg

LD₅₀ (female) = 970 mg/kg

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

See human health data at: http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2ffe19-4ff0-8761-4d0e436e73e2&idx=0.

Rat LD₅₀ = 590 mg/kg

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

Sprague-Dawley rats (5/sex/dose) were administered a single dose of CASRNs 68516-20-1 and 68477-54-3 via gavage at 2000 mg/kg and observed for 14 days. No mortalities were observed.

LD₅₀ > 2000 mg/kg

Subcategory III:

MCPD Dimer (CASRN 26472-00-4)

Male Wistar rats (5/dose) were administered a single dose of CASRN 26472-00-4 via gavage at 10,000 mg/kg and observed for 14 days. One death was observed on day 4.

LD₅₀ > 10,000 mg/kg

Acute Inhalation Toxicity

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

(1) Fischer 344 rats (6/sex/dose) were exposed (whole-body) to CASRN 77-73-6 as a vapor at 46, 130, 260 or 557 ppm (0, 0.25, 0.70, 1.41 or 3.01 mg/L, respectively) for 6 hours and observed for 14 days. Mortality occurred at ≥ 260 ppm (data not reported).

LC₅₀ (male) = 1.54 mg/L

LC₅₀ (female) = 1.91 mg/L

(2) B6C3F1 mice (6/sex/dose) were exposed (whole-body) to CASRN 77-73-6 as a vapor at 46, 130, 260 or 557 ppm (0, 0.25, 0.70, 1.41 or 3.01 mg/L, respectively) for 6 hours and observed for 14 days. Mortality occurred at ≥ 260 ppm (data not reported).

LC₅₀ (male) = 0.77 mg/L

LC₅₀ (female) = 0.70 mg/L

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7)

Fischer 344 rats (5/sex/dose) were exposed (whole-body) to high DCPD resin oil as an aerosol (MMAD = 5.0 $\mu\text{m} \pm 1.4$ SD; 89% of particles < 10 μm) at a concentration of 5.4 g/m³ for 4 hours and observed for 14 days. No mortalities were observed.

LC₅₀ > 5.4 mg/L

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

See human health data at: http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

Rat LC₅₀ = 1000 ppm/4-h

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

Sprague-Dawley rats (5/sex/dose) were exposed (whole-body) to low DCPD resin oil as an aerosol (MMAD = 1.9 – 3.4 μm) at actual concentrations of 1.03, 2.07 or 5.01 mg/L for 4 hours and observed for 14 days. Mortalities were 1/10, 7/10 and 10/10 at 1.03, 2.07 and 5.01 mg/L, respectively.

LC₅₀ (male) = 1.4 mg/L

LC₅₀ (female) = 1.9 mg/L

Subcategory III: MCPD Dimer

MCPD Dimer (CASRN 26472-00-4)

(1) Fischer 344 rats (6/sex/dose) were exposed (whole-body) to CASRN 26472-00-4 as a vapor at a single concentration of 495 ppm (3.24 mg/L) for 4 hours and observed for 14 days. No mortalities were observed.

LC₅₀ > 3.24 mg/L

(2) B6C3F1 mice (6/sex/dose) were exposed (whole-body) to CASRN 26472-00-4 as a vapor at a single concentration of 495 ppm (3.24 mg/L) for 4 hours and observed for 14 days. No mortalities were observed.

LC₅₀ > 3.24 mg/L

Acute Dermal Toxicity

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

Male albino New Zealand rabbits (4/dose) were administered CASRN 77-73-6 via dermal application at unspecified concentrations to clipped skin, under occluded conditions for 24 hours and observed for 14 days. Mortality data were not reported (Smyth et al., 1962).

LD₅₀ = 4460 mg/kg

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7)

New Zealand White rabbits (5/sex/dose) were administered high DCPD resin oil via dermal application at 2000 mg/kg-bw to clipped, abraded skin, under occluded conditions for 24 hours and observed for 14 days. No mortalities were observed.

LD₅₀ > 2000 mg/kg

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

See human health data at: http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

Rabbit LD₅₀ = 5080 mg/kg

Subcategory III: MCPD Dimer

New Zealand White rabbits (4/dose, sex not reported) were administered CASRN 26472-00-4 via dermal application at 3160 mg/kg to clipped, abraded skin, under occluded conditions for 24 hours and observed for 14 days. No mortalities were observed.

LD₅₀ > 3160 mg/kg

Repeated-Dose Toxicity

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

(1) In a combined repeated-dose/reproductive/developmental toxicity screening test, Sprague-Dawley rats (10/sex/dose) were administered CASRN 77-73-6 in olive oil via gavage at 0, 4, 20 or 100 mg/kg-day for 2 weeks of pre-mating and approximately 2 weeks of mating; males were treated for at least 2 more weeks and females were treated throughout gestation and up to day 3 of lactation. Mortality occurred in two females at 100 mg/kg-day. Decreased body weight gain and food consumption were noted in surviving animals. No hematological effects were noted. Males treated with 100 mg/kg-day exhibited increased liver enzymes (AST and ALT) and increased liver and kidney weights, single cell necrosis in the liver, accumulation of hyaline droplets⁷ and renal tubular changes in the kidney. Histopathological changes were observed in

⁷ The reported accumulation of hyaline droplets in the kidneys of male but not female rats and the presence of nephropathy in association with the hyaline droplet accumulation suggest that the nephropathy in the males is

the adrenals (increased fatty droplets in the fascicular zone) of males treated with ≥ 20 mg/kg-day and females treated with 100 mg/kg-day. See human health data at:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

LOAEL = 20 mg/kg-day (based on single cell necrosis in the liver, hyaline droplets and tubular changes in the kidneys)

NOAEL = 4 mg/kg-day

(2) Fischer 344 rats (9/sex/concentration) were exposed (whole-body) to CASRN 77-73-6 as a vapor at concentrations of 0, 1.0, 5.1 or 51 ppm (0, 0.0054, 0.028 or 0.28 mg/L) for 6 hours/day, 5 days/week for 2, 6 or 13 weeks. Additional animals (9/sex/concentration) were observed for 28 or 90 days of post treatment recovery. Histopathological examination of the kidneys was performed on additional groups of 3 rats/sex/concentration at the termination of the 13-week exposure period and following a 13-week recovery period. There were no treatment-related mortalities, clinical signs, changes in body weight, feed consumption or hematological effects noted. Calcium levels were increased and ALT was decreased at ≥ 5.1 ppm (unclear if this was males only or males and females). In males, epithelial cell casts in the kidneys were observed at all concentration levels. Kidney tubular protein and kidney tubular hyperplasia were observed in males treated with ≥ 1 ppm after 6 weeks of treatment. Significant increases in relative liver weight and absolute and relative kidney weight were observed in males at 51 ppm (duration of treatment unclear). At ≥ 5.1 ppm, males exhibited hyaline droplets⁷ in the proximal convoluted tubular epithelial cells, tubular hyperplasia, tubule proteinosis and basement membrane thickening all in the kidney after 2 weeks of treatment. These effects were not observed in females.

LOAEC (male) = 0.0054 mg/L/day (histopathological changes in the kidney)

NOAEC (male) = Not established

NOAEC (female) = 0.28 mg/L/day (highest concentration tested)

(3) B6C3F1 mice (9/sex/concentration) were exposed (whole-body) to CASRN 77-73-6 as a vapor at concentrations of 0, 1.0, 5.1 or 51 ppm (0, 0.0054, 0.028 or 0.28 mg/L) for 6 hours/day, 5 days/week for 2, 6 or 13 weeks. Additional animals (9/sex/concentration) were observed for 28 or 90 days of post treatment recovery. At the highest exposure level (51 ppm), approximately 20% of the males and females died during the study; no more than two mice died at any other exposure level. No clinical signs of toxicity or changes in body weight were observed prior to death; however, surviving animals of both sexes of 51-ppm mice exhibited an increase in body weight gain during treatment but not during recovery. The cause of death appeared to be pulmonary congestion and possible renal failure. In 5.1 and 51 ppm treated mice, clinical signs included loss of coordination and/or decreased activity. There were no treatment-related effects on serum chemistry, hematology, gross pathology, organ weights or histopathology.

LOAEC = 0.28 mg/L/day (based on mortality)

occurring by an α_{2u} -globulin-mediated mechanism. Based upon analysis of the scientific literature, EPA's Risk Assessment Forum provided steps to determine that chemical-induced changes in male kidneys are acting through this pathway, including measuring the levels of the α_{2u} -globulin protein, and this has not been provided. (Alpha_{2u}-Globulin: Association with Chemically Induced Renal Toxicity and Neoplasia in the Rat, EPA/625/3-91/019F). Therefore, these endpoints will be considered along with others in determining NOAEL/LOAEL values.

NOAEC = 0.028 mg/L/day

DCPD/Codimer Concentrate (CASRN 68478-10-4)

In a combined repeated-dose/reproductive/developmental toxicity screening test, Sprague-Dawley rats (12/sex/dose) were administered CASRN 68478-10-4 via gavage in corn oil at 0, 5, 25 or 100 mg/kg-day for 30 days (males) or 31 days (females). Additional reproductive/developmental satellite groups (12/sex/dose) were treated in a similar manner for two weeks of premating, two weeks of cohabitation, approximately three weeks of gestation and three days of lactation (satellite females) or for 29 days (satellite males). There were no mortalities, clinical signs of toxicity, changes in food consumption or effects on hematology and clinical chemistry parameters. At ≥ 25 mg/kg-day, a slight decrease in body weight gain was noted in females. Histopathological effects included an increase in renal tubular hyaline droplets⁷ associated with an increased incidence of bilateral pale kidney discoloration and changes in kidney weight parameters in all treated males, hepatocellular hypertrophy associated with increases in liver weight parameters in animals of both sexes treated with 100 mg/kg-day and minimal thyroid follicular cell hypertrophy in males and females in the ≥ 25 mg/kg-day dose groups. No treatment-related effects were observed on functional observational battery endpoints, including motor activity, grip strength, foot splay, rearing or body temperature.

LOAEL (male) = 5 mg/kg-day (based on increased incidence of renal tubular hyaline droplets)

NOAEL (male) = Not established

LOAEL (female) = 100 mg/kg-day (based on hepatocellular hypertrophy and increased liver weight)

NOAEL (female) = 25 mg/kg-day

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRN 68516-20-1 & 68477-54-3)

In a combined repeated-dose/reproductive/developmental toxicity screening test, Sprague-Dawley rats (12/sex/dose) were administered low DCPD resin oil in corn oil via gavage at 0, 35, 125 or 375 mg/kg-day for 30 days (males) or 31 days (subchronic females). Additional reproductive/developmental satellite groups (12/sex/dose) were treated in a similar manner for 2 weeks of premating, 2 weeks of cohabitation, approximately 3 weeks of gestation and 4 days of lactation (females) or for 30 days (males). No mortality was observed. Clinical signs of toxicity included stained and/or wet fur in animals of both sexes treated with ≥ 125 mg/kg-day and decreased body weight and food consumption in males treated with ≥ 125 mg/kg-day and females treated with 375 mg/kg-day. Histopathological examination revealed dose-related increases in renal tubular hyaline droplets⁷ in all treated males (without hyaline droplet nephropathy), minimal to mild hepatocellular hypertrophy and associated increases in liver weight parameters in females treated with ≥ 125 mg/kg-day and males treated with 375 mg/kg-day. A slight treatment-related increase in the incidence of minimal thyroid follicular cell hypertrophy was observed in males treated with 375 mg/kg-day and decreased thymus weight was observed in males treated with ≥ 125 mg/kg-day and females treated with 375 mg/kg-day. There were no treatment-related effects on functional observational battery, motor activity, grip strength, foot splay, rearing or body temperature.

