

**Office of Pesticide Programs**

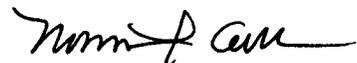
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

September 8, 2008

**MEMORANDUM**

**SUBJECT: Revised PCP Human Exposure RED Chapter**

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**DP Barcode (s): N/A**

**Pesticide Chemical No.: 063001**

**MRID #: 44813701**

**Enclosed please find the revised Human Exposure RED Chapter for Pentachlorophenol.**

## Executive Summary

The Occupational and Residential Exposure Chapter of the Pentachlorophenol (PCP) Re-registration Eligibility Decision (RED) Document addresses potential exposures and risks to humans who may be exposed to PCP in “occupational settings” and to the general population in residential settings. Exposure may occur to: (1) handlers (mixers, loaders, applicators) of PCP products; and (2) individuals who are involved in post-application or reentry activities. The absorbed dose is addressed for occupational workers using chemical-specific biological monitoring data submitted by the Pentachlorophenol Task Force.

This chapter revises the earlier draft Human Exposure RED Chapter for Pentachlorophenol (PCP) which was completed February 1, 1999. The revision is based on EPA’s receipt of a PCP-specific exposure study from the Pentachlorophenol Task Force entitled “*Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure Treatment of Lumber*” (MRID No. 44813701) and the biological monitoring data for electrical utility linemen (Thind et al. 1991). Many of the earlier exposure assumptions in the previous chapter were estimated using Asurrogate data from the Pesticide Handlers Exposure Database (PHED). In this revised chapter, the scenarios and exposures in the original chapter were either revised to account for the data that were provided in the new studies, or were deleted based on the voluntary cancellation of non pressure treatments. The scenarios involving pressure treatment of wood and electrical utility linemen were completely revised to use data only from the PCP biological monitoring study.

### **Handlers**

Occupational handler scenarios (i.e., job functions/tasks) for pressure treatment using PCP were identified using a study entitled: *Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber*. Occupational handler scenarios deal principally with exposure to workers participating while pressure treatment is taking place. Handling exposure activities may include handling charge leads, unwrapping block penta, and opening and closing cylinder doors. The technical or PCP formulating products (e.g., liquids or crystalline PCP) are loaded and applied in a retort at a wood pressure treatment plant. The handlers who are involved in the application process include the pressure treatment operator and the

treatment assistant. Both the liquid and crystalline PCP formulations were examined separately at five different wood pressure treatment plants. The maximum dose for the pressure treatment operator and treatment assistant was used to estimate short- and intermediate-term risks and the average dose was used to estimate long-term risks. Total absorbed dose from the biological monitoring study, encompassing dermal, inhalation, and incidental oral exposure, was used to calculate non cancer risks (i.e., margin of exposure or MOE). An oral endpoint from a developmental toxicity study in rats was used for the short- and intermediate-term durations and an oral chronic dog study was used for the long-term endpoint. In the case of cancer risk, lifetime average daily doses (LADDs) were multiplied by an appropriate EPA cancer slope factor [ $0.07 \text{ (mg/kg/day)}^{-1}$ ] for PCP. The biological monitoring study represents absorbed dose, no dermal absorption factor was necessary.

Based on the data and assumptions used in this risk assessment, the short- and intermediate-term non-cancer total risks for occupational handlers are not of concern (i.e., above the target MOE of 100 for short- and intermediate-term duration). Long-term non-cancer risks are of concern for 3 of the 4 handler scenarios with a target MOE of 300 (MOEs range from 79 to 480). Estimated cancer risks for handlers are of concern for the same 3 of the 4 scenarios with cancer risks ranging from  $4.9\text{E-}4$  to  $7.9\text{E-}5$ .

It should be noted that many of the uses that were originally covered in the earlier draft Human Exposure RED Chapter for Pentachlorophenol (PCP), which was completed February 1, 1999, were voluntarily cancelled by the registrants and are not covered in this assessment. These uses include groundline remediation of telephone poles, non pressure applications in joinery mills (dipping, spraying, flood coating, and vacuum treatment), home and farm uses, and railroad repair.

### **Post-application**

Post-application or reentry exposures may occur after the wood has been treated. Individuals may become exposed to PCP by contacting treated wood products such as telephone poles, fence posts, and lumber. This may occur in occupational settings such as wood pressure treatment plants or in commercial and residential outdoor settings where treated lumber is installed.

## **Occupational Post-application Exposure**

Occupational post-application scenarios for pressure treatment using PCP were identified using a study entitled “*Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber*” (MRID No. 44813701). Based on the results of this study, three job functions were used to assess post-application exposure at pressure treatment facilities. These job functions were identified as the pressure treatment loader operator, pressure treatment test borer, and pressure treatment general helpers. Additionally, to assess exposures to pole installers (electrical utility linemen) a chemical-specific biological monitoring post-application study was used by the Agency (Thind et al. 1991). The purpose of the study was to characterize chronic or long-term exposure of PCP to lineman by examining PCP levels in worker’s urine.

Based on the data and assumptions used in this risk assessment, the short-, intermediate-, and long-term non-cancer risks for occupational workers in a wood pressure treatment facility and the electrical lineman are not of concern (i.e., estimated risks are above the target MOE). In addition, the cancer risks do not exceed the Agency’s level of concern. The cancer risks at the pressure treatment facility are characterized as 6.9E-5 for the Loader Operator, 6.1E-5 for the Test Borer, 3.6E-5 for the General Helpers, and 2.5E-5 for the electrical utility linemen.

## **Residential Exposure and Risk Characterization**

Population-based biological monitoring data from the National Health and Nutrition Surveys (NHANES) are available to assess the exposure of the general population to PCP. The NHANES data provides an encompassing review of all PCP exposures; the specific PCP-treated wood contribution to total PCP exposure can not be differentiated. Because NHANES does not include exposures to children under the age of 6 years old, the Children’s Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP) study (Wilson, et al. 2007) was used to include estimates of exposures to children under 6 years old ((Refer to the residential exposure and risk characterization section of this report for details).

## OCCUPATIONAL EXPOSURE AND RISK ASSESSMENT

An occupational and/or residential exposure risk assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (e.g., mixers, loaders, applicators, etc.) during use, or to persons entering treated sites after application is complete. For pentachlorophenol, both criteria are met for the occupational uses of pentachlorophenol but the post-application residential exposure is expected to be negligible for utility poles.

### Summary of Toxicity Concerns Relating to Occupational Exposures

#### Acute Toxicology

The toxicological data base for PCP [2,3,4,5,6- pentachlorophenol] is adequate and will support a re-registration eligibility decision. Acute toxicity categories for Pentachlorophenol are shown in Table 1. Route-specific data for assessment of inhalation hazard and risk were not available for PCP, as waivers had previously been granted by the Agency. Thus, in accordance with Agency policy, for acute inhalation exposures, PCP was assigned a Toxicity Category I and a respirator requirement recommended for PCP labels. Pentachlorophenol is not classified as a dermal sensitizer. Table 1 summarizes these toxicity findings (USEPA 1997).

**Table 1. Acute Toxicity Categories for Pentachlorophenol**

Study	Results	Toxicity Category
Acute Oral Toxicity	LD <sub>50</sub> = 155 mg/kg (male) LD <sub>50</sub> = 137 mg/kg (female)	II
Acute Dermal Toxicity	LD <sub>50</sub> > 3,980 mg/kg	IV
Acute Inhalation Toxicity	No guideline study available to determine a LD <sub>50</sub> . (data waived)	I
Primary Eye Irritation	Corneal involvement at day 7 post-instillation.	II

Study	Results	Toxicity Category
Primary Dermal Irritation	Moderate irritation at 72 hrs. Post-application.	III
Dermal Sensitization	No dermal sensitization.	NA

### **Selection of Toxicological Endpoints for Risk Assessment**

The Hazard Identification Assessment Review Committee (HIARC), dated December 8, 1997, indicates that there are toxicological endpoints of concern for PCP. Table 2 summarizes these endpoints. Dermal endpoints of concern, based on oral studies, have been identified for short-term and intermediate-term dermal exposures. The no-observed-adverse-effect level (NOAEL) selected for short- and intermediate-term dermal exposures is 30 mg/kg/day, based on effects from an oral developmental toxicity study in rats (i.e., increased resorptions, reduced fetal weight and skeletal malformations/variations at the lowest-observed-adverse-effect level (LOAEL) of 80 mg/kg/day) (MRID 43091702). Since the endpoint is specific for females (i.e., only female pregnant rats received the oral administration of pentachlorophenol), the body weight of a female (60 kg) should be used to assess handler and post-application exposures/risks.

Dermal endpoints of concern have also been identified for long-term (chronic) dermal exposures. A LOAEL of 1.5 mg/kg/day was identified, based on chronic hepatotoxicity effects from an oral chronic toxicity study in dogs [(i.e., increases in liver weights, alkaline phosphatase activity, and increased incidences of granular cytoplasmic pigment accumulation in the liver, and lymphocytic mucosal inflammation in the stomach) (MRID 43982701)]. For long-term (chronic) dermal risk assessment, however, a MOE of 300 was recommended because in the absence of a NOAEL, a LOAEL was used to establish the toxicological endpoint for this risk assessment. Since the endpoint is not specific for male or females, the average adult body weight of 70 kg was used.

For inhalation exposure the Agency lacked acceptable guideline inhalation toxicity studies, and had granted data waivers in 1995 for submission of both the acute and 90-day inhalation toxicity studies, based on the inability to generate respirable vapors or dust from technical-grade PCP. As indicated in Section 4.2.1.1 of this document, only 2 of 66 inhalation exposure replicates were above the limit of detection (LOD). Therefore, EPA has not provided a separate inhalation risk estimate for inhalation exposure. Instead, EPA has used biological monitoring data to assess all of the exposure scenarios in this risk assessment. The absorbed dose from the biological monitoring represents total dose (i.e., dermal and inhalation routes combined) and is compared to the oral endpoint to estimate risk.

The cancer slope factor for PCP is calculated as  $7.0 \times 10^{-2} \text{ (mg/kg/day)}^{-1}$ , based on combined incidence of hemangiosarcomas, liver adenomas/carcinomas, and adrenal pheochromocytomas observed in female mice from a study conducted by the National Toxicology Program (NTP, 1989). The slope factor was calculated as the geometric mean of the individual slope factors derived from two data sets: female mouse data for technical grade and Dowicide EC-7 pentachlorophenol. Both PCP preparations were used because the two grades of PCP induced neoplasms at the same anatomical sites. tPCP, however, appeared to be slightly more potent than EC-7, suggesting some enhancing activity due to the impurities. A recently conducted rat chronic toxicity/carcinogenicity study by NTP (NTP, 1999) showed some evidence of carcinogenicity of pentachlorophenol in males, based on increased incidences of mesothelioma and nasal squamous cell carcinoma in a stop-exposure study (60 mg/kg/day for one year, followed by one year no treatment). There was no evidence of carcinogenic activity of PCP in female rats in this study.

