U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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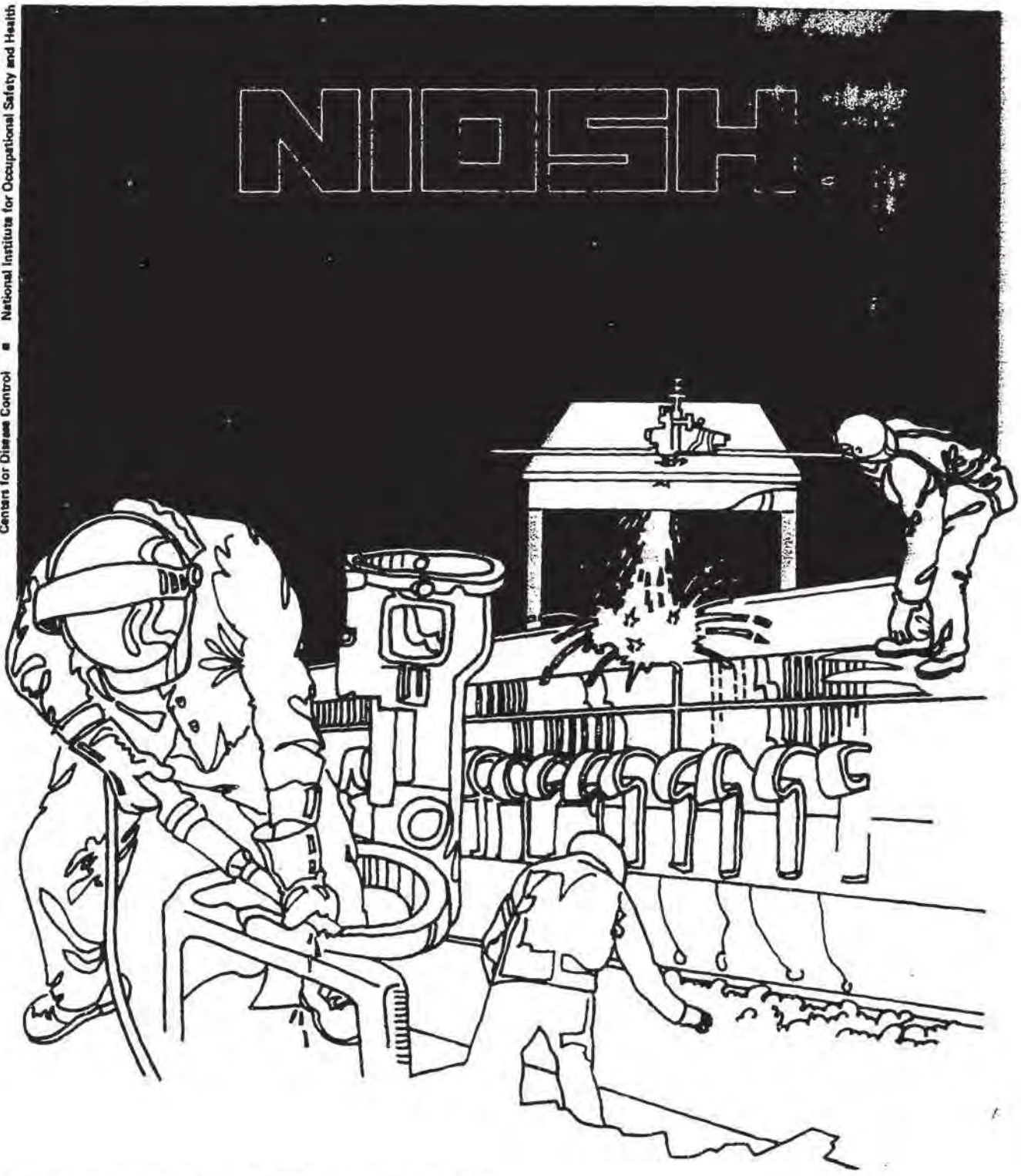

Health Hazard Evaluation Report

HETA 83-258-1859
PLANNED PARENTHOOD OF
SOUTH CENTRAL INDIANA
BLOOMINGTON, INDIANA

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 nygiene 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.

