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**HIGH PRODUCTION VOLUME (HPV)
CHEMICAL CHALLENGE PROGRAM**

TEST PLAN

For The

Resin Oils and CycloDiene Dimer Concentrates Category

Prepared by:

**American Chemistry Council
Olefins Panel
HPV Implementation Task Group**

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PLAIN ENGLISH SUMMARY

This category test plan addresses 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 category has been designated “Resin Oils and Cyclodiene Dimer Concentrates.” The defining substance in the category is the dicyclic alkene, dicyclopentadiene (DCPD). Based on processing and compositional differences, the streams are grouped into three subcategories: 1) High DCPD Resin Oils, 2) Low DCPD Resin Oils, and 3) Cyclodiene Dimer Concentrates. The streams that form this category are complex mixtures containing primarily C8 to C12 cycloalkenes and aromatic hydrocarbons.

Human Health Effects

DCPD, the defining substance of this category had been addressed under the OECD (Organization for Economic Cooperation and Development) SIDS (Screening Information Data Sets) program, and therefore has an established screening data set and hazard profile for human health and environmental effects and fate. DCPD process streams are expected to possess toxicity similar to DCPD and a limited but appropriate amount of testing is proposed to demonstrate this premise.

The strategy of this screening level test program for characterizing human health hazards of members of this category is to evaluate data for the key component (existing data for DCPD) and component families [existing and new data that will be generated by the Olefins Panel and by other groups as part of the EPA HPV (High Production Volume) Challenge, OECD SIDS, and ICCA (International Council of Chemical Associations) HPV programs]. In addition, three representative streams are proposed to be tested in this program. These data are expected to satisfy HPV program requirements for the substances included in this category.

The following health effects tests are proposed to be conducted by the American Chemistry Council Olefins Panel within this test plan:

- Bacterial genetic toxicity test, mouse genetic toxicity test, and rat repeated dose test for toxicity screening to the reproductive, developmental and nervous systems for the Resin Oils representative stream, Low DCPD Resin Oil.
- Bacterial genetic toxicity test, mouse genetic toxicity test, and rat repeated dose test for toxicity screening to the reproductive, developmental and nervous systems for the Cyclodiene Dimer Concentrates stream, DCPD/Codimer Concentrate.
- Bacterial genetic toxicity test, mouse genetic toxicity test, and rat repeated dose test for toxicity screening to the reproductive, developmental and nervous systems for the Cyclodiene Dimer Concentrates stream, Methylcyclopentadiene Dimer (MCPD Dimer).

Environmental Effects and Fate

The following environmental effect and fate tests, technical discussions, and computer modeling are proposed to be conducted or prepared by the Panel within this test plan:

- Resin Oils representative stream, Low DCPD Resin Oil - Fish acute toxicity test, invertebrate immobilization acute toxicity test, alga growth inhibition test, and manometric respirometry biodegradation test. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. Indirect photodegradation rates will be calculated for selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model are proposed for selected chemicals in this stream.
- Cyclodiene Dimer Concentrates representative stream, DCPD/Codimer Concentrate - Fish acute toxicity test, invertebrate immobilization acute toxicity test, alga growth inhibition test, and manometric respirometry biodegradation test. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. Indirect photodegradation rates will be calculated for selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model are proposed for selected chemicals in this stream.
- Cyclodiene Dimer Concentrates representative stream, MCPD Dimer - An alga growth inhibition test and a manometric respirometry biodegradation test. Additional aquatic toxicity testing will depend on the outcome of the alga study and may include a fish acute toxicity test and an invertebrate immobilization acute toxicity test. Technical discussions will be prepared on the potential of MCPD dimer to undergo hydrolysis and photolysis. The indirect photodegradation rate for MCPD dimer will be calculated. Fugacity calculations (chemical distribution) using a computer model are proposed for the MCPD Dimer.

Physicochemical Properties

The following physicochemical data are proposed to be developed by the Panel within this test plan for the Low DCPD Resin Oil and DCPD/Codimer Concentrate streams: Measured physicochemical data will be developed for the boiling point range, vapor pressure, and octanol-water partition coefficient (Kow) range endpoints. Calculated data are also proposed to be developed for these three endpoints, as well as melting point range and water solubility range. Measured and calculated physicochemical data for the MCPD dimer are proposed to be developed and will include: boiling point, vapor pressure, Kow, and water solubility. A calculated melting point is also proposed.

EXECUTIVE SUMMARY

The Olefins Panel (Panel) of the American Chemistry Council and the Panel's member companies hereby submit for review and public comment the test plan for the Resin Oils and Cyclodiene Dimer Concentrates Category under the Environmental Protection Agency's (EPA) High Production Volume (HPV) Chemical Challenge Program. It is the intent of the Panel and its member companies to make maximum possible use of existing data, in conjunction with new information and scientific judgment/analysis, to characterize the Screening Information Data Set (SIDS) human health, environmental fate and effects, and physicochemical endpoints for this category in satisfaction of HPV program requirements.

The category test plan addresses 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 containing primarily C8 to C12 cycloalkenes and aromatic hydrocarbons. The defining substance in the category is the dicyclic alkene, dicyclopentadiene (DCPD). Ten CAS numbers are used to describe the streams in this category. The category has been designated "Resin Oils and Cyclodiene Dimer Concentrates" and based on processing and compositional differences, the streams are grouped into three subcategories: 1) High DCPD Resin Oils, 2) Low DCPD Resin Oils, and 3) Cyclodiene Dimer Concentrates. All but two of the streams contain amounts of DCPD (> 1%). One of the streams, Low DCPD Resin Oils, contains insignificant DCPD content in the resin oil matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons. The other stream containing de minimis DCPD content is Methylcyclopentadiene Dimer (MCPD Dimer), a Cyclodiene Dimer Concentrates stream processed to maximize MCPD Dimer content.

DCPD, the defining substance of this category, is an OECD SIDS chemical with an established screening data set and hazard profile for human health and environmental effects and fate. DCPD process streams are expected to have toxicity properties similar to DCPD and will be tested to demonstrate this premise.

The streams that are proposed to be tested by the Panel are described below:

- **Low DCPD Resin Oil**: This is a low DCPD stream (typically <1%) comprised of the resin oil matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons and is representative of the Low DCPD Resins Oils.
- **DCPD/Codimer Concentrate**: This is a DCPD stream typically containing approximately 40% DCPD in addition to the non-resin oil matrix of comparable molecular weight codimers and is representative of the Cyclodiene Dimer Concentrates group of streams.
- **MCPD Dimer**: This is a MCPD Dimer stream typically containing 90% MCPD dimer. The majority of the remaining chemical constituents in this stream can include codimers and trimers of DCPD and MCPD.

Based upon existing information plus the newly to-be-developed data from this and other testing programs, scientifically-based characterizations of the streams in this category will be achieved.

Human Health Effects

The following health effects tests are proposed by the Panel within this test plan:

- Low DCPD Resin Oil: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).
- DCPD/Codimer Concentrate: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).
- MCPD Dimer: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/ neurotoxicity screen (OECD Guideline 422).

Based upon examination of stream compositions and existing toxicity data for C8 to C12 cycloalkenes and aromatic hydrocarbons, there is minimal likelihood for the appearance of unexpected or remarkable biological findings in testing of streams within this chemical class. Chemicals in this class have been evaluated as isolated components or components of mixed streams for CNS (central nervous system) depressant and anesthetic potencies, irritation properties, and aspiration hazards. Reviews of this literature appear in *Patty's Industrial Hygiene & Toxicology, Chapters 20 and 21, Volume IIB, 4th Edition (1994)*. Less information exists regarding the repeated exposure cumulative toxicity properties of these chemicals. DCPD, however, has been tested for repeated exposure toxicity and demonstrated to be moderately toxic with kidney toxicity consistently observed. The kidney toxicity, however, is hyaline droplet nephropathy, a condition commonly observed in male rats that receive hydrocarbon and other substances. Hyaline droplet nephropathy is not considered relevant to humans. Non-specific systemic effects (such as depression of body weight) and changes to the liver and other organs have also been observed in laboratory animals receiving high doses of DCPD.

The strategy of this screening level test plan for characterizing the human health hazards of the members of this category is to evaluate data for three representative streams and for the major component/component families (existing and new data that will be generated by the Olefins Panel and by other groups as part of the EPA HPV, OECD SIDS, and ICCA HPV programs). These data are expected to be sufficient to satisfy HPV requirements regarding the human health hazards of the substances included in this category.