**Table 2. Toxicological Endpoints for Assessing Occupational Exposures/Risks**

Study	Endpoint	Recommended MOE
Short- (1 to 30 days) and Intermediate-term exposure (1 to 6 months)	Oral NOAEL = 30 mg/kg/day	100
Long-term Exposure (greater than 6 months)	Oral LOAEL = 1.5mg/kg/day	300
Oral Cancer Slope Factor	$0.07 \text{ (mg/kg/day)}^{-1}$	NA

NA- Not Applicable.

Note: All exposure scenarios are based on absorbed dose from the biological monitoring studies (oral short- and intermediate-term NOAEL and oral long-term LOAEL are used to estimate risks with the Target MOEs of 100 and 300, respectively).

### **Dermal Absorption**

The total absorbed dose from the submitted biological monitoring studies for handler and post-application exposure scenarios represent exposures received from the dermal and inhalation routes. Therefore, the dermal absorption rate of 40 percent recommended by the Hazard Identification Assessment Review Committee report was not used in conjunction with the absorbed dose.

### **Occupational Exposures and Risks**

#### **Handler Exposures and Risks**

EPA has determined that there are potential exposures to workers at pressure treatment facilities during typical use-patterns associated with pentachlorophenol. As a

restricted use chemical, PCP can only be applied by a certified applicator. The following handler exposure scenarios have been identified:

- (1a) mixing/loading/applying crystalline technical grade product- pressure treatment operator;
- (1b) mixing/loading/applying liquid formulation - pressure treatment operator;
- (2a) mixing/loading/applying crystalline technical grade product- pressure treatment assistant;
- (2b) mixing/loading/applying liquid formulation - pressure treatment assistant.

A brief description of these scenarios is presented in Table 3. These scenarios are specific **only for pressure treatment uses** and represent uses according to the study entitled *AI Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber* (MRID No. 44813701). The job functions of treatment operator and treatment assistant from the Vulcan Block Penta at study sites A, B, and D were used to represent the activities of mixing/loading/applying the crystalline block products. The job functions of the treatment operators and treatment assistants while using the Pentacon-40 liquid formulation at study sites C and E were used to represent the exposure activities associated with mixing/loading/applying liquids.

**Table 3. Exposure Scenarios for Occupational Handlers**

Exposure Scenario	Scenario Description
<i>Primary Handlers</i>	
(1a) Mixing/loading/applying crystalline technical grade product- Pressure Treatment Operator	Scenario pertains to a formulating facility or wood pressure treating facility (e.g., manufacturing telephone poles). A crystalline penta block is loaded and mixed with solvent at the correct use dilution to make a liquid ready-to-use product. The mixing usually occurs in a closed system. Potential exposure to workers results from open loading of the crystalline block, unwrapping plastic wrap from block and positioning of block into the vessel. Additional handling of ready-to-use product may occur after mixing with a solvent. Primary duties for a pressure treatment operator include: opening closing valves transferring treatment liquids, opening and closing treatment vessel doors, cleaning PCP residues on doors and latches, performing tram maintenance and positioning, and handling leads, chains and cleanup.
(1b) Mixing/loading/applying liquid formulation - Pressure Treatment Operator	Scenario pertains to a wood pressure treatment plant. Liquid ready-to-use PCP is prepared from concentrate and loaded into the retort using a mechanical pump. Potential exposure occurs while pumping liquid into the retort. Additional exposure may occur when a pressure treatment operator opens and closes valves transferring treatment liquids and treatment vessel doors, cleaning PCP residues on doors and latches, performing tram maintenance and positioning, and handling leads, chains and cleanup.

Exposure Scenario	Scenario Description
(2a) Mixing/loading/applying crystalline technical grade product- Pressure Treatment Assistant	Scenario also pertains to a formulating facility or wood pressure treatment facility. Crystalline penta block is loaded and mixed with solvent at the correct use dilution to make a liquid ready-to-use product. The mixing usually occurs in a closed system. Potential exposure to workers results from open loading of the crystalline block, unwrapping plastic wrap from block and positioning of block into the vessel. Performs many of the same functions as the Treatment Operator including opening and closing valves and doors, cleaning PCP residues on doors and latches, perform tram maintenance and positioning, and handle leads and chains and cleanup. Treatment Assistants may perform more manual duties such as drip pad and filter cleaning.
(2b) Mixing/loading/applying liquid formulation - Pressure Treatment Assistant	Scenario pertains to a wood pressure treatment plant. Liquid ready-to-use PCP is prepared from concentrate and loaded into the retort using a mechanical pump. Potential exposure occurs while pumping liquid into the retort. Additional exposure may occur when a pressure treatment operator opens and closes valves transferring treatment liquids and treatment vessel doors, cleaning PCP residues on doors and latches, performing tram maintenance and positioning, and handling leads, chains and cleanup. Treatment Assistants may perform more manual duties such as drip pad and filter cleaning.

### Handler Exposure Data and Assumptions

In the course of development of these RED, exposures were predicted using chemical-specific handler data identified from pertinent literature sources, and from the *“Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber”*. The data in this report were judged to be representative of the daily activities for the worker exposures, no extrapolations for amount of product handled was necessary.

*“Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber”* was submitted by the Pentachlorophenol Task Force in support of the re-registration of the wood preservative pentachlorophenol. The study is a 1999 worker exposure study sponsored by the Pentachlorophenol (PCP) Task Force and Vulcan Chemicals. The study quantified total worker exposure to PCP during pressure treatment of wood poles at five commercial facilities in the U.S. and Canada. During this study, twenty-two workers were monitored for three consecutive work days. Two PCP pressure-treatment product formulations were used, a solid block and a liquid formulation. The solid block formulation, Vulcan Block Penta (EPA Reg. 5382-16), contains 86 percent active ingredient (a.i.) by weight. The block weighs approximately 2,000 lbs and is moved with a lifting hook. The Vulcan

Block Penta was used at sites A, B, and D. The liquid formulation, Pentacon-40 (EPA Reg 7234-11) is 34.4% a.i. by weight and is delivered to the plant by truck through a metered pump and stored in a 40,000-65,000 gallon storage tank. The Pentacon-40 liquid formulation was used at sites C and E.

The field portion of the study was conducted by American Agricultural Services, Inc. between August 25 and October 21, 1998. The analytical phase was conducted by Morse Laboratories. Twenty-four hour urine (N= 63 replicates) and personal air samples (N= 66 replicates) were collected over three consecutive days from 21 and 22 workers, respectively. The workers, distributed among the five test sites, were categorized into five job categories. The 18 replicates of Treatment Operator work shifts and 6 replicates of Treatment Assistant work shifts are designated in this risk assessment as "handlers". The 15 replicates of Test Borer work shifts, 15 replicates of Load Operator work shifts, and 9 replicates of General Helper work shifts are categorized as "post-application" and are assessed in the post-application section of this risk assessment. The wood treatment process involved a total of 26 individual work tasks; each job category performed some subset of these tasks.

In this study, workers wore different clothing and had varying degrees of PPE (e.g., some wore respirators and wore chemical resistant gloves, while others had no PPE) which can influence exposure. Also, engineering controls at the sites were different (e.g., exhaust hoods, fans, automatic hydraulic doors, and automated closed systems) and they can influence the exposure. In addition, the amount of PCP handled (e.g., some sites were large and treated more wood with PCP than others) and the varying types of tasks that workers performed (e.g., opening cylinder doors, coring wood, handling leads and chains) can also influence the exposure. Therefore, it is difficult to characterize each exposure unless you consider each factor separately. The effect on exposures using PPE and engineering controls were not specifically analyzed at each site in the study report and were not emphasized.

The differences in PPE and engineering controls among sites, and the fact that the exposure based on these controls was not assessed, makes it impossible to evaluate the effect that PPE and engineering controls have on exposure. Because of these uncertainties, short-term and intermediate doses for maximally exposed individuals at the five sites were considered. Note that the treatment operators and treatment assistants most likely represent handling and the activities of the loader operators, test borers, and

helpers most likely represent post-application. There is some overlap between the tasks of the workers and the activities of the workers may represent both handler and post-application application activities. A brief description of each site, the associated work tasks which may lead to exposure, and the PPE and engineering controls existing at the site is presented below.

Site A uses block penta which is wrapped in plastic. The blocks are unwrapped using a pen knife and moved by fork lift and lowered into the mixing tanks by means of a wench. The mixing tank is closed manually. All control valves are manually operated. One cylinder is closed by a hydraulic door and the other is closed by fastened bolts. No exhaust fans or hoods are in place; the site is roofed over, but has no sides to permit free air flow. For site A, treatment operators (TO) and treatment assistants (TA) wore uniforms, rubber gloves and goggles. The TO wore a respirator when performing high exposure tasks (e.g., handling cylinder doors, loaders or cleaning system filters). The TO had the principal responsibility for cleaning cylinder doors, handling charge leads, and handling block penta. The test borers (TB) also wore uniforms and rubber gloves when testing cores and collecting samples. The clothing for loader operator (LO) was jeans, and a short-sleeved shirt. He wore chemical resistant gloves when operating the loader and handling charge leads after the leads were removed from the cylinder. The helper (H) wore a one-piece uniform over a tee-shirt. He wore chemical-resistant gloves when handling used penta wrappers, or when operating the hydraulics used in opening cylinder doors.

Site B uses block penta, but mixes it in a cylinder. The system is controlled from a small building and most valves are automated and can be controlled from the building. The TO wore a one-piece uniform and chemical-resistant gloves while working near the cylinder doors. He opened and closed the retort door hydraulically through automated controls inside a separate building, but sometimes participated in cleaning the cylinder door. In these cases, he wore chemical-resistant gloves. The TB wore a uniform and a tee-shirt. He wore lightweight rubber gloves when coring poles and samples. The LO wore a uniform and tee-shirt and leather gloves when operating the loader and handling charge leads. Two helpers worked at the site. Both wore uniforms with tee-shirts and high rubber boots. They wore chemical resistant gloves while steam cleaning drip pads.

