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OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: REVIEW OF STUDY MEASURING INDOOR LEVELS OF
AND EXPOSURE TO CHLORPYRIFOS FOLLOWING
CARPET TREATMENT

TO: Dennis Edwards
PM 19
Registration Division (7505C)

FROM: David Jaquith
Special Review and Registration Section I
Occupational and Residential Exposure Branch
Health Effects Division (7509C)

THRU: Steve Knott, Section Head
Special Review and Registration Section I
Occupational and Residential Exposure Branch
Health Effects Division (7509C)

Larry Dorsey, Chief
Occupational and Residential Exposure Branch
Health Effects Division (7509C)

Please find below the OREB review of

DP Barcode: D168824 Pesticide Chemical Code: 059101

EPA Reg. No.: 464-571

Deferral to:

PHED: N/A



Recycled/Recyclable
Printed with Soy/Canola Ink on paper that
contains at least 50% recycled fiber

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1.0 INTRODUCTION

DowElanco has submitted a study measuring the levels of chlorpyrifos and exposures of individuals to the insecticide following indoor broadcast treatment of carpets. The study was conducted to evaluate the potential exposures of children to chlorpyrifos residues associated with playing on surfaces treated with this material. The product evaluated was DURSBAN LO, an emulsifiable concentrate containing 41.5 percent chlorpyrifos as the active ingredient (4 pounds chlorpyrifos per gallon). The material is to be applied by or under the direct supervision of commercial applicators. Sale to or use by persons occupying a dwelling are prohibited. The chemical is applied at a concentration of 0.25 percent for light infestations or 0.5 percent for heavy infestations or residual control. The material is applied as a low pressure spray, pinstream, or painted on the surfaces. The 0.25 percent emulsion may be applied at a maximum rate of 1 gallon per 800 ft² for heavy infestations. The emulsion is normally applied to 1600 ft² at concentrations of 0.25 or 0.5 percent for light and heavy infestations, respectively.

2.0 CONCLUSIONS

OREB has reviewed a study monitoring the exposures of individuals performing activities on a carpet treated with 0.5 percent chlorpyrifos (Dursban LO). The purpose of the study was to extrapolate the exposures of infants from measurements taken from adult volunteers performing specified activities immediately after the carpet had dried.

The study measured total deposition of the insecticide using gauze patches and aluminum foil coupons. Total internal doses of six volunteers were measured directly using measurements of the metabolite 3,5,6-trichloro-2-pyridinol (3,5,6-TCP) in the urine. Extrapolation to total internal dose from urine monitoring was conducted using a pharmacokinetic model previously submitted to the Agency. OREB based its assessment on the assumption that this model is correct but emphasizes that it must be verified by Toxicology Branch.

Indirect estimates of exposure were also obtained by using air measurements, the amount of chlorpyrifos obtained by dragging a weighted patch over the carpet, and by hand rinses. The weighted patch (Dow Sled) is described in Appendix A and was designed to simulate the amount of force applied by a one year old child. The transfer coefficients obtained by this method are presented in Table 6 and Figure 5 (Section 4.3). It must be recognized that the "Sled" dosimeter represents new technology and that the relationship between dragging a denim patch and transfer to actual human skin has not been established. Determination of dislodgeable (transferable) residues is currently a subject of considerable research and better methods may be determined in the future.

Total residues tended to dissipate within approximately 12 hours to a relatively constant level of about 4000 μg per ft^2 . It is unknown how long this level remains before additional dissipation occurs. OREB notes that, even though the total residues level off after about 12 hours, the transfer coefficients continued to decline over time. This may be due to increased binding of chlorpyrifos to the carpet material. The material is often applied several times per year, at uneven intervals. Labels do not specify an interval between applications or avoidance of the use of other chlorpyrifos products in the home environment. The decrease in transfer coefficient, even though absolute residue levels tend to remain fairly constant (and therefore insecticidally efficacious) for a period of time, indicates to OREB that the remaining residues probably contribute a negligible amount to the exposure that would occur following a subsequent application, assuming that a few days had passed between applications.

The registrant attempted to address the issue of possible exposure of children through hand/oral contact following contact with a treated surface. The volunteers hands were washed and it was assumed that all of the material rinsed from the hands was available for oral ingestion. There are no quantitative data addressing the possible exposure via the hand/oral route currently available. OREB considers the approach used by the registrant to provide a reasonable estimate of exposure via this route.

Airborne chlorpyrifos concentrations in all rooms monitored reached a maximum within 8 hours after application. Levels then dissipated to an average of approximately $0.5 \mu\text{g}/\text{m}^3$ after 24 hours (average of 1 physicochemical monitoring room and 1 activity room in each house). After 48 hours the level had decreased to an average of $0.26 \mu\text{g}/\text{m}^3$. These samples were measured in the physicochemical monitoring rooms only. The Mean air concentrations are presented graphically in Figure 3.

OREB has calculated exposures of individuals for the day of treatment and for the following day. Both the direct measurements and indirect estimates are presented in Table 1. The estimates derived from measurement of the metabolite 3,5,6-TCP in urine should probably be considered to be more accurate since fewer assumptions are required. OREB realizes that failure to adjust for surface area to body weight ratio introduces some error to the estimates but believes that this error is probably less than that resulting from the assumptions required to utilize the indirect measurements for exposure estimation.

Table 1. Estimates of the Exposures of Children to Chlorpyrifos Following Broadcast treatment of a Carpet with a 0.5 Percent Solution of Dursban LO.

Method	Exposure ($\mu\text{g}/\text{kg}$)	
	Day 1	Day 2
Direct (Biomonitoring)		12
Hand/Oral	10	1.9
Total (Direct)	23	14 ¹
Indirect:		
Dermal	1.4	0.27
Respiratory	2.8	1.5
Hand Oral	10	1.9
Total (Indirect)	15	3.7

¹ Second day direct monitoring estimate is sum of second day estimated Hand/Oral exposure + Results of biological monitoring (specimens collected over several days) and should be considered to be conservative.

3.0 DESCRIPTION OF STUDY

3.1 Treatment

The study was divided into two portions, physicochemical evaluation and activity monitoring. Dursban LO was applied as a broadcast spray to eight rooms without furniture in two separate uninhabited dwellings. A total of six bedrooms and two living rooms were treated. The application rate was approximately 1 gallon per 1600 ft² as specified by the label instructions. The concentration of the emulsion was 0.5 percent chlorpyrifos, the maximum specified by the label. All applications were performed by a certified applicator. After completion of the application, the surfaces were allowed to dry for a period of two hours using natural ventilation (at least one window was open to allow air exchange). At the end of the drying period the rooms were closed for the duration of the testing period.

3.2 Physicochemical Monitoring

This portion of the study was designed to determine the dissipation rate of chlorpyrifos from carpeted surfaces. These studies were conducted in the living room of each dwelling, designated PC-I and PC-II. Two types of coupons were laid on the floor prior to application. Eighteen gauze sponges (4 in x 4 in) were distributed in each room according to the pattern presented in Figure 1. Four of these gauze coupons were collected immediately after treatment (time 0). Two gauze sponges were collected in each room at intervals of 1, 2, 4, 8, 12, 24, and 48 hours after application. The sponges from each room were stored in amber bottles on dry ice during shipment to the laboratory where they remained frozen until analysis. A second set of coupons consisting of aluminum squares (3 in x 3 in) were also placed on the carpeted surface next to the gauze sponges to represent a non-porous surface. These coupons were collected in the same manner as the gauze sponges.

Wipe testing was conducted using a 3" x 3" plywood block with a 8.5 lb weight. A denim patch was fastened to the bottom of the block which was then dragged across a 48 inch distance, yielding a total area sampled of 144 in². The pressure exerted by the weighted system (0.94 lbs/in²) is approximately that expected from a one year old child either standing or crawling (see Appendix A for derivation of this number and detailed description of the drag system). Physicochemical sampling was also conducted in the activity rooms to verify that dissipation characteristics were similar to those in the physicochemical rooms.

3.2 Air Sampling

Air concentrations of chlorpyrifos were determined by drawing air through sampling cassettes at a rate of one liter per minute using calibrated high speed Flow-Lite pumps for approximately one hour. The sampling cassettes consisted of cellulose membrane filters backed up by tubes containing Chromosorb 102 as the trapping agent. Samples were collected one day before treatment, immediately after application, and at intervals of 1, 2, 4, 8, 12, 24, and 48 hours post-application. The sampling height was 15 inches from the floor, imitating the probable breathing zone of a child on a carpeted surface.

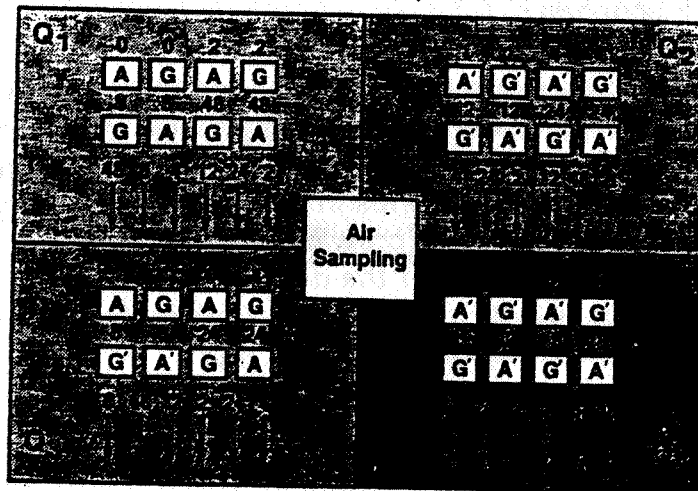
In addition to the above sampling, two air samples were collected in each home starting at 2 hours after application and continuing for 4 hours. These samples were collected in the physicochemical sampling rooms and the activity rooms and included the entire activity session.

Immediately after completion of the sampling, the tubes were capped and stored in plastic bags on dry ice. The samples were kept frozen until analysis.

