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Indoor Air Levels of Chlordane and Heptachlor Following Termiticide Applications

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Chlordane and heptachlor are organochlorine insecticides used primarily for the control of subterranean termites. Several characteristics of the organochlorines make them desirable for use as termiticides - persistence, low volatility, effective control of termites, and low cost per treatment. Chlordane is available either as the technical product (e.g. C-100) which contains 72% chlordane (C-100 label 1986) and from 7 to 13% heptachlor as a contaminant (Brooks 1987), or as a mixture (Termide) containing 39.2% chlordane and 19.6% heptachlor (Termide label 1986).

Prior to 1975 these chemicals had a number of agricultural and residential uses. Concerns regarding the health and environmental effects of these compounds caused EPA to limit their use to subsurface control for termites. Both the International Agency for Research on Cancer (IARC) and the EPA sponsored Gene-Tox program have concluded that there is limited evidence that both chlordane and heptachlor are carcinogens (WHO 1982; Nesnow 1986). In 1982 the New Jersey Department of Environmental Protection (NJDEP) restricted the sale of these materials to certified pesticide applicators. In 1985, regulations describing the permitted use of these termiticides went into effect (NJDEP 1985).

The major focus of these regulations was that (1) a certified applicator must be on site for all termiticide treatments, (2) the use of organochlorine termiticides on interior portions of slabs containing heating ducts was prohibited, and (3) for heating systems located in crawl spaces the ducts must be directed to the outside, and the crawl space must be vented. These regulations were adopted in response to misapplication cases investigated by NJDEP (Fenske and Sternbach 1987).

The Committee on Toxicology of the National Academy of Sciences (NAS) was asked to determine an acceptable level for chlordane in indoor air. In August 1982, NAS recommended an interim guidelines for chlordane of 5.0 ug/m^3 and for heptachlor of 2.0 ug/m^3 (NAS 1982). These guidelines were not health based numbers, but were set by using occupational TLVs and relative tumor incidences.

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One study on pre- and post-treatment air levels of chlordane and heptachlor was conducted by Wright and Leidy (1982). They measured the indoor air levels of chlordane and heptachlor in six houses for a period of one year after a termiticide application. The levels of chlordane found in these houses ranged from 0.3 to 5.8 ug/m^3 and the heptachlor levels ranged from 0.01 to 1.8 ug/m^3.

The study discussed in this paper was initiated in 1985 to investigate levels of chlordane and heptachlor in indoor air following proper termiticide treatments. Proper application means that the treatment was made according to EPA approved label instructions, and regulations under the New Jersey Pesticide Code. A major objective of this work was to determine if the guidelines set by NAS could be met or lowered with current treatment technology.

MATERIALS AND METHODS

The Department of Environmental Protection with the cooperation of the New Jersey Pest Control Association solicited volunteers for this project. A total of 10 commercial pest control firms supplied us with 13 homes that needed termiticide treatment. Of these, seven belonged to employees of the pest control firms, while the other six belonged to customers of those firms.

The 13 homes were visited before the termiticide treatment, and the optimum sampling locations were determined. The air pumps were located on the main and lower level of each house. If no lower level existed, sampling sites were dispersed equally on the main floor. A total of 3 to 5 air samples were taken at each house. After treatment samples were collected at those same locations one week, three months, and one year after treatment. The treatment was observed by NJDEP personnel and all pertinent information about each house and the treatment techniques was recorded (Louis and Kisselbach 1987). The termiticide treatments occurred between April, 1985 through October, 1986.

The sampling was conducted using commercial ORBO-44 tubes (10 cm x 6 mm I.D.) containing Supelpak 20E (Supelco, Inc., Bellaforte, PA). The tubes were connected by tygon tubing to either a Dupont P4000 or Alpha One constant flow pump, which was calibrated using a soap film tube. The pumps were placed at a height of approximately one meter off the floor. Samples were collected at a rate of 2.5 l/min for a 4 hour sampling time (600 l of air). It was demonstrated in a series of laboratory experiments that breakthrough did not occur with the pesticide concentrations of concern. After the samples were collected they were sealed, placed into a sterilized plastic bag, and transported on ice, in the dark to the laboratory for analysis.