HETA 83-258-1859
JANUARY 1988
PLANNED PARENTHOOD OF
SOUTH CENTRAL INDIANA
BLOOMINGTON, INDIANA

NIOSH INVESTIGATORS:
Kenneth M. Wallingford, C.I.H.
Jan L. Handke, M.Sc.

I. SUMMARY

On April 29, 1983, NIOSH was asked by an employer representative to investigate reported cases of illness among employees exposed to chlordane at a family planning clinic. The clinic was treated for termites with a 1% chlordane emulsion on August 20, 1982. Following the treatment, the clinic was closed temporarily because of a strong chemical odor and the occurrence of headaches and nausea among the employees. Within 30 days after the treatment, 4 of the 5 pregnant employees had spontaneous abortions, which they believe might be the result of chlordane exposure.

NIOSH investigators conducted 3 site visits to the clinic over a 12-month period to evaluate this problem. A questionnaire was administered to all employees to collect information on reproductive history, occupational history, and symptoms associated with chlordane exposure. Additionally, 2 bulk (crawl space soil and wall-block fill), 47 air, 28 surface, and 44 blood samples were collected to further define the employees' exposures to chlordane. Results showed that chlordane concentrations ranged from 34 to 68 microgram/gram (ug/g) in the crawl space soil, from 0.51 to 17 microgram/cubic meter (ug/m^3) in the indoor air, and from <1.0 to 28 microgram/square foot (ug/ft^2) on interior surfaces.

The current OSHA air standard for chlordane is 500 ug/m^3. In 1979, the Committee on Toxicology of the National Research Council (NRC) suggested that an interim guideline of 5 ug/m^3 chlordane be used in military housing. In 1982, this same committee reviewed available evidence and saw no reason to change their recommendation, but stressed that there was a need for more information. The U.S. Air Force recommends that chlordane residues on surfaces in housing used by adults not exceed 50 ug/ft^2 on walls and ceilings and 10 ug/ft^2 on floors.

Forty-four blood samples were collected from 19 employees to measure levels of chlordane metabolites in the blood. Some employees had detectable levels of chlordane metabolites. As of July, 1984, four employees whose next pregnancy outcome after the clinic treated with chlordane, had higher blood levels of chlordane and its metabolites, than other employees.

Although it is not possible to directly link chlordane exposure to the spontaneous abortions, the environmental results indicate a chronic low-level exposure that may have increased the total body burden of chlordane and its metabolites in these employees. Furthermore, employees whose pregnancy resulted in a miscarriage between September 1982 and July 1984 also had higher blood chlordane levels than the other female employees.

KEYWORDS: SIC 8010 (Offices of Physicians and Surgeons), chlordane, heptachlor epoxide, oxychlordane, trans-nonaclor

II. INTRODUCTION

On April 29, 1983, NIOSH was requested by an employer representative to investigate the cause of spontaneous abortions among the employees of Planned Parenthood of South Central Indiana after the application of the insecticide chlordane to their Bloomington, Indiana clinic.

In response to the request, a NIOSH medical investigator and an industrial hygienist conducted 3 site visits to the clinic over a 12-month period to complete the evaluation. The first visit was made on July 19, 1983, 11 months after the termite treatment. The second visit was made on December 13, 1983, 15 months after treatment. The final visit was made on July 23, 1984, 23 months after treatment. Results of the surveys were forwarded to the requester(s) by letter on November 30, 1983; June 15, 1984; and on March 24, 1985. All persons who participated in the NIOSH blood tests were individually notified of their results.

III. BACKGROUND

The family planning facility consists of a two-story building with one single-floor rear wing addition. The original structure has only a crawl space, but the rear wing has a combination basement/crawl space and houses the medical facilities of the clinic on the ground floor.