Diagram of Sampler Locations Used During Study Measuring Exposure of Individuals to Chlorpyrifos Following Broadcast Treatment of a Carpet.

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Diagram 2. THE ARRANGEMENT OF ALUMINUM/GAUZE COUPONS IN THE PHYSICOHEM ROOMS AND THE DRAG PATTERNS FOR HOUSES ONE AND TWO, APRIL 24, 1990, AND JUNE 25, 1990



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3.3 Monitoring During Defined Activities

Six healthy adult male volunteers participated in the activity portion of the study. All participants were employees of Dow chemical Company or DowElanco. Each subject was examined by a physician and clinical laboratory tests were conducted prior to taking part in the study. Human activity took place in three bedrooms in each of the two test homes. These activities commenced immediately following the drying period. The individual activities are presented in Table 2. Clothing consisted of bathing suits only. Each activity was performed for 15 minutes during each hour over the 4 hour activity period. For example, during the first hour of activity the volunteers began with activity A, sitting, after 15 minutes they performed the crawling exercise for 15 minutes, after which they switched to the other activities. Although activity was minimal during the last 2 activities, considerable surface area was in contact with the carpets during these times.

At the conclusion of the 4-hour activity period, hand rinses were collected from each of the volunteers. The hands were held over a bowl and washed with 250 ml of a 0.008 percent surfactant solution (Dioctyl sodium sulfosuccinate, DSS). the hands were then rubbed for 10 seconds and washed with an additional 250 ml of deionized water. The bowl was rinsed with 200-250 ml of ethyl acetate and the washings decanted into a 32-ounce jar which was shaken to partition the chlorpyrifos into the solvent. The solution was then placed on ice for shipment to the analytical laboratory. The amount measured by hand rinse was later used to estimate the potential exposure of a child via the oral route.

Table 2. Activities Performed by Adult Volunteers to Determine Exposures to Chlorpyrifos Applied as a Broadcast Spray.

Activity Designation	Description	Total Time (min)
A	Sitting-Playing Blocks	60
B	On Hands and Knees Crawling	60
C	Walking on Carpet	60
D	On Back	30
E	On Abdomen	30

3.4 Biological Monitoring

Two blood samples were collected from each participant during the week prior to the conduct of the study. Additional samples were collected approximately 24 and 48 hours after the exposure period. These samples were analyzed for plasma cholinesterase activity. Collections and assays were performed by the Medical Department of the registrant.

All urine voided was collected on the day prior to the start of the study and for the subsequent 4-5 days. Each daily sample was collected as two specimens, each representing the total urine voided during a 12 hour period. The first collection period started after the first voiding in the morning and ended at approximately 7 PM. The second began with the first voiding after this time and ended with the first voiding the next morning. Urine voided at the start of the first pre-study collection period was discarded. Specimens were collected at ambient temperatures in 4-liter amber Polypac containers.

The specimens were weighed upon receipt and the volume calculated by weight, assuming a specific gravity of 1.00. Aliquots were removed, transferred to glass containers, and stored frozen until analysis for creatinine and 3,5,6-trichloro-2-pyridinol (3,5,6-TCP), a metabolite of chlorpyrifos. To document that 3,5,6-TCP was not lost during storage or analysis spiked control urine samples were stored and analyzed with the study samples.

4.0 RESULTS AND CALCULATION OF EXPOSURES

4.1 Estimation of Exposure from Urinary 3,5,6-trichloro-2-pyridinol (3,5,6-TCP) Measurements

The registrant calculated exposures from urinary metabolites using two separate methods. One method estimated the absorbed dose by dividing the amount of the metabolite 3,5,6-TCP by the fraction of absorbed dose expected to be excreted during the collection period. The factor used for the correction adjusts for the fact that only 72 percent of chlorpyrifos is excreted in the urine as 3,5,6-TCP, that all of the 3,5,6-TCP was not excreted during the collection period, and for the difference in molecular weight between chlorpyrifos and 3,5,6-TCP (350.6 versus 198). The pharmacokinetic model is presented in Appendix B. The registrant used a computer program to estimate the cumulative percent of excretion at differing time intervals. OREB duplicated these predictions, within rounding error, using a personal computer spreadsheet program.

The second method was derived from a one compartment model designed to describe the time course of 3,5,6-TCP excretion in volunteers after administration of chlorpyrifos to their forearms (4). A previous study by the registrant indicated that 72 percent of the administered chlorpyrifos was excreted in the urine. The absorption and elimination constants from this study were 0.0308/hr and 0.0258/hr, respectively. This study has been reviewed by Toxicology Branch (5). However, that document did not mention the kinetic constants presented by the registrant. Exposures derived from both the pharmacokinetic model and the one compartment model were in excellent agreement. OREB calculated exposures based on the equation presented in Appendix B only, with the assumption that the parameters of that model are correct but notes that the first order rate constants

used in the calculations were obtained from that literature study. The suitability of these constants and the model should be verified by Toxicology Branch. The pharmacokinetic parameters for the six volunteers participating in this study are presented in Appendix C.

Estimates of total chlorpyrifos absorbed were obtained by inserting the interval during which urine was collected into the model presented in Appendix B. The values calculated by OREB differ slightly from those submitted by the registrant. The estimates of chlorpyrifos absorption calculated by OREB are presented in Table 3. Table 4 contains the values presented by the registrant and includes the factors provided by the one-compartment model. The registrant used whichever model yielded the highest exposure value in their submission. OREB restricted its calculations to the pharmacokinetic model presented in Appendix B. Urine collection data are presented in Appendix D. Subject JJ apparently did not submit urine samples for the earlier portions of the collection period. Factors were developed for this individual based on the difference in expected output between the start of actual collection (48.5 hrs after dosing) and the end of the sampling intervals (120.5 hrs). The results from this individual may therefore contain more uncertainty since the early portion of the excretion curve is missing. Creatinine measurements, were collected during each sampling period. The creatinine excretion was measured for each sampling interval. Urine collection was considered to be complete if the amount of creatinine was consistent throughout the study and if the value fell within the normal range obtained from the literature, 1.0 to 2.0 g per day for men (2). Creatinine excretion of all volunteers, with the exception of KA, were within the normal range. The excretion of this individual was slightly lower (983 mg). The registrant, because of consistency in the previous urine samples, considered that this was due to incomplete collection of the last sample. OREB considered all collections to be essentially complete and does not believe that this slightly lower value appreciably affects the outcome of the biological monitoring data.

4.2 Total Deposition

The registrant measured total deposition of chlorpyrifos on household surfaces using gauze pads (4 in x 4 in) and aluminum squares placed on the carpet prior to application. The product used was Dursban LO, containing 4 pounds of chlorpyrifos per gallon (128 oz). To make a 0.5 percent spray solution, the label states that 1-1/3 fluid ounces of the concentrate should be mixed per gallon of finished spray. This should contain:

$$\begin{aligned} \text{lb/gal spray} &= 1\text{-}1/3 \text{ oz conc} \times 4 \text{ lbs chlorpyrifos/gal conc} \times 1 \text{ gal conc}/128 \text{ oz conc} \\ &= 0.042 \text{ lb} = 19 \text{ g} = 19000 \text{ mg/gal} = 1.9 \times 10^6 \mu\text{g/gal} \end{aligned}$$

Table 3. Estimated Amounts of Chlorpyrifos Absorbed by Active Volunteers Following Broadcast Treatment of a Carpet with 0 Percent Dursban LO, as Estimated by OREB.

Subject	BW (kg)	Urine Collection Interval (hrs)	Cumulative Urinary Excretion of 3,5,6-TCP (μg)	Expected Excretion During Urine Collection Period ¹	Factor ²	Chlorpyrifos Absorption (μg)		Chlorpyrifos Absorbed ($\mu\text{g}/\text{kg}$)
						Based on Factor ³	Kinetic Model	
KC	81.7	94	317	0.5412	0.3056	1037	Not Calculated	12.7
KR	74.9	96	488	0.5412	0.3056	1597	Not Calculated	21.3
KA	84.0	96	170	0.5412	0.3056	556	Not Calculated	6.6
MS	81.7	123	166	0.6124	0.3726	446	Not Calculated	5.8
SM	79.5	123	538	0.6124	0.3459	1555	Not Calculated	19.6
JJ	88.5	48.5-120.5	139	0.3304	0.1866	745	Not Calculated	8.4

¹ Fraction of absorbed chlorpyrifos expected to be excreted during urine collection interval obtained by substituting collection interval into equation for predicted excretion in Appendix B.

² Factor represents expected excretion during urine collection interval multiplied by ratio of molecular weight of 3,5,6-TCP and chlorpyrifos (198/350.6).

³ Cumulative excretion of 3,5,6-TCP divided by factor.

Table 4. Estimated Amounts of Chlorpyrifos Absorbed by Active Volunteers Following Broadcast Treatment of a Carpet with 0.5 Percent Dursban LO, as Estimated by DowElanco.

Subject	BW (kg)	Urine Collection Interval (hrs)	Cumulative Urinary Excretion of 3,5,6-TCP (μg)	Expected Excretion During Urine Collection Period ¹	Factor ²	Chlorpyrifos Absorption (μg)		Chlorpyrifos Absorbed ($\mu\text{g}/\text{kg}$)
						Based on Factor ³	Kinetic Model	
KC	81.7	94.3	317.4	0.5356	0.3025	1049	1043	12.8
KR	74.9	95.7	488.0	0.5408	0.3054	1598	1374	21.3
KA	84.0	96	170.1	0.5419	0.3060	556	503	6.6
MS	81.7	122.8	166.4	0.6196	0.3499	476	506	6.2
SM	79.5	123.5	538.1	0.6211	0.3508	1534	1175	19.3
JJ	88.5	48.5-120.5	138.7	0.3286	0.1856	748	673	8.4

¹ Fraction of absorbed chlorpyrifos expected to be excreted during urine collection interval obtained by substituting collection interval into equation for predicted excretion in Appendix B.

