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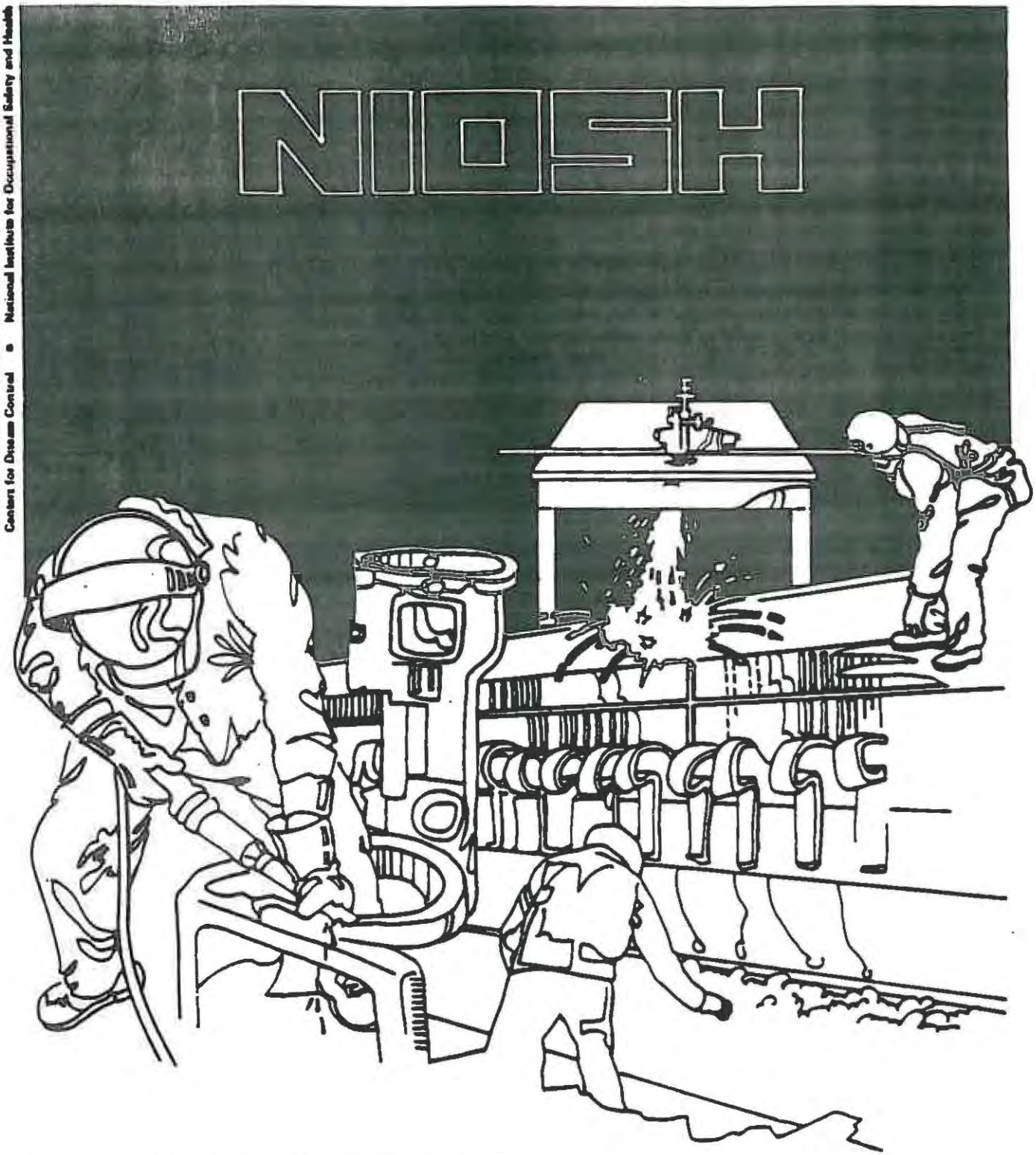

Health Hazard Evaluation Report

HETA 84-043,
HETA 84-425-1680
MONTANA LOG HOME RESIDENTS
KALISPELL, MONTANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 84-053
HETA 84-425-1680
April 1986
MONTANA LOG HOME RESIDENTS
KALISPELL, MONTANA

NIOSH INVESTIGATORS:
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I. SUMMARY

In November 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Montana Department of Health for assistance in evaluating exposures to pentachlorophenol (PCP) among Montana residents whose homes had been treated with wood preservatives containing PCP.