The size of workforce at the clinic varies from day to day because many of the personnel are volunteers or part-time employees. At any one time there may be as many as 20 staff members in the facility. No one works in the basement and few work on the second floor. The majority of the staff work on the first floor in either the examination room wing or the original structure. Three heating, ventilation, and air cooling (HVAC) units are used in the facility: one for the rear wing (located in the basement), one for the main structure ground floor, and one for the main structure second floor (both located on the second floor).

On the afternoon of August 30, 1982, the clinic was treated for termites with a 1% chlordane emulsion. The application was made around the exterior perimeter of the building through small diameter holes drilled vertically near the foundation, one foot apart. Clinic employees also reported that the pesticide applicator sprayed the crawl space soil with this same emulsion.

Immediately after the pesticide application, the clinic employees noticed a strong chemical odor. When several of the employees later experienced headaches and nausea, the director closed the clinic early. Within 30 days after the termite treatment, 4 of the 5 pregnant employees had confirmed spontaneous abortions, which they believed might be the result of chlordane exposure. These four miscarriages all occurred in the first trimester of pregnancy.

IV. METHODS

A. Environmental

Chlordane levels in the clinic were evaluated on three occasions. On July 19, 1983, 2 bulk samples, one of crawl space soil and another of wall block fill, were collected for the analysis of the pesticides chlordane and chlorpyrifos. Six air samples were collected on each floor of the clinic for chlordane and chlorpyrifos vapors and particulates. In addition, 7 surface wipe samples for pesticides were collected from wall surfaces on each floor.

During the follow-up survey on December 13, 1983, 22 samples for chlordane vapors and 11 surface wipe sample for chlordane were collected at the clinic.

On the last survey, July 24, 1984, 14 samples for chlordane vapors and 14 surface wipe samples for chlordane were collected.

Airborne pesticide samples were collected using SKC Model 224 constant flow pumps calibrated at a flow rate of 1.0 liter of air per minute. The collection media consisted of a 13-mm AE glass fiber filter followed by a Supelco, ORBO-42, 150 milligrams (mg) sorbent tube. During the second and third surveys, chlordane vapor sampling was performed without the glass fiber filter. The filter media samples were prepared for analysis by desorption with 1 ml of toluene and rotated for one hour. The ORBO-42 samples were desorbed in 2 ml toluene and sonicated for 1 hour. The samples were then analyzed by gas chromatography with electron capture detection. A 6' x 2-mm glass column packed with 3% OV-17 and 3% QF-1 on 100/120 mesh gas Chrom Q was used isothermally at 180°C. Quantification was accomplished by summing the peak heights of the five major peaks. The ORBO-42 samples had limits of detection of 0.1 ug/sample for the chlordane mixture and 0.005 ug/sample for chlorpyrifos. The filter samples had limits of detection of 0.05 ug/sample for the chlordane mixture and 0.005 ug/sample for chlorpyrifos.

The surface wipe samples were collected on dry Whatman smear tabs and placed in glass vials. They were desorbed with toluene and analyzed as described above. The limit of detection for this analysis was 0.05 ug/sample.

Bulk samples were collected in glass vials, prepared using Environmental Protection Agency (EPA) sonication test Method 8.85 for evaluating solid waste. The extracts were cleaned up using a florisil column with a 200-ml elution of 6% ether in hexane. The limit of detection for this analysis was 0.04 ug/sample.

B. Medical

In July 1983 a questionnaire was administered to all employees to collect information on reproductive history, occupational history, and various symptoms potentially associated with chlordane exposure. A follow-up pregnancy outcome questionnaire was administered in July 1984.

Venous blood was drawn from 19 of the 26 employees on December 13, 1983, and again for 18 of the 19 on July 24, 1984. The specimens were analyzed for chlordane, trans-nonaclor, oxychlordane, and heptachlor epoxide. Specimens were collected in evacuated tubes, refrigerated until clotted, and centrifuged for one-half hour. The serum was then pipetted into a capped vial. The specimens were kept cold until analysis, which was performed by gas chromatography with electron capture detection. The limit of detection for this analysis was one part per billion (ppb).