Site C uses a liquid penta solution that is transferred from delivery trucks to storage tanks using a closed system operated by the delivery driver. The system is totally enclosed in a single building and operated from the control room. Nearly all valves are automated, and operated from the control room. Poles are loaded on trams on tracks outside of the building. Electric winches are used to move the charge into the cylinder areas and kilns. At the time of the monitoring, the fans were not fully operational. For site C, the TO was completely enclosed in a ventilated building. However, the exhaust fan did not completely remove the condensate from the building. The TO wore a one-piece uniform and chemical-resistant gloves when cleaning cylinder doors. The TB wore jeans and a short-sleeved shirt under a sweatshirt that was removed in warm weather. He wore leather gloves when coring treated poles. The LO wore jeans, a tee- or sweat shirt, and a denim jacket while working. He wore chemical-resistant gloves when operating his loader and handling charge leads.

Site D uses block penta which is mixed with oil in the cylinder. The blocks are placed using a forklift into a pot-like container on wheels, which is rolled to the cylinder and placed inside. The single penta cylinder is adjacent to a creosote cylinder and housed under one roof. The cylinder door is hydraulic. The TO wore uniform pants and a shirt over a long-sleeved shirt and wore leather gloves when handling valves and cylinders. The TB wore uniform pants and a shirt over a long-sleeved shirt and wore leather gloves when coring poles. He wore a dust mask when handling penta blocks. The LO wore uniform pants and a shirt over a long-sleeved shirt and wore leather gloves when handling charge leads after they had been pulled from the cylinder.

Site E uses a liquid penta solution that is transferred from delivery trucks to storage tanks using a closed system operated by the delivery driver. There is a hydraulic door, but all valves must be adjusted manually. For site E, treatment operators and treatment assistants all wore short-sleeved shirts. The first TO spent the majority of his time in an enclosed room. The second TO mainly performed inspections. The treatment assistant (TA) wore gloves to handle doors and leads and a respirator when opening cylinder doors. The TB wore jeans and short sleeve shirts and did not wear gloves to take wood cores. The LO wore jeans and short sleeve shirts, but worked inside a closed cab loader.

The results of the study indicated that virtually all the inhalation exposure monitoring data were below the limit of detection (LOD). Only 2 of 66 replicates had air concentrations above the limit of detection, and only one data point achieved the level of quantitation (LOQ). Since the inhalation data were primarily below the LOQ, it is assumed that the majority of the total absorbed dose of PCP is attributed to the dermal route.

The biomonitoring data indicate that PCP levels were highest in the Treatment Assistant job category, followed by Treatment Operators; Load Operators; Test Borers; and General Helpers. This sequence was consistent with the PCP exposure potential of the tasks each group of workers performed and the number of the tasks the worker performed in the wood treatment areas.

For eight of the twenty-one workers monitored, PCP levels increased significantly with time over the three consecutive monitored days, suggesting that steady state levels had not been reached in these workers. Exposure estimates based on an average 24 hour urine concentration might underestimate the total PCP exposure for these workers. Twenty three urinary creatinine values were below, and five urinary creatinine values exceeded the normal range reported in the literature (i.e. 15 to 25 mg/day) (Merk 1977). Individual sample coefficients of variation (i.e. three samples per worker) ranged between 4.09 percent and 32.12 percent.

Field fortified sample recoveries ranged between 73.6 percent to 94.3 percent for urine samples and between 85.2 percent to 93.3 percent for air samples. These values were used to correct field sample data for sample handling and storage losses. Laboratory fortified urine sample recoveries ranged between 101 percent to 107 percent, with a CV of 5.5 percent to 6.7 percent. The limit of detection for PCP in urine samples was 10  $\mu\text{g/L}$  and the limit of quantitation was set at 30  $\mu\text{g/L}$  because of the ubiquitous presence of PCP in human urine. The laboratory fortified air sampling tube sample recoveries ranged between 105 percent and 110 percent, with a CV of 1 percent to 5.9 percent. The limit of detection and limit of quantitation were 2.0  $\mu\text{g/section}$  and 6.0  $\mu\text{g/section}$ , respectively.

This exposure study met most, but not all, of the requirements specified in OPPTS Guidelines 875.1000, 875.1300, and 875.1500. In general, major limitations for this study include: it was not clear whether a steady-state PCP urine concentration existed prior to the initiation of the study; pharmacokinetic data were not presented in any detail to support the biomonitoring urine excretion rates; and, personal protective equipment and clothing worn by the workers were not well described. Several issues must be considered when interpreting the occupational exposure risk assessment. These include limitations and concerns about the study, "*Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to*

*Pentachlorophenol During Pressure-Treatment of Lumber*", submitted by the Pentachlorophenol Task Force in support of the re-registration of the wood preservative pentachlorophenol:

- (1) It is not clear whether the air sampling methodology used was sensitive enough to successfully detect the very low levels expected in (largely) outdoor exposure situations. The protocol specified that the method validation target LOQ would be 1 ng/L or 300 ng for a 5 hour sampling cycle. (Note: The LOQ actually achieved was  $6 \mu\text{g}/372 \text{ L air}$ , or 16 ng/L air). Very little discussion regarding the validation of the method was provided. A working range (i.e. range of air volumes required at specific air concentrations of PCP) for the method used was not given in the text. A table of desorption efficiencies is given for the method at 0.5, 1.0 or  $2.0 \text{ mg}/\text{m}^3$  PCP in air, however, these air concentrations are much higher than those measured in this study.

For comparison, the NIOSH Method #5512 recommends use of a mixed cellulose ester filter and a 25 mL bubbler containing ethylene glycol, and has a working range of  $130 \mu\text{g}$  to  $1,130 \mu\text{g}/\text{m}^3$  in 180 L air samples. [The NIOSH method is intended for use with higher air levels of PCP, such as those in the general range of the OSHA PEL (i.e.  $500 \mu\text{g}/\text{m}^3$ ), and these methods are best applied in high exposure indoor venues.]

- (2) The effect of mitigation of risks using PPE and engineering controls were not specifically analyzed at each site in the study report and were not emphasized. Because of the differences in PPE and engineering controls

between sites, and the fact that the mitigation based on these controls was not assessed, it is impossible to evaluate what effect mitigation by PPE and engineering controls had on exposure. Because of these uncertainties, short-term and intermediate doses for maximally exposed individuals at the five sites were considered.

- (3) According to a 1984 study conducted by U.S. EPA OPTS (cited in the study report), a typical 87 kg wood treatment worker would be expected to adsorb between 112 and 293  $\mu\text{g}$  PCP/kg body weight/day by all routes. This range of PCP exposure was much higher than the highest total absorption of 15.3  $\mu\text{g}$  PCP/kg body weight/day reported in this study. The discrepancy was not explained in the study report.
- (4) Guideline 875.1500 specifically requires that 15 replicates be evaluated for each exposure scenario. Six Treatment Assistant replicates and nine General Helper replicates were used to evaluate PCP exposures in the study.

Industry maintained that “Because there are relatively few workers in this industry (only 102 treatment operators in the U.S. and Canada, and 44 treatment assistants in the U.S. and Canada, the replicates represent a significant portion of the work force.” Thus, the sample size is representative and provides adequate statistical power (Penta Task Force 1999).

Despite the key non-compliance and data gaps presented in this report, the decision of EPA is that the data are of sufficient scientific quality to be used in the RED document. However, recent communication between EPA and the California Environmental Protection Agency indicates that the absorbed doses calculated in the study report should be further adjusted (increased) for acute exposure. This is due in part because “*PCP cannot reach a steady-state in an acute toxicity study. Theoretically, a steady state level cannot be reached until the individual has been working in a treatment facility for 8 consecutive days*” (CDPR 1999) This is based on a pharmacokinetics study by Braun et al.(1979) in which human volunteers did not excrete all the 86% of the single

oral dose in the urine until day 8. EPA will therefore increase the short-term absorbed doses reported in the biodosimetry study three-fold to account for acute exposure effects.

For the PCP biomonitoring study, data were based on a full work day of typical exposure for each of the handler scenarios; therefore, a further estimate of the amount handled was not required. It should be noted that biomonitoring study covers both inhalation and dermal exposure to PCP.

### **Handler Risk Characterization**

Both non-cancer and cancer risks were assessed for the handlers of PCP at the pressure treatment facilities.

### **Handler Non-Cancer Risk Estimates and Characterization**

The absorbed doses from the biological monitoring study were used to represent total aggregated exposure for dermal, inhalation, and incidental ingestion for pressure treatment workers.

The absorbed dose was estimated from PCP residue levels in worker urine samples. The raw PCP residue level (in  $\mu\text{g/L}$ ) in each urine sample was adjusted to account for 86% excretion of absorbed PCP. For example, a treatment operator at site A had a raw urinary PCP residue level of 191  $\mu\text{g/L}$ . In order to correct for excretion, the raw urinary PCP concentration was divided by the fraction of PCP excreted (0.86) to obtain 222  $\mu\text{g/L}$  of PCP excreted. The number must be further corrected to account for field recovery. In the case of Site A, samples that were spiked at 60  $\mu\text{g/L}$  had field recoveries of 85.7%. The urinary PCP concentration of 222  $\mu\text{g/L}$  of PCP excreted was divided by the recovery fraction (0.857) at a similar spike to obtain a final urine concentration of 259  $\mu\text{g/L}$  of PCP. The urinary concentration of PCP was then normalized to obtain a daily absorbed dose using the following equation (note: CF is the unit conversion factor):

$$Absorbed\ Dose\left(\frac{mg\ ai}{kg/day}\right) = Urinary\ Conc.\left(\frac{\mu g}{L}\right) \times CF\left(\frac{mg}{\mu g}\right) \times Urinary\ Volume(L) \times \left(\frac{1}{Body\ Weight(kg)}\right)$$

For example, for a pressure treatment operator at site A, the urinary concentration is normalized to an absorbed dose using the equation as follows:

$$(259\ \mu g/L \times 0.001\ mg/\mu g \times 2.17L)/79.8\ kg = 0.007\ mg/kg/day$$

The short- and intermediate-term doses are based on the **maximum** absorbed dose in the three-day PCP study. The long-term dose is based on the **average** absorbed doses for all sites monitored. Note that the average exposure for mixing/loading/applying (MLA) crystalline grade product was determined for Sites A, B, and D, and the MLA of liquid exposure was averaged for Sites C and E. In addition to using the maximum dose for short- and intermediate-term doses, the doses are also adjusted as follows:

### **Short-term dose**

The maximum dose was selected for the short-term PCP exposure duration. The maximum short-term dose was then further adjusted by three-fold to account for steady state levels. Communication between EPA and the California Environmental Protection Agency indicates that the absorbed doses calculated in the study report should be further adjusted (increased) for acute exposure. *“This is due in part because APCP cannot reach a steady-state in an acute toxicity study”* (CDPR 1999). This is based on a pharmacokinetics study by Braun et. al. (1979) in which human volunteers did not excrete all the 86% of the single oral dose in the urine until day 8. Note that the maximum exposure for mixing/loading/applying (MLA) crystalline grade product was determined for Sites A, B, and D, and the maximum MLA of liquid exposure for Sites C and E.