NIOSH and Montana H.D. investigators conducted evaluations of nine homes during November 29 - December 1, 1983, and six additional homes on August 14 - 16, 1984. Skin and wood surface wipe samples were collected along with air samples in each home. Urine samples were collected from all available residents.

No airborne PCP was detected (<7 ug/m^3) in any of the fifteen homes that were sampled. Wipe samples of wood surfaces contained up to 380 ng/cm^2 PCP. No PCP was detected in skin wipe samples. The 23 potentially exposed residents had urine PCP concentrations ranging up to 35 ug PCP/gram creatinine (g.Cre.) with a mean of 12 ug PCP/g.Cre. Seventeen urine samples from the control group ranged up to 11 ug PCP/g.Cre. with a mean of 4 ug/g.Cre.

Symptoms of known adverse health effects do not occur until urinary PCP concentrations exceed 150 ug/g Cre.

On the basis of the data obtained in this evaluation, it has been determined that there were no known health hazards due to PCP exposure in any of the homes that were studied at that time. Recommendations for reducing exposure are included in Section VII of this report.

KEYWORDS: Pentachlorophenol, PCP, Chlorophenols, Wood preservatives.

II. INTRODUCTION

In November 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Montana Department of Health and Environmental Sciences for assistance in evaluating exposures to pentachlorophenol (PCP) among northwest Montana residents whose homes had been treated with wood preservatives containing PCP.

During November 29 - December 1, 1983, NIOSH investigators conducted environmental and urine sampling in nine log homes and the results of that survey were sent to the Montana Department of Health on February 15, 1984. In June 1984, the Montana Department of Health and Environmental Sciences requested further assistance to develop their laboratory's ability to analyze air and urine samples for PCP and tetrachlorophenol (TCP).

On August 14-16, 1984, NIOSH and Montana Health Department investigators conducted side-by-side sampling for PCP and TCP in nine homes. Three of these had also been sampled during the earlier survey. The results of the follow-up survey were sent to the Montana Department of Health on January 28, 1985. The Health Department distributed the results of both surveys to the log home residents.

III. BACKGROUND

The 15 homes of this study were treated with wood preservatives by a variety of methods (Tables I and II). The most common product used by occupants who treated their own homes was "Nevarot", manufactured by Texas Refinery Corporation. It contains 4.4% PCP and 0.6% TCP and was used by seven of the homeowners. Another product used in one home was "Jasco Penta 40" which contains 34.7% PCP and 4.7% TCP with instructions to dilute with 10 parts of diesel fuel. The logs of one house had been pressure treated by a lumber yard. The other homes had either been treated with unknown wood preservatives or the occupants were not sure if the homes had been treated. A few of the treatments were applied by spraying but in most cases the logs were simply brushed with the preservative.

IV. METHODS

Skin and surface PCP and TCP contamination was studied by obtaining wipe samples from the palmar surface of the hands of some residents and from various wood surfaces in the homes. The samples were collected on Whatman® smear tabs moistened with distilled water and were analysed by high pressure liquid chromatography. The accuracy and precision of this wipe procedure are limited by variations in surface characteristics that effect sampling efficiency. Therefore, the results should only be considered rough measures of relative contamination.

NIOSH collected 49 air samples for PCP and TCP using two methods. The air samples collected during the first survey were each drawn at a flow rate of 1.5 liters per minute through a mixed cellulose ester membrane filter connected in series to a midget impinger containing 15 ml of ethylene glycol. After sampling, the filter was removed and added to the impinger solution. Ten milliliters of methanol were added to each sample prior to analysis by high performance liquid chromatography (HPLC) using ultraviolet detection at a wavelength of 254 nanometers (NIOSH Method S-297).[1]

During the second survey a solid sorbent sampling method[2] was used along with the impinger method. The air samples were collected on silica gel tubes at a flow rate of 1.0 liters per minute for five to six hours. Each sample was desorbed in methanol with 30 minutes of sonication before analysis by HPLC.