LOAEL (male) = 35 mg/kg-day (based on increases in renal tubular hyaline droplets)

NOAEL (male) = Not established

LOAEL (female) = 125 mg/kg-day (hepatocellular hypertrophy and increased liver weight)
NOAEL (female) = 35 mg/kg-day

Subcategory III: MCPD Dimer

MCPD Dimer (CASRN 26472-00-4)

In a combined repeated-dose/reproductive/developmental toxicity screening test, Sprague-Dawley rats (12/sex/dose) were administered CASRN 26472-0-4 via gavage in corn oil at 0, 20, 100 or 300 mg/kg-day for 28 days. Additional reproductive/developmental satellite groups (12 /sex/dose) were treated in a similar manner for 2 weeks of premating, 2 weeks of cohabitation, approximately 3 weeks of gestation and 4 days of lactation (females) or for 31 days (males). No mortality was observed. Clinical signs included: salivation, stained/wet fur and decreased body weight and food consumption at ≥ 100 mg/kg-day in both sexes, lacrimation in 300 mg/kg-day females, and salivation in 20 mg/kg-day males and satellite females. No hematological or clinical chemistry effects were noted. Histopathological findings revealed an increase in hyaline droplets⁷ in the kidneys of all treated male rats, a slight increase in kidney weight parameters in 300 mg/kg-day females, hepatocellular hypertrophy and associated increases in liver weight parameters in females treated with ≥ 100 mg/kg-day and in males treated with 300 mg/kg-day, and slightly increased adrenal gland weight parameters in 300 mg/kg-day females. Significantly decreased motor activity was observed in males treated with 300 mg/kg-day during the last 20 min of observations in week 4. No treatment-related neurobehavioral effects were observed in females and no other neurobehavioral effects (grip strength, foot splay, rearing, body temperature or any other FOB parameters) were observed in males.

LOAEL (male) = 20 mg/kg-day (based on an increase in hyaline droplets in the kidneys)

NOAEL (male) = Not established

LOAEL (female) = 100 mg/kg-day (decreased bodyweight gain, hepatocellular hypertrophy and associated increases in liver weight parameters)

NOAEL (female) = 20 mg/kg-day

(2) Fischer 344 rats (10/sex/concentration) were exposed (whole-body) to CASRN 26472-0-4 as a vapor at concentration of 0, 5, 50, or 404 ppm (approximately 0, 0.03, 0.32, or 2.64 mg/L) for 6 hours/day for 9 days (days 1-5 and 8-11). No mortalities were observed. Clinical signs included urogenital wetness, periocular redness and lacrimation. Significant decreases in body weight and food consumption were observed in rats treated with 404 ppm. Male rats exhibited epithelial cells and cell casts in urine at all treatment levels. No treatment-related changes in hematological endpoints were observed. Absolute and relative kidney and liver weights were increased in both sexes at 404 ppm and in males at 50 ppm. Males also exhibited an increase in the liver mitotic index at all doses, a significant frequency of kidney color changes at ≥ 50 ppm, and histopathological lesions in the kidney (protein accumulation in the proximal tubule and tubular hyperplasia in the cortex) at all doses.

LOAEC (male) ~ 0.32 mg/L/day (based on an increase in mitotic figures in the liver and increased liver weight)

NOAEC (male) ~ 0.03 mg/L/day

LOAEC (female) ~ 2.64 mg/L/day (based on increased liver and kidney weight)

NOAEC (female) ~ 0.32 mg/L/day

(3) B6C3F1 mice (10/sex/concentration) were exposed (whole-body) to CASRN 26472-0-4 as a vapor at concentration of 0, 5, 50, or 404 ppm (approximately 0, 0.03, 0.32, or 2.64 mg/L) for 6 hours/day for 9 days (days 1-5 and 8-11). One male mouse in the 404 ppm group died. There were no other mortalities. Treatment related changes in body weight gain in females were obscured by a drop in body weight of control animals during the first week of treatment. No treatment-related changes in body weight gain were observed in males. A statistically significant decrease in erythrocyte count, hemoglobin concentration and hematocrit was observed in both sexes at 404 ppm and for hemoglobin concentration in males at 50 ppm. Lymphocyte count was decreased in females at 404 ppm (statistical significance not reported). Significant increases in absolute and relative liver weight were observed at ≥ 50 ppm in males and at 404 ppm in females. Male mice treated with ≥ 50 ppm had increased mitotic figures in the liver. No significant histopathological effects were observed in the kidneys of male or female mice.

LOAEC (male) ~ 0.32 mg/L/day (based on an increase in mitotic figures in the liver and increased liver weight)

NOAEC (male) ~ 0.03 mg/L/day

LOAEC (female) ~ 2.64 mg/L/day (based on increased liver weight and hematology)

NOAEC (female) ~ 0.32 mg/L/day

Reproductive Toxicity

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

(1) In a three generation reproductive toxicity study, Sprague-Dawley rats (10 males and 20 females/dose) were exposed to CASRN 77-73-6 in corn oil in the diet at concentrations of 0, 69 or 693 ppm (approximately 0, 4.14 and 41.6 mg/kg-day for males and 0, 3.45 and 34.7 mg/kg-day for females, respectively) for 7 weeks. Exposures continued throughout 2 weeks of mating, gestation and lactation. One week following weaning of F1a pups, F0 parental rats were subjected to another mating session to produce F1b pups. One week following weaning of F1b pups, F0 parental rats were sacrificed and subjected to gross necropsy. Selected F1b rats were similarly exposed to the same diet to produce F2a and F2b pups. Selected F2b rats were similarly exposed and mated to produce F3a and F3b litters. At day 4 of lactation, each litter was reduced to eight pups (4/sex). At weaning, gross necropsies were performed on 1/3 of the first litter (a) from all three generations and on 1/3 of F3b litters. The only mortality was one F0 female in the 69 ppm (3.45 mg/kg-day) dose group during week 28. There were no treatment-related effects on body weight or food consumption and no findings upon necropsy of F0, F1, F2 and F3 parental animals. A non-statistically significant decrease in female fertility was observed at 693 ppm (34.7 mg/kg-day) in the F2a dams. The robust summary stated that this may have been attributable to a single male failing to sire a litter in either mating. No other treatment-related effects were observed for any reproductive/developmental parameters examined (mating fertility, fertility index, gestation index, number of live pups per litter, newborn pup viability, pup viability on lactation day 4, sex ratio of pups, mean pup weight) and there were no treatment-related findings upon necropsy of F1, F2 and F3 pups.

NOAEL (reproductive toxicity) ~ 34.7 mg/kg-day (highest dose tested)

(2) In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, there were no treatment-related effects on mating, fertility, gestation, implantation, delivery indices, gestation length, number of corpora lutea, number of implantations, parturition, number of offspring, live offspring at birth, sex ratio, live birth index or gross pathology of pups.

NOAEL (reproductive toxicity) = 100 mg/kg-day (highest dose tested)

DCPD/Codimer Concentrate (CASRN 68478-10-4)

In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, there were no treatment-related effects on gestation length, number of implantation sites, implantation efficiency, pre-implantation loss, post-implantation loss, number of corpora lutea, gross pathology of reproductive organs, mean pup weight, number of pups born, number of pups born alive, sex ratio, gestation index, gross abnormalities or litter survival.

NOAEL (reproductive toxicity) = 100 mg/kg-day (highest dose tested)

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

In the combined oral repeated-dose/reproductive/developmental toxicity screening test in rats, no effects on reproductive parameters were observed up to the highest dose tested. However, two dams in the 100 mg/kg-day group did not nurse their litters and lost all of them within 2 days. See human health data at: http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

NOAEL (reproductive toxicity) = 100 mg/kg-day (highest dose tested)

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, there were no treatment-related effects on gestation length, number of implantation sites, implantation efficiency, pre-implantation loss, post-implantation loss, number of corpora lutea, gross pathology of reproductive organs, number of pups born, number of pups born alive, sex ratio, gestation index, gross abnormalities or litter survival.

NOAEL (reproductive toxicity) = 375 mg/kg-day (highest dose tested)

Subcategory III: MCPD Dimer

MCPD Dimer (CASRN 26472-00-4)

In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, there were no effects observed on mating or delivery. There were no effects on gross pathology of reproductive organs, mating index, fertility index, the number of corpora lutea, pre-implantation loss, post-implantation loss, gestation length, number of implantation sites, implantation efficiency, number of pups per litter, percent born alive, pup viability, pup viability index, sex ratio, gestation index, gross abnormalities or litter survival.

NOAEL (reproductive toxicity) = 300 mg/kg-day (highest dose tested)

Developmental Toxicity

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

(1) In the three generation reproductive toxicity study, described above, rats were administered the test substance via the diet. There were no treatment-related effects on body weight or food consumption and no findings upon necropsy of F0, F1, F2 and F3 parental animals. In the F3b litters, a statistically significant decrease in pup weight at day 21 was observed at 693 ppm (34.7 mg/kg-day). No other treatment-related effects were observed for any reproductive/developmental parameters examined (mating fertility, fertility index, gestation index, number of live pups per litter, newborn pup viability, pup viability on lactation day 4, sex ratio of pups, mean pup weight) and there were no treatment-related findings upon necropsy of F1, F2 and F3 pups.

NOAEL (maternal toxicity) ~ 34.7 mg/kg-day (highest dose tested)

LOAEL (developmental toxicity) ~ 34.7 mg/kg-day (based on decreased pup body weight)

NOAEL (developmental toxicity) ~ 3.45 mg/kg-day

(2) In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, two females died and two high-dose dams lost 100% of their litters during lactation (days 1 – 4) at 100 mg/kg-day. Low viability index, lower birth weight and decreased weight gain were observed in pups in the 100 mg/kg-day group (data/statistical significance not provided). There were no treatment-related effects on mating, fertility, gestation, implantation, delivery indices, gestation length, number of corpora lutea, number of implantations, parturition, number of offspring, live offspring at birth, sex ratio, live birth index or gross pathology of pups.