### Intermediate-term dose

The intermediate-term dose represent the maximum dose in the 3-day biomonitoring study. These doses were not adjusted to account for steady state levels. Note that the maximum exposure for mixing/loading/applying (MLA) crystalline grade product was determined for Sites A, B, and D, and the maximum MLA of liquid exposure for Sites C and E.

### Long-term dose

The long-term doses represent the average doses in the 3-day biomonitoring study. These doses were not adjusted to account for steady state levels. Note that the average exposure for mixing/loading/applying (MLA) crystalline grade product was determined for Sites A, B, and D, and the MLA of liquid exposure was averaged for Sites C and E.

The PPE and engineering controls for maximally exposed handlers are described below.

(1a) For site A, the TO had the principal responsibility for cleaning cylinder doors, handling charge leads, and handling block penta. He wore a uniform, rubber gloves and goggles and a full-face respirator when cleaning doors, handling charge leads, and handling block penta. For Site A, the mixing tank is closed manually. All control valves are manually operated. For sites B and D, the mixing/loading operations are more automated. The TO's exposure at sites B and D is mitigated by the engineering controls and exposure is much less.

(1b) The maximum exposed individual at site C is the TO. He applied the highest quantity of PCP. For site C, the TO was completely enclosed in a ventilated building. However, the exhaust fan did not completely remove the condensate from the building. The TO wore a one-piece uniform and chemical-resistant gloves when cleaning cylinder doors. The TA at site E appeared to do most of the tasks involved with exposure to penta at the site.

(2a) The maximum exposed individual at site A is the TA. The TA for site A wore a uniform, rubber gloves and goggles.

(2b) The maximum exposed individual at site E is the TA. The TA wore jeans and short-sleeved shirts and gloves to handle doors and leads and a respirator when opening cylinder doors.

Table 4 provides the non-cancer short-, intermediate-, and long-term absorbed dose estimates and MOEs for the two formulations (e.g. liquid or solid block penta). The MOE, based on the biological monitoring results, is calculated using an oral NOAEL of 30 mg/kg/day for short- and intermediate-term exposure, and an oral NOAEL of 1.5 mg/kg/day for chronic exposures. The following formula describes the calculation of a dermal MOE:

$$MOE = \left( \frac{NOAEL (mg/kg/day)}{Absorbed Dose (mg/kg/day)} \right)$$

The target MOE target for short- and intermediate-term exposure is 100 and the target MOE for long-term exposure is 300. The short- and intermediate-term MOEs are all above the target MOE of 100, and therefore, the risks are not of concern. The PPE factored into these calculations is unknown, but assumed to be at least baseline attire (i.e., long-sleeve shirt, long pants, shoes, and socks) plus chemical-resistant gloves. The long-term MOE for the pressure treatment operator for the solid block formulation is not of concern (i.e., MOE = 480). However, the risk is a concern (i.e., MOE<300) for the long-term duration for the pressure treatment operators using liquid formulation (MOE=230), and for pressure treatment assistants using both crystalline grade product (MOE=130) and liquid formulation (MOE=79).

**Table 4. Pentachlorophenol- Occupational Handler- Pressure Treatment [Absorbed Dose from the Biological Monitoring Study]**

Exposure Scenario	Adjusted Absorbed Short-Term Dose (mg/kg/day) <sup>a</sup>	Absorbed Intermediate-Term Dose (mg/kg/day) <sup>b</sup>	Absorbed Long-Term Dose (mg/kg/day) <sup>c</sup>	Lifetime Average Daily Dose (mg/kg/day) <sup>d</sup>	Short-term MOE <sup>e</sup>	Intermediate-Term MOE <sup>e</sup>	Chronic MOE <sup>f</sup>	Cancer Risk <sup>g</sup>
Mixing/Loading/Applying Crystalline Grade Product - Pressure Treatment Operator (1a)	0.021	0.007	0.0031	0.0011	1,400	4,300	480	7.9E-05
Mixing/Loading/Applying Liquid Formulation - Pressure Treatment Operator (1b)	0.036	0.012	0.0065	0.0024	830	2,500	230	1.7E-04
Mixing/Loading/Applying Crystalline Grade Product - Pressure Treatment Assistant (2a)	0.054	0.018	0.012	0.0044	560	1,700	130	3.1E-04
Mixing/Loading/Applying Liquid Formulation - Pressure Treatment Assistant (2b)	0.075	0.025	0.019	0.0069	400	1,200	79	4.9E-04

- a Adjusted based on increasing the maximum absorbed dose reported in the PCP biodosimetry study by 3 times to correct for the cumulative effects of an 8-day steady-state excretion.
- b Based on maximum absorbed doses from biological monitoring.
- c Based on average absorbed doses from biological monitoring.
- d Lifetime Average Daily Dose (LADD) = [Absorbed Dose(dermal) x Exposure Frequency (e.g. 250 working days) x Exposure Duration (e.g. 40 working days in a lifetime)]/ [(365 days/yr x Lifetime (e.g.,75 yrs))]
- e Short and Intermediate-term NOAEL (30 mg/kg/day)/ Adjusted Short and Intermediate Dose. Target MOE=100
- f Long-term LOAEL (1.5 mg/kg/day)/ Long-term Dose. Target MOE=300
- g LADD x Cancer Slope Factor (0.07 mg/kg/day).

## Handler Cancer Risk Estimates and Characterization

Biomonitoring absorbed doses were also used in the cancer assessment to represent total aggregated exposure for the dermal and inhalation routes. The lifetime average daily dose for the cancer risk assessment is based on the lifetime average absorbed doses in the PCP study (e.g., long-term dose estimates). Note that the average absorbed dose for mixing/loading/applying (MLA) crystalline grade PCP product was determined for Sites A, B, and D, and the MLA of liquid PCP absorbed dose was averaged for Sites C and E. These absorbed doses were then amortized over a lifetime. Exposure duration was assumed to be 40 years and is the standard value used by OPP to represent a working lifetime. This is assumed to be a conservative value. Lifetime is assumed to be 75 years. This is the recommended value for the U.S. population, as cited in EPA's Exposure Factors Handbook (U.S. EPA, 1997). Exposure frequency is assumed to be 250 working days per year (i.e., five days per week, 50 days per year). This is a standard Agency assumption for days worked per year. The following formula describes the calculation of the lifetime average daily dose:

$$\text{Lifetime Average Daily Dose} \left( \frac{\text{mg ai}}{\text{kg/day}} \right) = \left( \frac{[\text{AbsorDose}(\text{mg/kg/day})] \times \text{ExposureFrequency}(\text{days/yr}) \times \text{ExposureDuration}(\text{yrs})}{365 \text{ days/yr} \times \text{Lifetime}(\text{yrs})} \right)$$

Cancer risk was calculated by multiplying the lifetime average daily dose times the cancer slope factor of 0.07 (mg/kg/day)<sup>-1</sup> using the following formula:

$$\text{Risk} = \text{LADD} \left( \frac{\text{mg ai}}{\text{kg/day}} \right) \times \text{Cancer Slope Factor} \left( \frac{1}{(\text{mg/kg/day})} \right)$$

The results presented in Table 4 (above) for the cancer risk estimates indicate that cancer risks are of concern (i.e., 7.9E-5, 1.7E-4, 3.1E-4, and 4.9E-4 for the crystalline TO, liquid TO, crystalline TA, and the liquid TA, respectively).

## Post-application Exposures and Risks

The Agency is concerned about potential post-application exposures to pentachlorophenol. According to information obtained from the Agency for Toxic Substances and Disease Registry (ATSDR), soil half-lives are usually on the order of 2-4 weeks. Photolysis in water under laboratory ultraviolet (UV)-light irradiation indicates an estimated half-life of about 100 hours at pH 3.3 and 3.5 hours at pH 7.3. Atmospheric pentachlorophenol is probably photolyzed in the absence of water, although mechanisms for this reaction are not well known. Since the pentachlorophenol is not rapidly degraded, and exhibits moderate toxicity, potential post-application scenarios may be of concern (ATSDR 1994).

### Wood Pressure Treatment Facility

The Agency has determined that there are potential exposure concerns relating to post-application exposure to individuals following pentachlorophenol applications in commercial and industrial settings. In the case of the pressure treatment industry, post-application occurs when there is contact to the wet or dry wood after it has been pressure treated or contact to residues during maintenance. The following types of post-application exposures for pressure treatment uses of PCP have been identified:

- (a) pressure treatment loader operator;
- (b) pressure treatment borer; and
- (c) pressure treatment general helpers.

Brief descriptions of these scenarios are presented in Table 5. These scenarios are specific only for pressure treatment uses and represent uses according to the study entitled *Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber*.

**Table 5. Exposure Scenarios for Occupational Post-application at Wood Pressure Treatment Facilities**

Exposure Scenario	Scenario Description
<i>Occupational Post-application</i>	
(1) Pressure Treatment Loader Operator	Scenario pertains to a formulating facility or wood pressure treating facility (e.g., manufacturing telephone poles). Operates self-propelled vehicles that are used to load poles onto and off of trams, and to move charges into and out of treatment cylinders. May perform certain out-of-cab tasks such as tram placement and handling of chains and leads while pulling the freshly treated charge from the cylinder.

Exposure Scenario	Scenario Description
(2) Pressure Treatment Test Borer	Scenario pertains to a wood pressure treatment plant. This person takes pole cores to test for PCP penetration. May also test concentration of lots of PCP, and perform other QC laboratory duties.
(3) Pressure Treatment General Helpers	Scenario pertains to a wood pressure treatment plant. This person performs various labor and cleanup duties in treatment areas, drip pads, effluent-handling systems, and unrelated areas. This person may be exposed to PCP block wrappings, block hooks, residue-bearing wood waste and filter sludge.

### **Electrical Utility Linemen**

Another occupational post-application scenario which needs to be considered concerns utility pole installers or electrical utility linemen. The activities of the electrical utility linemen include frequent climbing of new or in-service PCP-treated poles, which require significant skin contact to PCP containing oils that run down the surface of the telephone pole (Thind 1991). For this scenario the Agency has used the biological monitoring data from Thind et al (1991).

### **Post-application Data and Assumptions**

#### **Pressure Treatment Facilities**

Data for the wood pressure treatment scenarios were taken from “*Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure-Treatment of Lumber*” submitted by the Pentachlorophenol Task Force in support of the re-registration of the wood preservative pentachlorophenol. For wood pressure treatment scenarios biological monitoring data are used to assess absorbed dose and risks to the workers. The daily absorbed dose for short- and intermediate-term exposure durations are based on the maximum absorbed dose in the PCP study. EPA has increased the short-term absorbed doses three-fold to account for acute exposure effects to account for steady-state effects. The daily absorbed dose for long-term and lifetime average dose are based on the average doses for all sites monitored. Note that the average dose for mixing/loading/ applying (MLA) for crystalline grade product was determined for Sites A, B, and D, and the MLA of liquids exposure was averaged for Sites C and E.