Bulk samples of "Nevarot" and "Jasco" were analysed for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) by gas chromatography/mass spectrometry with selected-ion monitoring.

Forty-one urine samples were collected from potentially exposed residents and 17 control samples were collected from 14 county government workers (three were tested on each visit) with no known PCP exposure. After collection, each sample was preserved with two to three drops of concentrated hydrochloric acid and kept frozen until analysis for PCP by gas chromatography according to NIOSH Method 8303.[3] Qualitative analysis for TCP was done by comparing the retention times of each of the three isomers with the retention time of PCP.

V. EVALUATION CRITERIA

Human Exposure to PCP[4,5,6,7]

Pentachlorophenol dust and mist cause irritation of the eyes and upper respiratory tract. Absorption results in an increase in metabolic rate and fever. Prolonged skin exposure causes an acneform dermatitis and solutions of PCP as low as 1% may cause irritation if contact is repeated. Human exposure to dust and mist concentrations greater than 1000 ug/m^3 causes pain in the nose and throat, violent sneezing, and cough; 300 ug/m^3 may cause some nose irritation; persons acclimated to pentachlorophenol can tolerate concentrations up to 2400 ug/m^3. Pentachlorophenol readily penetrates the skin, which has been determined to be the primary route of exposure in most of the fatalities that have occurred.

Intoxication is characterized by weakness, anorexia, weight loss, and profuse sweating; there also may be headache, dizziness, nausea, vomiting, shortness of breath, and chest pain. In fatal cases, the body temperature is frequently extremely high and death has occurred as early as three hours after the onset of symptoms. The risk of serious intoxication is increased during hot weather. Persons with impaired liver or kidney function are more susceptible to the effects of pentachlorophenol.

Environmental exposure limits for protecting the general population have not been developed. The current OSHA standard for pentachlorophenol is 500 micrograms of pentachlorophenol per cubic meter of air (ug/m^3) averaged over an eight-hour work shift. This was adopted from the American Conference of Governmental Industrial Hygienists, Threshold Limit Value (TLV), which is still set at 500 ug/m^3.[8] However, workplace standards should not be directly applied to environmental exposures experienced by the general population. Threshold limits are designed to protect healthy adult workers and may not provide the margin of safety necessary to protect children or persons with impaired health. Also, these limits are designed for exposures over an eight-hour work shift and attempts to extrapolate these limits to account for longer exposures may not be valid.

Animal studies have shown that technical grade PCP is capable of causing chloracne and chronic liver damage. Hexachlorodibenzodioxin (HCDD) is probably the major contaminant responsible for these effects. PCP has also been found to be embryotoxic in laboratory animals. The effects occur in early gestation, resulting in resorbed embryos and teratogenic effects (e.g. skeletal abnormalities and subcutaneous edema). Very few women have been employed in the lumber industries, thus, there are no reports of pregnant woman being exposed to PCP.[9]

Biological Monitoring

Chronic PCP exposure is best studied by urinalysis. PCP exposures produce first order absorption with enterohepatic circulation and first order elimination. Humans will eliminate 86% of absorbed PCP in the urine within one week, provided plasma concentrations do not exceed 500 ug/liter. Symptoms of PCP exposure begin to be noted when urine PCP levels reach 200 ug/liter. Urine PCP levels up to 40 ug/liter have been reported for "unexposed" populations in previous studies.[10,11]

The detectable presence of chlorophenols (CPs) in the blood and urine of most individuals tested so far in the general U.S. population has caused much concern among environmental investigators over the past 20 years. CPs have been identified in a wide variety of environmental samples, particularly, industrial and sewage effluents, their contiguous sediments and a variety of biota including fish and poultry. The largest portion of the CPs being dispersed in the environment are the PCP formulations used for wood preservation.[12]