V. EVALUATION CRITERIA

A. Chlordane Toxicity

Chlordane, a chlorinated cyclodiene, is very resistant to chemical destruction. At room temperature, technical chlordane is a thick amber liquid with a chlorine-like odor and a very low vapor pressure. Chlordane is known to be very persistent in the environment; a chlordane application is commonly effective against termites for up to 20 years. Technical chlordane is a mixture of chlorinated hydrocarbons, 60% of which are isomers of chlordane (alpha and gamma), with the remaining part consisting of heptachlor, nonachlor, hexachlorocyclopentadiene, and other related dicyclopentadiene derivatives. From its introduction in 1947 until regulatory action by the United States Environmental Protection Agency (EPA) in 1976, chlordane had been used extensively for control of insects on grains, fruits, vegetables, and other agricultural products. In 1978 the EPA cancelled chlordane's registration as an agricultural pesticide[1], restricting its use to control of household pests, in particular, termites. The sole U.S. manufacturer of chlordane recently discontinued its distribution in the United States.

Chlordane is rapidly absorbed following dermal contact, ingestion, or inhalation. Once inside the body, chlordane and its metabolites are deposited in body fat and have a biological half-life of several weeks. Chlordane is not found in tissue in the general population. Heptachlor epoxide, a metabolite of both chlordane and heptachlor, is found in tissue in the general population.

Oxychlordane, a metabolite specific to chlordane, and trans-nonachlor, a minor component of both technical chlordane and technical heptachlor, are also found in body tissues in the population.

The results of the second National Health and Nutrition Examination Survey (NHANES II) demonstrated chlordane metabolites (oxychlordane, heptachlor epoxide) and its contaminants (trans-nonachlor) to be present in blood in up to 6% of the sample population at levels greater than 1-2 ppb (the limit of detection). Analysis was based on approximately 4200 blood specimens from persons in 54 locations throughout the United States from 1976 to 1980.[2]

In 9000 samples of human adipose tissue, gas-liquid chromatography demonstrated quantifiable residues of heptachlor epoxide (approximately 0.10 ppm in 90% of those sampled), oxychlordane (approximately 0.10 ppm in 90% of those sampled), and trans-nonaclor (approximately 0.10-0.18 ppm in 96-97%).[3]

A Japanese study of 21 pest control operators reported total chlordane levels (cis-chlordane + trans-chlordane + trans-nonaclor + oxychlordane) ranging from 0.57 ppb to 83 ppb (mean of 12 ppb).[4] Oxychlordane and trans-nonaclor are both detected in human milk at an average concentration of 5 and 1 ppb, respectively.[5] Data from accidental ingestion of chlordane range from a whole body half-life of 21 days[6] to a serum half-life of 88 days,[7] with chlordane partitioning 300 times greater in adipose tissue than in serum.

All established cases of chlordane poisoning have been associated with gross exposure to large amounts of chlordane during spraying or manufacturing operations or by accidental ingestion or prolonged skin contact. Chlordane is a central nervous system stimulant. Acute chlordane poisoning produces headache, blurred vision, dizziness, slight involuntary muscular movements, tremor, sweating, insomnia, nauses, and general malaise. More severe illness is characterized by convulsions, disorientation, loss of consciousness, personality changes, psychic disturbances, and loss of memory.[8] In addition, gastritis, enteritis, kidney involvement, and diffuse bronchopneumonia leading to death have been reported in a cases of suicidal ingestion.[9] Although short-term exposure to low levels of chlordane does not typically produce symptoms, little information exists about the possible human health effects of continued low level exposure.