Environmental Effects and Fate

The following environmental effect and fate tests, technical discussions, and computer modeling are proposed to be conducted or prepared by the Panel within this test plan:

- **Low DCPD Resin Oil**: A fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), and a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the Low DCPD Resin Oil stream. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include chemicals in this stream.
- **DCPD/Codimer Concentrate**: A fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), and a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the DCPD Concentrate stream. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include chemicals in this stream.
- **MCPD Dimer**: An alga growth inhibition test (OECD Guideline 201) and a manometric respirometry biodegradation test (OECD Guideline 301F). Additional aquatic toxicity testing will depend on the outcome of the alga study and may include a fish acute toxicity test (OECD Guideline 203) and an invertebrate immobilization acute toxicity test (OECD Guideline 202), an invertebrate reproduction test (OECD Guideline 211). Technical discussions will be prepared on the potential of MCPD dimer to undergo hydrolysis and photolysis. The indirect photodegradation rate for MCPD dimer will be calculated. Fugacity calculations (chemical distribution) using a computer model will be performed for the MCPD Dimer.

Read across aquatic toxicity data as well as limited data for a product in this category suggest that resin oil and cyclodiene dimer concentrate products have the potential to produce a moderate level of toxicity in freshwater algae and acute toxicity in freshwater fish and invertebrates. To confirm this assessment, the toxicity of three products from this category to three freshwater organisms will be determined by laboratory testing.

Limited biodegradation data for chemical components and complex products identified as read across data to the Resin Oils and Cyclodiene Dimer Concentrates Category suggest that products in this category have the potential to biodegrade to a significant extent. To confirm this assessment, the biodegradability of three products from this category will be determined. The chemical components in these products are relatively volatile, and if released they would be expected to partition to the air to a significant extent. In the air, they are subject to rapid physical degradation through hydroxyl radical attack. Therefore, as a result of both biological and physical degradation processes, these products are not expected to persist in the environment.

Information has not been developed on the potential of products in this category to photodegrade, hydrolyze, and partition within the environment. Therefore, information or data will be developed for these endpoints.

Physicochemical Properties

The following physicochemical data are proposed to be developed by the Panel within this test plan for the Low DCPD Resin Oil and DCPD/Codimer Concentrate streams: Measured physicochemical data will be developed for the boiling point range, vapor pressure, and octanol-water partition coefficient (Kow) range endpoints. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components. Measured and calculated physicochemical data for the MCPD dimer will be developed and will include: boiling point, vapor pressure, Kow, and water solubility. A calculated melting point will also be developed. Although there are data for selected physicochemical endpoints, a comprehensive and consensus database does not exist for the Resin Oils and Cyclodiene Dimer Concentrates Category. Therefore, data will be developed and/or identified to characterize the physicochemical endpoints in the HPV Chemical Program.

LIST OF MEMBER COMPANIES
THE OLEFINS PANEL

The Olefins Panel includes the following member companies:

ATOFINA Petrochemicals, Inc.*
BP Chemical Company *
Chevron Phillips Chemical Company LP
The Dow Chemical Company
E. I. du Pont de Nemours and Company*
Eastman Chemical Company*
Equistar Chemicals, LP
ExxonMobil Chemical Company
Formosa Plastics Corporation, U.S.A.*
The Goodyear Tire & Rubber Company
Huntsman Corporation*
Koch Industries*
NOVA Chemicals Inc.
Noveon, Inc.
Sasol North America, Inc.*
Shell Chemical Company
Sunoco, Inc.*
Texas Petrochemicals Corporation*
Westlake Chemical Corporation*
Williams Olefins, LLC*

* These companies are part of the Olefins Panel but do not produce streams in the Resin Oils and CycloDiene Dimer Concentrates Category.

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TEST PLAN FOR THE RESIN OILS AND CYCLODIENE DIMER CONCENTRATES CATEGORY

I. INTRODUCTION

The Olefins Panel (Panel) of the American Chemistry Council and the Panel's member companies have committed to develop screening level human health effects, environmental effects and fate, and physicochemical data for the Resin Oils and CycloDiene Dimer Concentrates Category under the Environmental Protection Agency's (EPA's) High Production Volume (HPV) Challenge Program (Program).

In preparing this test plan, the Panel has given careful consideration to the principles contained in the letter EPA sent to all HPV Challenge Program participants on October 14, 1999. As directed by EPA in that letter, the Panel has sought to maximize the use of scientifically appropriate categories of related chemicals and structure activity relationships. Additionally, and also as directed in EPA's letter, in analyzing the adequacy of existing data, the Panel has conducted a thoughtful, qualitative analysis rather than use a rote checklist approach. The Panel has taken the same thoughtful approach when developing its test plan. The Panel believes its test plan conforms to the principles articulated in EPA's letter.

This plan identifies ten CAS numbers (Table 1) used to describe nine process streams in the category, identifies existing data of adequate quality for substances included in the category, and outlines testing needed to develop screening level data for this category under the Program. This document also provides the testing rationale for the Resin Oils and CycloDiene Dimer Concentrates Category. The objective of this effort is to identify and develop sufficient test data and/or other information to characterize the human health and environmental effects and fate for the category in accordance with the EPA HPV Program. Physicochemical data that are requested in this program will be calculated as described in EPA guidance documents. In addition, measured data will be provided for selected products in this category when available.

II. DESCRIPTION OF THE RESIN OILS AND CYCLODIENE DIMER CONCENTRATES CATEGORY

A. The Category

Ten CAS numbers are used to describe streams in this category (Table 1). The ethylene industry produces two types of Resin Oil streams; one that is relatively low in DCPD, and a second that contains a higher level of the dimer. These Resin Oils, and six other streams that are concentrates of DCPD, Methylcyclopentadiene Dimer (MCPD Dimer) and codimers of these two cycloDienes with other hydrocarbons of similar molecular weight, are grouped for HPV testing purposes.

The CAS Numbers in the Resin Oils and CycloDiene Dimer Concentrates Category are associated with nine streams that are commercial products or isolated intermediates:

Stream (Industry Description)
High DCPD Resin Oils
(1) High DCPD Resin Oil
Low DCPD Resin Oils
(2) Low DCPD Resin Oil
(3) Resin Former
Cycloodiene Dimer Concentrates
(4) DCPD Concentrate
(5) DCPD, High Purity
(6) DCPD Purge Stream
(7) MCPD Dimer
(8) DCPD Stream
(9) DCPD/Codimer Concentrate

B. Process Stream Descriptions

(1)-(3) Resin Oils, High DCPD, Low DCPD and Resin Former: Resin oils are produced as a distillate from pyrolysis gasoline and usually have a carbon number distribution that is predominantly C8 to C10. The composition of the resin oils varies and this is most obvious with respect to DCPD content, which is typically about 55% for the "high DCPD" streams and less than 1% for the "low" DCPD streams. This variation in composition results from the ethylene process design and feedstock.

(1) High DCPD Resin Oils: This stream typically contains about 55% DCPD, and significant levels of vinyl aromatics and codimers 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 less than about 0.5%.

(2) Low DCPD Resin Oils: This stream consist of components that are similar to those found in the high DCPD stream (vinyl aromatics) with the exception that DCPD and the codimers are present only at very low level (typically <1% DCPD).

(3) Resin Former: A participant in the Panel's HPV program who processes resin oil streams from various ethylene units produces this stream. Resin Former is most similar to the Low DCPD stream, with typical DCPD content reported as about 6.7%.

(4) Dicyclopentadiene (DCPD) Concentrate: DCPD 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 codimers of cyclopentadiene with other C5 monomers. The stream typically contains relatively low levels of low boiling hydrocarbons (C5-C8).

(5) Dicyclopentadiene (DCPD), High purity: Dicyclopentadiene can be purified to about 95% by a combination of thermal and distillation unit operations. The main impurities remaining in the stream are codimers and trimers of cyclopentadiene.

- (6) Dicyclopentadiene (DCPD) Purge Stream: The DCPD Purge Stream results from the distillation process that separates the DCPD/Codimer Concentrate stream and the MCPD Dimer stream from the C8+ fraction of a thermally-processed pyrolysis gasoline. The DCPD Purge Steam typically contains 18% DCPD, with the balance largely codimers and C8 Aliphatics and aromatics.
- (7) Methylcyclopentadiene Dimer (MCPD Dimer): MCPD Dimer is isolated by distillation from the C8+ fraction of a thermally processed pyrolysis gasoline. Typical purity is 90% as the dimer and the main impurities in the stream are codimers and trimers of DCPD and MCPD.
- (8) DCPD Stream: This stream is produced as the bottoms from a distillation tower that is charged with a DCPD-containing 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.
- (9) DCPD/Codimer Concentrate: This stream is isolated by distillation from the C8+ fraction of a thermally processed pyrolysis gasoline. This stream typically contains about 40% DCPD with the balance primarily codimers of cyclopentadiene with piperylene, butadiene and methylcyclopentadiene.