Contaminants and Derivatives of Chlorophenol Formulations

The chlorophenols are readily photolyzed and biodegraded, thus, their half-life in most aquatic environments generally does not exceed 5 days. Of the CPs, PCP has the highest bioaccumulation potential which is probably only about 1000 times the concentration in water. The greater potential for chronic toxic effects appears to be the result of the contaminants and derivatives of the parent compounds. 2,4,6-trichlorophenol, for example, has been shown to be carcinogenic in male rats as well as male and female mice. Another recognized problem is the microbial induced methylation of CPs to their corresponding chlorinated anisoles which cause the tainting of water, fish, and foul.[12]

By far the greatest concern over the ubiquity of CPs in the environment has been their association with polychlorinated dibenzo-p-dioxins (PCDDs). These isomers vary widely in their acute toxicity, with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) being the most toxic and the most widely studied. On a molecular basis, this compound is the most poisonous synthetic chemical known. Human exposure to 2,3,7,8-TCDD has induced chloracne, polyneuropathy, liver dysfunction, and enzyme elevations. Animal studies have shown the compound to be teratogenic, embryotoxic, carcinogenic, and cocarcinogenic.[13]

Bulk solutions of PCP preservatives have never been found to contain 2,3,7,8-TCDD[13] and rarely contain significant quantities of the other TCDD isomers. Up to several hundred ppm of the less toxic higher-chlorinated isomers may be found in many formulations. A more serious problem may arise from the action of light or heat on CPs whereby PCDDs may be formed. Tri and tetra chlorophenols, in particular, may be transformed into the more toxic PCDD isomers, including 2,3,7,8-TCDD.[12,13]

More sensitive analytical techniques will be required before any estimates can be made in correlating human exposure to chlorophenols with human exposure to PCDDs. Nevertheless, many investigators consider the evidence to be sufficient to argue that chlorophenols are the major known source of PCDDs in the environment[12] and that all uses of penta and tetra chlorophenols should be banned. The use of chlorophenols as wood preservatives was banned in Sweden in 1978,[14] primarily because of the "alarming" amounts of tetrachlorodibenzodioxins found to be formed during the combustion of chlorophenols.[15]

EPA Regulations

In 1981, the U.S. EPA initiated action to cancel or deny registration for pentachlorophenol home and farm uses unless the terms of registration were modified. The modifications included the prohibition of using PCP indoors and the treatment of wood intended for indoor use. Also prohibited was the use of PCP in a manner which may result in direct exposure to domestic animals or in the contamination of food, feed, or drinking and irrigation water. The other modifications were designed to protect people from the acute hazards of applying PCP. Included were requirements for the use of impervious gloves and disposable coveralls for PCP brush-on methods. More impervious clothing and half-mask respirators were specified for PCP spray methods.[16]

VI. RESULTS AND DISCUSSION

The results of air, wood surfaces, skin, and urine sampling are presented in Tables I and II. No PCP was detected (<7 ug/m^3) in any of the air samples. The analytical limit of detection for PCP in the silica gel samples was somewhat higher than expected. The "standard method of PCP analysis" published by Vulcan Materials Company reports a limit of detection of 0.3 ug/sample.[2] NIOSH's contract laboratory was able to achieve a limit of detection of 3 ug/sample. The major difference between the two methods is that the published method uses acetonitrile to desorb the silica gel samples whereas the NIOSH lab used methanol.

Wipe samples of wood surfaces contained up to 380 ng PCP/cm^2. No PCP was detected in skin wipe samples. However, it should not be concluded that skin absorbtion was not an important route of exposure. In a study of log home residents by the Kentucky State Health Department,[17] air samples were taken in a home from which the logs had been dipped in a 5% PCP solution about five years earlier. Indoor air PCP concentrations were only 0.2 to 0.4 ug/m^3, but urinary PCP levels among the five residents ranged up to 216 parts per billion (ppb). The fact that the highest PCP levels were found in the youngest children (ages 2 and 4) could be the result of their skin contact with treated wood surfaces while playing. Skin exposure may be difficult to detect because PCP is rapidly absorbed through the skin, such that only recent exposures would be detected by skin wipe sampling.