There is one report in the medical literature describing a community-wide "outbreak" of chlordane toxicity. Accidental

contamination of a public water system of Chattanooga, Tennessee resulted in exposure of 105 people in 42 houses to tap water containing concentrations of chlordane ranging from less than 0.1 to 92,500 ppb. In 23 houses the concentration exceeded 100 ppb, and in 11 houses it exceeded 1000 ppb. Of 71 residents affected, 13 (18%) had symptoms compatible with mild acute chlordane toxicity, including gastrointestinal symptoms (dizziness, blurred vision, irritability, headache, paresthesia, or muscle dysfunction). No individuals were hospitalized, and all recovered within 48 hours after exposure.[10]

Animal studies indicate that the liver can be affected and may be the most sensitive organ following chronic exposure to levels not producing overt symptoms of toxicity.[11] However, one study comparing 71 pesticide-exposed workers with unexposed persons showed no difference in five serum (SGOT, SGPT, LDH, alkaline phosphatase, CPK) and one urinary (D-glucaric acid) liver enzyme concentration despite larger tissue stores of DDT and dieldrin in the pesticide-exposed group.[12]

Carcinogenicity data are limited to long-term high-dose exposure of mice. The incidence of hepatoma is increased in B6C3F1 mice fed chlordane. However, a similar high incidence of hepatocellular carcinoma fails to appear in significant numbers in rats fed chlordane.[13] Death records of 1403 workers employed for longer than three months in the manufacture of chlordane and heptachlor from 1946-1976 showed no excess deaths from cancer.[14] An extension of the study showed a statistically significant trend in standard mortality ratios for cancer deaths in workers with increasing duration of employment. Measurements of and stratification by the extent of exposure were not reported.[15]

According to the National Research Council (NRC) Committee on Toxicology, "limited human studies with long-term exposure have not revealed any consistent or significant detrimental effect."[8]

The existing Occupational Safety and Health Administration (OSHA) permissible exposure limit for chlordane is 500 ug/m^3. The current American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value for chlordane is also 500 ug/m^3; their short term exposure limit is 2000 ug/m^3. Both the OSHA and ACGIH criteria are intended for the control of occupational exposures.

In 1979, the National Research Council's (NRC) Committee on Toxicology suggested an interim guideline of 5 ug/m^3 for airborne chlordane in military housing[16]. The NRC's interim guideline is intended for the control of residential exposures.

In addition, the U.S. Air Force developed a surface contamination standards for military housing[17]. These surface standards, 50 ug chlordane/ft^2 for walls and ceilings, and 10 ug/ft^2 for floors, are the maximum allowable levels for adult habitation. If children are living in the building, then the chlordane surface levels should be no greater than 7 ug/ft^2 on walls and should be undetectable on floors. These standards were derived from dermal absorption studies on rabbits. (When known quantities of chlordane were applied to glass cover slips that were then taped to the hair free skin of the rabbits, half the chlordane transferred from the glass to the rabbit after 10 to 12 minutes of contact. The investigators calculated that this corresponded to a transfer of approximately 1.5% of the total chlordane to the skin per minute. From this value, estimates were made for possible dermal contact with the walls and floor of a room by an adult and by a child.[17])

VI. RESULTS AND DISCUSSION

A. Environmental

1. Bulk Samples

The basement wall block fill contained 34 ug chlordane per g of material. The soil in the crawl space had a concentration of 68 ug chlordane per g of soil.

2. Airborne Samples

The air sample results are shown in Table 1. Since the air sample results from all three site visits were similar, they were combined in this Table. Chlordane air concentrations ranged from 4.2 to 17 ug/m^3 in the basement, and 0.6 to 1.1 ug/m^3 on the second floor. The first floor clinic had chlordane levels ranging from 1.4 to 3.1 ug/m^3, while the remainder of the first floor had lower levels ranging from 0.5 to 0.9 ug/m^3. These results indicate that airborne chlordane concentrations are consistently higher in the basement than elsewhere in the facility. Six of the 10 basement airborne chlordane concentrations were above the NRC's interim guideline of 5 ug/m^3.