The absorbed dose was estimated from PCP residue levels in worker urine samples. The raw PCP residue level (in µg/L) in each urine sample was first adjusted to account for 86% excretion of absorbed PCP, and then adjusted to account for field recovery. A more detailed explanation of this process and the description and a summary of the study’s limitations are discussed in the handler section (Section 4.2.1.1).

## Electrical Utility Linemen

To identify the electrical utility linemen's occupational exposure to pentachlorophenol, crews of workers were monitored for up to a six month period, examining total PCP in urine (per gram of creatinine) as a biological monitoring parameter. The monitoring took place during two different years, 1989 and 1990. In the 1989 study, 23 workers were divided into two groups: in group A, workers were asked to use new gloves every four weeks of work whereas in group B workers changed gloves as needed as per normal operating procedure. In the 1990 study, a total of 41 linemen were monitored in three different locations. Control groups consisted of administration workers.

Spot urine samples were collected approximately once per month with samples being collected prior to the second to last shifts of the work week (Thursday afternoons or Friday mornings). It has been noted that the results of the urinary sampling have been corrected for field recovery, however, no raw data was available, nor were any descriptions of field recovery methods or results available for review.

In the study, neither the urine volume nor the total gram creatinine collected was reported. Total daily exposure to pentachlorophenol was estimated using the spot sample values (ug PCP/g creatinine) multiplied by an assumed total daily creatinine output of 2.1 g creatinine/day. This estimate of daily urinary excretion of creatinine was taken from the study "Inhalation dosimetry and biomonitoring assessment of worker exposure to pentachlorophenol during pressure-treatment of lumber" study. In this study the average amount of creatinine excreted per day was 2.1 g with a standard deviation of 0.64 (n= 63)

The urinary value of  $\mu\text{g PCP /day}$  is also corrected for an 86% metabolism factor, which was also used to correct the results from the pressure treatment biological monitoring data, based on a single dose oral study in humans (*Braun et al, 1979*) and is also normalized for a 70 kg body weight.

$$\mu\text{g PCP/kg bw/day} = \frac{\mu\text{g PCP}}{\text{g creatinine}} * \frac{\text{g creatinine}}{\text{Day}} * \frac{100}{86} * \frac{1}{70\text{kg}}$$

In addition to the spot samples presented in the study, data from a preliminary study in 1989 were also submitted. These are the results of spot samples of PCP in urine (ug/L urine) during winter (Jan) and summer (Aug). No creatinine measurements were performed with these results and therefore these data were not combined with the other results, however, there was a trend of higher pentachlorophenol values in the summer versus the winter.

A general trend was observed in the data which indicated that higher levels of pentachlorophenol in urine were observed in July, Aug and Sept. The short- and

intermediate-term assessments are based on the higher levels absorbed in the summer months (i.e. August). The mean advanced dose in August was 0.00187 mg/kg/day. For the purposes of this review, an average daily exposure estimate per year was derived by using the existing data to extrapolate to periods when sampling was not performed. The mean long-term absorbed was 0.00098 mg/kg/day. As all individuals did not have samples taken during every month of the sampling period, the months during which no samples were taken were estimated by averaging the urinary values before and after the missing month. For example, if a July sample was not taken for a specific individual, the June and August measurements were averaged to estimate this value. In the case of the winter months (October to May) when no samples were taken, based on the preliminary test results and the trend in the data, it was assumed that these exposure values would be lower than the peak months of summer. Therefore, to estimate the values for the winter months, the urinary values from the earliest sample in spring/summer and the latest value for fall were averaged and this value was applied to all winter months without samples. An estimate of total daily exposure over a year was calculated by taking the average over all months.

The control group's exposure was low in all locations except for one sample that the author related to low creatinine measurements.

#### **Limitations:**

- Limited information is available on method validation and QA/QC. No field recovery results reported.
- Spot samples were taken instead of 24 hours urine collections.
- All samples were collected once a month, however time of collection was not consistent
- No description of the material used in the collection tube and possible interferences with pentachlorophenol is provided.
- No details were given on specific work functions performed by test subjects (e.g. schedules, number of poles handled per day). Personal information about the participants was also not provided (e.g. body weight, age).

#### **Post-application Risk Characterization**

Both non-cancer and cancer were assessed for the workers at pressure treatment facilities and for the electrical utility linemen. Table 6 indicates the short-, intermediate-, and long-term absorbed dose from the biological monitoring studies for PCP for the three pressure treatment post-application scenarios and the electrical utility linemen scenario. Table 6 also presents non-cancer and cancer risks. Communication between EPA and the California Environmental Protection Agency indicates that the absorbed doses monitored for the pressure treatment facility workers should be further adjusted (increased) for acute exposure (CDPR 1999). This is due in part because "PCP cannot reach a steady-state in an acute toxicity study (Braun 1979)." EPA will,

therefore, increase the short-term absorbed doses three-fold to account for acute exposure effects.

Post-application cancer risks were calculated in the same manner as for handlers. The exposure durations and lifetime values used were the same as for handlers. Exposure frequency was assumed to be 250 days/year (i.e., standard annual working frequency) Estimated cancer risks from the total absorbed dose from the biological monitoring studies are also presented in Table 6.

The following formula describes the calculation of the lifetime average daily dose:

$$\text{Lifetime Ave Daily Dose} \left( \frac{\text{mg ai}}{\text{kg/day}} \right) = \left( \frac{[\text{AbsLongTermDose}(\text{mg/kg/day})] \times \text{Expos Freque}(\text{days/yr}) \times \text{Expos Duration}(\text{yrs})}{365 \text{ days/yr} \times \text{Lifetime}(\text{yrs})} \right)$$

Risk was calculated by multiplying the lifetime average daily dose times the cancer slope factor of  $0.07 \text{ (mg/kg/day)}^{-1}$  using the following formula:

$$\text{Risk} = \text{LADD} \left( \frac{\text{mg ai}}{\text{kg/day}} \right) \times \text{Cancer Slope Factor} \left( \frac{1}{\text{mg/kg/day}} \right)$$

### **Post-application Non-Cancer Risk Estimates and Characterization**

Acute, sub chronic, and chronic oral toxicity endpoints related to dermal and inhalation exposures and risks to pentachlorophenol have been identified. MOEs greater than 100 for pentachlorophenol are considered to indicate no risk concern for short-term and intermediate-term exposures, and a MOE greater than 300 is considered to indicate no risk concern for chronic exposures. The long-term MOE of 300 was based on the use of a LOAEL value instead of a NOAEL value. The results of Table 6 are summarized in the following bulleted categories.

The calculations of short-term and intermediate-term risks indicate that MOEs are more than 100 at **baseline** for the following scenarios:

- Pressure Treatment Loader Operator;
- Pressure Treatment Borer;
- Pressure Treatment General Helpers; and
- Electrical utility linemen.

The calculations of chronic risks indicate that MOEs are more than 300 at **baseline** for the following scenarios:

- Pressure Treatment Loader Operator;
- Pressure Treatment Borer; and
- Pressure Treatment General Helpers.
- Electrical utility linemen.

### **Post-application Cancer Risk Estimates and Characterization**

Carcinogenic endpoints related to the total absorbed dose of pentachlorophenol have been identified. A risk greater than E-6 is of concern to be mitigated and risks greater than E-4 are generally considered unacceptable. The results in Table 6 indicate that cancer risks are greater than E-5 for pressure treatment loader operator ( $6.9E-5$ ), pressure treatment test borer ( $6.1E-5$ ), general helpers ( $3.6E-5$ ), and electrical utility linemen ( $2.5E-5$ ).

**Table 6. Pentachlorophenol- Occupational Post-application [Absorbed Dose from the Biological Monitoring Study]**

Exposure Scenario	Absorbed Short-Term Dose (mg/kg/day) <sup>a</sup>	Absorbed Intermediate-Term Dose (mg/kg/day) <sup>b</sup>	Absorbed Long Term Dose (mg/kg/day) <sup>c</sup>	Lifetime Average Daily Dose (mg/kg/day) <sup>d</sup>	Short-Term MOE <sup>e</sup>	Intermediate-Term MOE <sup>e</sup>	Chronic MOE <sup>f</sup>	Cancer Risk <sup>g</sup>
Pressure Treatment Loader Operator (1)	0.025	0.0084	0.0027	0.00098	1,200	3,600	560	6.9E-05
Pressure Treatment Borer (2)	0.016	0.0053	0.0024	0.0008	1,900	5,700	630	6.1E-05
Pressure Treatment General Helpers (3)	0.0066	0.0022	0.0014	0.00058	4,500	14,000	1,100	3.6E-05
Electrical Utility Linemen) (4)	0.0019	0.0019	0.00098	0.00036	16000	16000	1500	2.5E-05

- a Based on maximum absorbed doses adjusted based on increasing the maximum absorbed dose reported in the PCP biodosimetry study by 3 times to correct for the cumulative effects of an 8-day steady-state excretion.
- b Based on maximum absorbed doses.
- c Based on average absorbed doses.
- d Lifetime Average Daily Dose (LADD) = [(Abs. Long Term Dermal Dose) x Exposure Frequency (e.g. 250 working days) x Exposure Duration (e.g. 40 working years in a lifetime)] / [(365 days/yr x Lifetime (e.g., 75 yrs)]
- e Short and Intermediate-term NOAEL (30 mg/kg/day) Short and Intermediate Dose. Target MOE=100.
- f Long-term LOAEL (1.5 mg/kg/day) Long-term Dose. Target MOE=300.
- g LADD x Cancer Slope Factor (0.07 mg/kg/day)

## **Residential Exposure and Risk Characterization**

Population-based biological monitoring data from the National Health and Nutrition Surveys (NHANES) are available to assess the exposure of the general population to PCP. The NHANES data provides an encompassing review of all PCP exposures; the specific PCP-treated wood contribution to total PCP exposure can not be differentiated. Because NHANES does not include exposures to children under the age of 6 years old, the Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP) study (Wilson, et al. 2007) was used to include estimates of exposures to children under 6 years old.

Sources of PCPs other than the currently registered pressure treatment of wood include hexachlorobenzene and lindane as well as an emission from incineration of chlorine-containing waste and also during pyrolysis of polyvinyl chlorides (ATSDR 2001). In the past, PCP was also registered as a termiticide, fungicide, herbicide, molluscicide, algicide, disinfectant, and for antifoulant paint. It was also used as a preservative for timber used in the construction of log homes. The use of PCP was restricted to wood treatment in 1984. In 2003 PCP was further restricted to pressure treatments only; all non pressure wood treatments were removed from the labeled uses during this Reregistration Eligibility Decision (RED) process.