² Factor represents expected excretion during urine collection interval multiplied by ratio of molecular weight of 3,5,6-TCP and chlorpyrifos (198/350.6).

³ Cumulative excretion of 3,5,6-TCP divided by factor.

The finished spray is to be applied at a rate of 1 gallon per 1600 ft². The application of a 0.5 percent solution of chlorpyrifos should yield a surface deposition of:

$$\begin{aligned}\text{Surface deposition } (\mu\text{g}/\text{ft}^2) &= 19 \times 10^6 \mu\text{g}/\text{gal spray} \times 1 \text{ gal spray}/1600 \text{ ft}^2 \\ &= 1200 \mu\text{g}/\text{ft}^2\end{aligned}$$

The results of the deposition monitoring are presented graphically in Figures 2 and 3 for gauze pads and aluminum foil coupons, respectively. The initial deposition measurements indicate that the applications conducted during this study are within the range that would normally be expected when applied by hand held wand.

The surface levels on both media declined to relatively constant values of about 2000 to 4000 $\mu\text{g}/\text{ft}^2$ within 12 hours. Since there is limited data, no statistical analysis was performed on this information. The individual data points are presented in Appendix E. The deposition data obtained from the aluminum foil coupons were not used for exposure assessment but served only as a qualitative comparison between the deposition and dissipation from a porous surface (gauze) and a non-porous surface (aluminum foil). The information from the gauze deposition and dissipation was not used directly for the exposure assessment but was used to calculate the transfer coefficients as described in Section 4.4.2.

Deposition and Dissipation of Chlorpyrifos on Gauze Pads Following Broadcast Treatment with a 0.5 Percent Solution

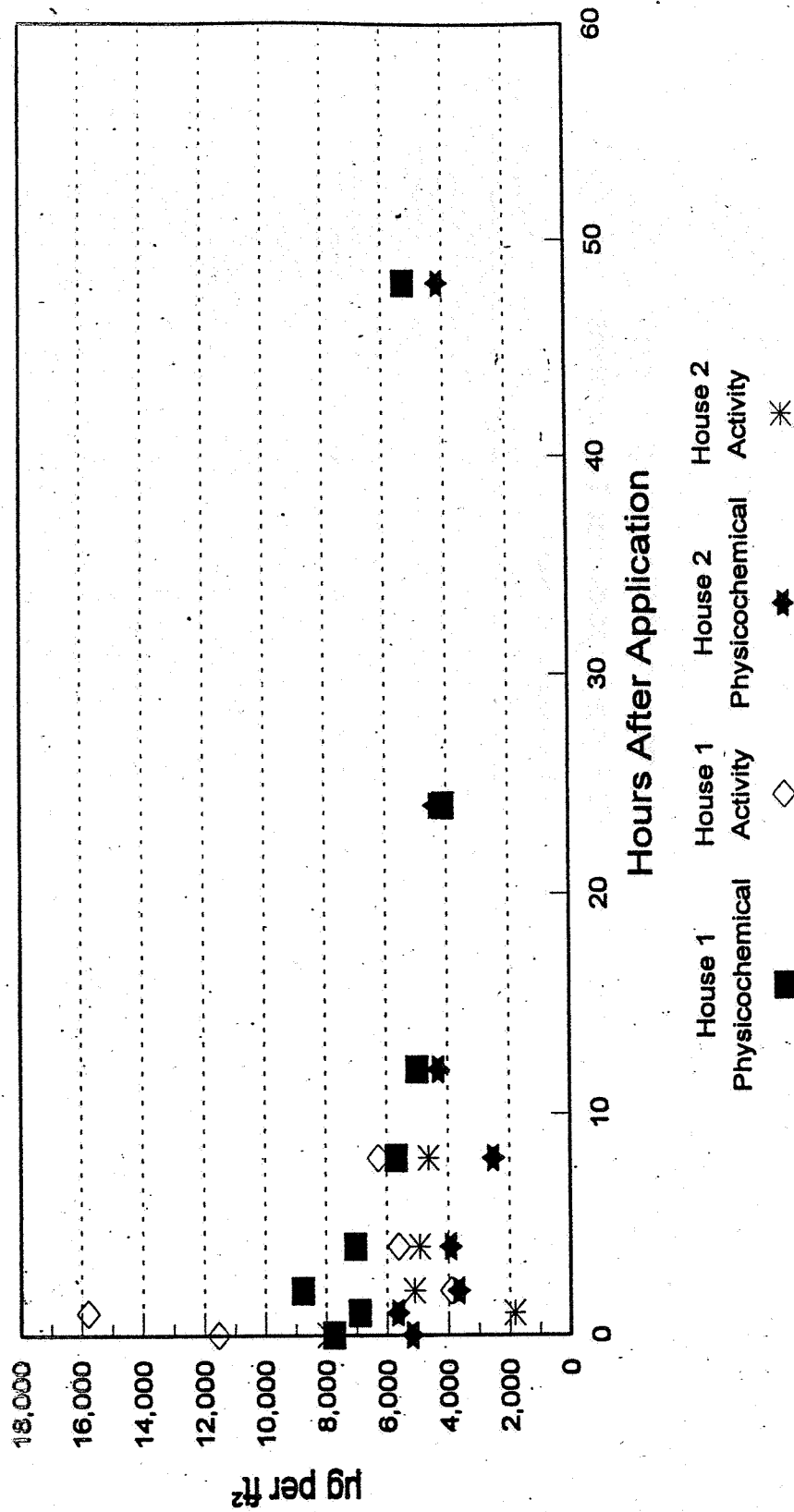


FIGURE 3

Deposition and Dissipation of Chlorpyrifos on Aluminum Foil Following Broadcast Treatment with a 0.5 Percent Solution

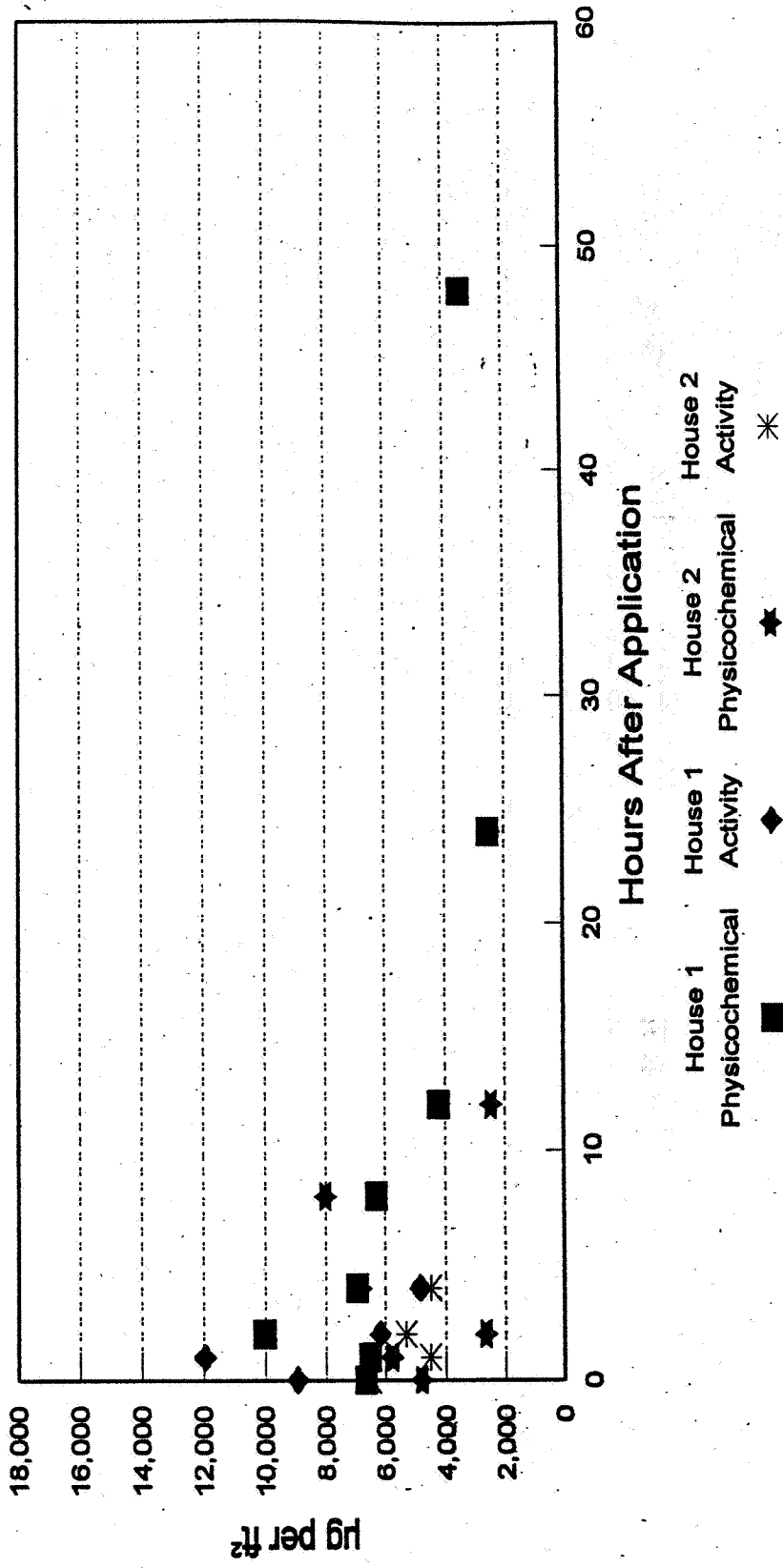


FIGURE 3

4.3 Inhalation Exposure Estimation

The results of air monitoring are presented in Figure 4. The individual data are presented in Appendix F. Air concentrations reached a maximum within the range of 4 to 8 hours after application and dropped to average levels of $7 \mu\text{g}/\text{m}^3$ after 24 hours. The average concentration at the 48 hour interval was $4.3 \mu\text{g}/\text{m}^3$.