The urinalysis results offered the best indicator of PCP exposure (Tables I & II). The 34 log home residents had urine PCP concentrations ranging from <1 to 35 ug PCP/gram creatinine (g.Cre.) with a mean of 10 ug PCP/g. Cre. However, it appears that some of the log homes did not have interior surfaces treated with PCP. Therefore, residents of those homes were removed from the "exposed" group if residents were not sure that interior surfaces had been treated and the wood surface wipe samples were negative (residence numbers 4,7,10, 11,13, and 15). Then 23 "exposed" log home residents had urine PCP

concentrations ranging from <1 to 35 ug PCP/g. Cre. with a mean of 12 ug PCP/g. Cre. Seventeen urine samples from the control group ranged from <1 to 11 ug PCP/g. Cre. with a mean of 4 ug PCP/g. Cre. Therefore, residents of homes with interior PCP treated materials are significantly more likely to have higher urinary PCP levels than that found in the general population (Students "t" test, $p < 0.005$).

Residence numbers 1 and 3 provide good "before and after" comparisons of urine PCP concentrations among residents of recently treated homes. Before moving into the PCP treated homes, six people had urine PCP levels ranging up to 6 ug/g.Cre. with a mean of 4 ug/g. Cre. After living in the treated houses for several months, their urine PCP levels ranged from 7 to 31 with a mean of 19 ug PCP/g.Cre.

No health guidelines have been developed for limiting the urinary concentrations of PCP found in persons among the general population. For PCP workers an exposure limit of 1000 ug PCP/g. Cre. has been suggested.[18] However, symptoms of PCP exposure have been associated with urinary levels as low as 200 ug PCP/liter[11] (Approximately 150 ug PCP/g. Cre., based on average creatinine excretion rates).

Airborne TCP was "detected" in five homes with levels ranging from 14 to 250 ug/m^3. Wood surfaces contained up to 60 ng/cm^2 and four people had TCP on their hands ranging from 50 to 110 ng/cm^2. However, only trace amounts of TCP were found in the urine of one resident and one control. Furthermore, the urine TCP "appeared" to be the 2,3,5,6 or 2,3,4,5 isomers, whereas, the environmental TCP was reported to be the 2,3,4,6 isomer. Therefore, all the TCP results should be considered suspect.

No 2,3,7,8-TCDD was detected in either bulk sample (Table III). The hexa, hepta, and octa isomers of PCDD and PCDF were found in concentrations typical of chlorophenol preservatives.

VII. CONCLUSIONS, DISCUSSION and RECOMMENDATIONS

It has been shown that residents of homes treated with chlorophenol preservatives are likely to have urine PCP levels greater than that found in the general population. All the exposure levels found were well below what would cause any symptoms of known health effects. Past studies of human exposure to PCP have focused on these readily observable symptoms. However, current knowledge is lacking in several areas, such as PCP's potential effects on reproductive health and potential long-term exposure to dioxins as a result of PCP use. The latter is a major concern for environmental investigators who assume that combustion will be the ultimate fate of many chlorophenol treated products, thereby providing a major source of dioxins in the environment.

Recent EPA restrictions will help limit environmental inputs of CPs and dioxins that result from what many consider to be the senseless consumer uses of CP formulations. The editor of "The Old-House Journal"[19] expressed the opinion that it doesn't make much sense to "use such a powerful killer [as PCP] when superficial brushing or dipping doesn't give long-term effectiveness anyway". Various low-toxicity varnish-type water repellents were recommended for most applications, especially indoor use.

For those who already have indoor CP treated surfaces, the application of varnish or polyurethane sealers will help reduce the vaporization of PCP.[20] PCP treated materials should be kept out of reach of small children. Treated wood products should never be burned.