LOAEL (maternal/developmental toxicity) = 100 mg/kg-day (based on maternal mortality and litter loss, low viability index, and decreased birth weight and weight gain in pups)

NOAEL (maternal/developmental toxicity) = 20 mg/kg-day

(3) In a prenatal developmental toxicity study, pregnant Sprague-Dawley rats (10-11/dose) were administered CASRN 77-73-6 in corn oil via gavage at 0, 50, 200, 300, 400, or 500 mg/kg-day on days 6 – 15 of gestation. Surviving dams were sacrificed on gestation day 20. By gestation day 9, all animals in the 400 and 500 mg/kg-day dose groups died and 3/7 and 8/9 of the dams in the 200 and 300 mg/kg-day groups had died or were sacrificed moribund. Clinical signs of systemic toxicity were observed beginning at gestation day 7 in all animals treated with ≥ 200 mg/kg-day. The severity of clinical signs, which included dried material around the nose and mouth, rough hair coat and lethargy increased in severity with increasing dose. Other clinical signs included convulsions in 1 rat at 200 mg/kg-day, hunched posture in 6 rats at the 300 mg/kg-day and ataxia in 5, 11 and 9 rats at 300, 400 and 500 mg/kg-day, respectively. Treated dams exhibited a dose-related decrease in body weight and body weight gain at all dose levels and a 10% decrease in the average fetal weight was noted at the 200 mg/kg-day dose level. The single surviving dam in the 300 mg/kg-day group resorbed her litter. There were no effects on all other fetal parameters (live fetuses/litter, dead fetus/litter, resorptions/litter, completely resorbed litter, dead implants/litter and total implants/litter) at the 50 and 200 mg/kg-day dose levels

LOAEL (maternal toxicity) = 50 mg/kg-day (based on decreased body weight and body weight gain)

NOAEL (maternal toxicity) = Not established

LOAEL (developmental toxicity) = 200 mg/kg-day (based on decreased fetal weight)

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

(4) In a prenatal developmental toxicity study, pregnant New Zealand White rabbits (10/dose) were administered CASRN 77-73-6 in corn oil via gavage at 0, 25, 100, 200, 300, or 400 mg/kg-day on days 6 – 19 of gestation. Surviving does were sacrificed on gestation day 30. Mortality was observed in 1/9 and 3/9 does at 300 and 400 mg/kg-day, respectively. Animals treated with ≥ 300 mg/kg-day exhibited decreased food and water consumption beginning on gestation day 9. At doses ≥ 100 mg/kg-day, incidences of aborted litters and bloody vaginal discharge were observed during later stages of gestation. A dose-related decrease in maternal body weight was noted on gestation day 8, becoming statistically significant ($p < 0.05$) on gestation days 10 – 18 at 300 mg/kg-day and 8 – 30 at 400 mg/kg-day. Developmental effects at the high-dose level included increased numbers of resorptions and non-live implants/litter and decreased number of fetuses. Two litters from does treated with 400 mg/kg-day showed gross deformities of kits; 1 with eyes open and 1 with eyes open and deformed hind limbs in 1 litter of 3 total live kits, and eyes open in all 12 kits from another high-dose litter. There were no other effects on gravid uterine weight, number of implantation sites, resorptions, dead fetuses and live fetuses in the other treated groups.

LOAEL (maternal toxicity) = 100 mg/kg-day (based on bloody vaginal discharge and abortion each by one doe)

NOAEL (maternal toxicity) = 25 mg/kg-day

LOAEL (developmental toxicity) = 400 mg/kg-day (based on increased number of resorptions and non-live implants/litter, decreased number of fetuses and gross deformities of kits)

NOAEL (developmental toxicity) = 300 mg/kg-day

(5) In a prenatal developmental toxicity study, pregnant Sprague-Dawley rats (20/dose) were administered CASRN 77-73-6 in corn oil, in the diet at 0, 80, 250, or 750 ppm (approximately 0, 4, 12.5 and 37.5 mg/kg-day) during days 6 – 15 of gestation. Surviving dams were sacrificed on gestation day 19. No mortality was observed and all dams appeared normal on gestation day 19, with the exception of one dam in the 80 ppm treatment group that was emaciated, had an arched back and red crust around the mouth and nose. There were no effects on mean body weight, food consumption or uterine contents. There were no treatment-related effects on pregnancy ratios, numbers of litters, percent resorptions, percentage of live fetuses/implantation site, mean live litter size, pups per litter, litters with dead fetuses or average fetal weight, length or sex ratio or gross examinations.

NOAEL (maternal/developmental toxicity) ~ 37.5 mg/kg-day (highest dose tested)

DCPD/Codimer Concentrate (CASRN 68478-10-4)

In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, systemic toxicity was observed in both sexes (see repeated-dose toxicity section) but there were no treatment-related effects on gestation length, number of implantation sites, implantation efficiency, pre-implantation loss, post-implantation loss, number of corpora lutea, gross pathology of reproductive organs, mean pup weight, number of pups born, number of pups born alive, sex ratio, gestation index, gross abnormalities or litter survival.

LOAEL (maternal toxicity) = 100 mg/kg-day (based on hepatocellular hypertrophy and increased liver weight)

NOAEL (maternal toxicity) = 25 mg/kg-day

NOAEL (developmental toxicity) = 100 mg/kg-day (highest dose tested)

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

In the combined oral repeated-dose/reproductive/developmental toxicity screening test in rats, no abnormal findings attributed to the test substance were found for external features, clinical signs or on necropsy of offspring. See human health data at:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

LOAEL (maternal toxicity) = 100 mg/kg-day (based on decreased body weight)

NOAEL (maternal toxicity) = 20 mg/kg-day

NOAEL (developmental toxicity) = 100 mg/kg-day (highest dose tested)

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, decreased body weight and body weight gain was observed in both sexes exposed to ≥ 125 mg/kg-day; systemic effects (see repeated-dose toxicity section) were also observed. Decreased mean pup weight (15% lower than the control values on lactation day 4) was observed in offspring of dams treated with 375 mg/kg-day. There were no treatment-related effects on gestation length, number of implantation sites, implantation efficiency, pre-implantation loss, post-implantation loss, number of corpora lutea, gross pathology of reproductive organs, number of pups born, number of pups born alive, sex ratio, gestation index, gross abnormalities or litter survival.

LOAEL (maternal toxicity) = 125 mg/kg-day (hepatocellular hypertrophy and increased liver weight)

NOAEL (maternal toxicity) = 35 mg/kg-day

LOAEL (developmental toxicity) = 375 mg/kg-day (based on low pup weight)

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

Subcategory III: MCPD Dimer

MCPD Dimer (CASRN 26472-00-4)

In the combined repeated-dose/reproductive/developmental toxicity screening test in rats described above, decreased body weight and food consumption were noted in dams treated with 300 mg/kg-day during gestation; no effects were observed on mating or delivery. Low pup weight and weight gain were noted in pups of dams treated with ≥ 100 mg/kg-day. There were no effects on gross pathology of reproductive organs, mating index, fertility index, the number of

corpora lutea, pre-implantation loss, post-implantation loss, gestation length, number of implantation sites, implantation efficiency, number of pups per litter, percent born alive, pup viability, pup viability index, sex ratio, gestation index, gross abnormalities or litter survival. The study authors noted that due to an error during gestation days 7-14, dams received dosages based on their day 0 or cohabitation day 0 body weights instead of gestation day 7 or 14 body weights.

LOAEL (maternal toxicity) = 100 mg/kg-day (decreased bodyweight gain, hepatocellular hypertrophy and associated increases in liver weight parameters)

NOAEL (maternal toxicity) = 20 mg/kg-day

LOAEL (developmental toxicity) = 100 mg/kg-day (based on low pup birth weight and weight gain)

NOAEL (developmental toxicity) = 20 mg/kg-day

Genetic Toxicity – Gene Mutation

In vitro

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

In two reverse-mutation assays, *S. typhimurium* strains TA98, TA100, TA1535 and TA1537 and *E. coli* strain WP2uvrA were exposed to CASRN 77-73-6 (75% pure) in ethanol. In the first experiment, the plates were exposed in the presence of metabolic activation (5% S9) at concentrations of 0, 3, 10, 33, 100, 167, 333, 1000, 3330, and 5000 µg/plate and in the absence of metabolic activation at concentrations of 0, 1, 3, 10, 33, 100, 333, 1000, 3330, and 5000 µg/plate. In the second experiment, the plates were exposed in the presence of metabolic activation (10% S9) at concentrations of 0, 3, 10, 33, 100, 167, 333, and 666 µg/plate and in the absence of metabolic activation at concentrations of 0, 1, 3, 10, 33, 66, and 100 µg/plate. In the first experiment, precipitate was observed, in the presence of S9, at ≥ 3330 µg/plate at the beginning of incubation, but not at the end of incubation. In the second experiment, precipitate was not observed. Positive controls produced an appropriate response. Cytotoxicity was observed beginning at 100 µg/plate in both experiments. The assay was negative for mutagenicity.

CASRN 77-73-6 was not mutagenic in this assay.

DCPD/Codimer Concentrate (CASRN 68478-10-4)

In a reverse mutation assay, *S. typhimurium* strains TA98, TA100, TA1535 and TA1537 and *E. coli* strain WP2uvrA were exposed to CASRN 68478-10-4 in ethanol in the presence and absence of metabolic activation at concentrations of 0, 15, 50, 150, 500, 1500 or 5000 µg/plate. Positive controls produced an appropriate response. Cytotoxicity was observed beginning at ≥ 1500 µg/plate. No precipitate was observed. The assay was negative for mutagenicity.

CASRN 68478-10-4 was not mutagenic in this assay.

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7)

In a forward mutation assay, Chinese hamster ovary (CHO) cells were exposed to CASRNs 68477-54-3 and 68477-40-7 in 10% Pluronic[®] polyol F68 in the presence and absence of

activation at concentrations of 0, 4, 8, 64, 128, 256, 512, 1024 or 2048 µg/mL in the cytotoxicity test and 0, 64, 128, 256 or 300 µg/mL (350, 400 µg/mL; cytotoxicity only) in the mutagenicity test. Positive controls produced an appropriate response. In the cytotoxicity assay, cytotoxicity was observed at ≥ 128 µg/mL in the absence of S9 and ≥ 4 µg/mL in the presence of S9. In the mutagenicity assay, cytotoxicity was observed at ≥ 64 µg/mL in the absence of S9, and ≥ 128 µg/mL in the presence of S9. The assay was negative for mutagenicity.

High DCPD resin oil was not mutagenic in this assay.

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

In a reverse mutation assay in bacteria with and without metabolic activation, CASRN 77-73-6 was not mutagenic. See human health data at:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

CASRN 77-73-6 was not mutagenic in this assay.

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

(1) *Salmonella typhimurium* strains TA98, TA100, TA1535 and TA1537 and *Escherichia coli* strain WP2uvrA were exposed to CASRN 68477-54-3 in ethanol at concentrations of 0, 75, 200, 600, 1800 or 5000 µg/plate in the presence and absence of metabolic activation. Positive controls produced an appropriate response. Cytotoxicity was noted at concentrations ≥ 1800 µg/plate.

CASRN 68477-54-3 was not mutagenic in this assay.

(2) *Salmonella typhimurium* strains TA97, TA98, TA100, TA102 and TA1535 and *Escherichia coli* strain WP2uvrA (pKM101) were exposed to CASRN 68477-54-3 in dimethyl sulfoxide (DMSO) at concentrations of 0, 39, 78, 156, 313 or 625 µg/plate in the absence of metabolic activation and at concentrations of 0, 78, 156, 313, 625 or 1250 µg/plate in the presence of metabolic activation. Positive controls produced an appropriate response. Cytotoxic concentrations were not specified.

CASRN 68477-54-3 was not mutagenic in this assay.

Subcategory III: MCPD Dimer

MCPD Dimer (CASRN 26472-00-4)

In a reverse mutation assay, *S. typhimurium* strains TA98, TA100, TA1535 and TA1537 and *E. coli* strain WP2uvrA were exposed to CASRN 26472-00-4 in ethanol in the presence and absence of metabolic activation at concentrations of 0, 15, 50, 150, 500, 1500 or 5000 µg/plate. No precipitate was observed. Positive controls produced an appropriate response. The cytotoxic concentration was ≥ 500 µg/plate in *S. typhimurium*. No cytotoxicity was observed in *E. coli*. The assay was negative for mutagenicity.

CASRN 26472-00-4 was not mutagenic in this assay.

Genetic Toxicity – Chromosomal Aberrations

In vitro

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

Chinese hamster lung (CHL) cells were exposed to CASRN 77-73-6 in acetone, at concentrations of 0, 0.014, 0.029 or 0.057 mg/mL in the absence of metabolic activation during continuous treatment for 24 and at concentrations of 0, 0.03, 0.05 or 0.10 mg/mL for short-term treatment (duration not specified) in the presence of metabolic activation. Positive controls were tested, but their responses were not provided. Cytotoxicity was observed, but the concentrations at which this effect occurred were not reported. Structural chromosomal aberrations were marginally induced at 0.057 mg/mL in the absence of metabolic activation, after 24 h of continuous treatment.