The following assumptions were used for the calculation of respiratory exposures:

1. A child spends 24 hours per day in the house. Two thirds of this time (16 hours) are at rest and the remainder (8 hours) are while active. On the day of treatment, four of the active hours are at the level actually measured during the study activity period. The other four hours of activity are at the TWA for the remainder of the first day (TWA of 8-, 12-, and 24-hour samples). All resting time is spent at the TWA for the 8-, 12-, and 24-hour period. All respiratory exposure following the first day after application is at the level measured after 48 hours.
2. The registrant used a respiratory volume of 1.5 liters per minute (LPM) for a one year old child at rest and 4.2 LPM while active. This is in reasonable agreement with a mean value of 0.84 (range, 0.25-2.09 LPM) for a two year old child as presented in the Agency's Exposure Factors Handbook (1). The Handbook does not have minute volumes for active children of that age. OREB used the values proposed by the registrant to facilitate the checking of calculations.
3. A child weighs 10.2 kg. This body weight is also in good agreement with the Handbook.
4. The values collected during the actual activity period were used to estimate the respiratory component of exposure resulting from active play (minute volume = 4.2 LPM). These samples were obtained from both the activity room and physicochemical sampling room during the activity period and had a sampling interval of about 4 hours. The data from these samples are presented in Table 5.
5. The air concentrations used to calculate respiratory exposure during the time a child is at rest were derived from the time weighted average of the 8, 12, and 24 hour sampling intervals. These data are also presented in Table 5. The TWA was calculated assuming that 4 hours were spent at the 8-hour level, 4 hours at the 12-hour level, and 12 hours at the 24-hour level. The resulting exposures are presented in Table 6.

Air Concentrations of Chlorpyrifos in Rooms of Homes Following a Broadcast Treatment with a 0.5 Percent Solution

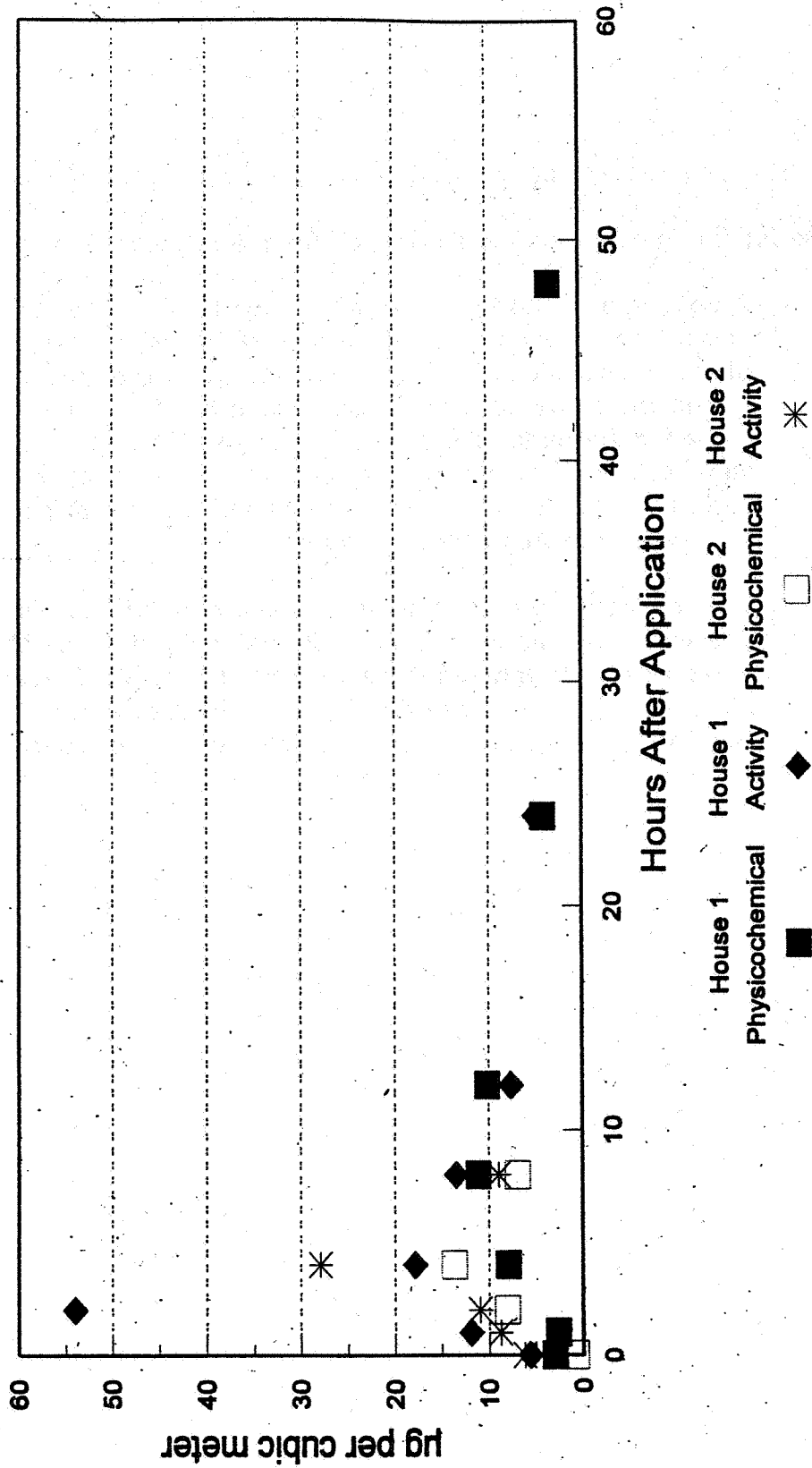


FIGURE 4

Table 5. Results of Air Sampling in Activity Rooms and Physicochemical Sampling Rooms After Broadcast Treatment with Chlorpyrifos at a Concentration of 0.5 Percent at a Rate of 1 Gallon per 1600 ft². Measured values are the average of two sampling cassette/tube units attached to a single pump. In the case of activity room measurements, only rooms sampled for periods of up to 24 hours are included.

Location	Room	Chlorpyrifos Concentration ($\mu\text{g}/\text{m}^3$)						
		4 Hr	8 Hr	12 Hr	24 Hr	8-24 Hr TWA ^{1,2}	48 Hr	
House 1	PC	11.1	11.1	10.2	4.2	6.8	3.3	
	Activity	9.5	13.7	No sample	6.9	9.6	No sample	
House 2	PC	16.9	17.8	13.5	7.6	10.8	5.3	
	Activity	11.5	27.9	No sample	9	16.6	No sample	
Overall Mean		12.3	17.7	6	7	8.9	4.3	

¹ TWA for Physicochemical Rooms (PC) = [(4 hrs x 8-hr conc) + (4 hrs x 12-hr conc) + (12 hrs x 24-hr conc)] + 20 hrs per day

² TWA for Activity (Act) Rooms = [(8 hrs x 8-hr conc) + (12 hrs x 24-hr conc)] + 20 hrs per day

Table 6. Estimates of the respiratory exposures of children and adults after broadcast treatment of a carpet with a 0.5 percent solution of chlorpyrifos. The first four hours of a child's activity are assumed to occur immediately after reentry is permitted.

Category	Hrs in House	Resp Vol (l/min)	Total Air Vol (m ³)	Air Conc (µg/m ³)	Exposure (µg/kg)
DAY 1:					
Child (10.2 kg):					
Active:	4	4.2	1.01	12.3	1.2
	4	1.5	0.36	8.9	0.31
At Rest:	16	1.5	1.44	8.9	1.3
					2.8
Adult (70 kg):					
Active:	4	29	6.96	12.3	1.2
	1	29	1.74	8.9	0.22
At Rest:	10	7.4	4.44	8.9	0.56
					1.98
DAY 2:					
Child (10.2 kg):					
Active:	8	4.2	2.02	4.3	0.85
At Rest:	16	1.5	1.44	4.3	0.61
					1.46
Adult (70 kg):					
Active:	5	29	8.7	4.3	0.53
At Rest:	10	7.4	4.44	4.3	0.27
					0.8

4.4 Dermal Exposure - Indirect Measurement

4.4.1 Adjustments for Size Differences Between Children and Adults

The exposures monitored in the six volunteers described in Section 4.1 were for adult males. In order to attempt to extrapolate these exposures to the potential exposures of infants several adjustments are required. The fraction of total exposure resulting from the dermal route must be partitioned from that estimated via inhalation. The surface area of a child is less than that of an adult. The registrant used a value of 3.9 m² for a 10.2 kg (22.5 lb) child and 17.5 m² for an adult. Since the surface area for an adult, as presented in the Pesticide Assessment Guidelines - Subdivision U (3) is 1.6 m², OREB assumed that the registrant meant 3.9 ft² (0.36 m²) and 17.5 ft² (1.6 m²), respectively. A surface area estimate of 0.36 m² for a child is in reasonable agreement with the surface area of a 2-3 year old child (50th percentile = 0.60 m²) as presented in the Agency's Exposure Factors Handbook (1). OREB used the Agency's values for calculation of dermal exposures. The surface area to body weight ratios then become:

$$\text{Child: } \frac{0.36 \text{ m}^2}{10.2 \text{ kg}} = 0.035 \text{ m}^2/\text{kg}$$

$$\text{Adult: } \frac{1.6 \text{ m}^2}{70 \text{ kg}} = 0.023 \text{ m}^2/\text{kg}$$

The ratio of these normalized values is:

$$\frac{0.035 \text{ m}^2/\text{kg}}{0.023 \text{ m}^2/\text{kg}} = 1.52$$

This is the value used by both the registrant and OREB to adjust the observed exposures to compensate for the size differences between children and adults.

4.4.2 Dislodgeable Residues and Transfer Coefficients:

Dislodgeable residues were used to estimate the contribution of the dermal route to total exposure. The drag sled (described in Appendix A), with attached denim patch, was drawn across a section of carpet. The amounts of chlorpyrifos dislodged are presented in Table 7 and graphically in Figure 2. These values were then used to calculate a transfer coefficient (TC) which is the amount of dislodged residues compared to the total residues deposited on a surface. Deposition on gauze pads was used to represent the total amount found on a carpet. The deposition data are tabulated in Appendix H and the calculated transfer coefficients

are presented in Table 8. A graphical presentation of the average transfer coefficients is presented in Figure 4.