### **NHANES Data and Dose Conversion**

The following information has been excerpted from Cohen (2008). Since the 1960s, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention has conducted the National Health and Nutrition Surveys (NHANES), a series of US national surveys of the health and nutrition status of the non-institutionalized civilian population. NHANES 2001 to 2002 included laboratory measurements on 9,929 subjects. This analysis uses urinary concentrations of pentachlorophenol measured in urine spot samples of at least 20 mL collected from a random one-third sample of 3,028 subjects of ages 6 and older. The dose conversion calculations also used the NHANES measurements of creatinine concentrations, body weight, body height, as well as the age, gender, and race of each subject. The NHANES 2001-2002 data were obtained from the NHANES website: [www.cdc.gov/nchs/nhanes.htm](http://www.cdc.gov/nchs/nhanes.htm). Although pentachlorophenol data have been collected for the 2003-2004, these data have not yet been publicly released. The data are expected to be released by the end of 2008.

EPA evaluates health effects in terms of toxicity endpoints that represent an exposure level in mg or  $\mu\text{g}$  per kilogram body weight that is not expected to be associated with adverse health effects. The conversion of measured spot urine concentrations to daily doses can be difficult because of variable dilution caused by wide fluctuations in fluid intake and excretion. Dose calculation is also difficult because there is no way to determine from the NHANES data from what route of exposure (i.e., oral, dermal, inhalation) and when (i.e., duration and time interval prior to measurement) the exposure to

PCP occurred, and because of uncertainty and variability in the absorption, distribution, metabolism, and excretion (ADME) parameters. If NHANES collected total daily urine excretion for each participant, then that participant's dose could be more accurately estimated by multiplying the PCP concentration by the total daily urine volume and then dividing by the body weight. However, NHANES only collected spot urine samples so that total urine volume was not measured.

In the absence of total urine volume data, various methods have been proposed to estimate the dose from the measured spot urine concentration. The methods have been categorized into two main groups: one that uses measured pesticide concentrations in urine directly and the other that standardizes urinary concentrations on the basis of creatinine, a by-product of metabolism. There is some debate on whether creatinine excretion is less variable (i.e., more consistent within an individual) than urinary output. Therefore, at this time, results of both methods are presented. The dose conversion methods are summarized below:

- Mage et al. (2004, 2007) use the estimated daily creatinine excretion for specific individuals based on their anthropometric measurements and demographic characteristics (e.g. age, sex, race (Black, non-Hispanic or not), height, weight, and obesity (based on the BMI)). The PCP concentration is divided by the creatinine concentration in the urine, multiplied by the estimated daily creatinine excretion in  $\mu\text{g}/\text{day}$  specific to the individual being considered, and divided by the body weight.
- Schafer et al. (2004) use the estimated daily urine excretion in L/day and the average body weight for a demographic group; the PCP concentration is multiplied by the daily urine excretion in L/day, and divided by the average body weight. Because the raw data were available in NHANES, actual (measured) body weights of subjects were used instead of average body weights as described by Schafer et al. (2004).
- The EPA Office of Research and Development (ORD) does not currently recommend any single approach for converting spot urine concentration to a dose. However, the approach used by some ORD researchers is to use the estimated daily urine excretion in L/kg-day (as opposed to L/day above) for a demographic group; the PCP urinary concentration is multiplied by the estimated daily urine excretion in L/kg-day. Two variations of this approach are used. Both mean and the 95<sup>th</sup> percentile urine volumes from Geigy (1981) were used in this method.

Detailed procedures and assumptions used by EPA/OPP/AD to convert spot urine concentrations into dose to assess the PCP risks are provided by Cohen (2008). Cohen (2008) provided the dose conversion from spot urine samples and also corrected for the pharmacokinetics of PCP. The pharmacokinetics of PCP have been accounted for in the dose estimate using the results of a pharmacokinetic study (Braun et al., 1978) that estimated 86% of PCP is excreted in urine.

Several uncertainties exist in the residential exposure assessment for PCP that is based on using the biological monitoring using spot urine samples from NHANES. Therefore, EPA used conservative assumptions to err on the side of overestimating the potential dose. Conservatism used in the assessment include: (1) assumptions used by Cohen (2008) for one of the methods used for the dose conversion (e.g., 95<sup>th</sup> percentile of urinary volume assumed for all individuals); (2) exposures to PCP can not be differentiated from the contribution from PCP-treated wood, and therefore, the exposures and risks presented overstate the risks to the antimicrobial registered use as a wood preservative; and (3) the inclusion of these conservative assumptions even at the upper percentile of exposure. Future refinements to using the NHANES data for the PCP risk assessment should focus on refining these parameters. The following uncertainties and data limitations are noted for the residential assessment:

- It is assumed that the ADME parameters are the same across all individuals within the NHANES study and are constant within individuals over time.
- NHANES urinary metabolite concentration data are not collected in a way to directly determine the dose, and CDC has not reported dose estimates for PCP based on NHANES measurement data. In order to determine how sensitive the estimated dose was to urinary excretion volume, one of the dose conversion methods (Geigy 1981 95% urine volume upper bound estimate) is used to estimate a 24 hour urinary excretion volume for all individuals in the NHANES data set.
- Dose calculation is also difficult because there is no way to determine from the NHANES data from what route of exposure (i.e., oral, dermal, inhalation) and when (i.e., duration and time interval prior to measurement) the exposure to PCP occurred. Therefore, it is assumed that the levels of PCP are a constant daily exposure (e.g., contact with contaminated house dust, soil, etc.) and that they represent people being exposed on a long-term basis.

### **CTEPP Data and Dose Conversion**

CTEPP studied 50+ chemical exposures to 257 preschool children ages 1.5 to 5 years old (Wilson et al. 2007). PCP was one of the chemicals analyzed in the urine of these children. Specific details on the observational design and sampling methodology of the CTEPP study are provided by Wilson (2004). The randomly designed observational sampling of the children took place in North Carolina (NC) and Ohio (OH). Potential sources of PCP exposure were not recorded during the study.

The results of the urine PCP monitoring are also reported as a urine concentration (ng/mL). For the samples taken in NC, 128 of the samples were analyzed for PCP of which 89 percent showed detectable levels with mean of 0.605 +/- 0.629 ng/mL. The OH sampling included 126 samples analyzed for PCP of which 99 percent had detectable levels with a mean of 1.27 +/- 2.2 ng/mL. These urine concentrations were converted to a dose using 22.4 mL/kg BW for the non-cancer risk estimates and by the Geigy (1981) mean daily urinary excretion in Cohen (2008) for the estimation of the lifetime average daily dose (LADD).

## Uncertainties in NHANES and CTEPP Studies

In addition to the uncertainties in the spot urine concentration to dose conversion, there are also uncertainties in the collection of general population biological monitoring samples in the NHANES and CTEPP studies. Uncertainties associated with the data collection to consider in the residential assessment include:

- There are multiple sources of PCP exposure, not all of which are attributable to PCP-treated wood. Other sources discussed in ATSDR (2001) include hexachlorobenzene and lindane as well as an emission from incineration of chlorine-containing waste and also during pyrolysis of polyvinyl chlorides. PCP was registered as a termiticide, fungicide, herbicide, molluscicide, algicide, disinfectant, and for antifoulant paint but these uses have been removed. It was also used as a preservative for logs used in the construction of log homes. The use of PCP was restricted to wood treatment in 1984. In 2003 PCP was further restricted to pressure treatment only; all non pressure wood treatments were removed from the label during this Reregistration Eligibility Decision (RED) process. Other sources of PCP exposure in the environment contributing to exposure can not be differentiated from the existing labeled uses (i.e., pressure treatment of wood such as poles). Therefore, to be conservative, the exposures monitored in NHANES and CTEPP were not adjusted to account for other potential sources. Further refinements to the risks should be made to determine the contribution of exposure to PCP from treated wood to the total PCP exposure monitored in individuals sampled in NHANES and CTEPP.
- Incidental exposures from directly contacting treated poles may or may not be included in the NHANES and/or CTEPP biological monitoring surveys. Most likely an activity that is expected to be episodic such as contacting PCP-treated wood may not have occurred during the NHANES or CTEPP study period. However, incidental exposures that are intermittent would not substantially affect the lifetime average daily dose (LADD) or the long-term non cancer risks. The impact on the LADD for an episodic exposure is small in comparison to the daily exposure over a 75 year lifetime as assumed in this assessment.
- The age groups sampled in both CTEPP and NHANES did not include exposures to infants of nursing age. Given the relatively low levels of PCP found in the NHANES adult female population, the potential contribution of contaminated-breast milk would not substantially affect the lifetime average daily dose (LADD). The non-cancer risks (MOEs) for the 1.5 to 5 year olds monitored in the CTEPP study also provide a large margin of exposure to account for additional dose contribution from nursing.
- Potential exposures in the vicinity of wood treatment plants are most likely not represented in the NHANES and/or CTEPP studies. Dahlgren (2007) reports biological monitoring of residents within 2 miles of a wood treatment plant that is on the EPA's "*Facilities on the RCRA GPPRA Cleanup Baseline*". This report indicates that blood levels of octachlorodibenzo-p-dioxin (OCDD) and

chlorodibenzo-p-dioxin (HpCDD) are elevated approximately 3x higher than an unexposed population (i.e., population not adjacent to a wood treatment plant).

- The contribution from each of the three routes of exposure (oral, dermal, inhalation) is unknown. Wilson et al (2007) also monitored concentrations of PCP in environmental media (e.g., air, dust, soil, hand wipes, food, and drinking water). Wilson et al (2007) suggested that PCP exposure was predominantly by the inhalation route but that the estimated exposures from the environmental media were exceeded by the exposures measured via the biological monitoring and indicated the need for further research on the exposure assessment parameters. This assessment is based on the highest exposure estimate (i.e., the results of the biological monitoring) and is compared to the most sensitive toxicological endpoints (i.e., exposure is assumed to occur daily over a long-term duration).
- It is assumed that exposure frequency occurs daily (i.e., 365 days per year) at the levels monitored in NHANES and CTEPP and that the daily exposures continue for the entire lifetime. Although this is the most conservative assumption, it also appears reasonable to assume that low levels of exposure to PCP are occurring on a daily basis.
- NHANES and CTEPP urine samples were analyzed for PCP, not HCB and dioxins. The HCB and dioxin cancer risk estimates provided herein are based on contaminant levels found in PCP from historical samples. Future contributions of these contaminants from new sources of PCP-treated wood are expected to be less than what is assumed in this assessment because the HCB and dioxin contaminant levels in PCP have been in decline. This decline has been indicated by industry data analysis of the contaminants like dioxins, furans, and HCB. Contaminant-level samples were collected by the industry for the 2007 Technical Penta batches. Lowering of the concentrations of these contaminants is likely due to the changes in the manufacturing process of the technical Penta as communicated to the Agency by the industry recently. Thus in turn lowered the values of TEFs and TEQs for 2007 samples compared to 1988-1999 and 2000-2004 samples. Adjustments to the cancer risk estimates for these contaminants can be made once the data are submitted and reviewed by EPA [For details see the PCP Product Chemistry Chapter for this risk assessment].