III. TEST PLAN RATIONALE

A. Human Health Effects - Overview

The Resin Oils and Cyclodiene Dimer Concentrates Category consists of mixed hydrocarbon streams with a carbon number distribution that is predominantly C8 to C12. The predominant components are cycloalkenes and aromatic hydrocarbons.

DCPD (CAS No. 77-73-6) is a mid-range (C10) dicyclic alkene found at varying levels in many of the category streams. DCPD is an OECD (Organization for Economic Cooperation and Development) SIDS (Screening Information Data Sets) chemical with an established screening data set and hazard profile for human health and environmental effects (OECD, 1998). The toxicology of DCPD has been reviewed by Cavender (1994a) and ECETOC (1991) and a summary of this information follows. Details of key studies pertinent to the OECD SIDS health effects endpoints are provided in the robust summaries that accompany this test plan. The available health effects information indicates that DCPD is moderately toxic by relevant routes of exposure. Acute lethal oral doses in animal species are variable ranging from 0.19 g/kg in the mouse to approximately 1.2 g/kg in cattle. Lethal vapor concentrations are also variable, ranging, for 4-hour exposures, from 145 ppm for the mouse, to approximately 770 ppm for the guinea pig and rabbit. With substantially saturated vapor concentrations (2500 ppm), death ensued in rats within 60 minutes of exposure. Similar to other hydrocarbons, the predominant acute systemic effect is on the central nervous system; DCPD produces initial stimulation followed by prolonged depression. DCPD has a

disagreeable odor similar to camphor and has reportedly resulted in headaches in workers following prolonged exposure to low vapor concentrations. DCPD is also irritating when directly applied to the skin and eyes and may be an aspiration hazard.

Several studies have evaluated DCPD for repeated exposure effects. The most consistent effect at non-lethal doses was to the kidneys of male rats but some studies also found effects to the lung, liver, gastrointestinal tract, and adrenal gland. In feeding studies, DCPD given for up to 90 days to mice and rats did not result in treatment-related effects at nominal dietary concentrations up to 273 ppm or 750 ppm, respectively. Dogs in a similar study exhibited some evidence of gastro-intestinal disturbance at the highest dietary concentration (1,000 ppm nominal). In the most recent study conducted by gavage and according to OECD Guideline 422, daily exposure to 4, 20, or 100 mg/kg DCPD produced a variety of effects to male and female rats (JETOC, 1998). Two females (of ten) in that received 100 mg/kg died during treatment and (all) males and surviving females exhibited slight suppression of body weight gain and decreased feed consumption. Male rats of the high dose group demonstrated increase in liver enzymes, increased liver and kidney weight, and microscopic findings of single cell necrosis in the liver and hyaline droplets and renal tubular changes in the kidney. The kidney microscopic changes were also observed in the male rats that received 4 and 20 mg/kg DCPD. Both males and females in the 100 mg/kg group and males in the 20 mg/kg group also exhibited increase in fatty droplets in the adrenal glands. The no observed effect level doses for repeat dose toxicity for this study were considered to be 20 mg/kg/day for females and less than 4 mg/kg/day for males.

Repeated inhalation exposure of laboratory animals to DCPD vapor also produced kidney lesions in male rats of several studies. The kidney lesions described in these studies give the appearance of the male rat specific disease hyaline droplet nephropathy, a condition not considered relevant to humans. Lung lesions described as chronic pneumonia and bronchiectasis was reported in rats exposed to 35 and 74 ppm (Kinkead *et al.*, 1971); however in a second study (Bevan *et al.*, 1992), no lung lesions were observed in rats repeatedly exposed to 50 ppm DCPD.

DCPD is not selectively toxic to rodent reproduction or the developing embryo/fetus. In a reproductive/developmental toxicity screening study conducted by oral gavage (JETOC, 1998), no effects were noted on reproductive parameters at up to 100 mg/kg. This dose, however, was lethal to 2 (of 10) female rats and 2 rats of this group (presumably the same animals) lost 100% of their litters during lactation (days 1-4). A low viability index and tendency to lower birth weight and body weight gain were observed in neonates in the highest dose group. The no observed effect level doses for this study were 100 mg/kg/day for parental males and 20 mg/kg/day for parental females and offspring. The NTP evaluated the potential reproductive toxicity of orally (gavage) administered DCPD (10, 30, or 100 mg/kg) in rats using a continuous breeding protocol (Jamieson *et al.*, 1995). DCPD at 100 mg/kg produced lower pup weights, increased pup mortality, fewer pups born alive, and increased cumulative days to litter. In the 30 mg/kg group, only a slight (4%) reduction in the average female pup weight was observed. There were no reproductive effects observed in the 10 mg/kg group. Decreased (F2) pup weight in the 100 mg/kg group was noted in the

second generation litters. Epididymal sperm density, percent motility, percent abnormal sperm, spermatids per milligram of testis, and total spermatids per testis were not affected by the administration of DCPD at dose levels employed in this study. At the doses that yielded reproductive effects, parental animals exhibited effects on liver and kidney; hence the DCPD reproductive effects that were observed in this study were not considered by NTP to be selective. A 3-generation reproduction study of DCPD administered to rats in the diet at 80 and 750 ppm resulted in no deleterious effects on reproductive processes or general condition of the rats and no evidence of dose-related teratologic effect over three successive generations with two matings per generation (Hart, 1980).

Developmental toxicity range-finding studies were conducted by NTP in New Zealand White rabbits and Sprague-Dawley rats (Gulati *et al.*, 1993a,b). DCPD administered by gavage at 25, 100, 200, 300, or 400 mg/kg to rabbits caused maternal toxicity at 200 mg/kg and higher doses. Gross deformities were evident at 400 mg/kg but no other developmental endpoints were significantly affected. Rats were administered DCPD at 50, 200, 300, 400, and 500 mg/kg by gavage. Body weights were significantly decreased at two time points and for body weight gain throughout the treatment for rats in the 50 and 200 mg/kg groups. Clear maternal toxicity, including maternal death, was observed at 200 mg/kg and higher doses (3/7 in the 200 mg/kg group, 8/9 in the 300 mg/kg group, and all in the 400 and 500 mg/kg groups were found dead by gestation day 9). Developmental toxicity in the form of decreased fetal weight was observed in the 200 mg/kg group. In a rat teratology study there were no effects on pregnant dams from dietary administration of 80, 250, or 750 ppm DCPD and no compound-induced terata, variation in sex ratio, embryo toxicity or inhibition of fetal growth and development (Hart, 1980).

DCPD is not toxic to genetic mechanisms either in bacterial or mammalian systems. Tests for mutations and chromosomal effects have been negative for DCPD. DCPD has not been evaluated for carcinogenic effects.

The biological activity of DCPD is expected to be similar to that of other physicochemically similar C8 to C12 cycloalkenes. There is less information available, however, for other mono- and dicyclic alkenes and their substituted derivatives as these substances are of lesser commercial interest. The toxicology properties of cycloalkenes is reviewed by Cavender (1994a). The available information for C8 to C12 cycloalkenes indicate these hydrocarbons show similar acute toxicity profiles as DCPD in terms of lethal dosages and clinical signs dominated by CNS effects. The liquid cycloalkenes in this range are also considered aspiration hazards. These hydrocarbons exhibit irritation effects with some producing severe and corrosive effects to the skin (e.g. cyclooctadiene). Some members are also skin sensitizers. There is very limited reliable information available on the toxic effects of C8 to C12 cycloalkenes following repeated exposure. A few studies have been conducted on limonene (a C10 cycloalkene that occurs in the oil of many plants). Decreases in body weight and non-specific systemic effects were noted in mice and dogs that received oral doses of limonene for up to 1 to 6 months. In male rats, limonene resulted in formation of hyaline droplets in the kidneys, a similar finding with DCPD. A short term (9 day) repeated inhalation exposure study has been conducted in the rat and mouse for

methylcyclopentadiene dimer (MCPD dimer), a C12 dicyclic alkene (Dodd and Longo, 1982). As with DCPD, MCPD dimer was found to target the rat kidney and there was some indication of effects to the liver. In the mouse, kidney effects were not observed; however, MCPD dimer did affect red blood cell indices as indicated by an approximately 10% decrease in erythrocyte count, hemoglobin concentration and hematocrit at the highest dose studied (400 ppm), and there was some indication of effects to the liver. Limitations, however, on the exposure duration and experimental design features of this study preclude drawing definitive interpretations with regards to the repeated exposure toxicity profile of MCPD dimer.