4.4.3 Calculation of the Dermal Component of Exposure

In order to calculate a dermal exposure, some estimate of the surface area contacted is necessary. The registrant measured the floor surface for the activity room. Areas covered by gauze patches and aluminum coupons (about 12.5 ft²) were subtracted from this area. After definition of the remaining activity areas, the registrant arbitrarily assumed that half of this area would be contacted by the subject. The formula for calculation of dermal dose using this method is:

$$\text{Dermal Dose } (\mu\text{g}/\text{kg}) = \frac{\text{Dislodg. Res. } (\mu\text{g}/\text{ft}^2) \times \text{Area Contacted } (\text{ft}^2) \times \text{Abs } (\%)}{\text{Body Weight}(\text{kg})}$$

The registrant estimated the dermal component of exposure using the dislodgeable residue values obtained after 4 hours, a body weight of 10.2 kg, and an absorption value of 3 percent. OREB used an absorption value of 1 percent as indicated in a Toxicology Branch review (4). The estimated values for the dermal component of exposure using the indirect measurements (area contacted and transfer coefficients) are presented in Tables 9 and 10 for the day of treatment and the day after application, respectively.

4.4.4 Estimation of Hand/Oral Exposure

One potential source of exposure of children comes from hand to mouth contact after contact with a contaminated surface. After the four-hour activity period, the hands of each volunteer were rinsed in a dilute soap solution containing dioctyl sodium succinate (DSS). Aliquots of 100, 100, and 50 ml were added to a bowl as the hands were rubbed together. The hands were rinsed again with 100, 100, and 50 ml of deionized water. The rinsate was then poured into a bottle and the bowl rinsed with 100, 100, and 50 ml of ethyl acetate. The ethyl acetate extract was added to the washing solution and the bottle was shaken to partition the chlorpyrifos into the ethyl acetate layer. This layer was analyzed for chlorpyrifos.

The registrant assumed that all of the chlorpyrifos recovered from the hand rinse would be available for oral exposure. There are no data to support this assumption but, in lieu of such information, it provides a reasonable estimate of potential oral

exposure from contaminated surfaces. The surface area of the hand of a small child was considered by the registrant to be approximately one fourth that of an adult. After adjustment for this difference the calculation of the hand/oral exposure becomes:

$$\text{Exposure } (\mu\text{g}/\text{kg}) = \frac{\text{Chlorpyrifos in rinse } (\mu\text{g}) \times 0.25}{10.2 \text{ kg}}$$

For subsequent days the hand/oral exposure was adjusted to account for the change in dislodgeable residues. The amount recovered from the hand rinses was multiplied by the ratio of the dislodgeable residues found after 48 hours to the amount found during the activity period (T4). The hand/oral data for the subjects of this study are presented in Table 11.

Table 7. Residues Dislodged Using a Drag Sled After Broadcast Treatment of a Carpet with 0.5 Percent Chlorpyrifos. All values are in $\mu\text{g}/\text{ft}^2$.

	Interval	2 Hrs	4 Hrs	8 Hrs	12 Hrs	24 Hrs	48 Hrs
House No. 1:							
Physicochemical Room	Replicate 1	24.2	26.7	39.5	23.2	22.2	
	Replicate 2	33.6	23.8	25.3	18.1	14.4	6.7
	Replicate 3	22.3	34.1	21.8	15.2	8.9	10.1
	Replicate 4	35.6	32.6	26	12.6	13.9	8.9
	Average	28.9	29.3	28.2	17.3	14.9	8.6
Activity Room	Replicate 1	27.8		20.3		31.8	
	Replicate 2	22.8		29.8		26.1	
	Replicate 3	29.8		25.9		33.8	
	Replicate 4	26.1		16.4		30.3	
	Average	26.6		23.1		30.5	
House No. 2:							
Physicochemical Room	Replicate 1	21.4	13.2	9.1	7.4	2.1	1.5
	Replicate 2	12	9.3	10	5.1	4	1.9
	Replicate 3	29.7	29.3	2.2	8.3	3.8	1.8
	Replicate 4	36.1	8.7	5.7	6.2	2.4	0.9
	Average	24.8	15.1	6.8	6.8	3.1	1.5
Activity Room	Replicate 1	31.5		29.8		19.6	
	Replicate 2	24.6		28.7		31.6	
	Replicate 3	62.3		38.1		7.7	
	Replicate 4	78.8		37.9		8.7	
	Average	49.3		33.6		16.9	

Average Residues Recovered by Drag Sampling of Carpets After Broadcast Treatment with Dursban

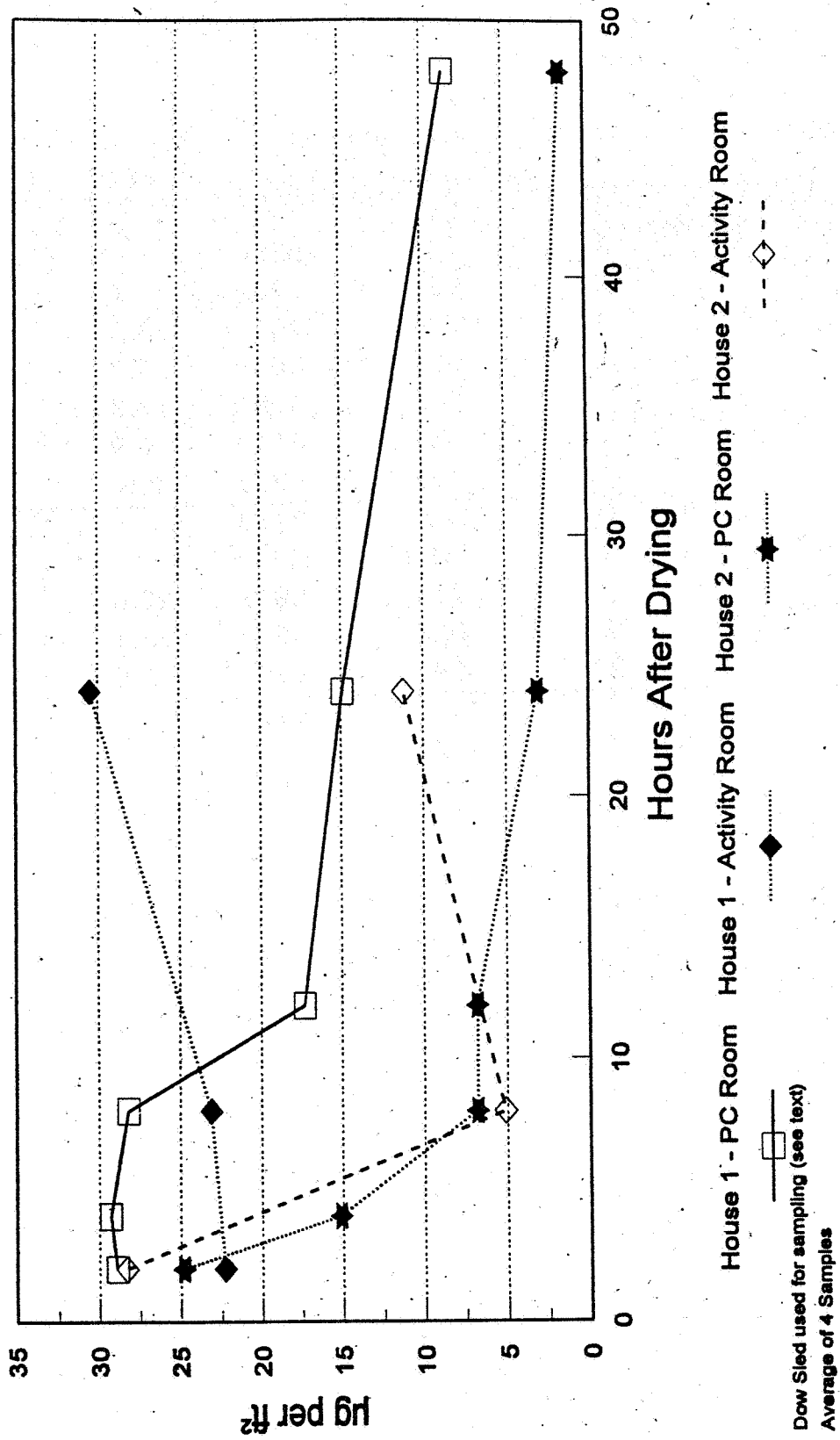
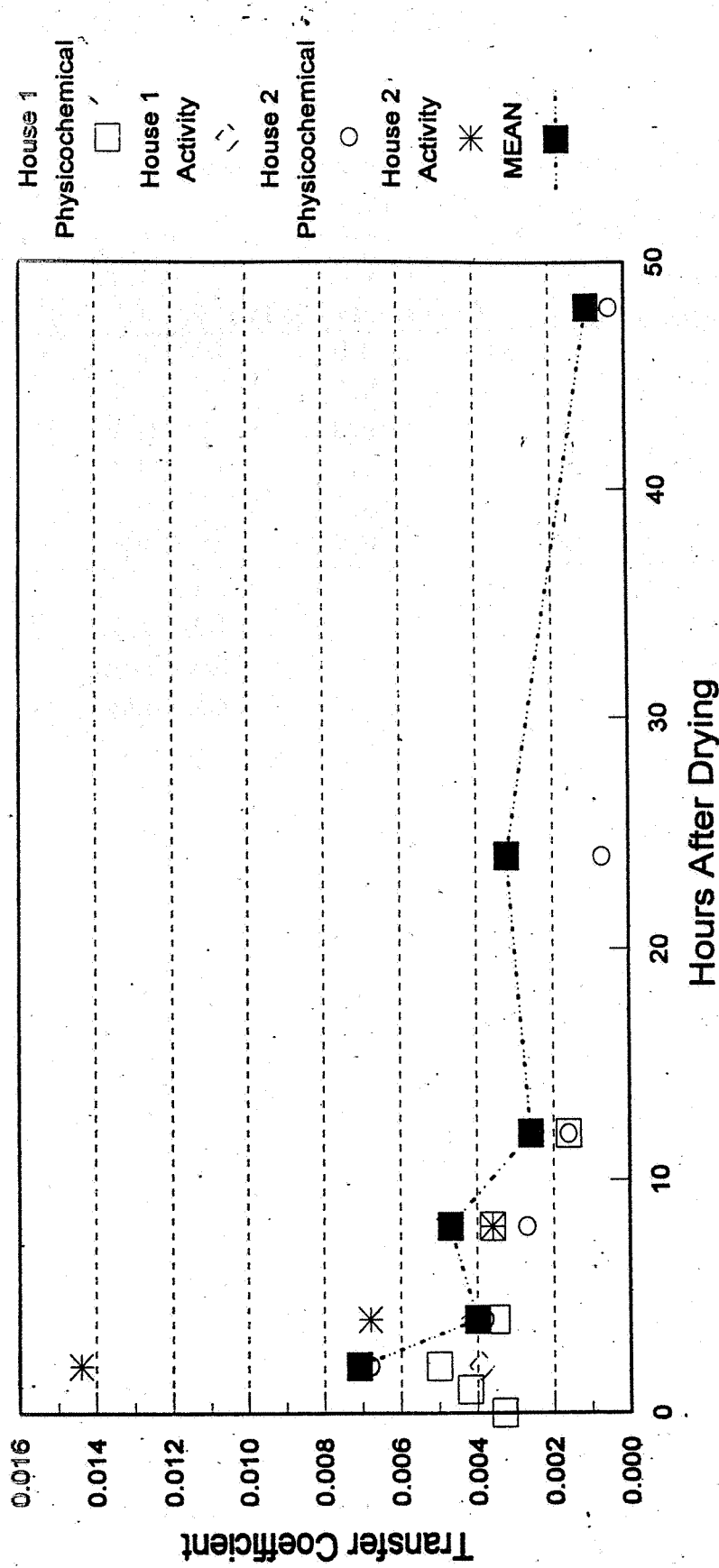