CASRN 77-73-6 induced chromosomal aberrations in this assay.

Dicyclopentadiene (CASRN 77-73-6, supporting chemical)

In Chinese hamster lung (CHL/IU) cells treated with CASRN 77-73-6 with and without metabolic activation, structural chromosomal aberrations were marginally induced at 0.057 mg/mL after 24-h continuous treatment. However, the documents state that the test substance did not induce structural chromosomal aberrations or polyploidy in CHL/IU cells up to a concentration causing more than 50% cell growth inhibition. See human health data at: http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

CASRN 77-73-6 was not considered to induce chromosomal aberrations in this assay.

In vivo

Subcategory I: DCPD High Purity and related streams

DCPD/Codimer Concentrate (CASRN 68478-10-4)

CD-1 mice (5/sex/dose) were administered CASRN 68478-10-4 in corn oil via gavage at 0, 437.5, or 875 mg/kg-day once a day for 2 days and observed for 24 hours. Additional animals (7/sex) were administered 1750 mg/kg-day in the same manner. Positive controls produced an appropriate response. There was no increase in micronucleated cells when compared to control animals. Although not statistically significant ($p < 0.05$), a 30% decrease in the PCE/NCE ratio was noted in females treated with 1750 mg/kg-day. The assay was negative for micronuclei induction.

CASRN 68478-10-4 did not induce chromosomal aberrations in this assay.

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7)

CD-1 mice (10/sex/dose) were administered CASRNs 68477-54-3 and 68477-40-7 in corn oil via gavage at 0, 125, 250 or 500 mg/kg-day once a day for 2 days and killed on day 3 or day 4 (5/sex/dose, respectively). Additional animals (15/sex) were administered DCPD resin oil via gavage as a single dose at 500 mg/kg-day and killed on day 2, 3 or 4 (5/sex/dose), respectively. At the highest dose level, one male and six females in the 2-day treatment group died on or before day 2 and two males and nine females in the 1-day treatment group died. There were no

treatment-related effects on body weight. Animals exhibited perianal staining and yellow oily or red material in the small intestines and/or stomach as well as bilateral hydrometra in one female during gross necropsy (animal sex, number and/or dose levels were not specified for all observations). A decrease in PEC/NORM ratio was noted in the two surviving high-dose females that were in the 2-day treatment group and killed on day 4.

High DCPD resin oil did not induce chromosomal aberrations in this assay.

Subcategory II: Low DCPD Resin Oil and Resin Former

Low DCPD Resin Oil (CASRN 68516-20-1 & 68477-54-3)

CrI:CD-1 mice (5/sex/dose) were administered CASRN 68477-54-3 in corn oil via gavage at 0, 437.5 or 875 mg/kg-day once a day for 2 days and observed for 24 hours. Additional animals (7/sex) were administered 1750 mg/kg-day in the same manner. No mortality was observed. No clinical signs of toxicity were observed in male animals at any dose level; however, one high-dose female exhibited lethargy 1 hour after dosing. Females at 875 and 1750 mg/kg-day exhibited 7 and 15% decreases in body weight, respectively. Positive controls produced an appropriate response. A depression in the PCE/NCE ratio of approximately 16% in males and 43% in females was noted at 1750 mg/kg-day.

Low DCPD resin oil did not induce chromosomal aberrations in this assay.

Subcategory III: MCPD Dimer

MCPD Dimer (CASRN 26472-00-4)

CD-1 mice (5/sex/dose) were administered CASRN 26472-00-4 in corn oil via gavage at 0, 500 or 1000 mg/kg-day once a day for 2 days and observed for 24 hours. Additional animals (7/sex) were administered 2000 mg/kg-day in the same manner. Mortality occurred at 2000 mg/kg-day in 1/7 females. A statistically significant increase in micronucleated PCE cells was observed at \geq 1000 mg/kg-day. A statistically significant decrease in the PCE/NCE ratio was observed at \geq 1000 mg/kg-day.

CASRN 26472-00-4 induced chromosomal aberrations in this assay.

Genetic Toxicity – Unscheduled DNA Synthesis

In vitro

Subcategory I: DCPD High Purity and related streams

High DCPD Resin Oil (CASRN 68477-54-3 & 68477-40-7)

In an unscheduled DNA synthesis assay, Fischer 344 male rat primary hepatocyte cells were exposed to CASRN 68477-54-3 and 68477-40-7 in Pluronic[®] polyol F68 at concentrations of 0, 10, 20, 40 or 100 μ g/mL for 18 – 20 hours. Positive controls produced an appropriate response. Cytotoxicity was observed at \geq 40 μ g/mL. The assay was negative for unscheduled DNA synthesis.

High DCPD resin oil did not induce unscheduled DNA synthesis in this assay.

Additional Information

Skin Irritation

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

Three New Zealand White rabbits (sex not reported) were administered CASRN 77-73-6 (75% pure; 0.5 mL) to clipped skin for 4 hours under semi-occlusive conditions and observed for 14 days. Well-defined erythema was observed within 3 days of exposure in all animals. Signs of keratinization were observed on day 7. Moderate edema was observed at 24 hours in all animals, and regressed to slight by day 3. The primary irritation index was 4.7. These data are summarized in TSCATS OTS0558246.

CASRN 77-73-6 was moderately irritating to rabbit skin in this study.

Subcategory III: MCPD Dimer

Low DCPD Resin Oil ((CASRNs 68516-20-1 & 68477-54-3)

New Zealand White rabbits (three females) were administered CASRN 68477-54-3 (0.5 mL) to clipped, abraded skin for 4 hours under occlusive conditions and observed for 14 days. Slight erythema and edema with scores ranging from 1 to 2 were observed within 7 days of exposure. No irritation was noted on days 10 – 14; however, slight skin desquamation was observed. The primary irritation score was 2.6 ± 0.2 .

CASRN 68477-54-3 was mildly irritating to rabbit skin.

Eye Irritation

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

Three New Zealand White rabbits (sex not reported) were instilled with 0.1 mL of CASRN 77-73-6 (75% pure) into the eyes. A dulling of the corneal surface, iridial inflammation and moderate conjunctival irritation were observed. The test material produced a group mean score of 18.3. These data are summarized in TSCATS OTS0558243-1.

CASRN 77-73-6 was moderately irritating to rabbit eyes in this study.

Subcategory III: MCPD Dimer

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

Three New Zealand White rabbits (sex not reported) were instilled with 0.1 mL of CASRN 68477-54-3 as a neat solution, into the conjunctival sac of one eye of each of three rabbits for 24 hours. The cornea and iris were not affected; however, conjunctival redness and discharge was noted in the treated eye of each of the three rabbits. Effects were maximal after 72 hours and gradually cleared by day 5. At 72 hours, total scores for redness, chemosis and discharge in all three rabbits were 8, 12 and 2 with two of the three rabbits having individual scores of ≥ 2 .

CASRN 68477-54-3 was highly irritating to rabbit eyes in this study.

Neurotoxicity

Subcategory I: DCPD High Purity and related streams

DCPD High Purity (CASRN 77-73-6)

(1) In the acute inhalation toxicity study in rats described above, rats of both sexes exposed to 3.01 mg/L exhibited signs of neurotoxicity including loss of righting reflex, impaired gait and convulsions immediately prior to death. Stereotypic behavior and respiratory difficulty were observed in both sexes exposed to 1.41 mg/L and sluggish movement was noted in both sexes exposed to 0.7 mg/L. Convulsions were observed immediately before death in animals that died from exposure. All surviving animals fully recovered from clinical effects by day 2. No signs of neurotoxicity were noted at the lowest test concentration.

CASRN 77-73-6 was neurotoxic to rats in this study.

(2) In the acute inhalation toxicity study in mice described above, mice of both sexes exhibited signs of neurotoxicity including loss of righting reflex at 3.01 mg/L, impaired gait and loss of coordination at ≥ 1.41 mg/L and stereotypic behavior and respiratory difficulty at ≥ 0.7 mg/L. Females also exhibited loss of coordination and slight tremors at 0.7 mg/L. Convulsions were observed immediately before death in animals that died from exposure. No signs of neurotoxicity were noted at the lowest exposure concentration.

CASRN 77-73-6 was neurotoxic to mice in this study.

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7)

In the repeated-dose inhalation toxicity study in rats described above, animals walked with arched backs and exhibited body rigidity/muscular tension and twitching throughout the study at 2500 mg/L and by the second week at 600 mg/L. At the highest exposure concentration, twitching was common by day 4 and lasted until termination and 8/10 rats convulsed at least once. Convulsions were observed in both sexes and varied in duration and severity but increased in incidence by the second week. Frequency and severity of neurological symptoms were related to dose level and duration of exposure. Infrequent occurrences of hyper-excitability, pupil dilation, ocular darkening and swaying were observed.

CASRNs 68477-54-3 and 68477-40-7 were neurotoxic to rats in this study.

Conclusion:

Subcategory I: DCPD High Purity and related streams

The acute toxicity of DCPD, High Purity (CASRN 77-73-6) is moderate via the oral route in rats, high via the inhalation route in rats and mice, and low via the dermal route in rabbits. The acute toxicity of High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) is low via the oral and dermal routes in rats and rabbits respectively, and low via the inhalation route in rats. In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with DCPD, High Purity (CASRN 77-73-6) male rats exhibited an increase in single cell necrosis in the liver and hyaline droplets and tubular changes in the kidneys at 20 mg/kg-day while female rats exhibited histopathological change in the adrenals and mortality at 100 mg/kg-day; the NOAEL for systemic toxicity is 4 mg/kg-day. In a 90-day inhalation repeated-dose toxicity study with DCPD, High Purity (CASRN 77-73-6), male rats exhibited histopathological changes in the

kidney at 0.0054 mg/L while female rats did not exhibit any significant adverse effects; the NOAEC is not established in male rats and is 0.28 mg/L (highest concentration tested) in female rats. In a 90-day inhalation repeated-dose toxicity study with DCPD, High Purity (CASRN 77-73-6) in mice, mortality was observed at 0.28 mg/L (highest concentration tested); the NOAEC is 0.028 mg/L. In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with DCPD/Codimer Concentrate (CASRN 68478-10-4) male rats exhibited an increase in renal tubular hyaline droplets at 5 mg/kg-day while female rats exhibited an increase in liver weight and hepatocellular hypertrophy at 100 mg/kg-day; the NOAEL for systemic toxicity is not established in males and is 25 mg/kg-day in females. There were no treatment-related effects in dams or pups in the reproductive/developmental portion of the study; the NOAEL for reproductive/developmental toxicity is 100 mg/kg-day (highest dose tested); the NOAEL for maternal toxicity is 25 mg/kg-day. In the combined repeated-dose/reproductive/developmental toxicity screening test with DCPD, High Purity (CASRN 77-73-6) described above, mortality and litter loss were observed in dams and low viability index, low birth weight and decreased weight gain were observed in pups at 100 mg/kg-day; the NOAEL for reproductive/maternal/developmental toxicity is 20 mg/kg-day. In a dietary, three-generation reproductive toxicity study with DCPD, High Purity (CASRN 77-73-6), excepting decreased pup weight at 34.7 mg/kg-day, no significant effects on reproduction were observed; the NOAEL for reproductive toxicity is 34.7 mg/kg-day (highest concentration tested). The NOAELs for maternal and developmental toxicity are 34.7 mg/kg-day (highest concentration tested) and 3.45 mg/kg-day, respectively. In an oral gavage prenatal developmental toxicity study in rats with DCPD, High Purity (CASRN 77-73-6) dams exhibited decreased body weight and decreased body weight gain at 50 mg/kg-day and pups exhibited decreased fetal weight at 200 mg/kg-day; the NOAEL is not established for maternal toxicity and is 50 mg/kg-day for developmental toxicity. In an oral gavage prenatal developmental toxicity study with DCPD, High Purity (CASRN 77-73-6) in rabbits, bloody vaginal discharge and abortion were observed at 100 mg/kg-day and signs of developmental toxicity consisted of increased non-live implants/litter, decreased fetuses, and gross deformities at 400 mg/kg-day; the NOAELs for maternal and developmental toxicity are 25 mg/kg-day and 300 mg/kg-day, respectively. In a dietary prenatal developmental toxicity study with DCPD, High Purity (CASRN 77-73-6) in rats, no effects were observed at 37.5 mg/kg-day; the NOAEL for maternal/developmental toxicity is 37.5 mg/kg-day (highest concentration tested). DCPD, High Purity (CASRN 77-73-6) was not mutagenic in bacteria *in vitro* but induced chromosomal aberrations in mammalian cells *in vitro*. DCPD/Codimer Concentrate (CASRN 68478-10-4) and High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) were not mutagenic in bacteria *in vitro* and did not induce chromosomal aberrations in mammalian cells *in vivo*. High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) did not induce unscheduled DNA synthesis in mammalian cells *in vitro*. DCPD, High Purity (CASRN 77-73-6) is irritating to rabbit skin and eyes. DCPD, High Purity (CASRN 77-73-6) and High DCPD Resin Oil (CASRNs 68477-54-3 and 68477-40-7) are neurotoxic to rats and DCPD, High Purity (CASRN 77-73-6) is neurotoxic to mice.