## **Non-Cancer Long-term Margin of Exposure (MOE) Residential Risk to PCP**

### **NHANES MOE Results**

The long-term LOAEL of 1.5 mg/kg/day, based on chronic hepatotoxicity effects from an oral chronic toxicity study in dogs with a target MOE of 300 to account for the lack of an established NOAEL, is used to assess the PCP non-cancer risks. The non-cancer risk drivers are for PCP, not HCB (i.e., PCP non-cancer risks are greater than those of HCB). Therefore, only the non cancer risks for PCP are provided. EPA/OPP/AD is following the outcome of the current EPA/ORD's body burden approach/research for the non-cancer risks to dioxin.

The NHANES data show that roughly 16 percent of the samples had detectable levels of PCP. Tables 7 and 8 provide – for each of the three basic concentration to dose conversion methods -- the mean and 99<sup>th</sup> percentiles, respectively, of the (1) spot urine concentration to dose conversion which includes the pharmacokinetic 86 percent corrected daily dose and long-term MOEs. Total exposures and risks from NHANES are presented for the following age groups and subpopulations:

- All age groups;
- Ages 6-11;
- Ages 12-19
- Ages 20-59
- Ages >=60
- Male
- Females
- Mexican-American
- White, non-Hispanic
- Black, non-Hispanic

The three basic conversion methods used in this risk characterization are (1) Mage et al (2007) with an obesity correction factor; (2) Schafer et al (2004) using actual body weights from subjects; and (3) Geigy (1981) values for both a mean and 95<sup>th</sup> percentile of daily urine excretion volume. The mean MOEs range from 48,000 to 230,000. The MOEs at the 99<sup>th</sup> percentile of the dose range from 3,100 to 16,000. In conclusion, even with the considerable uncertainties in converting spot urine concentration to dose, the NHANES data as conservatively analyzed for PCP (e.g., assuming all PCP exposure results from PCP-treated poles, presentation of various dose conversion methods including the assumption that all individuals excrete a daily urine volume of the 95<sup>th</sup> percentile of the population) sufficiently characterizes the total risks as meeting the definition of not resulting in unreasonable adverse effects from the wood preservative use.

### **CTEPP MOE Results**

The long-term oral LOAEL of 1.5 mg/kg/day with a target MOE of 300 to account for the lack of an established NOAEL is used to assess the non-cancer risks to children 1.5 to 5 years old. The CTEPP data indicate 89 and 99 percent of the samples had detectable levels of PCP in NC and OH, respectively. Table 9 provides the mean and maximum value of the spot urine concentration to dose conversion which includes the pharmacokinetic corrected (i.e., 86 percent correction) daily dose and long-term MOEs. The highest dose monitored in the study indicates a MOE of 2,400.

**Table 7. PCP Long-term Risks (MOEs) Based on NHANES Mean Urine Concentrations Converted to Dose.**

Group	Method: Mage (2007) Obese Correct- based Dose <i>[Creatinine Correction]</i>			Method: Schafer (2004) Actual BW- based Dose <i>[Urinary Volume Correction]</i>			Method: Geigy 1981 <i>[Urinary Volume Correction]</i> Mean Urine Volume-based Dose					95% Urine Volume-based Dose		
	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	ug/kg	mg/kg/day	MOE
All	0.011	0.000011	131509	0.014	0.000014	107120	0.014	0.000014	109828	0.021	0.000021	0.021	0.000021	70730
6-11	0.014	0.000014	106905	0.018	0.000018	84274	0.015	0.000015	100162	0.022	0.000022	0.022	0.000022	69544
12-19	0.012	0.000012	126568	0.015	0.000015	102076	0.017	0.000017	88763	0.026	0.000026	0.026	0.000026	58512
20-59	0.011	0.000011	136078	0.013	0.000013	113667	0.013	0.000013	117378	0.020	0.000020	0.020	0.000020	74329
>= 60	0.011	0.000011	137686	0.014	0.000014	105012	0.014	0.000014	109907	0.021	0.000021	0.021	0.000021	69980
Male	0.010	0.000010	147152	0.014	0.000014	107627	0.013	0.000013	114591	0.020	0.000020	0.020	0.000020	75512
Female	0.013	0.000013	119363	0.014	0.000014	106638	0.014	0.000014	105603	0.023	0.000023	0.023	0.000023	66666
Mexican- American	0.007	0.000007	228041	0.007	0.000007	209441	0.007	0.000007	207983	0.011	0.000011	0.011	0.000011	134690
White, Non- Hispanic	0.011	0.000011	133400	0.014	0.000014	107230	0.014	0.000014	110945	0.021	0.000021	0.021	0.000021	71396
Black, Non- Hispanic	0.015	0.000015	100782	0.020	0.000020	74445	0.020	0.000020	74170	0.031	0.000031	0.031	0.000031	47774

See Cohen (2008) for details of the dose conversion methods (Mage 2007 is based on creatinine excretion correction and both Schafer (2004) and Geigy 1981 are based on urine volume excretion corrections).

Groups (demographics) are based on the available data in NHANES ages 6+ years old.

Doses in units of ug/kg/day are based on the spot urine conversions to daily dose corrected for the pharmacokinetics of PCP (86 percent).

Doses in units of mg/kg/day = [dose (ug/kg/day) x 0.001 mg/ug unit conversion].

Geigy (1981) 95% urine volume is the upper percentile of daily urine volume.

MOE = PCP LOAEL (mg/kg/day) / dose (mg/kg/day). Where the long-term PCP LOAEL is 1.5 mg/kg/day and Target MOE is 300.

**Table 8. PCP Long-term Risks (MOEs) Based on NHANES 99<sup>th</sup> Percentile Urine Concentrations Converted to Dose.**

Group	Method: Mage (2007) Obese Correct- based Dose <i>(Creatinine Correction)</i>				Method: Schafer (2004) Actual BW- based Dose <i>(Urinary Volume Correction)</i>				Method: Geigy 1981 <i>(Urinary Volume Correction)</i>						
	Mean Urine Volume-based Dose		95% Urine Volume-based Dose		Mean Urine Volume-based Dose		95% Urine Volume-based Dose		Mean Urine Volume-based Dose		95% Urine Volume-based Dose				
	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	MOE	ug/kg	mg/kg/day	MOE
All	0.219	0.00022	6865	0.201	0.00020	7466	0.205	0.00021	7315	0.315	0.00031	4763	0.205	0.00021	7315
6-11	0.219	0.00022	6865	0.209	0.00021	7183	0.189	0.00019	7926	0.276	0.00028	5427	0.189	0.00019	7926
12-19	0.128	0.00013	11738	0.179	0.00018	8390	0.182	0.00018	8259	0.293	0.00029	5112	0.182	0.00018	8259
20-59	0.306	0.00031	4900	0.285	0.00029	5262	0.258	0.00026	5804	0.397	0.00040	3779	0.258	0.00026	5804
>= 60	0.121	0.00012	12347	0.191	0.00019	7841	0.173	0.00017	8648	0.266	0.00027	5631	0.173	0.00017	8648
Male	0.128	0.00013	11738	0.177	0.00018	8495	0.155	0.00016	9655	0.239	0.00024	6287	0.155	0.00016	9655
Female	0.306	0.00031	4900	0.235	0.00023	6388	0.241	0.00024	6219	0.390	0.00039	3849	0.241	0.00024	6219
Mexican- American	0.093	0.00009	16199	0.083	0.00008	18114	0.087	0.00009	17269	0.140	0.00014	10688	0.087	0.00009	17269
White, Non- Hispanic	0.230	0.00023	6517	0.177	0.00018	8495	0.155	0.00016	9655	0.239	0.00024	6287	0.155	0.00016	9655
Black, Non- Hispanic	0.138	0.00014	10836	0.288	0.00029	5217	0.295	0.00030	5079	0.477	0.00048	3143	0.295	0.00030	5079

See Cohen (2008) for details of the dose conversion methods (Mage 2007 is based on creatinine excretion correction and both Schafer (2004) and Geigy 1981 are based on urine volume excretion corrections).

Groups (demographics) are based on the available data in NHANES ages 6+ years old.

Doses in units of ug/kg/day are based on the spot urine conversions to daily dose corrected for the pharmacokinetics of PCP (86 percent).

Doses in units of mg/kg/day =  $\text{ldose (ug/kg/day)} \times 0.001 \text{ mg/ug unit conversion}$ .

Geigy (1981) 95% urine volume is the upper percentile of daily urine volume.

MOE =  $\text{PCP LOAEL (mg/kg/day)} / \text{dose (mg/kg/day)}$ . Where the long-term PCP LOAEL is 1.5 mg/kg/day and Target MOE is 300.

**Table 9. PCP Long-Term Non-Cancer (MOE) Estimates from CTEPP.**

Scenario	Urine Concentration (ng/nL)		Dose (mg/kg/day)		MOEs (Long-term)	
	Mean	maximum	Mean	Maximum	Mean	Maximum
NC (n=128)	0.605	3.45	1.6E-5	9.0E-5	95,000	17,000
OH (n=126)	1.27	23.8	3.3E-5	6.2E-4	45,000	2,400
Urine concentration and daily urine volume from Wilson et al 2007. (CTEPP study children ages 1.5-5 years old)						
Daily urine volume (mL/kg BW) from Wilson et al 2007.						
Dose (mg/kg/day) = urine conc (ng/mL) / 0.86 PK correction x urine volume (mL/kg/day) / 1,000,000 ng/mg.						
MOE = LOAEL mg/kg/day / Dose mg/kg/day where long-term LOAEL = 1.5 mg/kg/day. Target MOE is 300.						

## Cancer Residential Risk Assessment to PCP/HCB/Dioxin

### Lifetime Average Daily Dose (LADD)

The lifetime average daily dose (LADD) is estimated by combining the results of both the CTEPP and NHANES data sets. The LADD is estimated by averaging the estimated daily dose for each year in a lifetime of 75 years. This assumes the frequency and lifetime duration of exposure is constant (i.e., exposed 365 days per year and 75 years of exposure). CTEPP data are used to estimate the ages 0 to 5 years and NHANES is used to estimate ages 6 to 75 years. In addition to the LADD, the 95<sup>th</sup> percent lower and upper confidence intervals are also provided for the means. A detailed description of the LADD estimate combining both CTEPP and NHANES data sets are provided in Cohen (2008).