Sample analyses were performed by the NJDEP, Bureau of Environmental Laboratories using NIOSH Method S278 (USDHHS 1980). The samples were extracted with toluene, and analyzed on a Varian 6000 GC using an electron capture detector. The method detection

TABLE 1. CHLORDANE AND HEPTACHLOR LEVELS (ug/cubic meter) in 12 HOMES TREATED FOR TERMITE CONTROL

Living Areas

SAMPLING PERIOD	# SAMPLES	CHLORDANE % DETECTABLE	CHLORDANE MEAN (RANGE)	HEPTACHLOR % DETECTABLE	HEPTACHLOR MEAN (RANGE)
Pretreatment	35	20%	0.14 (N.D.-1.10)	57%	0.04 (N.D.-0.21)
1 Week After Treatment	35	43%	0.15 (N.D.-1.06)	86%	0.14 (N.D.-0.94)
3 Months After Treatment	35	37%	0.22 (N.D.-1.40)	77%	0.15 (N.D.-0.64)
1 Year After Treatment	32	47%	0.15 (N.D.-0.81)	81%	0.13 (N.D.-0.57)
		Non-Living Areas*			
Pretreatment	13	80%	0.97 (N.D.-5.87)	67%	0.12 (N.D.-0.51)
1 Week After Treatment	13	62%	0.76 (N.D.-3.89)	77%	1.02 (N.D.-5.92)
3 Months after Treatment	15	73%	0.55 (N.D.-2.04)	93%	0.69 (N.D.-3.88)
1 Year After Treatment	13	92%	0.91 (N.D.-1.96)	100%	0.88 (N.D.-3.89)

* Crawl Spaces and Unfinished Basements

N.D. = Non-Detectable

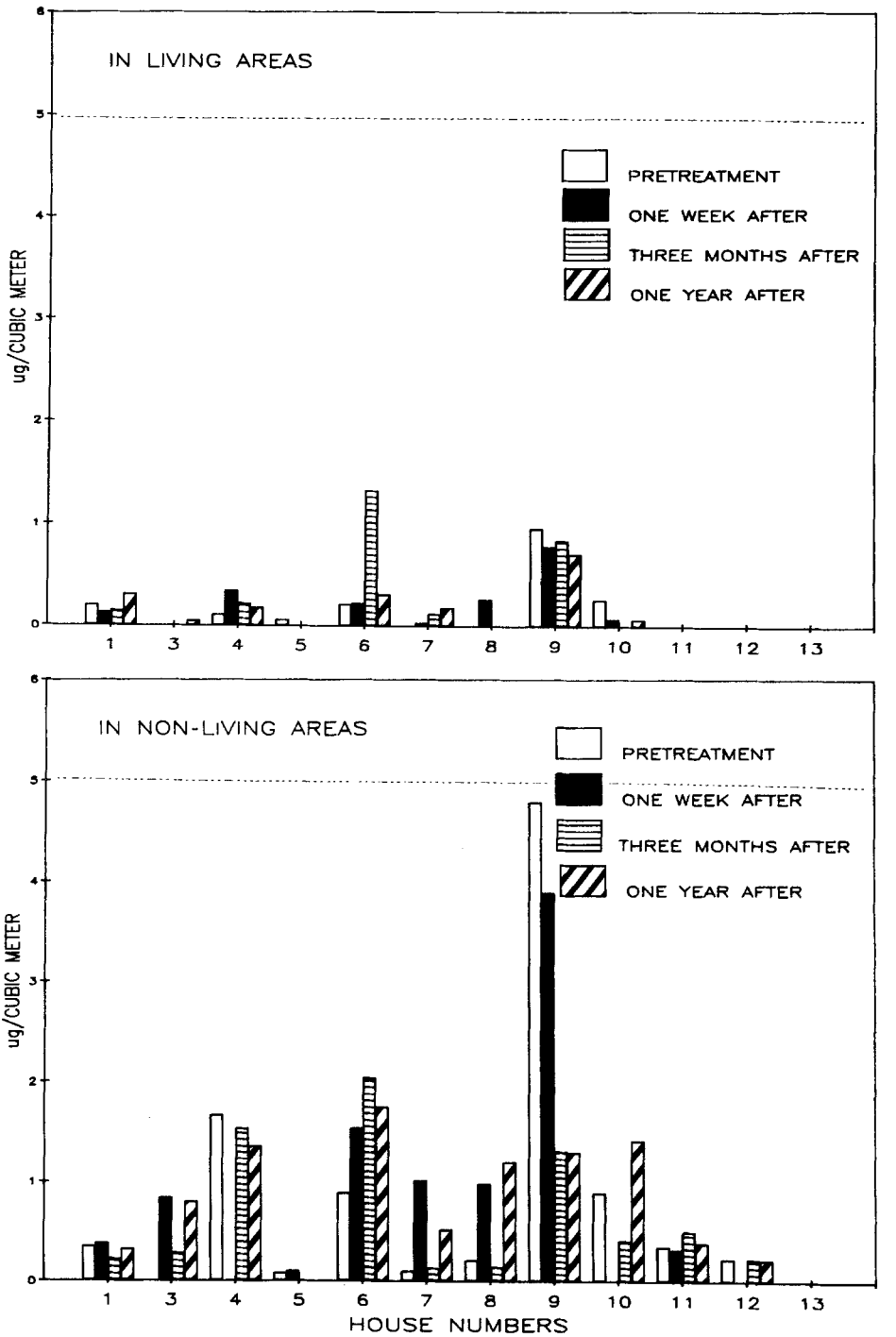

Figure 1: Chlordane levels measured in indoor air (ug/m^3)

limit (MDL) for chlordane and heptachlor in a 600 l sample was experimentally determined to be 0.09 ug/m^3 for chlordane, and 0.01 ug/m^3 for heptachlor.