Subcategory II: Low DCPD Resin Oil and Resin Former

The acute toxicity of Low DCPD Resin Oil (CASRNs 68516-20-1 and 68477-54-3) is low via the oral route (rats) and high via the inhalation route (rats). In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with Low DCPD Resin Oil (CASRNs 68516-20-1 and 68477-54-3) male rats exhibited histopathological changes in the

kidney at 35 mg/kg-day and female rats exhibited an increase in liver weight and hepatocellular hypertrophy at 125 mg/kg-day; the NOAEL for systemic toxicity is not established in males and is 35 mg/kg-day in females. There were no treatment-related effects in dams, while low pup weight was observed at 375 mg/kg-day; the NOAEL for reproductive toxicity is 375 mg/kg-day (highest dose tested) and the NOAEL for developmental toxicity is 125 mg/kg-day; the NOAEL for maternal toxicity is 35 mg/kg-day. Low DCPD Resin Oil (CASRN 68516-20-1 and 68477-54-3) is not mutagenic in bacteria *in vitro* and did not induce chromosomal aberrations in mammalian cells *in vivo*. Low DCPD Resin Oil (CASRN 68516-20-1 and 68477-54-3) is irritating to rabbit skin and eyes and is not neurotoxic in rats.

Subcategory III: MCPD Dimer

The acute toxicity of MCPD Dimer (CASRN 26472-00-4) is low via the oral and dermal routes in rats and rabbits, respectively and moderate via the inhalation route in rats and mice. In an oral gavage combined repeated-dose/reproductive/developmental toxicity screening test with MCPD Dimer (CASRN 26472-0-4) in rats, males exhibited histopathological changes in the kidney at 20 mg/kg-day while female rats exhibited an increase in liver weight and hepatocellular hypertrophy at 100 mg/kg-day; the NOAEL for systemic toxicity is not established in males and is 20 mg/kg-day in females. There were no treatment-related effects in dams, while low pup weight and decreased weight gain were observed in pups; the NOAEL for reproductive toxicity is 300 mg/kg-day (highest dose tested) and for developmental toxicity is 20 mg/kg-day; the NOAEL for maternal toxicity is 20 mg/kg-day. MCPD Dimer (CASRN 26472-00-4) is not mutagenic in bacteria *in vitro* but did induce micronuclei in erythrocytes *in vivo*. MCPD Dimer (CASRN 26472-00-4) is neurotoxic in rats.

Table 5. Summary Table of the Screening Information Data Set as Submitted under the U.S. HPV Challenge Program - Human Health Data

<i>Subcategory</i>	<i>I</i>					<i>II</i>			<i>III</i>
Endpoints	SPONSORED CHEMICAL DCPD high purity stream (77-73-6)	SPONSORED CHEMICAL DCPD purge stream (68526-24-2)	SPONSORED CHEMICAL DCPD/codimer concentrate (68478-10-4)	SPONSORED CHEMICAL DCPD concentrate (68478-08-0, 68527-26-4, 68603-02-1) (68477-53-2)	SPONSORED CHEMICAL CPD stream (68477-53-2)	SPONSORED CHEMICAL High DCPD resin oil (68477-54-3, 68477-40-7) (68477-54-3)	SPONSORED CHEMICAL Low DCPD resin oil (68516-20-1, 68477-54-3) (68477-54-3)	SPONSORED CHEMICAL Resin former (68477-54-3)	SPONSORED CHEMICAL MCPD dimer (26472-00-4)
Acute Oral Toxicity LD₅₀ (mg/kg)	353 – 590	No Data 353 - 590 (RA)	No Data 353 - 590 (RA)	No Data 353 - 590 (RA)	No Data 353 - 590 (RA)	(rat, m) >560 to <1000 (rat, f) 970	> 2000	No Data > 2000 (RA)	> 10,000
Acute Inhalation Toxicity LC₅₀ (mg/L)	(rat) 1.54 (m) - 1.91 (f) (mouse) 0.70 (f) - 0.77 (m)	No Data 1.54 (m) - 1.91 (f) (mouse) 0.70 (f) - 0.77 (m) (RA)	No Data 1.54 (m) - 1.91 (f) (mouse) 0.70 (f) - 0.77 (m) (RA)	No Data 1.54 (m) - 1.91 (f) (mouse) 0.70 (f) - 0.77 (m) (RA)	No Data 1.54 (m) - 1.91 (f) (mouse) 0.70 (f) - 0.77 (m) (RA)	> 5.4	(rat) 1.4 (m) - 1.9 (f)	No Data 1.4 (m) - 1.9 (f) (RA)	(rat) > 3.24 (mouse) > 3.24
Acute Dermal Toxicity LD₅₀ (mg/kg)	4460 - 5080	No Data 4460 - 5080 (RA)	No Data 4460 - 5080 (RA)	No Data 4460 - 5080 (RA)	No Data 4460 - 5080 (RA)	> 2000	-	-	> 3160
Repeated-Dose Toxicity NOAEL/LOAEL Oral (mg/kg-day)	NOAEL = 4 LOAEL = 20	No Data NOAEL = 4 LOAEL = 20 (RA)	NOAEL(m) = Not established LOAEL (m) = 5 NOAEL (f) = 25 NOAEL(f) =100	No Data NOAEL(m) = Not established LOAEL (m) = 5 NOAEL (f) = 25 NOAEL(f) = 100 (RA)	No Data NOAEL(m) = Not established LOAEL (m) = 5 NOAEL (f) = 25 NOAEL(f) = 100 (RA)	No Data NOAEL(m) = Not established LOAEL (m) = 5 NOAEL (f) = 25 NOAEL(f) = 100 (RA)	NOAEL(m) = Not established LOAEL (m) = 35 NOAEL (f) = 35 NOAEL(f) = 125	No Data NOAEL(m) = Not established LOAEL (m) = 35 NOAEL (f) = 35 NOAEL(f) = 125 (RA)	NOAEL(m) = Not established LOAEL (m) = 20 NOAEL (f) = 20 NOAEL(f) =100

Table 5. Summary Table of the Screening Information Data Set as Submitted under the U.S. HPV Challenge Program - Human Health Data

<i>Subcategory</i>	<i>I</i>						<i>II</i>		<i>III</i>
Endpoints	SPONSORED CHEMICAL DCPD high purity stream (77-73-6)	SPONSORED CHEMICAL DCPD purge stream (68526-24-2)	SPONSORED CHEMICAL DCPD/codimer concentrate (68478-10-4)	SPONSORED CHEMICAL DCPD concentrate (68478-08-0, 68527-26-4, 68603-02-1) (68477-53-2)	SPONSORED CHEMICAL CPD stream (68477-53-2)	SPONSORED CHEMICAL High DCPD resin oil (68477-54-3, 68477-40-7) (68477-54-3)	SPONSORED CHEMICAL Low DCPD resin oil (68516-20-1, 68477-54-3) (68477-54-3)	SPONSORED CHEMICAL Resin former (68477-54-3)	SPONSORED CHEMICAL MCPD dimer (26472-00-4)
Repeated-Dose Toxicity NOAEC/LOAEC Inhalation (mg/L/day)	(rat) NOAEC (m) = Not established LOAEC (m) = 0.0054 NOAEC (f) = 0.28 (highest concentration tested) (mouse) NOAEC = 0.028 LOAEC = 0.28	No Data (rat) NOAEC (m) = Not established LOAEC (m) = 0.0054 NOAEC (f) = 0.28 (mouse) NOAEC = 0.028 LOAEC = 0.28 (RA)	No Data (rat) NOAEC (m) = Not established LOAEC (m) = 0.0054 NOAEC (f) = 0.28 (mouse) NOAEC = 0.028 LOAEC = 0.28 (RA)	No Data (rat) NOAEC (m) = Not established LOAEC (m) = 0.0054 NOAEC (f) = 0.28 (mouse) NOAEC = 0.028 LOAEC = 0.28 (RA)	No Data (rat) NOAEC (m) = Not established LOAEC (m) = 0.0054 NOAEC (f) = 0.28 (mouse) NOAEC = 0.028 LOAEC = 0.28 (RA)	No Data (rat) NOAEC (m) = Not established LOAEC (m) = 0.0054 NOAEC (f) = 0.28 (mouse) NOAEC = 0.028 LOAEC = 0.28 (RA)	-	-	(rat, mouse) NOAEC (m) = 0.03 LOAEC (m) = 0.32 NOAEC (f) = 0.32 LOAEC (f) = 2.64
Reproductive Toxicity NOAEL/LOAEL Oral (mg/kg-day) Reproductive Toxicity	(gavage) NOAEL = 20 LOAEL = 100 (diet) NOAEL = 34.7 (highest dose tested)	No Data (gavage) NOAEL = 20 LOAEL = 100 (diet) NOAEL = 34.7 (RA)	(gavage) NOAEL = 100 (highest dose tested)	No Data (gavage) NOAEL = 20 LOAEL = 100 (diet) NOAEL = 34.7 (RA)	No Data (gavage) NOAEL = 20 LOAEL = 100 (diet) NOAEL = 34.7 (RA)	No Data (gavage) NOAEL = 20 LOAEL = 100 (diet) NOAEL = 34.7 (RA)	(gavage) NOAEL = 375 (highest dose tested)	No Data (gavage) NOAEL = 375 (RA)	NOAEL = 300 (highest dose tested)

Table 5. Summary Table of the Screening Information Data Set as Submitted under the U.S. HPV Challenge Program - Human Health Data