3. Surface Wipe Samples

The surface wipe sample results are presented in Table 2. As with the air sample results, the surface sample results from all three site visits were similar and were combined in the Table. Nine of the 10 basement surface samples had detectable

chlordane (>2.0 ug/ft^2); the highest concentration in the basement was 28 ug/ft^2. In the first floor clinic, 6 of the 10 surface samples had detectable chlordane. The highest level in this area was 9.6 ug/ft^2. On the first and second floors none of the samples had detectable chlordane. None of the surface sample results at the clinic were above the Air Force's surface contamination standard for walls of 50 ug/ft^2. Like the air monitoring data, these results indicate that surface chlordane contamination is consistently higher in the basement area than elsewhere in the facility.

B. Medical

Blood samples for chlordane, trans-nonaclor, and oxychlordane/hepachlor epoxide were drawn from 19 of 26 employees in December, 1983, and replicated for 18 of these 19 in July, 1984. The blood sample results are shown in Tables 3 and 4. These results indicate detectable levels of chlordane (1 ppb) and its metabolites in the blood of several employees. Fifteen months after the chlordane application, the highest detectable level of chlordane in serum was 7.5 ppb. The highest concentration of trans-nonaclor was 2.1 ppb, and for oxychlordane/hepachlor epoxide it was 3.4 ppb. Twenty-three months after application, the highest concentrations were 11 ppb for chlordane, 9 ppb for trans-nonaclor, and 1.8 ppb for oxychlordane/heptachlor epoxide. At this time however, only one sample had detectable trans-nonaclor, the same one had detectable chlordane, and two had detectable oxychlordane/heptachlor epoxide. There was no obvious pattern to chlordane blood levels by job or time spent in the clinic.

Five of 26 female respondents reported never being pregnant. One of these five stated she had had a problem becoming pregnant and that her husband had a low sperm count. Two of the remaining 21 female respondents also reported past problems in becoming pregnant, but both reported they had had at least one live birth.

There were 50 pregnancies among the 21 respondents reporting at least one pregnancy prior to September 1982. Thirty-seven (74%) terminated in a live birth. There were 10 pregnancies among these 21 respondents on or after September 1982. Four (40%) terminated in a live birth. (Follow-up histories were obtained in July 1984 from 20 of the 26 employees who completed the July 1983 questionnaire).

Three of the 21 respondents reported two or more abortions or miscarriages. (It was apparent from some questionnaire responses that the distinction between "abortion" and miscarriage was not

necessarily clear to each respondent, so that the two events are treated equivalently.) Eliminating pregnancies among these women from consideration, 36 of 46 (78%) pregnancies terminating prior to September 1982 ended in live birth, while three of the six pregnancies (50%) on or after September 1, 1982, ended in a live birth.

In Table 4, employee blood concentrations of chlordane, trans-nonaclor, and oxychlordane/hepatachlor epoxide are shown for respondents whose next pregnancy outcome after September 1982 was a miscarriage (Group 1), respondents whose next pregnancy outcome after September 1982 was a live birth (Group 2), and all respondents excluding Group 1 (Group 3). Mean blood chlordane, t-nonachlor, and oxychlordane/heptachlor epoxide were greater among the four Group 1 respondents than among those from Group 2 or Group 3. (This latter comparison may be inappropriate, because the next subsequent outcome is unknown for 13 of the 15 in comparison Group 3, since no subsequent pregnancies were reported for these 13. The observations are too few, and too many observation censored (i.e., below a level of detection) for a meaningful statistical comparison. Nonetheless, females who miscarried subsequent to September 1982, had appreciably higher blood chlordane levels (1.4 ppb vs <1 ppb, Group 1 vs Group 2; or 1.4 ppb vs 0.3 ppb, Group 1 vs Group 3). Subsequent to July 1984, two of three pregnancies terminated in live births.