The quality assurance program for this project consisted of laboratory blanks, field blanks, and duplicate samples. Eight laboratory blanks were analyzed prior to the beginning of the project and no detectable levels of chlordane or heptachlor were found. A total of 31 field blanks were analyzed throughout the project, two of which contained low levels of chlordane and heptachlor (chlordane = 0.27, 0.80 ug/m^3; heptachlor = 0.05, 0.02 ug/m^3). A total of 10 duplicate samples were collected throughout the project. The average precision for these samples was $\pm$ 8.9% for chlordane and $\pm$ 7.4% for heptachlor.

RESULTS AND DISCUSSION

A total of 13 houses were studied during this project. During the treatment of one of these houses (House 2) a spill occurred in the basement. The data collected at this house is not included in the data analysis, since it could not be considered a background site. Out of a total of 190 samples collected, 93 (48.9%) did not contain detectable levels of chlordane and 42 (22.1%) did not contain detectable levels of heptachlor. The fact that chlordane has a higher MDL than heptachlor (0.09 versus 0.01 ug/m^3) probably accounts for this difference.

A summary of the air levels measured for the remaining twelve houses is shown in Table 1. The non-detectable samples were considered to have no chlordane or heptachlor for calculation of the average concentrations. The data is separated into samples collected in living areas of the houses, and those collected in non-living areas (crawl spaces and unfinished basements).

In the living areas of the houses the average levels of chlordane were low, ranging from 0.14 to 0.22 ug/m^3. No samples were over the NAS guideline. There were 100 post-treatment samples taken in the living areas of these twelve homes. A total of 57 (57%) did not have detectable levels of chlordane, 32 (32%) had levels up to 0.5 ug/m^3 or 1/10th of the NAS guideline. Only 11 samples (11.0%) had levels above 0.5 ug/m^3, and eight of these were associated with House 9, which had previously been treated with chlordane. In the non-living areas of the twelve houses both the average and the maximum levels of chlordane were higher than in living areas with the highest levels of chlordane measured in crawl spaces.

For each house an average living and non-living area chlordane level was calculated for each sampling period. The results are shown in Figure 1. The differences between the levels measured in the living areas versus the non-living areas are apparent. Additionally, most of the higher levels of chlordane are associated with House 9. Finally, looking at the levels in each house over time, one notes the fluctuation in the levels measured. Wright and Leidy (1982) point out that indoor air levels can be