<i>Subcategory</i>	<i>I</i>						<i>II</i>		<i>III</i>
Endpoints	SPONSORED CHEMICAL DCPD high purity stream (77-73-6)	SPONSORED CHEMICAL DCPD purge stream (68526-24-2)	SPONSORED CHEMICAL DCPD/codimer concentrate (68478-10-4)	SPONSORED CHEMICAL DCPD concentrate (68478-08-0, 68527-26-4, 68603-02-1)	SPONSORED CHEMICAL CPD stream (68477-53-2)	SPONSORED CHEMICAL High DCPD resin oil (68477-54-3, 68477-40-7)	SPONSORED CHEMICAL Low DCPD resin oil (68516-20-1, 68477-54-3)	SPONSORED CHEMICAL Resin former (68477-54-3)	SPONSORED CHEMICAL MCPD dimer (26472-00-4)
Developmental Toxicity		No Data (gavage, rat)		No Data (gavage, rat)	No Data (gavage, rat)	No Data (gavage, rat)		No Data	
NOAEL/LOAEL	(gavage, rat) NOAEL = 20 LOAEL = 100	NOAEL = 20 LOAEL = 100	(gavage) NOAEL = 25 LOAEL = 100	NOAEL = 20 LOAEL = 100	NOAEL = 20 LOAEL = 100	NOAEL = 20 LOAEL = 100	(gavage) NOAEL = 35 LOAEL = 125	NOAEL = 35 LOAEL = 125	(gavage) NOAEL = 20 LOAEL = 100
Oral (mg/kg-day)									
Maternal Toxicity									
Developmental Toxicity	NOAEL = 20 LOAEL = 100	NOAEL = 20 LOAEL = 100	NOAEL = 100 (highest dose tested)	NOAEL = 20 LOAEL = 100	NOAEL = 20 LOAEL = 100	NOAEL = 20 LOAEL = 100	NOAEL = 125 LOAEL = 375	NOAEL = 125 LOAEL = 375 (RA)	NOAEL = 20 LOAEL = 100
Maternal Toxicity	(diet 3-gen, rat) NOAEL = 37.5 (highest dose tested)	(diet) NOAEL = 37.5		(diet) NOAEL = 37.5	(diet) NOAEL = 37.5	(diet) NOAEL = 37.5			
Developmental Toxicity	NOAEL = 3.45 LOAEL = 34.7	NOAEL = 3.45 LOAEL = 34.7		NOAEL = 3.45 LOAEL = 34.7	NOAEL = 3.45 LOAEL = 34.7	NOAEL = 3.45 LOAEL = 34.7			
Maternal Toxicity	(gavage, rabbit) NOAEL = 25 LOAEL = 100	(gavage, rabbit) NOAEL = 25 LOAEL = 100		(gavage, rabbit) NOAEL = 25 LOAEL = 100	(gavage, rabbit) NOAEL = 25 LOAEL = 100	(gavage, rabbit) NOAEL = 25 LOAEL = 100			
Developmental Toxicity	NOAEL = 300 LOAEL = 400	NOAEL = 300 LOAEL = 400 (RA)		NOAEL = 300 LOAEL = 400 (RA)	NOAEL = 300 LOAEL = 400 (RA)	NOAEL = 300 LOAEL = 400 (RA)			

Table 5. Summary Table of the Screening Information Data Set as Submitted under the U.S. HPV Challenge Program - Human Health Data

<i>Subcategory</i>	<i>I</i>						<i>II</i>		<i>III</i>
Endpoints	SPONSORED CHEMICAL DCPD high purity stream (77-73-6)	SPONSORED CHEMICAL DCPD purge stream (68526-24-2)	SPONSORED CHEMICAL DCPD/codimer concentrate (68478-10-4)	SPONSORED CHEMICAL DCPD concentrate (68478-08-0, 68527-26-4, 68603-02-1)	SPONSORED CHEMICALD CPD stream (68477-53-2)	SPONSORED CHEMICAL High DCPD resin oil (68477-54-3, 68477-40-7)	SPONSORED CHEMICAL Low DCPD resin oil (68516-20-1, 68477-54-3)	SPONSORED CHEMICAL Resin former (68477-54-3)	SPONSORED CHEMICAL MCPD dimer (26472-00-4)
Genetic Toxicity – Gene Mutation <i>In vitro</i>	Negative	No Data Negative (RA)	Negative	No Data Negative (RA)	No Data Negative (RA)	Negative	Negative	No Data Negative (RA)	Negative
Genetic Toxicity – Chromosomal Aberrations <i>In vitro</i>	Positive	No Data Positive (RA)	No Data Positive (RA)	No Data Positive (RA)	No Data Positive (RA)	No Data Positive (RA)	–	–	–
Genetic Toxicity – Chromosomal Aberrations <i>In vivo</i>	No Data Negative (RA)	No Data Negative (RA)	Negative	No Data Negative (RA)	No Data Negative (RA)	Negative	Negative	No Data Negative (RA)	Positive
Genetic Toxicity- Unscheduled DNA Synthesis	–	–	–	–	–	Negative	–	–	–
Additional Information									
Neurotoxicity	Positive	–	Negative	–	–	Positive	Negative	–	Positive
Skin Irritation	Moderately irritating	–	–	–	–	–	Mildly irritating	–	–
Eye Irritation	Moderately irritating	–	–	–	–	–	Highly irritating	–	–

Measured data in bold; (RA) = Read Across; – indicates that the endpoint was not addressed for this stream; (m) = male; (f) = female

4. Hazard to the Environment

A summary of aquatic toxicity data submitted for SIDS endpoints is provided in Table 5. The table also indicates where data for tested category members are read-across (RA) to untested members of the category.

Acute Toxicity to Fish

DCPD High Purity (CASRN 77-73-6)

(1) Bluegill sunfish (*Lepomis macrochirus*) toxicity was reported in several studies after exposure to CASRN 77-73-6. The fish were tested in nominal concentrations ranging from 11.5 to 60.2 mg/L under static conditions for 96 hours.

96-h LC₅₀ = 14.2-47.5 mg/L

(2) Fathead minnow (*Pimephales promelas*) toxicity was reported in several studies after exposure to CASRN 77-73-6. The fish were tested in nominal concentrations ranging from 21 to 171 mg/L under static conditions for 96 hours.

96-h LC₅₀ > 21- 86.3 mg/L

(3) See ecotoxicity data for Dicyclopentadiene (CASRN 77-73-9-6) at:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

High DCPD Resin Oil (CASRNs 68477-54-3 & 68477-40-7)

(1) Rainbow trout (*Oncorhynchus mykiss*) were exposed to high DCPD resin oil at nominal concentrations of 3.2, 5.6, 10, 14, 18 or 32 mg/L under static-renewal conditions for 96 hours. Measured concentrations were not specified.

96-h LC₅₀ = 10.6 mg/L

(2) Bluegill sunfish (*Lepomis macrochirus*) were exposed to high DCPD resin oil at nominal concentrations of 10, 14, 18, 32, 56 or 100 mg/L under static renewal conditions for 96 hours. Measured concentrations were not specified.

96-h LC₅₀ = 13.5 mg/L

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

Rainbow trout (*Oncorhynchus mykiss*) were exposed to low DCPD resin oil as WAFs under static conditions for 96 hours. The loading rates were 0 (control), 0.43, 0.92, 2.1, 4.5 and 10 mg/L and measured concentrations were 0 (control), 0.41, 0.84, 1.8, 4.4 and 9.8 mg/L, respectively.

96-h LC₅₀ = 6.1 mg/L

DCPD/Codimer Concentrate (CASRN 68478-10-4)

Rainbow trout (*Oncorhynchus mykiss*) were exposed to DCPD/codimer concentrate as water accommodated fractions (WAFs) under static conditions for 96 hours. The loading rates were 0 (control), 0.21, 0.49, 1.1, 2.3 and 4.9 mg/L and measured concentrations were 0 (control), 0.25,

0.39, 0.85, 2.0 and 5.0 mg/L, respectively.

96-h LC₅₀ = 0.53 mg/L

Acute Toxicity to Aquatic Invertebrates

DCPD High Purity (CASRN 77-73-6)

(1) Water fleas (*Daphnia magna*) were exposed to DCPD high purity. Test concentrations, environmental conditions and effects were not specified. Limited data were provided. Effects were apparent at test concentrations below the water solubility limit (20 mg/L) for pure DCPD.

48-h LC₅₀ = 10.5 mg/L

(2) Water fleas (*Daphnia magna*) were exposed to DCPD high purity under flow-through conditions for 48 hours. Test concentrations, environmental conditions and effects were not specified. Limited data were provided.

48-h EC₅₀ = 8.0 mg/L

(3) See ecotoxicity data for dicyclopentadiene (CASRN 77-73-9-6) at:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

Low DCPD Resin Oil (CASRNs 68516-20-1 & 68477-54-3)

Water fleas (*Daphnia magna*) were exposed to low DCPD resin oil as WAFs under static conditions for 48 hours. The loading rates were 0 (control), 0.22, 0.43, 1.0, 2.3 and 4.9 mg/L and measured concentrations were 0 (control), 0.19, 0.35, 0.85, 2.0 and 4.6 mg/L. Immobilization rates ranged from 5% at the lowest concentration (0.19 mg/L) to 100% at the highest concentration (4.6 mg/L). The results of this test indicated that there were effects at or below the water solubility limit (saturation) of low DCPD resin oil (value unknown). The solubility limit for the test material was not specified, but estimated or measured water solubilities of low DCPD resin oil components that constitute approximately 40% of the stream range from 31 to 332 mg/L. Effects likely to occur below water solubility limit.

48-h LC₅₀ = 3.0 mg/L

DCPD/Codimer Concentrate (CASRN 68478-10-4)

Water fleas (*Daphnia magna*) were exposed to DCPD/codimer concentrate as WAFs under static conditions for 48 hours. The loading rates were 0 (control), 0.09, 0.23, 0.49, 1.1 and 2.4 mg/L and measured concentrations were 0 (control), 0.07, 0.17, 0.40, 0.92 and 2.1 mg/L. The highest test substance concentration (2.1 mg/L) caused immobilization in 100% of the test organisms.

48-h LC₅₀ = 0.76 mg/L

Toxicity to Aquatic Plants

DCPD High Purity (CASRN 77-73-6)

See ecotoxicity data for dicyclopentadiene (CASRN 77-73-9-6) at:

http://webnet.oecd.org/hpv/UI/SIDS_Details.aspx?Key=c1669b2f-fe19-4ff0-8761-4d0e436e73e2&idx=0.

72-h EC₅₀ = 27.0 mg/L (growth rate)

Low DCPD Resin Oil (CASRN 68516-20-1 & 68477-54-3)

Green algae (*Pseudokirchneriella subcapitata*) were exposed to low DCPD resin oil as WAFs under static conditions for 96 hours. The loading rates were 0 (control), 0.2, 0.5, 1.1, 2.7 and 7.3 mg/L and measured concentrations were 0 (control), 0.3, 0.4, 0.9, 2.7 and 7.4 mg/L.

96-h EC₅₀ < 0.27 mg/L (growth rate)

96-h EC₅₀ = 0.94 mg/L (biomass)

DCPD/Codimer Concentrate (CASRN 68478-10-4)

Green algae (*Pseudokirchneriella subcapitata*) were exposed to DCPD/codimer concentrate as WAFs under static conditions for 96 hours. The loading rates were 0 (control), 0.21, 0.49, 1.1, 2.3 and 4.9 mg/L and measured concentrations were 0 (control), 0.25, 0.39, 0.85, 2.0 and 5.0 mg/L, respectively. The 72- and 96-hour EC₅₀ values for growth rate were 0.94 and 1.0 mg/L, respectively, and 1.2 mg/L for biomass for both time periods. The highest test substance concentration (2.1 mg/L) caused immobilization in 100% of the test organisms

96-h EC₅₀ = 1 mg/L (growth rate)

96-h EC₅₀ = 1.2 mg/L (biomass)

MCPD Dimer (CASRN 26472-00-4)

Green algae (*Pseudokirchneriella subcapitata*) were exposed to MCPD dimer concentrate as WAFs under static conditions for 96 hours. The loading rates were 0 (control), 0.019, 0.068, 0.17, 0.51 and 1.1 mg/L and measured concentrations were 0 (control), 0.029, 0.048, 0.096, 0.28 and 0.76 mg/L.