The C8 to C12 aromatic hydrocarbons in general show qualitatively similar toxicological properties as the C8 to C12 cycloalkenes (Cavender, 1994a,b). There are quantitative differences, however, between these hydrocarbons with the cycloalkenes producing greater toxicity at comparable dosages. The available information for solvents that are mixtures of C8 to C12 aromatic hydrocarbons indicate in general that this range of aromatic hydrocarbons are: of low to moderate acute toxicity producing transient CNS effects at high doses, of low repeated exposure systemic toxicity, not genotoxic, and not selectively toxic to the developing fetus, embryo, or reproductive system. The specific assessment of the available toxicology information for the C8 to C12 aromatic hydrocarbons is to be included in the International Hydrocarbon Solvents Consortium C9 Aromatic Hydrocarbon Solvents and C10+ Aromatic Hydrocarbon Solvents categories and will not be discussed more specifically in this test plan.

In addition to the existing information on DCPD as the dominant and or representative cycloalkene and on C8 to C12 aromatic hydrocarbons, there is also some limited information available on streams that consist of both kinds of hydrocarbons. And as expected, the toxicological properties of the streams are not dissimilar to that of this range of cycloalkenes and aromatic hydrocarbons. Resin-Former Feedstock, a test sample that consisted of 50-60% DCPD, 15-20% cyclopentadiene/methyl cyclopentadiene dimer, < 2% butadiene dimer, 10-12% styrene, < 2% xylene, and < 2% cyclopentadiene, exhibited low acute toxicity with CNS effects presented (Rausina, 1983; Gordon, 1983a). In addition, the stream was shown to possess low to moderate toxicity following repeated exposure with evidence of CNS (likely acute), liver and kidney (hydrocarbon nephropathy) effects, and generally an absence of genotoxic effects including an *in vivo* mouse micronucleus test (Rausina, 1984; Gordon, 1983b; Papciak and Goode, 1984; Brecher and Goode, 1984; Khan and Goode, 1984). The stream did exhibit positive activity in one *in vitro* system, a test of cell transformation in mouse embryo cells (Brecher and Goode, 1983). Details on these studies are provided in The Resin Oils and Cycloodiene Dimer Concentrates Category robust summaries. The Resin-Former Feedstock is believed to be representative of the High DCPD Resin Oil Stream.

One of the category streams, the DCPD Stream, in addition to containing approximately 50% DCPD, also contains a significant fraction of lighter hydrocarbons, primarily C5 olefins and paraffins. There is existing toxicology information for these substances and an assessment is planned for C5 mixed streams in support of the C5 Non-Cyclics Category that is also

sponsored by the Olefins Panel (A complete list of test categories sponsored by the Olefins Panel is provided in Table 9).

The expectation, therefore, is for the Resin Oils and Cyclodiene Dimer Concentrates Category of streams to have similar biological activity as demonstrated by DCPD and other physicochemically-similar carbon range cycloalkenes and aromatic hydrocarbons. Thus, the strategy of this screening level test plan for characterizing the human health hazards of this category include development and evaluation of data for DCPD and representative streams. These data are expected to be sufficient to satisfy the HPV requirements regarding the toxicity of all substances included in this category.

The details of the strategy are as follows:

1. Evaluation of existing data and new data resulting from other testing programs will be conducted for components or component families present in significant amounts in the streams of the Resin Oils and Cyclodiene Dimer Concentrates Category derived from:
 - a. Existing data: See Table 3.
 - b. DCPD: OECD SIDS.
 - c. C8 to C12 aromatic hydrocarbons: Included in the International Hydrocarbon Solvents Consortium C9 Aromatic Hydrocarbon Solvents and C10+ Aromatic Hydrocarbon Solvents categories to be addressed in OECD SIDS (ICCA).
 - d. Mixture of C5 olefins and paraffinic hydrocarbons: Included in the Olefins Panel C5 Non-Cyclics Category submitted November 2001.
2. To supplement the above data from other testing programs, testing is proposed for three representative streams taken from the two major category stream processes.

One type of stream in the category is a C8-C12 hydrocarbon fraction that is distilled from pyrolysis gasoline. Streams of this type are either low in DCPD content (Low DCPD Resin Oil), or high in DCPD content (High DCPD Resin Oil). These streams contain DCPD in concentrations ranging from less than 1% to about 70% and have the background matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons.

The second types of streams are the cyclodiene dimer concentrates (Cyclodiene Dimer Concentrates). In one processing arrangement for isolating these concentrates, a C5 fraction is distilled from pyrolysis gasoline, dimerized and then redistilled to produce a DCPD concentrate. In alternate processing, pyrolysis gasoline is distilled to isolate two other cyclodiene dimer streams, a) DCPD/Codimers Concentrate, and 2) the MCPD Dimer stream. In these DCPD-containing streams, DCPD is in a mixture with codimers of comparable molecular weight.

To bracket the two processes and the overall category of streams, testing is proposed

on three representative streams: 1) a high C8 to C12 resin oil matrix stream with low levels of DCPD (Low DCPD Resin Oil), 2) a representative stream from the dimer, non-resin oil matrix cyclodiene dimer concentrates process with DCPD and comparable molecular weight codimers (DCPD/Codimer Concentrate), and 3) a stream from the dimer, non-resin oil matrix cyclodiene dimer concentrates process high in MCPD Dimer. The toxicity findings from the testing of these streams and the existing information on DCPD are expected to characterize the expected toxicity properties of the High DCPD Resin Oils group of streams, which will not be tested, and the Resin Oils and Cyclodiene Dimer Category as a whole.

The specific testing proposed for the two streams follow:

a. Low DCPD Resin Oil

This stream is proposed to be tested to assess the toxicity of resin oil streams with a low (typically < 1%) DCPD content. This stream will be high in C8 to C12 cycloalkenes and aromatic hydrocarbon components. The stream will be tested as derived from the production facility, and not as a prepared mixture. The exact composition of the tested stream will be determined analytically at the time of testing. The proposed testing is a full SIDS human health test battery (except for acute toxicity which is not deemed informative for the HPV program). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

b. DCPD/Codimer Concentrate

A DCPD/Codimer Concentrate stream is proposed to be tested to assess the toxicity of a non-resin oil matrix stream with a mid-range content of DCPD (typically 40%) and comparable molecular weight codimers. The stream will be tested as derived from the production facility, and not as a prepared mixture. The exact composition of the tested stream will be determined analytically at the time of testing. The proposed testing is a full SIDS human health test battery (except for acute toxicity which is not deemed informative for the HPV program). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

c. MCPD Dimer

MCPD Dimer is proposed to be tested to assess the toxicity of a high purity C12 cycloalkene dimer. The stream will be tested as derived from the production facility, and not as a prepared mixture. The exact composition of the tested stream will be determined

analytically at the time of testing. The proposed testing is a full SIDS human health test battery (except for acute toxicity which is not deemed informative for the HPV program). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

The three streams are proposed for testing by the oral route of exposure. The most relevant routes of potential exposure to Resin Oils and Cyclodiene Dimer Concentrate Category streams are by inhalation and skin contact, but given the low volatility of the streams and variable dermal penetration rates of the stream components, these routes may not adequately characterize the streams' hazard potential. In addition, for DCPD SIDS testing, the oral route of exposure was utilized for the reproductive/developmental toxicity screening study; hence use of this same exposure route for the stream testing will provide for consistency in data interpretation.

The recommended testing together with existing data, data for components and component family under development by the Panel for other categories under the HPV program, by other HPV consortia, and by the OECD program, are expected to provide data to satisfy the HPV program requirements for the related hydrocarbon substances included in this category. This position is supported by the fact that previous testing and human experience with the category's major component, component families, and streams demonstrate a lack of biological activity that is outside of the range of typical hydrocarbon effects.

B. Human Health Effects - Stream Specific Rationales

The rationale for the test plan strategy specific to each stream in the Resin Oils and Cyclodiene Dimer Concentrates Category are presented below:

1. High DCPD Resin Oils

These streams are similar to the Low DCPD Resin Oil streams with the exception of the presence of high amounts of DCPD (range from 40-70%). Assessment of these streams is to be provided by the existing data for DCPD and the testing results of the Low DCPD Resin Oil stream. No additional testing of a stream from this group is proposed.