### PCP LADD

As described above, there are other sources of PCP exposure that are not attributable to PCP pressure treated wood. However, the general population biological monitoring data do not allow for the proportioning of exposure to source of contamination. Therefore, the exposures and risks reported in this assessment are based on the total exposure to PCP. Future refinements to this assessment should focus on determining contributions of sources to total PCP exposure.

### HCB LADD

Direct measurements of HCB exposures for the general population attributed to PCP pressure treated wood are not available for this assessment. Therefore, to be inclusive

of determining potential exposures to PCP contaminants, the amount of HCB in PCP is used to extrapolate PCP measured exposures to estimated HCB exposures. HCB is present in PCP at a concentration of 75 ppm. To estimate the HCB LADD, the LADD for PCP is multiplied by the HCB conversion factor (i.e., 1 mg/kg/day PCP x 75 ng HCB/mg PCP x 1 mg/1,000,000 ng unit conversion = 0.000075).

### **Dioxin LADD**

Direct measurements of dioxin exposures for the general population attributed to PCP pressure treated wood are also not available for this assessment. Therefore, to be inclusive of determining potential exposures to PCP contaminants, the amount of TEQ dioxin in PCP is used to extrapolate PCP measured exposures to estimated TEQ dioxin exposures. TEQ dioxin is present in PCP at a concentration of 0.413 ng TEQ dioxin/mg PCP (Van den Berg et al, 2006). To estimate the TEQ dioxin LADD, the LADD for PCP is multiplied by the TEQ dioxin conversion factor (i.e., 1 mg/kg/day PCP x 0.413 ng TEQ dioxin/mg PCP x 1 mg/1,000,000 ng unit conversion = 4.13E-7).

### **1.5.2 Cancer Risks Results (PCP/HCB/Dioxin)**

The potential cancer risk estimates for PCP, HCB, and dioxin are presented in Table 10. These potential risks are the product of the assumptions and uncertainties described above. The results of the assessment indicate that the cancer risks from the three contaminants do not exceed 1E-6. The risks for PCP, HCB, and dioxin are 9.8E-7, 1.1E-9, and 5.8E-7, respectively. The risks at the 95th percent upper confidence interval for PCP, HCB, and dioxin are 1.5E-6, 1.6E-9, and 8.7E-7, respectively.

<b>Table 10. Cancer Risk Estimates for PCP/HCB/Dioxin.</b>			
<b>Data Source</b>	<b>Statistic</b>	<b>LADD mg/kg/day</b>	<b>Cancer Risk</b>
<b>NHANES &amp; CTEPP</b>	<b>PCP Cancer Risk Estimates</b>		
	mean	0.000014	9.8E-7
	95% LCI	0.000007	4.9E-7
	95% UCI	0.000021	1.5E-6
	<b>HCB Cancer Risk Estimates</b>		
	mean	1.05E-9	1.1E-9
	95% LCI	5.25E-10	5.4E-10
	95% UCI	1.58E-9	1.6E-9
	<b>Dioxin Cancer Risk Estimates</b>		
	mean	5.8E-12	5.8E-7
	95% LCI	2.9E-12	2.9E-7
	95% UCI	8.7E-12	8.7E-7

PCP LADD (ug/kg/day) is from Cohen PCP computations memo dated July 31, 2008.

HCb LADD (mg/kg/day) = PCP LADD (mg/kg/day) x 75 ng HCB/mg PCP x 1 mg/1,000,000 ng unit conversion  
Dioxin LADD (mg/kg/day) = PCP LADD (mg/kg/day) x 0.413 ng Dioxin/mg PCP x 1 mg/1,000,000 ng unit conversion  
Cancer risk = CSF (mg/kg/day)<sup>-1</sup> x LADD (mg/kg/day); where cancer slope factors (CSF) for PCP = 0.07 (mg/kg/day)<sup>-1</sup>, HCB = 1.02 (mg/kg/day)<sup>-1</sup>, and dioxin 1E+5 (mg/kg/day)<sup>-1</sup>.

## **References**

Arsenault RD. 1976. Pentachlorophenol and Contained Chlorinated Dibenzodioxins in the Environment. Alexandria, VA: American Wood Preservers Association (AWPA), 122-147.

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. Toxicological Profile for Pentachlorophenol. Prepared by Clement International Corporation Contract No. 205-88-0608. Prepared for U.S. Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. May 1994.

Braun, W.H.; Blau, G.E.; Chenoweth, M.B. 1979. The Metabolism/Pharmacokinetics of Pentachlorophenol in Man, and a Comparison with Rat and Monkey. In: Toxicology and Occupational Medicine (Deichmann, W.E., ed.). Elsevier/North Holland, New York, Amsterdam, Oxford. Pp. 289-296.

Brodberg, R.K. and Thonginthusak, T. 1995. AEstimation of Exposure of Persons in California to Pesticide Products Containing Pentachlorophenol.@ Worker Health and Safety Branch. California Department of Pesticide Regulation. Sacramento, CA. March 1995.

CDPR. 1999. Comments on the Pentachlorophenol (PCP) Task Force=s Biomonitoring Study. Memorandum from Michael H. Dong, Staff Toxicologist to John H. Ross, Senior Toxicologist. California Environmental Protection Agency. Department of Pesticide Regulation. August 13, 1999.

Coad, C. and Newhook, R, 1992. APCP Exposure for the Canadian General Population: A Multimedia Analysis.@ Journal of Exposure Analysis and Environmental Epidemiology, Vol 2, No. 4.

Cohen J. 2008. Computations of Human Pentachlorophenol Dose Based On NHANES Urine Concentrations. Memorandum from Dr. Jonathan Cohen, ICF International to Tim Leighton and David Miller, USEPA, dated July 31, 2008. Contract EP-W-06-091, WA 0-02, TAF CM 28.

Dahlgren et al. 2007. Residential and biological exposure assessment of chemicals from a wood treatment plant. *Chemosphere* 67 (2007) S279-S285.

Electric Power Research Institute (EPRI) 1995. Pentachlorophenol (PCP) in Soils Adjacent to In-Service Utility Poles in New York State. March 1995. EPRI TR-104893.

Geigy. 1981. *Geigy Scientific Tables, Volume 1. Units of measurement, body fluids, composition of the body, nutrition*. Eighth edition. (Edited by C. Lentner). CIBA-GEIGY. IBC, 1999. Pentachlorophenol Uses for the following products. Memorandum from Gail Early, Registrations Representative, IBC Manufacturing Company to Connie B. Welch, Chief, Regulatory Branch II, Antimicrobial Division, U.S EPA Office of Pesticide Programs. September 10, 1999.

Mage D.T., Allen R., Gondy G., Smith W., Barr D.B., Needham L.L. 2004. Estimating Pesticide Dose from Pesticide Exposure Data by Creatinine Correction in the Third National Health and Nutrition Examination Survey (NHANES-III). *J Exposure Anal Environ Epidemiol* 14:457-465.

Mage D.T., Allen, R.H., Kodali, A. 2007. Creatinine corrections for estimating children's and adult's pesticide intake doses in equilibrium with urinary pesticide and creatinine concentrations. *J Exposure Sci Environ Epidemiol* 1-9.

Pekari, K.; Liotamo, M.; Jarvisalo, J.; Lindroos, L.; Aito, A. 1991. Urinary Excretion of Chlorinated Phenols in Saw-Mill Workers. *Int. Arch. Occup. Environ. Health.* 63(1): 57-62.

Pentachlorophenol Task Force. 1999. Inhalation Dosimetry and Biomonitoring Assessment of Worker Exposure to Pentachlorophenol During Pressure Treatment of Lumber. Sponsor Vulcan Chemicals, Washington, DC. AASI Study No. AA980307. MRID 44813701.

Pentachlorophenol Task Force. 1999. Re: Response to Comments on Penta Biomonitoring Study. Memorandum from E. John Wilkinson to Michael H. Dong. Vulcan Chemicals. October 22, 1999.

Personal Communication, 1998. Personal Communication with Dr. Timothy McMahon, Toxicologist.  
U.S. EPA. Risk Assessment Science Support Branch. Antimicrobial Division. July 1998.

Schafer, K.S., Reeves, M., Spitzer, S., Kegley, S. E. 2004. Chemical Trespass: Pesticides in Our Bodies and Corporate Accountability. Pesticide Action Network North America. May 2004.

The Merk Manual of Diagnosis and Therapy. 1977. Eds: Berkonw, R. and Talbott, J.H. Rahway, NJ: Merck, Sharp and Dohme Research Laboratories.

Thind, K.S., Karmali, S., and House, R.A., 1991. Occupational Exposure of Electrical Utility Linemen to Pentachlorophenol. American Industrial Hygiene Association Journal 52:547-552.

Treble, R.G. and Thompson, T.S. 1996. Normal Values for Pentachlorophenol in Urine Samples Collected from a General Population. J. Anal. Toxicol. 20(5):313-317.

U.S. EPA 1986. Pentachlorophenol in Log Home: A Study of Environmental and Clinical Aspects. Office of Toxic Substances. Washington, DC. EPA-560/5-87-001. December, 1986.

U.S. EPA 1989. Risk Assessment Guidance for Superfund. Vol I. Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/002.

U.S. EPA. 1997. Pentachlorophenol-Report of the Hazard Identification Assessment Review Committee. December 8, 1997.

U.S. EPA . 1998. Integrated Risk Information System (IRIS) database.

U.S. EPA. 1998. Series 875 - Occupational and Residential Exposure Test Guidelines, Group B - Postapplication Exposure Monitoring Test Guidelines, Version 5.4. Office of Pesticide Programs, Health Effects Division. February 1998.

U.S. EPA 2002. Child-Specific Exposure Factors Handbook. National Center for Environmental Assessment-Washington. Office of Research and development. USEPA. Washington D.C. 20460. EPA-600-P-00-002B, September 2002, interim Report.

Van den Berg et al, 2006. Review, The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Factors for Dioxins and Dioxin -Like Compounds. Toxicological Sciences 93 (2), 223-241.

Wilson et al 2004. Design and sampling methodology for a large study of preschool children's aggregate exposures to persistent organic pollutants in their everyday environments. Journal of Exposure Analysis and Environmental Epidemiology (2004) 14, 260-274.

Wilson et al. 2007. An observational study of the potential exposures of preschool children to pentachlorophenol, bisphenol-A, and nonylphenol at home and daycare. Environmental Research 103 (2007) 9-20.

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