96-h EC₅₀ = 0.83 mg/L (growth rate)

96-h EC₅₀ = 0.42 mg/L (biomass)

Conclusion: The 96-h LC₅₀ of CASRN 77-73-6 ranges from 14.2 to 86.3 mg/L for fish. The 96-h LC₅₀ of high DCPD resin oil (CASRN 68477-40-7 and 68477-54-3) for fish ranges from 10.6 to 13.5 mg/L. The 96-h LC₅₀ of low DCPD resin oil (CASRN 68477-54-3) for fish is 6.1 mg/L. The 96-h LC₅₀ of DCPD/codimer concentrate (CASRN 68478-10-4) for fish is 0.53 mg/L. The 48-h EC₅₀ of CASRN 77-73-6 for aquatic invertebrates ranges from 8.0 to 10.5 mg/L. The 48-h EC₅₀ of low DCPD resin oil (CASRN 68516-20-1 and 68477-54-3) for aquatic invertebrates is 3.0 mg/L. The 48-h EC₅₀ of DCPD/codimer concentrate (CASRN 6878-10-4) for aquatic invertebrates is 0.76 mg/L. The 72-h EC₅₀ of CASRN 77-73-6 for aquatic plants is 27.0 mg/L for growth rate. The 96-h EC₅₀ of low DCPD resin oil (CASRN 68516-20-1 and 68477-54-3) for aquatic plants is 0.94 and <0.27 mg/L for biomass and growth rate, respectively. The 96-h EC₅₀ of DCPD/codimer concentrate (CASRN 68478-10-4) for aquatic plants is 1.0 and 1.2 mg/L for biomass and growth rate, respectively. The 96-h EC₅₀ of MCPD dimer (CASRN 26472-00-4) for aquatic plants is 0.42 and 0.83 mg/L for biomass and growth rate, respectively. The 21-d chronic toxicity of CASRN 77-73-6 for aquatic invertebrates is 3.2 mg/L.

5. References

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Table 5. Summary Table of the Screening Information Data Set as Submitted under the U.S. HPV Challenge Program - Aquatic Toxicity Data									
Endpoints	SPONSORED CHEMICAL DCPD High Purity (77-73-6)	SPONSORED CHEMICAL DCPD Conc. (68478-08-0) (68527-26-4) 68603-02-1)	SPONSORED CHEMICAL DCPD Stream (68477-53-2)	SPONSORED CHEMICAL DCPD Purge Stream (68527-24-2)	SPONSORED CHEMICAL Resin Former (68477-54-3)	SPONSORED CHEMICAL High DCPD Resin Oil (68477-40-7), (68477-54-3)	SPONSORED CHEMICAL Low DCPD Resin Oil (68516-20-1), (68477-54-3)	SPONSORED CHEMICAL DCPD/ Codimer Conc. (68478-10-4)	SPONSORED CHEMICAL MCPD Dimer (26472-00-4)
Fish 96-h LC₅₀ (mg/L)	14.2 – 86.3	No Data 6.1 - 13.5 (RA)	No Data 6.1 - 13.5 (RA)	No Data 6.1 - 13.5 (RA)	No Data 6.1 – 13.5 (RA)	10.6 - 13.5	6.1	0.53	No Data 0.53 (RA)
Aquatic Invertebrates 48-h EC₅₀ (mg/L)	8.0 - 10.5	No Data 8.0 - 10.5 (RA)	No Data 8.0 - 10.5 (RA)	No Data 8.0 - 10.5 (RA)	No Data 8.0 - 10.5 (RA)	No Data 8.0 - 10.5 (RA)	3.0	0.76	No Data 0.76 (RA)
Aquatic Plants 96-h EC₅₀ (mg/L) (biomass) (growth rate)	– 27 (72-h)	No Data – 27 (RA)	No Data – 27 (RA)	No Data – 27 (RA)	No Data – 27 (RA)	No Data – 27 (RA)	0.94 <0.27	1.2 1.0	0.42 0.83
Chronic Aquatic Invertebrates 21-d (mg/L) LOEC	3.2	No Data 3.2 (RA)	No Data 3.2 (RA)	No Data 3.2 (RA)	No Data 3.2 (RA)	No Data 3.2 (RA)	No adequate data	No adequate data	No adequate data

bold = measured data (i.e., derived from testing); (RA) = Read-Across; – indicates that endpoint was not addressed for this chemical

APPENDIX

The following pages show:

- Table 6 shows representative structures of the sponsored substances
- Table 7 shows the typical composition ranges (%) for the resin oils and cyclodiene dimer concentrates streams.
- Description of ethylene manufacturing process and the associated diagram are taken from the sponsor's original HPV submission of Resin Oils and Cyclodiene Dimer Concentrates Category: <http://www.epa.gov/chemrtk/pubs/summaries/resinoil/c13434tc.htm>)

Note on representative structures: The structures chosen for each category member were based on the description of the process stream provided in the Test Plan and Robust Summary and supplemented by information from the CAS definition included in the CAS registry name. It should be understood that several of the process streams consist of many substances, well beyond the two or three substances shown in the Appendix for most members.

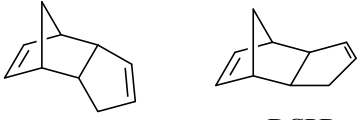
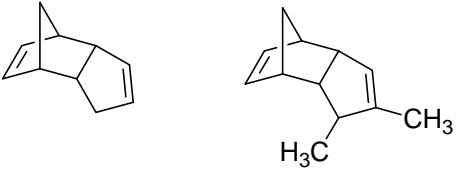
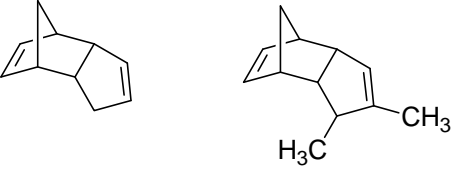
Table 6. Process Streams, CASRN, and Description of the Resin Oils and Cyclodiene Dimer Concentrates Category		
Name	CASRN	TSCA Description
DCPD High Purity¹	77-73-6	 <p>endo DCPD exo DCPD</p> <p>The Olefins Industry produces this high purity DCPD stream by distillation and/or thermal processing of the DCPD Concentrate stream. DCPD content of the stream is reported at 94 to 99.5%. The main impurities remaining in the stream are co-dimers and trimers of cyclopentadiene. DCPD can exist in two stereoisomers, the endo and exo forms, with commercial DCPD being predominantly the endo isomer.</p>
DCPD Purge Stream	68527-24-2	 <p>MCPD Dimer and DCPD/Codimer Concentrate are obtained by "heat soaking" the C5 to C6 fraction (debutanizer bottoms) of pyrolysis gasoline obtained from the ethylene pyrolysis process, followed by removal via distillation of unreacted, undimerized C5 and C6 molecules, followed by a thermal cracking/distillation/dimerization sequence that isolates these two streams. The DCPD Purge stream is a bottoms stream from this separation sequence. It typically contains 18% DCPD, with the balance largely co-dimers and C8 aliphatics and aromatics.</p>
DCPD/Codimer Concentrate	68478-10-4	 <p>This stream is obtained by "heat soaking" the C5 to C6 fraction (debutanizer bottoms) of pyrolysis gasoline obtained from the ethylene pyrolysis process, followed by removal via distillation of unreacted, undimerized C5 and C6 molecules, followed by a thermal cracking/distillation/dimerization sequence that isolates the DCPD/Codimer and other streams.</p>

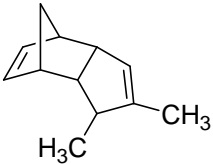
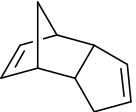
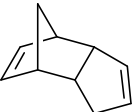
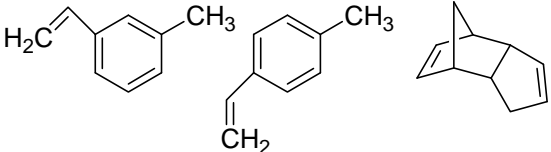
Table 6. Process Streams, CASRN, and Description of the Resin Oils and Cyclodiene Dimer Concentrates Category		
Name	CASRN	TSCA Description
MCPD Dimer¹	26472-00-4	 <p>Representative structure of the endo stereoisomer. The position of the methyl groups are non specific.</p> <p>MCPD Dimer is obtained by "heat soaking" the C5 to C6 fraction (debutanizer bottoms) of pyrolysis gasoline obtained from the ethylene pyrolysis process, followed by removal via distillation of unreacted, undimerized C5 and C6 molecules, followed by a thermal cracking/distillation/dimerization sequence that isolates the MCPD Dimer and other streams. The tested substance described in the Robust Summary contained 90.8% MCPD dimer, 2.6% MCPD, and 1.6% cyclopentadiene (CPD-MCPD) co-dimer. The balance of the stream consists of other hydrocarbons, primarily C4-C7 co-dimers of MCPD or CPD.</p>
DCPD Concentrate	68478-08-0; 68527-26-4; 68603-02-1	 <p>DCPD Concentrate is produced from the Pyrolysis C5 Fraction by a combination of distillation and heat soak (dimerization) unit operations. DCPD content of the stream is typically 75%, with the balance predominantly co-dimers of cyclopentadiene with other C5 monomers. The stream typically contains relatively low levels of low boiling hydrocarbons (C5-C8).</p>
DCPD Stream	68477-53-2	 <p>This stream is produced as the bottoms from a distillation tower that is charged with a DCPD-containing stream (or with a DCPD Concentrate intermediate processing stream) together with the heavy ends and raffinate from an isoprene extractive distillation unit. This stream is reported to contain about 50% DCPD, with the balance being largely C5s, both saturates and unsaturates.</p>
High DCPD Resin Oil Stream	68477-54-3; 68477-40-7	

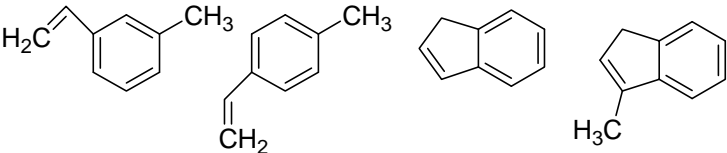
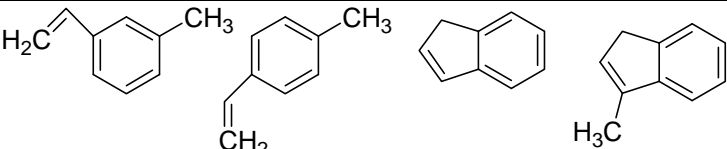
Table 6. Process Streams, CASRN, and Description of the Resin Oils and Cyclodiene Dimer Concentrates Category		
Name	CASRN	TSCA Description
		<p>This stream is the C8-C10 fraction obtained by distillation from pyrolysis gasoline. The stream consists predominantly of the C8-C10 aromatics produced in the ethylene process, plus DCPD and co-dimers of cyclopentadiene with other reactive monomers. DCPD and the co-dimers are formed in the process equipment during and incidental to upstream processing and storage. This stream typically contains about 55% DCPD and significant levels of vinyl aromatics and co-dimers of cyclopentadiene with other monomers such as isoprene, pentadiene, and methylcyclopentadiene. The highest boiling component in the stream is normally naphthalene, and it is present usually at <0.5%.</p>
Resin Former Stream	68477-54-3	<div style="display: flex; justify-content: space-around; align-items: center;">  </div> <p>This stream is produced by the processing of resin oil streams from various ethylene units, and represents only about 1.5% of the category production. Resin Former is most similar to the Low DCPD stream, with typical DCPD content reported at about 6.7%.</p>
Low DCPD Resin Oil Stream	68477-54-3; 68516-20-1	<div style="display: flex; justify-content: space-around; align-items: center;">  </div> <p>This is a C8 to C10 distillate obtained from a pyrolysis gasoline stream produced by an ethylene production process (steam cracking process). The sample tested consisted of vinyltoluenes (17%), trimethylbenzenes (9%), styrene and methylstyrenes (3%), indene (14%), methylindene (8%), and naphthalene (1%). The balance of the composition is expected to consist of other hydrocarbons with carbon range primarily 8 to 10, mainly aromatics and olefins, with some paraffins.</p>