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Montana State Health Department
2. NIOSH, Region VIII

TABLE I

Pentachlorophenol (PCP) and Tetrachlorophenol (TCP) Concentrations -
Air, Wood, Surfaces, Skin Surfaces, and Urine
Montana Residences
HETA 84-053
Novmeber 29-December 1, 1983

Location	Air (ug/m^3)		Wood Surfaces (ng/cm^2)		Skin Surfaces (ng/cm^2)			Urine			Comments
	PCP	TCP	PCP	TCP		PCP	TCP		PPB	ug PCP/gram creatinine	
Residence #1											
Living Room	N.D.	53	30	N.D	Person #1	N.D.	N.D.	Person #1	5	3	7 gallons of "Nevarol" were applied indoors about 1 1/2 months ago. The logs were later cleaned isoamyl acetate and trisodium phosphate. Then 2 coats of urethane varnish were applied. The family was was not living in the house,yet
S.E. Bedroom	N.D.	28	20	N.D.				Person #2	9	6	
S.W. Bedroom	N.D.	66	N.D.	N.D.				Person #3	7	3	
								Person #4	N.D.	-	
Residence #2											
Dining Room	N.D.	N.D.	-**	-	Person #1	N.D.	N.D.	Person #1	7	2	"Nevarol" was applied to a small portion of the house about 1 year ago. Indoors, only 1 log near the kitchen floor was treated.
Kitchen	N.D.	250	N.D.	N.D.				Person #2	N.D.	-	
								Person #3	22	11	
								Person #4	27	18	
esidence #3											
N.W. Living Room	N.D.	21	N.D.	N.D.	Person #1	N.D.	N.D.	Person #1	18	15	The logs were treated with 10 gallons of an unknown PCP-type preservative about 6 years ago. The logs were then left outdoors for 1 1/2 years before building the house.
Kitchen	N.D.	N.D.	-	-	Person #2	N.D.	N.D.	Person #2	17	10	
S.W. Living Room	N.D	N.D.	20	N.D.							
idence #4											
.E Living Room	N.D.	N.D.	-	-	Person #1	N.D.	N.D.	Person #1	8	5	7 gallons of "Nevarol" were applied only to the outside of the house. 4 coats of urethane varnish were applied to indoor log surfaces.
S. Living Room	N.D.	N.D.	N.D.	N.D.							
dence #5											
.. Living Room	N.D.	N.D.	30	N.D.	-	-	-	Person #1	13	6	3-1/2 gallons of "Jasco" were applied to the inside and the outside of the house about 8 months ago. The house is not yet occupied.
I. Living Room	N.D.	N.D.	80	N.D.				Person #2	10	6	
. Bedroom	N.D.	N.D	N.D.	N.D.							

continued

TABLE I
(continued)
HETA 84-053
November 29-December 1, 1983

Location	Air (ug/m³)		Wood Surfaces (ng/cm²)		Skin Surfaces (ng/cm²)			Urine			Comments
	PCP	TCP	PCP	TCP		PCP	TCP		PPB	ug PCP/gram creatinine	
Residence #6											
Bedroom	N.D.	N.D.	N.D.	N.D.	Person #1	N.D.	110	Person #1	7	4	2 gallons of "Nevarol" were applied inside the basement about 1 year ago.
Pantry	N.D.	N.D.	N.D.	N.D.	Person #2	N.D.	60	Person #2	5	5	
Kitchen	N.D.	N.D.	N.D.	N.D.							
Residence #7											
Attic	N.D.	N.D.	N.D.	N.D.	Person #1	N.D.	50	Person #1	5	6	The occupants moved into this 50 yr old house about 2yrs ago. They were not sure if the logs had ever been treated.
Kitchen	N.D.	N.D.	N.D.	N.D.							
Residence #8											
North Wall	N.D.	N.D.	N.D.	N.D.	Person #1	N.D.	50	Person #1	N.D.	-	30 gallons of "Nevarol" was applied to the inside and the outside of the house about 4 years ago.
South Wall	N.D.	N.D.	280	N.D.							
West Wall	N.D.	N.D.	N.D.	N.D.							
Residence #9											
North Wall	N.D.	N.D.	N.D.	40	Person #1	N.D.	N.D.	Person #1	7	5	The logs were treated at a lumber yard about 13 years ago.
West Wall	N.D.	N.D.	N.D.	60				Person #2	6	20	
Upstairs	N.D.	N.D.	N.D.	N.D.				Person #3	7	9	
*Limits of Detection (N.D. = none detected)	10	15	20	20		20	20		5	-	