2. Low DCPD Resin Oils

A stream from this group is proposed to be tested in a complete SIDS battery of human health tests (except for acute toxicity) to assess the toxicity of resin oil streams with a very low (< 1%) DCPD content and significant amounts of C8 to C12 cyclodiene and aromatic hydrocarbons. Testing this stream will allow an assessment of 1) the impact of a very low level of DCPD on the toxicity of resin oil streams, 2) the hazards of a subset of the other components when the influence of DCPD is reduced or eliminated, and 3) the hazards of the High DCPD Resin Oils streams when this stream information is evaluated with the existing information for (pure) DCPD.

3. Resin Former

Resin Former streams are generally similar to the Low DCPD Resin Oil stream except for containing low levels of DCPD. The typical stream content of DCPD is about 7%. With this minimal composition of DCPD, the toxicity of the Resin Former streams are expected to be characterized by the testing results of the Low DCPD Resin Oil stream. No HPV testing of a stream from this group is proposed.

4. DCPD Concentrate

The DCPD Concentrate streams contain a high content of DCPD (typically 75% with range from 70 to 90%) in the non-resin oil matrix of comparable molecular weight cycloalkene dimers and smaller amounts of lighter, < C8, cycloalkenes, alkenes, aliphatic, and aromatic hydrocarbons. Assessment of these streams is to be provided by the existing data for DCPD. No additional testing of a stream from this group is proposed.

5. DCPD, High purity

The DCPD, High purity stream is similar, if not equivalent, to the DCPD assessed in the OECD SIDS program. With respect to the HPV program endpoints, the human health toxicity profile of this stream is expected to be the same as that of the OECD SIDS assessment for DCPD. No additional HPV testing of a stream from this group is proposed.

6. DCPD Purge Stream

This stream is a concentrates process stream with a mid-level of DCPD (average 18%) and amounts of comparable molecular weight codimers. With the lower composition of DCPD, the toxicity of the DCPD Purge Stream is expected to be conservatively characterized by the testing results of the DCPD/Codimer Concentrates stream (average 40% DCPD). Similar to the resin oils, this stream also contains a low amount (about 10%) of C8 aliphatics and aromatics; however, at these levels their potential impact on toxicity is considered minimal. No additional HPV testing of a stream from this group is proposed.

7. MCPD Dimer

The MCPD Dimer stream is a concentrate process stream with typical purity of 90% for MCPD Dimer. MCPD Dimer is also present at low levels in several of the resin oils and cyclo diene dimer concentrates streams. A MCPD Dimer stream is proposed to be tested in a complete SIDS battery of human health tests (except for acute toxicity). Testing this stream will allow an assessment of 1) the hazards of MCPD Dimer due to its high purity in the stream, 2) the comparative hazards of MCPD Dimer to DCPD for the overall assessment of C8 to C12 cycloalkenes, and 3) the hazards of other category streams (e.g., Resin Former, High DCPD Resin Oil, DCPD Purge Stream, and DCPD/Codimer Concentrate) that contain an amount of MCPD Dimer.

8. DCPD Stream

This stream typically contains about 50% DCPD and the remaining lighter hydrocarbons, primarily C5 olefins and paraffins. There is existing toxicology information for these substances and also an assessment planned for C5 mixed streams in support of the C5 Non-Cyclics Category also sponsored by the Panel. The toxicity of the DCPD Stream therefore can be characterized through the existing and new data from DCPD, the DCPD/Codimer Concentrates stream, and the C5 Non-Cyclics Category. No additional testing of this stream is proposed at this time.

9. DCPD/Codimer Concentrate

A stream from this group is proposed to be tested in a complete SIDS battery of human health tests (except for acute toxicity) to assess toxicity of the Cyclodiene Dimer Concentrates streams. The DCPD/Codimer Concentrate stream typically contains about 40% DCPD and the remaining components are predominantly codimers of cyclopentadiene with methylcyclopentadiene, piperylene and butadiene. MCPD dimer is also present at about 10%. The components of this stream are essentially the same as the dimers and codimers found in the High DCPD Resin Oils, but with the ratio of the concentrations of codimers to DCPD much higher. Testing this stream will allow an assessment of: 1) the impact of DCPD in the non-resin oil matrix on the toxicity of Cyclodiene Dimer Concentrates streams, 2) the hazards of Cyclodiene Dimer Concentrates streams when this stream information is evaluated with the existing information for (pure) DCPD, and 3) the hazards of Cyclodiene Dimer Concentrates streams that contain a significant amount of codimers.

C. Physicochemical Properties

The physicochemical (PC) endpoints in the HPV Chemical Program include:

- Melting Point
- Boiling Point
- Vapor Pressure
- Water Solubility
- Octanol/Water Partition Coefficient (K_{ow})

Although some of these data for product streams in the Resin Oils and Cyclodiene Dimer Concentrates Category exist, not all of these endpoints are defined, and a comprehensive and consensus database for chemicals that represent product streams in this category does not exist. Therefore, calculated PC data for selected component chemicals in this category will be developed using a computer model to provide a consistent, representative data set. In addition, selected physicochemical data will be developed for three products, a Low DCPD Resin Oil product, a Dicyclopentadiene (DCPD)/Codimer Concentrate product, and a MCPD Dimer product.

Calculated PC data for selected component chemicals in the Resin Oils and Cyclodiene Dimer Concentrates Category will be developed using the EPIWIN© computer model (EPIWIN, 1999) as discussed in the US EPA document entitled *The Use of Structure-Activity Relationships (SAR) in the High Production Volume Chemicals Challenge Program* (EPA, 1999a). The use of computer modeling for the development of these data is justified since components of the streams in this category are all chemically related and are expected to exhibit relatively similar environmental properties. In addition, for all the chemicals selected to represent products in this category, a calculated dataset provides a common method in the development of these values.

Boiling point, melting point, and vapor pressure ranges will be determined using the MPBPVP subroutine in EPIWIN. K_{ow} and water solubility will be calculated using KOWIN and WSKOW subroutines, respectively. There is more information on calculating data for the HPV chemical program in the EPA document titled, *The Use of Structure-Activity Relationships (SAR) in the High Production Volume Chemicals Challenge Program*.

Because the HPV substances covered under the Resin Oils and Cyclodiene Dimer Concentrates Category testing plan are mixtures containing differing compositions, it is not possible to develop or calculate a single numerical value for each of the physicochemical properties. For example, a product that is a mixture of chemicals does not have a melting point, but rather a melting range. Calculated values for physicochemical properties will be represented as a range of values according to the product's component composition and based on the results of computer modeling.

Robust summaries characterizing the PC endpoints will be prepared upon completion of the proposed testing, and will include the calculated data and testing results.

D. Ecotoxicity

The aquatic toxicity endpoints for the HPV Chemical Program include:

- Acute Toxicity to a Freshwater Fish
- Acute Toxicity to a Freshwater Invertebrate
- Toxicity to a Freshwater Alga

Acute fish toxicity data are available for a product in the Resin Oils and Cyclodiene Dimer Concentrates Category. There are no invertebrate or alga toxicity data available for products in this category. However, there are read across data to initially characterize these two endpoints for chemicals found in products from this category and complex products that contain chemicals found in products from this category. The use of data from selected read across materials to products in this category can be justified for the following reasons:

- Individual chemicals and complex products used for read across purposes contain a chemical class or combinations of chemical classes (i.e., olefins, and aromatics) that are found in products from this category.

- Individual chemicals and complex products used for read across purposes have a carbon number or carbon number range that falls within the range of carbon numbers found in products from this category.
- Individual chemicals and complex products used for read across purposes as well as the products in this category are composed of chemicals that all act by a similar mode of toxic action.

The data in Table 4 compare the range of product compositions (i.e., carbon number, chemical class, weight percent) in the Resin Oils and Cyclodiene Dimer Concentrates Category to products that will be used to initially characterize the aquatic toxicity of this category. This comparison illustrates the similarity in carbon number ranges between products in this category and the selected products with read across data. The data in Tables 5, 6, and 7 establish the range of toxicity that products in this category would be expected to demonstrate, based on the read across data.