VII. CONCLUSION

Based on the study results, it is not possible to establish that chlordane exposure caused the four spontaneous abortions. The environmental data indicates an apparently stable, low level exposure to chlordane in the first floor clinic. These exposures are consistent with data obtained from other sites that were treated for termites with chlordane. Although the long-term health significance of these low level exposures are not known, they were accompanied by the presence of chlordane in the blood of some of the exposed employees.

Follow-up blood testing in July 1984 resulted in a decrease in the prevalence of detectable chlordane in the blood.

VIII. RECOMMENDATIONS

1. Repair leaks in the negative pressure return air ducts in the basement/crawl space area. This should reduce the potential for the transfer of contaminated air to the occupied portion of the clinic.

2. Cover the crawl space soil with either polyvinylidine chloride or polyamide plastic sheeting having a minimum thickness of one mil. This should serve as a barrier that reduce the airborne concentrations in the basement.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Kenneth M. Wallingford, C.I.H.
Supervisory Industrial Hygienist
Industrial Hygiene Section

Bruce Hills
Industrial Hygienist
Industrial Hygiene Section

Alexander Blair Smith, M.D. M.S.
Section Chief, Medical Officer
Medical Section

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National

Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Planned Parenthood of South Central Indiana

2. OSHA Regional Office

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Chlordane Vapor Concentrations
Planned Parenthood of South Central Indiana
HETA 83-258

		Chlordane Concentrations in ug/m^3		
Location	Number of Samples	Range	Mean	Standard Deviation
Basement	17	4.2-17	9.4	3.9
First Floor Clinic	16	1.4- 3.1	2.2	0.52
First Floor	5	0.51-0.91	0.74	0.17
Second Floor	9	0.64-1.1	0.90	0.18

Table 2
Chlordane Surface Wipe Sample Results
Planned Parenthood of South Central Indiana
HETA-83-258

		Chlordane Concentrations in ug/ft2		
Location	Number of Samples	Range	Mean	Standard Deviation
Basement	10	<2.0 - 28	9.2	8.1
First Floor Clinic	10	<1.0 - 9.6	3.1	3.1
First Floor	3	<1.0 - <2.0	-	-
Second Floor	5	<1.0 - <2.0	-	-

Table 3
Blood Sample Results
Planned Parenthood of South Central Indiana
HETA 83-258

Blood Chlordane Concentrations in ppb

Compound	Year	Number of Samples	Samples > LOD	Range	Estimated* Mean
Chlordane	1983	20	9	<1-7.5	0.2
	1984	23	3	<1-11	-
trans-Nonachlor	1983	20	9	<1-2.1	0.9
	1984	24	1	<1-9	-
Oxychlorane and Hepatachlor Epoxide	1983	20	14	<1-3.4	1.2
	1984	24	3	<1-1.8	-

LOD = level of detection

*Using normal probability paper to plot empirical cumulative distribution function, and determine 50th percentile.

Table 4
Blood Sample Results
Blood Chlordane Concentration in Employee Groups
HETA 83-258

Group	Chlordane	t-Nonachlor	Oxychlordane and Heptachlor epoxide
Group 1			
Number	4	4	4
Number > LOD	3	3	3
Range (ppb)	<1-5.2	<1-1.2	<1-1.7
Estimated* Mean (ppb)	1.4	1.05	1.65
Group 2			
Number	2	2	2
Number > LOD	0	0	0
Range (ppb)	-	-	<1-1.2
Estimated* Mean (ppb)	<1	<1	?
Group 3			
Number	15	15	15
Number > LOD	6	6	11
Range (ppb)	<1-7.5	<1-2.1	<1-3.4
Estimated* Mean (ppb)	0.3	0.95	1.35

Group 1: Respondents whose next pregnancy outcome after September 1982, was a miscarriage.

Group 2: Respondents whose next pregnancy outcome after September 1982, was a live birth.

Group 3: All respondents excluding Group 1.

* Using normal probability paper to plot empirical cumulative distribution function, and determine the 50th percentile.