FIGURE 4

Table 8. Transfer Coefficients Derived from Gauze Deposition Pads and Drag Sled Sampling of a Carpet Following Broadcast Treatment with 0.5 Percent Chlorpyrifos.

House	Room	Interval	Avg Deposition		Avg Drag $\mu\text{g}/\text{ft}^2$	Transfer Coefficient (= Avg Drag/Avg Dep.)	
			$\mu\text{g}/103 \text{ cm}^2$	$\mu\text{g}/\text{ft}^2$			
1	PC	0	861	7749			
		1	766	6894			
		2	974	8766	28.9	0.0033	
		4	781	7029	29.3	0.0042	
		8	632	5688	28.2	0.0050	
		12	555	4995	17.3	0.0035	
		24	457	4113	14.9	0.0036	
		48	587	5283	8.6	0.0016	
	Activity	0	1052	9468			
		1	1186	10674			
		2	767	6903	26.6	0.0039	
		8	623	5607	23.1	0.0041	
		24	696	6264	30.5	0.0049	
		<hr/>					
		2	PC	0	575	5175	
1	627			5643			
2	407			3663	24.8	0.0068	
4	436			3924	15.1	0.0038	
8	280			2520	6.8	0.0027	
12	478			4302	6.8	0.0016	
24	488			4392	3.1	0.0007	
48	464			4176	1.5	0.0004	
Activity	0		503	4527			
	1		337	3033			
	2		380	3420	49.3	0.0144	
	8		548	4932	33.6	0.0068	
	24		515	4635	16.9	0.0036	
	<hr/>						
	Mean					0.0042	

Transfer Coefficients for Chlorpyrifos on a Carpet Following Broadcast Treatment with a 0.5 Percent Spray



TC = Dislodgeable Sample ($\mu\text{g}/\text{sq ft}$)/Deposition Sample ($\mu\text{g}/\text{sq ft}$)
Two sited used for dislodgeable sampling

FIGURE 5

Table 9. Estimation of Dermal Component of Exposure of Six Volunteers to Chlorpyrifos on the Day of Broadcast Treatment of a Carpet Using Dislodgeable Residue Values.

Subject	House No	Dislodgeable Residue	Area of Contact	Dermal Doses
		At 4 Hours ($\mu\text{g}/\text{ft}^2$)	ft^2	($\mu\text{g}/\text{kg}/\text{day}$)
KC	1	29.3	43.1	1.2
KR	1	29.3	43.5	1.2
KA	1	29.3	39.7	1.1
MS	2	15.1	41.1	0.6
SM	2	15.1	41.1	0.6
JJ	2	15.1	32	0.5
Mean				0.9
Std. Dev.				0.3
Maximum				1.2
Minimum				0.5

Body weight (kg) = 10.2 kg

Dermal Absorption = 1 %

Table 10. Estimation of Dermal Component of Exposure of Six Volunteers to Chlorpyrifos On the Second Day Following Broadcast Treatment of a Carpet Using Dislodgeable Residue Values.

Subject	House No	Dislodgeable Residue	Area of Contact	Dermal Doses
		At 4 Hours ($\mu\text{g}/\text{ft}^2$)	ft^2	($\mu\text{g}/\text{kg}/\text{day}$)
KC	1	8.6	43.1	0.36
KR	1	8.6	43.5	0.37
KA	1	8.6	39.7	0.33
MS	2	1.5	41.1	0.06
SM	2	1.5	41.1	0.06
JJ	2	1.5	32	0.06
Mean				0.21
Std. Dev.				0.16
Maximum				0.37
Minimum				0.05

Body weight (kg) = 10.2 kg

Dermal Absorption = 1 %

Table 11. Summary of the Estimated Hand/Oral Exposures of Children to Chlorpyrifos Following Broadcast Treatment of a Carpet.

Subject	Hand Rinse (μg)	Dislodgeable Residue ($\mu\text{g}/\text{ft}^2$)		Exposure ($\mu\text{g}/\text{kg}$)	
		4 Hour	48 Hour	Day 1	Day 2
MS	325	1.5	15.1	7.97	0.791
SM	611	1.5	15.1	14.98	1.488
JJ	621	1.5	15.1	15.22	1.512
KA	362	8.6	29.3	8.87	2.604
KC	292	8.6	29.3	7.16	2.101
KR	635	8.6	29.3	15.56	4.568

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4. Nolan, R.J, D.L. Rick, N.L. Freshour, and J.H. Saunders (1984) Chlorpyrifos: Pharmacokinetics in Human Volunteers. Toxicol and Applied Phamacol., 73, pp 8-15.
5. Memorandum from A. Levy (TB-I) to L. Propst (SRRD) titled "CHLORPYRIFOS - Human Oral and Dermal Absorption", dated March 6, 1995.

cc: Chlorpyrifos file
Correspondence file
Circulation
J. Redden (RCAB/7509C)
D. Edwards (RD/7505C)

APPENDIX A. Comparison of the pressure exerted on the Dow "Sled" and that from a One Year Old Child. (Note: This Appendix was extracted verbatim from the registrant's submission)

"To provide uniform pressure, a drag system was used to obtain wipe test results. A 3" x 3" x 3/4" piece of plywood was used as the base of the drag system. On the top of the plywood, a cradle to hold an 8.5 pound lead sphere, commonly used as a downrigger in fishing, was constructed. The rationale for using this weight was that it approximated the pressure exerted by a child standing (on two feet) and/or crawling with hands and knees touching the floor. The pressure applied by the 8 1/2 pound sphere, on the block, was $8.5 \times 454 \text{ g/lb}$ divided by 9 in^2 , which is equal to 492 g/in^2 or 0.944 lbs/in^2 . A one year old child has an approximate weight of 20-25 pounds (average 22.5 pounds). The approximate area of a one year old's hand is $2" \times 4"$ or 8 in^2 ; two hands equal 16 in^2 . The contact area of a one year old's knee is approximately $2" \times 2"$ or 4 in^2 ; two knees equal 8 in^2 . Therefore, the approximate area of two hands and two knees is $16 \text{ in}^2 + 8 \text{ in}^2 = 24 \text{ in}^2$. The weight of the child when crawling is supported by two hands and two knees. Minimum balance support is given by the top of the feet. Using 22.5 pounds $\times 454 \text{ g/lb}$, divided by 24 in^2 is equal to 426 g/in^2 or 0.938 pounds per in^2 . A 22.5 pound child standing supports his/her weight on two feet approximately $5" \times 2.5"$ or 12.5 in^2 ; two feet have 25 in^2 of surface. The pressure applied by a 22.5 pound child is $22.5 \text{ lb} \times 454 \text{ g/lb}$ divided by 25 in^2 equals 408.6 g/in^2 or 0.9 lbs/in^2 . The pressure applied by the proposed drag system approximates the pressure applied by a one year old child weighing 22.5 pounds. The 8 1/2 pound lead sphere was placed in the cradle to distribute uniform pressure on the 9 in^2 piece of plywood. To the underside of the 9 in^2 plywood block, a $4" \times 4"$ denim pad was fastened to the front eye hook. The pad was folded up the front of the plywood block such that the entire bottom surface was covered by the denim."

Appendix B. Pharmacokinetic Model Used by DowElanco to Estimate the Amount of Chlorpyrifos Absorbed After Broadcast Treatment of a Carpet.