The aquatic toxicity data presented in this test plan fall within a narrow range of values regardless of their varying chemical class content and carbon number range. This is not unexpected, because the constituent chemicals of products in this category are neutral organic hydrocarbons whose toxic mode of action is non-polar narcosis. The mechanism of short-term toxicity for these chemicals is disruption of biological membrane function (Van Wezel and Opperhuizen, 1995), and the differences between measured toxicities (i.e., LC/LL50, EC/EL50) can be explained by the differences between the target tissue-partitioning behavior of the individual chemicals (Verbruggen *et al.*, 2000).

The existing fish toxicity database for narcotic chemicals supports a critical body residue (CBR, the internal concentration that causes mortality) of between approximately 2-8 mmol/kg fish (wet weight) (McCarty and Mackay, 1993; McCarty *et al.*, 1991), supporting the assessment that these chemicals have comparable potencies. When normalized to lipid content, the CBR is approximately 50 umol of hydrocarbon/g of lipid for most organisms (Di Toro *et al.*, 2000). Because the products in this category are all complex mixtures containing relatively similar series of homologous chemicals, their short-term toxicities are expected to fall within the range of toxicity demonstrated by the individual chemicals, as well as comparable products summarized in this test plan. Therefore, the existing data are believed to form a sufficiently robust dataset to initially characterize the aquatic toxicity endpoints in the HPV Chemical Program for this category.

The fish and invertebrate acute and alga toxicity values for individual chemicals and products that are complex mixtures of chemicals [used as read across data to products in this category (Tables 5, 6, 7), as well as a product from this category] fall within a range of 1.0-21.3 mg/L. Because the products in the Resin Oils and Cyclodiene Dimer Concentrates Category will range in alkene and/or aromatic carbon number content within approximately C8 to C12, a range in toxicity for products in this category is expected to be comparable to the range of data summarized in Tables 5, 6, and 7.

As suggested by the experimental data, this category is expected to exhibit a moderate range of acute toxicity to fish and invertebrates, and a moderate range of toxicity to algae. For

representative chemicals, complex products, and one category product, acute fish toxicity values range between 2.6 and 18.0 mg/L for four species (Table 5). For representative chemicals and complex products, acute invertebrate toxicity values range between 1.0 and 21.3 mg/L for one species (Table 6). For representative complex products, alga toxicity values range between 1 and 3 mg/L (for biomass and growth rate endpoints) for one species, while the alga NOELR values were 1.0 mg/L (for biomass and growth rate endpoints) (Table 7).

To confirm that products from the streams in this category will exhibit a range of toxicity equivalent to the acute fish and invertebrate, and alga toxicity results in Tables 5, 6, and 7, data for these endpoints will be developed for three products:

- a Low DCPD Resin Oil product that contains a lower level of DCPD
- a DCPD/Codimer Concentrate product that contains a mid level of DCPD and comparable molecular weight codimers
- a MCPD Dimer (methylcyclopentadiene dimer) product that contains approximately 90% MCPD Dimer

The DCPD/Codimer Concentrate and Low DCPD Resin Oil products will contain mid range and low concentrations of DCPD, respectively. The remaining chemical constituents for these two products will vary in composition, but can include a selection of chemicals listed in Table 2. The majority of chemicals in these products will have carbon numbers in the range of eight to ten. It is anticipated that the aquatic toxicity of these two products will be similar because, as discussed above, all the component chemicals act by the same mode of action and have equivalent potencies.

The MCPD Dimer stream was selected because unlike most other products in this category, it is a relatively pure product and represents the highest molecular weight compounds in the range of chemical carbon numbers found in this category. As such, it is projected to have the highest Kow (octanol-water partition coefficient) value of the predominant chemicals in this category, and may demonstrate a high level of aquatic toxicity for the endpoints in the HPV Chemicals program. However, it is calculated to have relatively low water solubility, and because of possible water solubility limitations, it may not produce effects in the three aquatic test species. Therefore, proposed testing for this product will follow a tiered approach as follows:

- The first test will be the alga toxicity test.
- If MCPD Dimer demonstrates toxicity to an alga, an acute invertebrate test will be conducted.
- If MCPD Dimer demonstrates toxicity to an invertebrate, an acute fish test will be conducted.
- If MCPD Dimer does not demonstrate toxicity to an alga, the acute fish and invertebrate tests will not be conducted because it is highly unlikely that MCPD Dimer will cause acute effects to these organisms.

The fish and invertebrate acute and alga toxicity tests will follow OECD Guidelines 203, 202, and 201, respectively. When appropriate, the test procedures will also apply the OECD guidance for testing complex substances as described in *Guidance Document on Aquatic Toxicity Testing of Difficult Substances and Mixtures* (OECD, 1999).

E. Environmental Fate

The environmental fate endpoints in the HPV Chemical Program include:

- Biodegradation
- Photodegradation
- Hydrolysis
- Fugacity

Although biodegradation data are not available for products in the Resin Oils and Cyclodiene Dimer Concentrates Category, there are data for selected component chemicals of those products, as well as for complex products, that can be used to initially characterize the potential biodegradability of this category. The complex product values are for substances composed of a range of chemicals with regard to carbon numbers and chemical classes (i.e., alkenes, alkylbenzenes, and naphthalenes). As suggested by the experimental data, products in this category are expected to exhibit a significant extent of biodegradation. To confirm and characterize the potential of products in this category to biodegrade, three products will be tested.

Data and/or information in the form of a technical discussion will be provided for photodegradation. Chemicals in this category are not subject to hydrolysis at measurable rates, therefore information for this endpoint will be summarized in a technical review document.

Equilibrium models are used to calculate chemical fugacity, which can provide information on where a chemical is likely to partition in the environment. These data are useful in identifying environmental compartments that could potentially receive a released chemical. Fugacity data can only be calculated for individual chemicals. For the HPV Chemical Program, environmental partitioning data will be developed for selected component chemicals of the products in this category.

A preliminary evaluation of chemicals in the Resin Oils and Cyclodiene Dimer Concentrates Category suggests that they will partition largely to the air and soil, and therefore their fate in these compartments is of environmental interest. Because the air phase may be a compartment that could potentially receive many of the component chemicals in this category, data characterizing their potential for physical degradation in the atmosphere will be developed (this is discussed below under photodegradation).

1. Biodegradation

Data for constituent chemicals of products in this category and for complex products suggest that resin oil and cyclodiene dimer concentrate products have the potential to biodegrade to a significant extent (Table 8). The complex products contain chemicals that can be found in products from this category. The carbon number of products in the Resin Oils and Cyclodiene Dimer Concentrates Category ranges primarily between C8 to C12. Single chemicals and complex products with chemicals that have carbon numbers in this range and are contained by products in this category have been shown to biodegrade from 29 to 100% after 14 or 28 days.

The data from the majority of studies in Table 8 were developed using a manometric respirometry test procedure (OECD guideline 301F). This procedure uses continuously stirred, closed systems, which is recommended when assessing the potential biodegradability of chemically complex, poorly water soluble, and volatile materials like those in this category. Stirring is recommended when evaluating products containing several chemicals, some of which may have limited water solubility.

A predominant chemical component for several products in this category is dicyclopentadiene (DCPD). Therefore, the potential biodegradability of this chemical will largely influence the relative biodegradability of several products in this category. Because there are no reliable data for this component and because it can be a significant component in products from this category, evaluating two products containing DCPD will provide sufficient data to characterize the biodegradability of products in this category that contain DCPD.

To fully characterize the potential biodegradability of products in this category, the Panel proposes to test three products, a DCPD/Codimer Concentrate product that contains a mid level of DCPD and comparable molecular weight codimers, a Low DCPD Resin Oil product that contains a lower level of DCPD, and a MCPD Dimer product. The testing procedure for these products will follow the OECD Guideline 301F, Manometric Respirometry Biodegradation Test. The data from the proposed testing will be compared to the data discussed above to confirm that products in this category are as readily biodegraded as suggested by those data.

2. Photodegradation – Photolysis

Direct photochemical degradation occurs through the absorbance of solar radiation by a chemical substance. If the absorbed energy is high enough, then the resultant excited state of the chemical may lead to its transformation. Simple chemical structures can be examined to determine whether a chemical has the potential for direct photolysis in water. First order reaction rates can be calculated for some chemicals that have a potential for direct photolysis using the procedures of Zepp and Cline (1977).

To develop information or data that will characterize the potential of products in this category to undergo direct photochemical degradation, the existing product chemical

composition data and composition data that will be developed for the three products identified for biodegradation testing will be evaluated together to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. The UV light absorption of the selected chemicals will then be evaluated to identify those chemicals with a potential to degrade in solution. When possible, first order reaction rates will be calculated for those chemicals identified to have a potential for direct photolysis in water. The results of the calculations will be summarized in a technical discussion for this endpoint. If instead, a low potential for direct photolysis is suggested by the evaluation, a technical discussion will be prepared to summarize the findings.