Table 7. Typical Composition Ranges (Percent) for Resin Oils and Cyclodiene Dimer Concentrates Streams. (See notes 1-3 at the end of this table)

Component Name	High DCPD Resin Oil	Low DCPD Resin Oil	Resin Former	DCPD Conc.	DCPD, High Purity	MCPD Dimer	DCPD Purge	DCPD Stream	DCPD/Codimer Conc.
Isoprene (2-Methyl-1,3-Butadiene)				0.5					
Pentane				1 - 1.5					
Cis-2-Pentene				3.5					
1,3-Cyclopentadiene	2			0 - 3	0.2 - 1.5				
1,3-Pentadiene				3					
Cyclopentene				4.8					
Cyclopentane				0.8 - 1					
C5 Olefins and Paraffins								35 - 45	
C6-C8 Non-Aromatics				1 - 7					
CPD or MCPD Codimers with Vinyl Aromatics			8.2						
Benzene	0 - 0.01			0 - 2.5		0.01			
C7 Cyclics						1			
Toluene				0 - 2					
Xylenes, Mixed		1 - 5	1.2						
Styrene	2 - 6	0 - 11	4.5						
Allylbenzene			2.5						
Propylbenzene	0.5 - 1	1.4	2						
C9 Substituted Benzenes		20							
Ethyltoluenes	1 - 2.5	4	7						
1,3,5-Trimethylbenzene (Mesitylene)	0 - 1								
Alpha-Methylstyrene	0.5 - 3.5	1 - 5	4.5						
o-,p-,m-Methylstyrene		12							
1,2,4-Trimethylbenzene (Pseudocumene)		1 - 10							
Trimethylbenzenes	1 - 2.3	5 - 20	4						
Cyclopentadiene/Isoprene Codimers	0 - 1								
Cyclopentadiene/1,3-Pentadiene Codimers	0.6 - 1.6								9.9
Piperylene-MCPD Codimers									5.7
Butadiene-CPD Codimers									6.3
Butadiene-MCPD Codimers							6		
Isoprene-cyclopentadiene codimers				11					
Cyclopentadiene / Methylcyclopentadiene Codimers	1 - 7		5.3				10		24
Dicyclopentadiene	40 - 70	0.5	6.7	70 - 90	94 - 99.5	0.1	18		41
DCPD and codimers of C5s								55-60	
MCPD-C7 Codimers							5		
C5-MCPD Codimers							18		
C5-CPD Codimers							5		
Tetrahydro-Indiene							5		
C8 aliphatics and aromatics							10		
Vinyl Toluene	4 - 14	5 - 25	13.6						

Component Name	High DCPD Resin Oil	Low DCPD Resin Oil	Resin Former	DCPD Conc.	DCPD, High Purity	MCPD Dimer	DCPD Purge	DCPD Stream	DCPD/Codimer Conc.
Vinyl Aromatics	10								
Isobutylbenzene			1.4						
Remaining C8+ Olefins and Aromatic Components, Including Various Oligimers of CPD and MCPD	2.5 - 15								
C10 & C11 Codimers of C5 & C6					0.2 - 4				
Propenylbenzene		1.5							
Beta-Methylstyrene	0.5 - 1.5	1 - 5	6.4						
Indane (Indan)		1 - 1.5							
C10 Substituted Benzenes		3 - 7							
Indene	2 - 9	5 - 20	13.4						
Butylbenzene	0 - 1.5		2						
C10 Substituted Styrene		4 - 10							
Dimethylstyrene		2.1							
Methyl Indenes		5 - 30	1.1						
Methyl Indane		1							
C10-C11 Alkylbenzenes		10 - 30							
Methylcyclopentadiene Dimers	0.5 - 1.2		5.2			90	18		9.6
Acyclic Dienes					2 - 2.3	1			
Trimers				1.1	0 - 2		4		2.4
Naphthalene	0.5	1 - 8	1						
C6 - C9 Saturates								0 - 5	

NOS not otherwise specified

Note 1: The composition data shown above are composites of reported values.

Note 2: The balance of these streams is expected to be other hydrocarbons that have boiling points in the range of the listed components.

Note 3: The listed highs and lows should not be considered absolute values for these limits. They are instead the highs and lows of the reported values.

ETHYLENE PROCESS DESCRIPTION

1. Steam Cracking

Steam cracking is the predominant process used to produce ethylene. Various hydrocarbon feedstocks are used in the production of ethylene by steam cracking, including ethane, propane, butane, and liquid petroleum fractions such as condensate, naphtha, and gas oils. The feedstocks are normally saturated hydrocarbons, but may contain minor amounts of unsaturates. These feedstocks are charged to the coils of a cracking furnace. Heat is transferred through the metal walls of the coils to the feedstock from hot flue gas, which is generated by combustion of fuels in the furnace firebox. The outlet of the cracking coil is usually maintained at relatively low pressure in order to obtain good yields to the desired products. Steam is also added to the coil and serves as a diluents to improve yields and to control coke formation. This step of the ethylene process is commonly referred to as “steam cracking” or simply “cracking” and the furnaces are frequently referred to as “crackers”.

Subjecting the feedstocks to high temperatures results in the partial conversion of the feedstock to olefins. In the simplest example, feedstock ethane is partially converted to ethylene and hydrogen. Similarly, propane, butane, or the liquid feedstocks are also converted to ethylene. While the predominant products produced are ethylene and propylene, a wide range of additional products are also formed. These products range from methane (C1) through fuel oil (C12 and higher) and include other olefins, diolefins, aromatics and saturates (naphthenes and paraffins).

2. Refinery Gas Separation

Ethylene and propylene are also produced by separation of these olefins from refinery gas streams, such as from the light ends product of a catalytic cracking process or from coker offgas. This separation is similar to that used in steam crackers, and in some cases both refinery gas streams and steam cracking furnace effluents are combined and processed in a single finishing section. These refinery gas streams differ from cracked gas in that the refinery streams have a much narrower carbon number distribution, predominantly C2 and/or C3. Thus the finishing of these refinery gas streams yields primarily ethylene and ethane, and/or propylene and propane.

Products of the Ethylene Process

The intermediate stream that exits the cracking furnaces (i.e., the furnace effluent) is forwarded to the finishing section of the ethylene plant. The furnace effluent is commonly referred to as “cracked gas” and consists of a mixture of hydrogen, methane, and various hydrocarbon compounds with two or more carbon atoms per molecule (C2+). The relative amount of each component in the cracked gas varies depending on what feedstocks are cracked and cracking process variables. Cracked gas may also contain relatively small concentrations of organic sulfur compounds that were present as impurities in the feedstock or were added to the feedstock to control coke formation. The cracked gas stream is cooled, compressed and then separated into the individual streams of the ethylene process. These streams can be sold commercially and/or put into further steps of the process to produce additional materials. In some ethylene processes, a liquid fuel oil product is produced when the cracked gas is initially cooled. The ethylene process is a closed process and the products are contained in pressure systems.

The final products of the ethylene process include hydrogen, methane (frequently used as fuel), and the high purity products ethylene and propylene. Other products of the ethylene process are typically mixed streams that are isolated by distillation according to boiling point ranges and

then further processed. It is a subset of these mixed streams that make up the constituents of the Resin Oils and Cyclodiene Dimer Concentrates Category. The chemical process operations that are associated with the process streams in the Resin Oils and Cyclodiene Dimer Concentrates Category are shown in Figure 1.

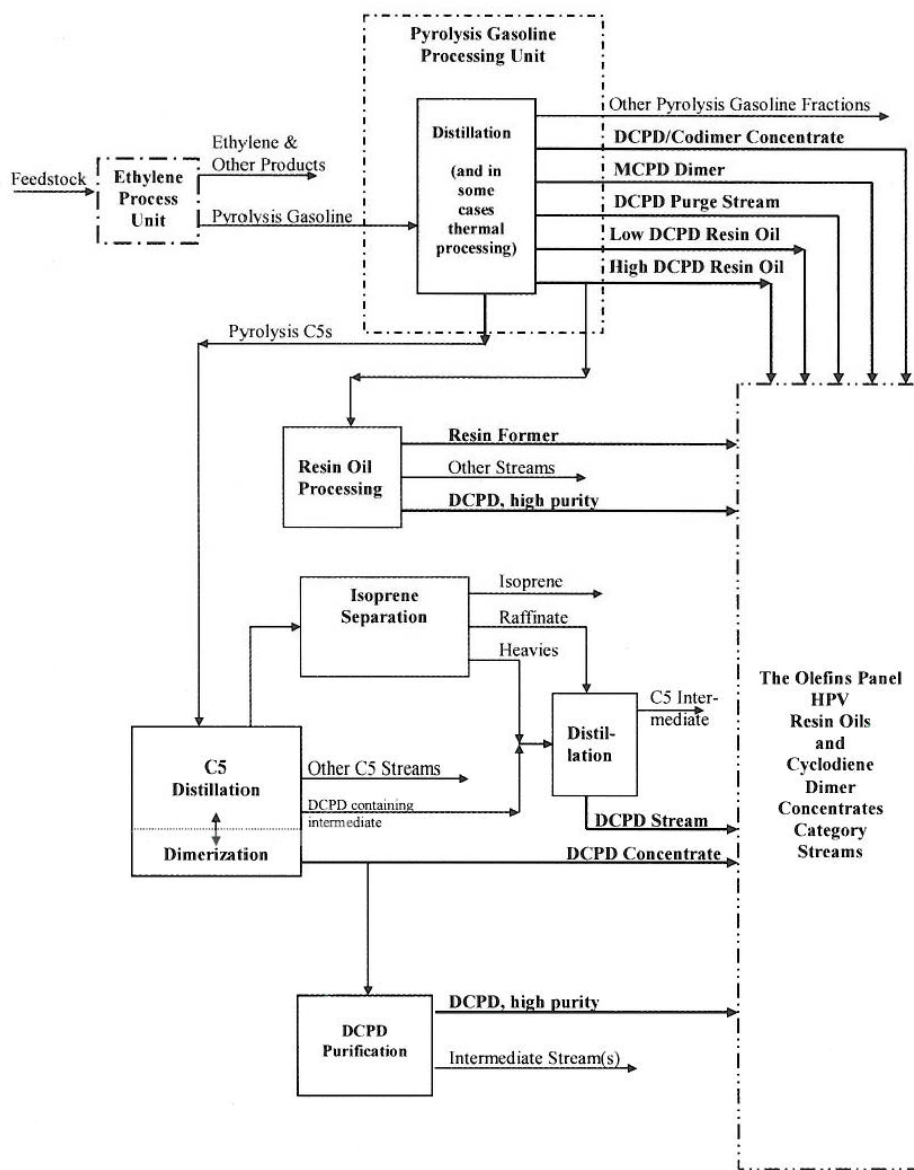


Figure 1. Chemical Process Operations Associated with process streams in the Resin Oils and Cyclodiene Dimer Concentrates Category.