The Model is of the form:

$$X_u(t) = K_a * f X_0 \left[\frac{1}{K_a} + \frac{\exp(-Kt)}{(K-K_a)} - \frac{K \exp(-K_a t)}{(K_a(K-K_a))} \right]$$

Where:

t = time in hours

K = 0.0258 = per hr, rate constant for elimination

K_a = 0.0308 per hr, rate constant for absorption

f = 0.72 = fraction of dose as 3,5,6-TCP absorbed through the skin

X₀ = 1

Day	Hours Post Dosing	K _a *f	1/K _a	exp(-Kt)/(K-K _a)	-K*exp(-K _a *t)/K _a *(K-K _a)	Cum. Exc. X _{ut} (t)	Int. Excr X _{ut} (t)-X _{ut} (t-1)
	0	0.0222	32.47	-200	167.53	0.0000	0.0000
	12	0.0222	32.47	146.75	115.77	0.0331	0.0331
1	24	0.0222	32.47	107.67	80	0.1064	0.0733
	36	0.0222	32.47	79.01	55.28	0.1941	0.0877
2	48	0.0222	32.47	57.97	38.2	0.2820	0.0879
	60	0.0222	32.47	42.53	26.4	0.3626	0.0806
3	72	0.0222	32.47	31.21	18.24	0.4329	0.0703
	84	0.0222	32.47	22.90	12.6	0.4922	0.0593
4	96	0.0222	32.47	16.80	8.71	0.5412	0.0490
	108	0.0222	32.47	12.33	6.02	0.5808	0.0396
5	120	0.0222	32.47	9.05	4.16	0.6124	0.0316
	132	0.0222	32.47	6.64	2.87	0.6372	0.0248
6	144	0.0222	32.47	4.87	1.99	0.6569	0.0197
	156	0.0222	32.47	3.57	1.37	0.6719	0.0150
7	168	0.0222	32.47	2.62	0.95	0.6837	0.0118
	180	0.0222	32.47	1.92	0.66	0.6928	0.0091
8	192	0.0222	32.47	1.41	0.45	0.6995	0.0067
	204	0.0222	32.47	1.04	0.31	0.7047	0.0052
9	216	0.0222	32.47	0.76	0.22	0.7088	0.0041
	228	0.0222	32.47	0.56	0.15	0.7118	0.0030
10	240	0.0222	32.47	0.41	0.10	0.7140	0.0022
	252	0.0222	32.47	0.30	0.07	0.7157	0.0017

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Appendix C. Pharmacokinetic Parameters Used by OREB to Estimate the Amount of Chlorpyrifos Absorbed By Six Volunteers After Broadcast Treatment of a Carpet. See Appendix B for description of the model.

Subject	Day	Hours Post Dosing	Ka*f	1/Ka	Exp(-Kt)/(K-Ka)	-K*exp(Ka*t)/Ka*(K-Ka)	Xut(t)	Xut(t)-Xut(t-1)
KC	5	118	0.0222	32.47	-9.52	-4.42	0.6075	-0.1121
KR	5	120	0.0222	32.47	-9.05	-4.16	0.6124	0.0049
KA	5	120	0.0222	32.47	-9.05	-4.16	0.6124	0.0000
MS	6	146	0.0222	32.47	-4.63	-1.87	0.6597	0.0473
SM	6	149	0.0222	32.47	-4.28	-1.7	0.6635	0.0038
JJ	6	142	0.0222	32.47	-5.13	-2.11	0.6538	-0.0097

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Appendix D. Urine Collection Data Used for the Determination of Cumulative Chlorpyrifos Excretion Following Broadcast treatment of a Carpet with 0.5 Percent Dursban LO.

Participant	length of collection	wt (g)	conc (ng/g)	Amt (μ g)
MS	11.5	453.3	2.1	1
MS	12	1163.9	1.6	1.9
MS	11	883	5.7	5
MS	13.5	1480.9	23.5	34.8
MS	9	1546.2	12.8	19.8
MS	15	1454	21.4	31.1
MS	9.75	1024.5	19	19.5
MS	14.25	1014.3		
MS	9.67	1391.5	9.9	13.8
MS	12.33	1290.5	10.7	13.8
MS	13.67	1120.3	13.7	15.3
MS	14.58	1840.7	7.2	13.3
	146.25			169.3
	(6.1 Days)			
SM	26	1220.3	6.1	7.4
SM	10.25	499.8	18.7	9.3
SM	13.83	730.7	18.7	13.7
SM	9.58	737.4	128.2	94.5
SM	14.41	2457.4	72.8	178.9
SM	9.92	610.6	74.9	45.7
SM	14.25	858	65.3	56
SM	10.08	486.2	70.5	34.3
SM	13.17	1686	24.9	42
SM	12	574.7	66.9	38.4
SM	16	3644.5	6.9	25.1
	149.49			545.3
	(6.2 Days)			

Appendix D. Urine Collection Data Used for the Determination of Cumulative Chlorpyrifos Excretion Following Broadcast treatment of a Carpet with 0.5 Percent Dursban LO.

Participant	length of collection	wt (g)	conc (ng/g)	Amt (μ g)
JJ	7.5	1448.8	2.5	3.6
JJ	13.5	702.8	5.5	3.9
JJ	24.5		232.3	
JJ	10		108.4	
JJ	14		181.2	
JJ	8	263.9	105.8	27.9
JJ	16	428.3	80.7	34.6
JJ	10	542.8	28.4	15.4
JJ	14	1328.5	17.4	23.1
JJ	10	608.4	28.6	17.4
JJ	14	663.6	30.6	20.3
	141.5			146.2
	(5.9 Days)			
KC	6.5	245.1	2.7	0.7
KC	17.5	516.2	5.3	2.7
KC	6.25	375.8	3.6	1.4
KC	17.75	603.2	112.4	67.8
KC	9.75	333.7	156	52.1
KC	14.25	359.3	171.5	61.6
KC	10	307.3	123.9	38.1
KC	14	356.6	132.5	47.2
KC	9.25	239.2	90.8	21.7
KC	13	457.2	60.2	27.5
	118.25			320.8
	(4.9 Days)			
KR	10.5	336.6	4.8	1.6
KR	13.5	626.9	11.1	7
KR	10.75	509	22.3	11.4
KR	13.25	608.9	157.2	95.7
KR	13.08	542	198.1	107.4
KR	11	409.8	189.6	77.7
KR	10.58	325.9	198.1	64.6
KR	13.5	485.3	112.2	54.5
KR	8.83	303.9	85.6	26

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Appendix D. Urine Collection Data Used for the Determination of Cumulative Chlorpyrifos Excretion Following Broadcast treatment of a Carpet with 0.5 Percent Dursban LO.

Participant	length of collection	wt (g)	conc (ng/g)	Amt (μ g)
KR	14.67	635.7	80	50.9
	119.66			496.8
	(5.0 Days)			
KA	10	570.9	0.9	0.5
KA	14	639.9	1	0.6
KA	10	952.5	1.2	1.1
KA	14	613.6	66.5	40.8
KA	10	269.3	106.9	28.8
KA	14	217.2	132.3	28.7
KA	10	443.8	43.5	19.3
KA	14	320	93.3	29.9
KA	10	445.5	36.6	16.3
KA	14	408.4	12.6	5.1
	120			171.1
	(5.0 Days)			

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Appendix E. Results of Deposition Sampling of Gauze Pads Placed on a Carpet Prior to Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos.

House No.	Room Type	Interval (hrs)	$\mu\text{g}/103.22 \text{ cm}^2$				$\mu\text{g}/\text{ft}^2$	
			Rep #1	Rep #2	Rep #3	Rep #4		
1	Physicochemical	0	930	934	1100	480	861	7757
1	Physicochemical	1	1063	468			766	6901
1	Physicochemical	2	1162	785			974	8775
1	Physicochemical	4	1101	460			781	7036
1	Physicochemical	8	616	647			632	5694
1	Physicochemical	12	645	465			555	5000
1	Physicochemical	24	417	496			457	4117
1	Physicochemical	48	673	500			587	5288
1	Activity	0	940	900			920	8288
1	Activity	1	926	661			794	7153
1	Activity	2	1555	802			1179	10622
1	Activity	0	1096	814			955	8604
1	Activity	1	789	1232			1011	9108
1	Activity	2	585	793			689	6207
1	Activity	0	1097	1465			1281	11541
1	Activity	1	1193	2310			1752	15784
1	Activity	2	693	174			434	3910
1	Activity	8	515	731			623	5613
1	Activity	24	490	902			696	6270
2	Physicochemical	0	547	348	593	812	575	5180
2	Physicochemical	1	564	690			627	5649
2	Physicochemical	2	484	330			407	3667

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Appendix E. Results of Deposition Sampling of Gauze Pads Placed on a Carpet Prior to Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos.

House No.	Room Type	Interval (hrs)	µg/103.22 cm ²				µg/ft ²	
			Rep #1	Rep #2	Rep #3	Rep #4		Average
2	Physicochemical	4	391	481			436	3928
2	Physicochemical	8	142	418			280	2523
2	Physicochemical	12	297	658			478	4306
2	Physicochemical	24	534	441			488	4396
2	Physicochemical	48	594	334			464	4180
2	Activity	0	269	398			334	3009
2	Activity	1	338	360			349	3144
2	Activity	2	388	253			321	2892
2	Activity	0	298	285			292	2631
2	Activity	1	418	507			463	4171
2	Activity	2	211	292			252	2270
2	Activity	0	242	1524			883	7955
2	Activity	1	314	93			204	1838
2	Activity	2	133	1003			568	5117
2	Activity	8	114	982			548	4937
2	Activity	24	809	221			515	4640

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Appendix F. Results of Deposition Sampling of Aluminum Foil Coupons Placed on a Carpet Prior to Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos.