3. Photodegradation – Atmospheric Oxidation

Photodegradation can be measured (the US EPA identifies OECD test guideline 113 as a test method) (EPA, 1999b) or estimated using models accepted by the US EPA (EPA, 1999a). An estimation method accepted by the US EPA includes the calculation of atmospheric oxidation potential (AOP). Atmospheric oxidation as a result of hydroxyl radical attack is not direct photochemical degradation, but rather indirect degradation. AOPs can be calculated using a computer model. Hydrocarbons, such as those in the Resin Oils and Cyclodiene Dimer Concentrates Category, have the potential to volatilize to air where they can react with hydroxyl radicals (OH⁻).

The computer program AOPWIN (atmospheric oxidation program for Microsoft Windows) (EPIWIN, 1999) is used by the US EPA OPPTS (Office of Pollution Prevention and Toxic Substances). This program calculates a chemical half-life based on an overall OH⁻ reaction rate constant, a 12-hr day, and a given OH⁻ concentration. This calculation will be performed for representative component chemicals of products in the Resin Oils and Cyclodiene Dimer Concentrates Category. The existing product chemical composition data and composition data that will be developed for the three products identified for biodegradation testing will be evaluated together to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. The resulting calculations will be summarized in a robust summary for this endpoint.

4. Hydrolysis

Hydrolysis of an organic chemical is the transformation process in which a water molecule or hydroxide ion reacts to form a new carbon-oxygen bond. Chemicals that have a potential to hydrolyze include alkyl halides, amides, carbamates, carboxylic acid esters and lactones, epoxides, phosphate esters, and sulfonic acid esters (Neely, 1985).

Chemical stability in water can be measured (EPA identifies OECD test guideline 111 as a test method) or estimated using models accepted by the EPA (EPA, 1999a). An estimation method accepted by the EPA includes a model that can calculate hydrolysis rate constants for esters, carbamates, epoxides, halomethanes, and selected alkylhalides. The computer program HYDROWIN (aqueous hydrolysis rate program for Microsoft windows) (EPIWIN,

1999) is used for this purpose by OPPTS. However, all of the chemical structures included in the Resin Oils and Cyclo diene Dimer Concentrates Category are hydrocarbons. That is, they consist entirely of carbon and hydrogen. As such they are not expected to hydrolyze at a measurable rate.

A technical document will be prepared that discusses the potential hydrolysis rates of chemicals in this category, the nature of the chemical bonds present, and the potential reactivity of this class of chemicals with water.

5. Chemical Transport and Distribution in the Environment - Fugacity Modeling

Fugacity based multimedia modeling can provide basic information on the relative distribution of chemicals between selected environmental compartments (i.e., air, soil, sediment, suspended sediment, water, biota). The U.S. EPA has acknowledged that computer modeling techniques are an appropriate approach to estimating chemical partitioning (fugacity is a calculated endpoint and is not measured). A widely used fugacity model is the EQC (Equilibrium Criterion) model (Mackay *et al.*, 1996). The U.S. EPA cites the use of this model in its document titled *Determining the Adequacy of Existing Data* (EPA, 1999b), which was prepared as guidance for the HPV Program.

In its document, the U.S. EPA states that it accepts Level I fugacity data as an estimate of chemical distribution values. The input data required to run a Level I model include basic physicochemical parameters; distribution is calculated as percent of chemical partitioned to 6 compartments described above within a defined unit world. Level I data are basic partitioning data that allow for comparisons between chemicals and indicate the compartment(s) to which a chemical is likely to partition.

The EQC Level I is a steady state, equilibrium model that utilizes the input of basic chemical properties including molecular weight, melting point, vapor pressure, and water solubility to calculate distribution within a unit world. This model will be used to calculate distribution values for representative component chemicals in products from this category. Existing product chemical composition data and composition data that will be developed for the three products identified for biodegradation testing will be evaluated together to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. A computer model, EPIWIN version 3.04 (EPIWIN, 1999), will be used to calculate the physicochemical properties needed to run the Level I EQC model. The resulting calculations will be summarized in a robust summary for this endpoint.

IV. TEST PLAN SUMMARY

The following evaluations, testing, modeling, and technical discussions are proposed for the Resin Oils and Cyclo diene Dimer Concentrates Category (Table 3) as follows:

- Conduct tests for SIDS human health and environmental fate and effects endpoints (except acute toxicity) on Low DCPD Resin Oil, a stream typically containing less than 1% DCPD content in the resin oil matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons (exact composition to be determined at the time of testing). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422), a fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the Low DCPD Resin Oil stream.

A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include selected chemicals in this stream. Measured physicochemical data specifically for a product in this stream will be developed and will include boiling point range, vapor pressure, and octanol-water partition coefficient range. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components.

- Conduct tests for SIDS human health and environmental fate and effect endpoints (except acute toxicity) on DCPD/Codimer Concentrate, a stream typically containing approximately 40% DCPD and the remainder codimers of cyclopentadiene with MCPD, piperylene, and butadiene (exact composition to be determined at the time of testing). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422), a fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the DCPD Concentrate stream.

A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated

for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category will include selected chemicals in this stream. Measured physicochemical data specifically for a product in this stream will be developed and will include boiling point range, vapor pressure, and octanol-water partition coefficient range. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components.

- Conduct tests for SIDS human health endpoints (except acute toxicity) on MCPD Dimer, a stream with high purity (typically 90%) MCPD Dimer (exact composition to be determined at the time of testing). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), and a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

For environmental fate and effects endpoints, the following tests are proposed for MCPD Dimer: An alga growth inhibition test (OECD Guideline 201) and a manometric respirometry biodegradation test (OECD Guideline 301F). Additional aquatic toxicity testing will depend on the outcome of the alga study and may include a fish acute toxicity test (OECD Guideline 203) and/or an invertebrate immobilization acute toxicity test (OECD Guideline 202).

A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the MCPD Dimer stream. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include chemicals in this stream. Measured physicochemical data specifically for a product in this stream will be developed and will include boiling point range, vapor pressure, and octanol-water partition coefficient range. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components.

- Evaluate all data for human health and environmental fate and effects endpoints obtained from testing in this program for the Low DCPD Resin Oil stream, DCPD/Codimer Concentrate stream, and MCPD Dimer stream, along with existing and new data for components and streams generated in other testing programs and prepare a technical discussion in terms of their representation of potential human and environmental health effects for streams in this category.

Summaries of the results will be developed once the data and analyses are available. This test plan is expected to provide data sufficient to satisfy HPV program requirements regarding the human health effects and environmental fate and effects endpoints for the category. After all indicated testing has been completed, all data will be evaluated to determine whether the data support the category or if additional data or testing is warranted.

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Table 1.
CAS Numbers used in the Resin Oils and
Cycloidiene Dimer Concentrates Category.

CAS Number	CAS Number Description
26472-00-4	4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydrodimethyl-
68477-40-7	Distillates, petroleum, cracked stripped steam-cracked petroleum distillates, C10-12 fraction
68477-54-3	Distillates, petroleum, steam-cracked, C8-12 fraction
68477-53-2 ¹	Distillates, petroleum, steam-cracked, C5-12 fraction
68478-08-0	Naphtha, petroleum, light steam-cracked, C5-fraction, oligomer conc.
68478-10-4	Naphtha, petroleum, light steam-cracked, debenzenized, C8-16-cycloalkadiene conc.
68516-20-1	Naphtha, petroleum, steam-cracked middle arom.
68527-24-2	Naphtha, petroleum, light steam-cracked arom., C5-12 cycloalkadienefraction, polymers
68527-26-4	Naphtha, petroleum, light steam-cracked, debenzenized
68603-02-1	Distillates, petroleum, thermal cracked naphtha and gas oil, dimerized

1 CAS number 64742-49-0 Naphtha, petroleum, hydrotreated light was submitted for the corresponding stream in one company's TSCA IUR submission but as part of the review for the HPV program, it was determined that CAS number 68477-53-2 Distillates, petroleum, steam-cracked, C5-12 fraction more appropriately describes the material.

Table 2.
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		

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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 Toluene	4 - 14	5 - 25	13.6						
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.