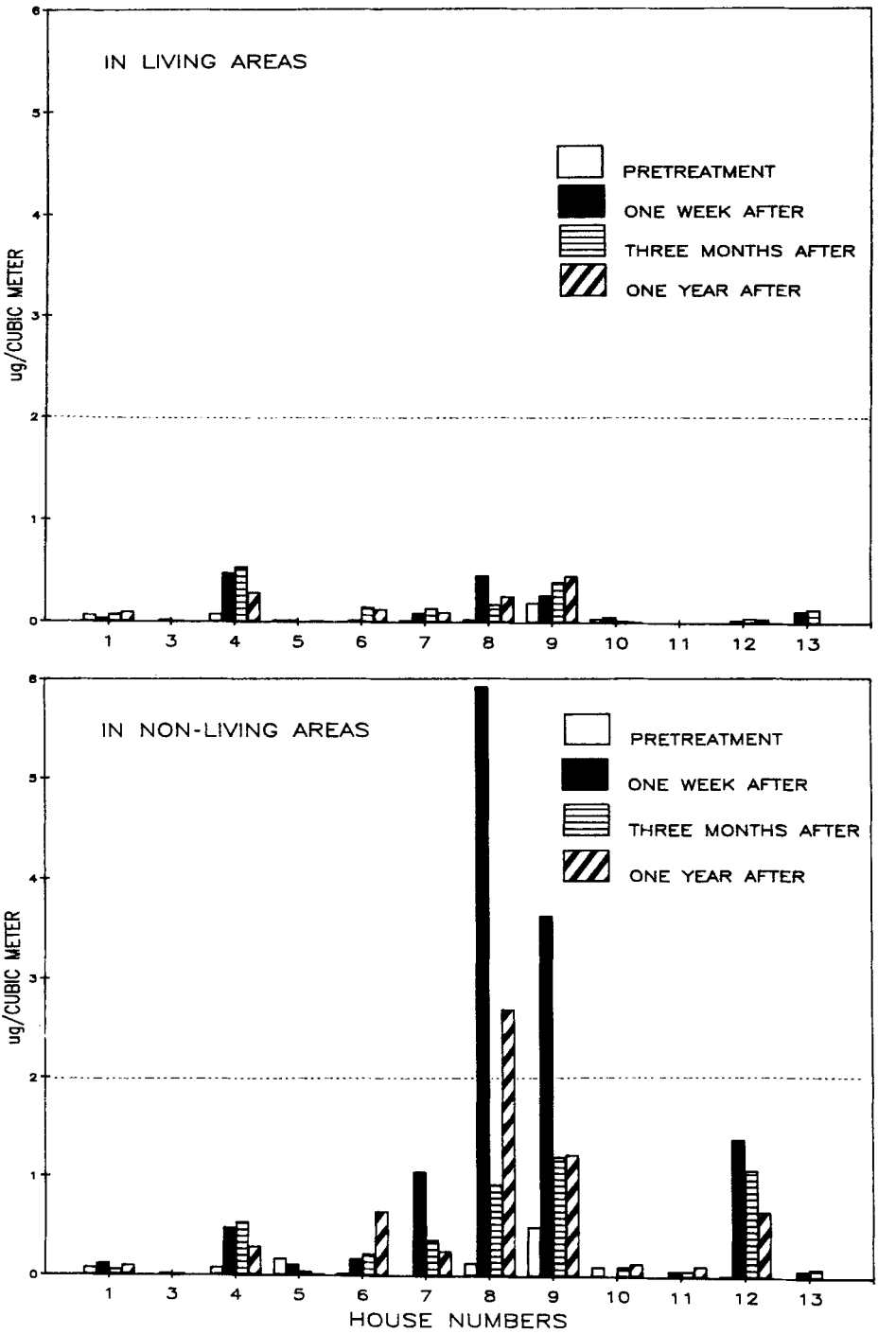

Figure 2: Heptachlor levels measured in indoor air (ug/m^3)

affected by a number of factors including temperature, humidity and air movement caused by heating and cooling systems.

There was an increase in the average concentration of heptachlor after the treatment in both the living and the non-living areas (See Table 1). The average heptachlor levels in the post-treatment living areas were low ranging from 0.13 to 0.15 ug/m^3. No samples were over the NAS guideline levels. The breakdown for the heptachlor concentrations in the 100 post-treatment living area samples is 19 (19%) samples had non-detectable levels, while 58 (58%) had levels up to 0.2 ug/m^3, or 1/10th the NAS guideline. A total of 23 samples (23%) had levels above 0.2 ug/cu.m. House 9 accounted for 8 of these samples. The heptachlor levels were higher than expected, since the concentration of heptachlor accounts for only 7 to 19.6% of the formulations. The average heptachlor levels in the post-treatment samples were similar to those measured for chlordane for this one year sampling period. This may be due to the slightly higher vapor pressure of heptachlor compared to chlordane (0.0003 versus 0.00001 mm at 25^{o} C).

The average living and non-living area heptachlor levels were calculated and are shown in Figure 2. Again the levels measured in the living areas were lower than those measured in the non-living areas of the houses. Houses 4,5,8, and 9 were all treated with Termide. In the living area of these houses the highest levels of heptachlor were associated with three of these houses (House 4,8, and 9). In the non-living areas of these 12 houses the heptachlor levels 1 week after treatment are generally the highest measured. Finally, in the non-living areas high heptachlor levels were found in two houses (7 and 12) which were treated with the C-100 formulation, indicating that high heptachlor levels can be found even when the formulation containing only 7-13% heptachlor is used.

The results from this study indicate that current treatment technology is capable of meeting the NAS guidelines. This conclusion is further supported by a larger study by Leidy et al. (1985), where samples were collected in 120 rooms of 60 homes that had been treated with chlordane during the previous five year period. It was reported that only 8 rooms (6.7%) in 7 houses had chlordane levels above the NAS guidelines (5.3 to 9.9 ug/m^3), while heptachlor levels did not exceed the NAS guideline.

In summary, the NAS guidelines of 5.0 and 2.0 ug/m^3 were not exceeded in the living areas of the houses studied. Since it is desireable to limit exposure to these chemicals, adoption of a lower guideline level is desireable. However, it will be difficult to reduce the guideline for chlordane and heptachlor proportionally, unless a limit on the concentration of heptachlor in the formulations is instituted.

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