House No.	Room Type	Interval (hrs)	Chlorpyrifos ($\mu\text{g}/58 \text{ cm}^2$)				$\mu\text{g}/\text{ft}^2$	
			Rep #1	Rep #2	Rep #3	Rep #4		Average
1	Physicochemical	0	440	546	320	373	420	6720
1	Physicochemical	1	565	256			411	6576
1	Physicochemical	2	738	526			632	10112
1	Physicochemical	4	644	231			438	7008
1	Physicochemical	8	436	358			397	6352
1	Physicochemical	12	213	319			266	4256
1	Physicochemical	24	168	153			161	2576
1	Physicochemical	48	366	63			215	3440
1	Activity	0	486	477			482	7712
1	Activity	1	623	545			584	9344
1	Activity	2	554	478			516	8256
1	Activity	0	475	444			460	7360
1	Activity	1	487	469			478	7648
1	Activity	2	818	512			665	10640
1	Activity	0	850	277			564	9024
1	Activity	1	394	1114			754	12064
1	Activity	2	334	444			389	6224
1	Activity	8	286	326			306	4896
1	Activity	24	270	820			545	8720
2	Physicochemical	0	132	380	391	308	303	4848
2	Physicochemical	1	369	358			364	5824
2	Physicochemical	2	151	184			168	2688
2	Physicochemical	4	410	450			430	6880
2	Physicochemical	8	736	274			505	8080

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Appendix F. Results of Deposition Sampling of Aluminum Foil Coupons Placed on a Carpet Prior to Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos.

House No.	Room Type	Interval (hrs)	Chlorpyrifos ($\mu\text{g}/58 \text{ cm}^2$)				$\mu\text{g}/\text{ft}^2$	
			Rep #1	Rep #2	Rep #3	Rep #4		Average
2	Physicochemical	12	104	207			156	2496
2	Physicochemical	24	60	254			157	2512
2	Physicochemical	48	14	28			21	336
2	Activity	0	128	282			205	3280
2	Activity	1	180	158			169	2704
2	Activity	2	225	238			232	3712
2	Activity	0	171	112			142	2272
2	Activity	1	331	96			214	3424
2	Activity	2	122	245			184	2944
2	Activity	0	180	637			409	6544
2	Activity	1	96	471			284	4544
2	Activity	2	200	469			335	5360
2	Activity	8	139	426			283	4528
2	Activity	24	723	31			377	6032

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Appendix G. Results of Air Monitoring in Rooms of Homes Following Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos. Backup tubes, which were virtually all non-detect, are not included.

House Id.	Room Type	Sampler	Interval	Sample Time (min)	L/min	Vol (l)	µg Found	Conc (ug/m3)	Avg
House 1	Activity	Cassette		246	0.94	231	3.01	13.03	
House 1	Activity	Cassette		246	1.03	253	1.50	5.93	9.48
House 1	Activity	Cassette	0	55	1.04	57	0.14	2.46	
House 1	Activity	Cassette	0	55	1.01	56	0.14	2.50	2.48
House 1	Activity	Cassette	0	56	0.93	52	0.57	10.96	
House 1	Activity	Cassette	0	56	0.9	50	0.60	12.00	11.48
House 1	Activity	Cassette	0	55	0.96	53	0.05	0.94	
House 1	Activity	Cassette	0	55	0.98	54	0.03	0.56	0.75
House 1	Activity	Cassette	1	52	0.81	42	0.14	3.33	
House 1	Activity	Cassette	1	52	0.93	48	0.16	3.33	3.33
House 1	Activity	Cassette	1	62	0.97	60	0.08	1.33	
House 1	Activity	Cassette	1	62	0.97	60	0.08	1.33	1.33
House 1	Activity	Cassette	2	62	0.83	51	0.47	9.22	
House 1	Activity	Cassette	2	62	0.9	56	0.51	9.11	9.17
House 1	Activity	Cassette	2	65	0.99	64	0.47	7.34	
House 1	Activity	Cassette	2	65	0.93	60	0.37	6.17	6.76
House 1	Activity	Cassette	2	67	0.88	59	0.49	8.31	
House 1	Activity	Cassette	2	67	0.96	64	0.50	7.81	8.06
House 1	Activity	Cassette	8	66	1.03	68	0.91	13.38	
House 1	Activity	Cassette	8	66	0.83	55	0.77	14.00	13.69
House 1	Activity	Cassette	24	70	0.86	60	0.46	7.67	

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Appendix G. Results of Air Monitoring in Rooms of Homes Following Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos. Backup tubes, which were virtually all non-detect, are not included.

House Id.	Room Type	Sampler	Interval	Sample Time (min)	L/min	Vol (l)	µg Found	Conc (µg/m ³)	Avg
House 1	Activity	Cassette	24	70	1.32	92	0.57	6.20	6.94
House 1	Physicochemical	Cassette		246	0.82	202	3.03	15.00	
House 1	Physicochemical	Cassette		246	0.94	231	1.65	7.14	11.07
House 1	Physicochemical	Cassette	0	63	0.97	61	0.16	2.62	
House 1	Physicochemical	Cassette	0	63	1.01	64	0.22	3.44	3.03
House 1	Physicochemical	Cassette	1	54	0.88	48	0.14	2.92	
House 1	Physicochemical	Cassette	1	54	0.85	46	0.11	2.39	2.66
House 1	Physicochemical	Cassette	2						
House 1	Physicochemical	Cassette	2						
House 1	Physicochemical	Cassette	4	58	0.98	57	0.48	8.42	
House 1	Physicochemical	Cassette	4	58	1.18	68	0.51	7.50	7.96
House 1	Physicochemical	Cassette	8	64	0.92	59	0.67	11.36	
House 1	Physicochemical	Cassette	8	64	1.05	67	0.73	10.90	11.13
House 1	Physicochemical	Cassette	12	56	0.96	54	0.54	10.00	
House 1	Physicochemical	Cassette	12	56	1.1	62	0.64	10.32	10.16
House 1	Physicochemical	Cassette	24	72	0.95	68	0.33	4.85	
House 1	Physicochemical	Cassette	24	72	0.94	68	0.24	3.53	4.19
House 1	Physicochemical	Cassette	48	63	0.99	62	0.20	3.23	
House 1	Physicochemical	Cassette	48	63	1.03	65	0.22	3.38	3.31
House 2	Activity	Cassette		264	0.95	251	4.99	19.88	
House 2	Activity	Cassette		264	0.98	259	0.81	3.13	11.51
House 2	Activity	Cassette	0	59	0.75	44	0.32	7.27	

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Appendix G. Results of Air Monitoring in Rooms of Homes Following Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos. Backup tubes, which were virtually all non-detect, are not included.

House Id.	Room Type	Sampler	Interval	Sample Time (min)	L/min	Vol (l)	µg Found	Conc (ug/m3)	Avg
House 2	Activity	Cassette	0	59	0.84	50	0.35	7.00	7.14
House 2	Activity	Cassette	0	59	1.05	62	0.56	9.03	
House 2	Activity	Cassette	0	60	0.91	55	0.49	8.91	8.97
House 2	Activity	Cassette	0	53	1.02	54	0.32	5.93	
House 2	Activity	Cassette	0	53	0.92	49	0.32	6.53	6.23
House 2	Activity	Cassette	1	61	0.81	49	0.50	10.20	
House 2	Activity	Cassette	1	61	0.94	57	0.54	9.47	9.84
House 2	Activity	Cassette	1	65	0.77	50	0.48	9.60	
House 2	Activity	Cassette	1	65	0.87	57	0.49	8.60	9.1
House 2	Activity	Cassette	1	61	0.8	49	0.41	8.37	
House 2	Activity	Cassette	1	61	0.77	47	0.43	9.15	8.76
House 2	Activity	Cassette	2	67	0.84	56	0.81	14.46	
House 2	Activity	Cassette	2	67	0.89	60	0.71	11.83	13.15
House 2	Activity	Cassette	2	67	0.81	54	0.67	12.41	
House 2	Activity	Cassette	2	67	0.8	54	0.61	11.30	11.86
House 2	Activity	Cassette	2	71	1.04	74	0.80	10.81	
House 2	Activity	Cassette	2	71	0.9	64	0.71	11.09	10.95
House 2	Activity	Cassette	8	80	0.91	73	2.12	29.04	
House 2	Activity	Cassette	8	80	0.9	72	1.93	26.81	27.93
House 2	Activity	Cassette	24	67	0.89	60	0.56	9.33	
House 2	Activity	Cassette	24	67	0.84	56	0.48	8.57	8.95
House 2	Physicochemical	Cassette		258	1.05	271	4.57	16.86	

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Appendix G. Results of Air Monitoring in Rooms of Homes Following Broadcast Treatment with a 0.5 Percent Solution of Chlorpyrifos. Backup tubes, which were virtually all non-detect, are not included.

House Id.	Room Type	Sampler	Interval	Sample Time (min)	L/min	Vol (l)	µg Found	Conc (µg/m ³)	Avg
House 2	Physicochemical	Cassette		258	0.88	227	3.55	16.96	16.91
House 2	Physicochemical	Cassette	0	65	1.03	67	0.23	3.43	
House 2	Physicochemical	Cassette	0	65	0.92	60	0.21	3.50	3.47
House 2	Physicochemical	Cassette	1	56	1.04	58	0.34	5.86	
House 2	Physicochemical	Cassette	1	56	0.83	46	0.25	5.43	5.65
House 2	Physicochemical	Cassette	2	60	0.78	47	0.59	12.55	
House 2	Physicochemical	Cassette	2	60	1.05	63	0.71	11.27	11.91
House 2	Physicochemical	Cassette	4	62	0.8	50	4.64	Outlier	
House 2	Physicochemical	Cassette	4	62	0.77	48	0.73	15.21	7.61
House 2	Physicochemical	Cassette	8	73	1.03	75	1.41	18.80	
House 2	Physicochemical	Cassette	8	73	0.92	67	1.13	16.87	17.84
House 2	Physicochemical	Cassette	12	60	0.92	55	0.77	14.00	
House 2	Physicochemical	Cassette	12	60	0.97	58	0.75	12.93	13.47
House 2	Physicochemical	Cassette	24	70	1.01	71	0.53	7.46	
House 2	Physicochemical	Cassette	24	70	0.9	63	0.49	7.78	7.62
House 2	Physicochemical	Cassette	48	70	0.91	64	0.31	4.84	
House 2	Physicochemical	Cassette	48	70	0.85	60	0.32	5.33	5.09