**Table 3. Assessment Plan for Resin Oils and Cyclodiene Dimer Concentrates Category Under the Program.
 (Robust summaries for existing studies are submitted separately.)**

Stream Description	Human Health Effects						Ecotoxicity			Environmental Fate				
	Acute Toxicity	Genetic Point Mut.	Genetic Chrom.	Sub-chronic	Developmental	Reproduction	Acute Fish	Acute Invert.	Algal Toxicity	Physical Chem. ¹	Photo-deg.	Hydrolysis	Fugacity	Biodeg.
High DCPD Resin Oils (DCPD Content = 42-70%)	A	A	A	RA	RA	RA	A	RA	RA	RA/CM	TD/CM	TD	CM	RA
Low DCPD Resin Oils (DCPD Content = < 1%)	NA	T	T	T	T	T	T	T	T	T/CM	TD/CM	TD	CM	T
Resin Former (DCPD Content = 7%)	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
DCPD Concentrate (DCPD Content = 70 – 90%)	NA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
DCPD, High Purity (DCPD Content = 95%)	A	A	A	A	A	A	A	A	RA	RA/CM	TD/CM	TD	CM	RA
DCPD Purge (DCPD Content = 20%)	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
MCPD Dimers (MCPD Content = 90%)	A	RA	RA	RA	RA	RA	T*	T*	T	T/CM	TD/CM	TD	CM	T
DCPD Stream (DCPD Content = 50%)	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
DCPD/Codimer Concentrate (DCPD Content = 41%)	NA	T	T	T	T	T	T	T	T	T/CM	TD/CM	TD	CM	T

1 Measured data for selected physicochemical endpoints will be identified in conjunction with calculated data to characterize this category.
 A Adequate existing data available TD Technical Discussion proposed RA Read Across (see Sec. III.B)
 CM Computer Modeling proposed T Testing proposed
 NA Not Applicable T* Testing dependent on outcome of alga study

Table 4.
Approximate Weight Percent and Carbon Number Range Comparison of
the Predominant Hydrocarbons in Products from the Resin Oils and Cyclodiene
Dimer Concentrates Category and Chemically Complex Products with Aquatic
Toxicity Data used to Read Across to the Category.
 (The complex products are not in this category.)

Substance Name	Olefins		Aromatics		Paraffins	
	% (wt.)	C # (a)	% (wt.)	C # (a)	% (wt.)	C # (a)
Products in Resin Oils and Cyclodiene Dimer Concentrates Category (b)	1-34	5-9	>40-100	6-11	>4-75	5-10
Alkenes, C7-9, C8 Rich	100	7-9	0	-	0	-
C8-C10 Aromatics, Predominantly C9 Aromatics	0	-	>97	8-10	<3	-
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	0	-	>94	10-14	<6	-

- a Predominant carbon number range
 b Approximate weight percent and carbon number ranges of the predominant chemical components for products contained by this category; % compositions may not total 100%.

Table 5.
Acute Fish Toxicity Data for Selected Chemicals, Chemically Complex Products, and a Product in this Category (Resin Former Feedstock).
 The Chemical and Complex Product Data are used to Read Across to Products from the Resin Oils and Cyclodiene Dimer Concentrates Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (96-hr, mg/L)	REFERENCE
Alkenes, C7-9, C8 Rich	7-9(b)	<i>Oncorhynchus mykiss</i>	LL50 = 8.9	HOP*
o-Xylene	8	<i>Pimephales promelas</i>	LC50 = 16.4	IHSC**
p-Xylene	8	<i>Oncorhynchus mykiss</i>	LC50 = 2.6	IHSC**
p-Xylene	8	<i>Pimephales promelas</i>	LC50 = 8.9	IHSC**
Ethylbenzene	8	<i>Pimephales promelas</i>	LC50 = 12.1	IHSC**
Resin Former Feedstock	8-10(b)	<i>Oncorhynchus mykiss</i>	LL50 = 10.6	Robust summary provided with this test plan
Resin Former Feedstock	8-10(b)	<i>Lepomis macrochirus</i>	LL50 = 13.5	Robust summary provided with this test plan
1,2,4-Trimethylbenzene	9	<i>Pimephales promelas</i>	LC50 = 7.7	IHSC**
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	<i>Oncorhynchus mykiss</i>	LL50 = 18.0	IHSC**
Dicyclopentadiene	10	<i>Oryzias latipes</i>	LC50 = 3.7(c)	Robust summary provided with this test plan
C8-C14 Aromatics, Predominantly alkyl Naphthalenes and Naphthalene	10-12(b)	<i>Oncorhynchus mykiss</i>	LL50 = 3.0	IHSC**

- a Endpoint is mortality; LC = Lethal Concentration; LL = Lethal Loading; NOELR = No Observed Effect Loading Rate; values cited as “concentration” are based on measured values
- b Predominant carbon number or range
- c 48-hour study
- * Robust summary from the Higher Olefins Panel: C6, C7, C8, C9, and C12 Internal Olefins and C16 and C18 Alpha Olefins Category Test Plan (submitted)
- ** Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

Table 6.
Acute Invertebrate Toxicity Data for Selected Chemicals and Chemically Complex Products.

The Chemical and Complex Product Data are used to Read Across to Products from the Resin Oils and Cyclodiene Dimer Concentrates Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (48-hr, mg/L)	REFERENCE
o-Xylene	8	<i>Daphnia magna</i>	EC50 = 1.0	IHSC*
m-Xylene	8	<i>Daphnia magna</i>	EC50 = 4.7	IHSC*
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	<i>Daphnia magna</i>	EL50 = 21.3	IHSC*
Naphthalene	10	<i>Daphnia magna</i>	EL50 = 16.7(c)	IHSC*
Dicyclopentadiene	10	<i>Daphnia magna</i>	EL50 = 10.5(c)	Robust summary provided with this test plan
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	<i>Daphnia magna</i>	EL50 = 3.0	IHSC*

- a Endpoint is immobility; EC = Effect Concentration; EL = Effect Loading; NOELR = No Observed Effect Loading Rate; values cited as “concentration” are based on measured values
- b Predominant carbon number or range
- c Based on nominal values
- * Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

Table 7.
Alga Toxicity Data for Chemically Complex Products
 used to Read Across to Products from the Resin Oils and Cyclodiene Dimer Concentrates
 Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (72-hr, mg/L)	REFERENCE
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	<i>Pseudokirchneriella subcapitata(c)</i>	EbL50 = 2.6 ErL50 = 2.9 NOELRb = 1.0 NOELRr = 1.0	IHSC*
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	<i>Pseudokirchneriella subcapitata</i>	EbL50 = 1-3 ErL50 = 1-3 NOELRb = 1.0 NOELRr = 1.0	IHSC*

- a Endpoint is growth inhibition; EbL = Effect Loading for biomass; ErL = Effect Loading for growth rate; NOELRb = No Observed Effect Loading Rate for biomass; NOELRr = No Observed Effect Loading Rate for growth rate
- b Predominant carbon number
- c Formally known as *Selenastrum capricornutum*
- * Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

Table 8.
Read Across data used to Characterize the Biodegradability of Products in
the Resin Oils and Cyclodiene Dimer Concentrates Category.
 The Data are for Chemicals Contained by Products in this Category and Chemically
 Complex Products not in this Category. (The complex products contain chemicals found
 in products from this category.)

CHEMICAL / PRODUCT	CARBON NUMBER	PERCENT BIODEGRADATION(a) (28 days)	REFERENCE
Alkenes, C7-C9, C8 Rich	7-9	29	HOP*
o-Xylene	8	70	IHSC**
p-Xylene	8	89	IHSC**
Styrene	8	100 (14 days)(c)	***
C8-C10 Aromatics, Predominantly C9 Alkylbenzenes	9(b)	78	IHSC**
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	61	IHSC**

- a OECD 301F, manometric respirometry test
- b Predominant carbon number or range
- c BOD test
- * Robust summary from the Higher Olefins Panel: C6, C7, C8, C9, and C12 Internal Olefins and C16 and C18 Alpha Olefins Category Test Plan (submitted)
- ** Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)
- *** Chemicals Inspection and Testing Institute, Japan. 1992.

Table 9.
American Chemistry Council Olefins Panel Sponsored
HPV Test Categories

Category Number	Category Description
1	Crude Butadiene C4
2	Low Butadiene C4
3	C5 Non-Cyclic
4	Propylene Streams
5	High Benzene Naphthas
6	Low Benzene Naphthas
7, 8, 9	Resin Oil and Cyclodiene Dimer Concentrates
10	Fuel Oils

Appendix I

ETHYLENE PROCESS DESCRIPTION

A. The Ethylene Process

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 diluent 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 primary ethylene and ethane, and/or propylene and propane.

B. 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.