** = not analysed

TABLE II

Pentachlorophehol (PCP) and Tetrachlorophenol (TCP) Concentrations -
Air, Wood Surfaces, and Urine
Montana Residences
HETA 84-425
August 14-16, 1984

Location	Air (ug/m³) PCP	Air (ug/m³) TCP	Wood Surfaces (ng/cm²) PCP	Wood Surfaces (ng/cm²) TCP		Urine-PCP PPB	Urine-PCP ug PCP/gram creatinine	Urine-TCP PPB	Comments
Residence #1					Person #1	37	19	N.D.	One more coat of
Kitchen	N.D.	32	380	N.D.	Person #3	40	16	N.D.	urethane varnish
Bedroom	N.D.	64			Person #4	22	31	N.D.	was applied after
					Person #5	48	17	trace	the first NIOSH visit (Table I).
Residence #3					Person #1	26	25	N.D.	No changes were made
Fireplace Mantle	N.D.	N.D.			Person #2	3	2	N.D.	since the first
Living Room	N.D.	N.D.	80	N.D.	Person #3	7	6	N.D.	NIOSH visit (Table I).
Residence #5					Person #1	30	22	N.D.	No changes were made
Living Room	N.D.	N.D.	N.D.	N.D.	Person #2	9	7	N.D.	since the first
1st Floor Closet	N.D.	N.D.							NIOSH visit (Table I).
Residence #10					Person #1	N.D.	N.D.	N.D.	The present occupants
Bathroom	N.D.	N.D.			Person #2	N.D.	N.D.	N.D.	were not sure if the
Loft	N.D.	N.D.							house had ever been
Living Room			N.D.	N.D.					treated.
Residence #11					Person #1	6	4	N.D.	The floor and cabinets
Bedroom	N.D.	N.D.	N.D.	N.D.	Person #2	2	1	N.D.	were treated with an
Living Room			N.D.	N.D.					unknown substance.
Residence #12			50	N.D.	Person #1	7	4	N.D.	The inside of the
Kitchen	N.D.	26			Person #2	4	4	N.D.	house was treated with
Bedroom	N.D.	N.D.							Nevarot 2-3 years ago.

continued

TABLE II
(continued)

Location	Air (ug/m^3) PCP	Air (ug/m^3) TCP	Wood Surfaces (ng/cm^2) PCP	Wood Surfaces (ng/cm^2) TCP		Urine-PCP PPB	Urine-PCP ug PCP/gram creatinine	Urine-TCP PPB	Comments
Residence #13					Person #1	9	8	N.D.	The outside of the house was sprayed with a 10-15% solution of PCP about 4 years ago.
Living Room	N.D.	N.D.	N.D.	N.D.					
Bedroom	N.D.	N.D.							
Residence #14					Person #1	29	21	N.D.	Nevarot was applied to one wall about 4 years ago, then 3 coats of urethane varnish was applied
Bedroom	N.D.	35	320	N D.	Person #2	12	35	N.D.	
Workroom	N.D.	14							
Residence #15					Person #1	13	9	N.D.	The background of this house is unknown.
Bedroom	N.D.	N.D.			Person #2	?	3	N.D.	
Kitchen	N.D.	N.D.	N.D.	N.D.	Person #3	N.D.	N.D.	N.D.	

TABLE III

ISOMER GROUPS OF PCDDs AND PCDFs FROM PCP SAMPLES
Montana Residences
HETA 84-053

Isomer Group	Quantity found in specified sample, ug/g			
	Cl-substituted dioxin		Cl-substituted furan	
	Nevarot 5%	Jasco 40%	Nevarot 5%	Jasco 40%
Mono	ND[a]	ND	ND	ND
Di	ND	ND	ND	0.06
Tri	ND	ND	ND	0.95
Tetra	ND	ND	0.20	3.6
Penta	ND	0.14	0.90	6.7
Hexa	ND	7.0	4.4	40
Hepta	1.6	14	2.1	8.0
Octa	31	62[b]	0.40	1.2
LOD[c]	0.025	0.025	0.025	0.025

[a] Not detected; <LOD.
[b] Capillary column was overloaded, probably causing a low result.
[c] Limit of detection, ug/g.

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