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

FEB 27 1991

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

MEMORANDUM

SUBJECT: ADJUSTMENTS TO POST APPLICATION EXPOSURE ASSESSMENT FOR RESIDENTS OF HOMES TREATED WITH PROPOXUR (HED Project No. 1-0222)

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Please find below the OREB review of ....

HED Project #: 1-0222

RD or SRRD Record #: 047802 x

Caswell #: 508

Date Received: 11/30/90 Review Time: 15 days

Date Returned: 2/14/91

Deferral to: ______ Biological Analysis Branch/BEAD

______ Science Analysis & Coordination Branch

______ TB - Insecticide/Rodenticide Support Section

______ TB - Herbicide/Fungicide/Antimicrobial Support Section

1.0 INTRODUCTION

In November 1989 OREB/NDEB completed a review of an exposure study measuring the potential dermal and respiratory exposures of the residents of homes following crack and crevice treatment with the insecticide propoxur (1). The study measured the residues found in the air and on environmental surfaces (vinyl tile, carpet, and upholstery) for 48 hours after the application. The study also addressed the transfer of these residues from the surfaces to the skin but did not measure the dissipation of the material after the 48 hour sampling interval. In order to estimate exposures a number of assumptions were required. In some cases the exposure estimates were based largely on unsubstantiated assumptions that were judged reasonable by one or both of the parties involved. Exposures were estimated for three age categories of residents, an infant (6-9 months), a 12 year old child, and an adult male. The exposure assessment did not address possible accumulation of propoxur from repeated crack and crevice treatment nor did it address the dissipation of the insecticide with time. Residues were assumed to remain constant at a concentration measured during the first 48 hours after application. The potential oral exposure resulting from residues on the surfaces of kitchen items was not included because there is no method currently available with which to estimate such exposure. There are also no data with which to estimate the potential oral exposure of infants to surface residues on toys, etc. While OREB realizes that there will be an oral component contributing to the total exposure, this component cannot be quantified.

The dermal exposure of an individual will depend, not only on the levels of surface residues, but also on the surface area contacted. The registrant provided exposure estimates for a number of different scenarios in which the area contacted ranged from 5 to 50 square feet in a 4 hour interval. It was further assumed that exposure would occur over 50 percent of the body surface. OREB/NDEB noted that these are strictly arbitrary assumptions and not based on available data. However, OREB/NDEB has no data with which to provide alternative scenarios and accepted these assumptions as reasonable.

The measurement of resident exposure following pesticide application required new technology. The assessment was circulated to other parts of the Agency for comment. The Exposure Assessment Methods Branch/OHEA suggested that OREB conduct a sensitivity analysis (2) varying some of the parameters used for the assessment. BEAD/BAB submitted information regarding application frequency (3) and provided a literature study addressing the dissipation of propoxur on indoor surfaces (4).

2.0 CONCLUSIONS

OREB has calculated revised estimates of exposure of residents to the insecticide propoxur after crack and crevice treatment of their homes. The previous assessment, which was conducted in 1989, was forced to use a conservative approach and assume that the compound did not dissipate after application since no such data were available. Surface residue dissipation is a dynamic situation and the resident will be exposed to different levels over time. A recently published literature study addressing dissipation of propoxur was obtained and OREB was able to calculate adjusted surface residue values and estimates of exposure. **The study used to derive the adjustment factor was extremely limited and addressed only the dissipation of the compound on stainless steel plates. Any risk calculations derived from these adjusted values must be made cautiously and with knowledge of the limitations of these revised values.** It was assumed that the material is applied once a month (every 30 days) and that the occupants are exposed for 365 days per year. All other assumptions were the same as those used in the previous assessment. A comparison of the assumptions used by the registrant and OREB is presented in Table 1. It was calculated that the <u>average</u> surface residue to which a resident would be exposed was equal to 38 percent of that found soon after treatment. The previously calculated dermal exposure estimates were reduced using this factor and are presented in Table 2.

A similar procedure, also using dissipation data from a study found in the public literature, was used to adjust the respiratory exposure values for residents. The adjustment factor in this case was 40 percent. The respiratory exposures of residents to propoxur from crack and crevice treatment are presented in Table 3.

OREB emphasizes that these adjustments to the exposures estimated from the registrant's study are based on very limited data sets. The adjusted values, particularly those for dermal exposure, should be considered to represent the lower end of the exposure range. OREB has therefore presented a conservative estimate from the original exposure study and an estimate of the lower end of the exposure range using dissipation patterns derived from literature studies that may not accurately represent patterns that occur under actual treatment conditions.

Table 1. Comparison of Different Assumptions Used by Mobay Corporation and OREB for the Estimation of Post-Application Exposure of Residents to Propoxur. Assumptions used by both parties are included in the text.

OREB Assumptions	Mobay Assumptions
Dermal exposures were assumed to occur at a rate equal to the average of those for three different materials; vinyl tile, carpet, and upholstery material.	Five different scenarios were used to estimate exposure of infants and one for each of the other age groups. The scenarios assumed different times in each of the rooms.
The maximum geometric mean of all of the measured surface residues, from wipe samples taken between 6 and 48 hours, for a given material was used to represent that material. Residue levels from different rooms were pooled for each material.	Residues were assumed to be equal to the maximum arithmetic mean found on a material in a given room over the sampling interval.
Infant, 12 year old, and adult exposure times were assumed to be 24, 15, and 15 hours, respectively.	Contact for 4 hours was assumed.
During periods when the individual was assumed to be asleep levels found on upholstery were used to calculate dermal exposures. These intervals were 12 hours, 8 hours and 8 hours for infants, 12 year old children, and adults, respectively.	Not addressed.
Exposure occurs for 365 days per year.	Not addressed.
Dermal exposures are not corrected for dermal absorption.	Absorption was based on data from the public literature (2).

Table 2. Dermal Exposure Estimates for Residents of Homes Treated with Propoxur Using Crack and Crevice Treatment. Values for Scenarios Assuming No Dissipation and Adjusted for Dissipation Are Presented.

Age Category	Contact Area (ft^2)[1]	Exposure Time (hr/day)[2]	Dermal Exposure (mg/kg)			
			Unadjusted for dissipation		Adjusted for dissipation[3]	
			Daily	Annual	Daily	Annual
Infant	5	24	0.067	25	0.025	9.1
	50	24	0.43	159	0.163	59
12 Year Old	5	15	0.013	5	0.005	1.8
	50	15	0.053	19	0.020	7.3
Adult	5	15	0.01	4	0.004	1.4
	50	15	0.033	12	0.013	4.7
LDAE[4]			0.020		0.007	
	50		0.071		0.027	

1 Area of treated surface contacted in a 4 hour period.

2 Infants, 12 year old children, and adults are assumed to spend 12, 8, and 6 hours at sleep (exposed to upholstery levels only).

3 Residue levels are adjusted by multiplying by a factor of 0.39 to achieve a mean surface residue level as described in the text. A first order dissipation with a rate constant of 0.08 and initial levels presented in Table 3 is assumed. The material is assumed to be applied every 30 days.

4 LDAE = Lifetime Daily Average Exposure

= [(infant exp x 6) + (12 year old exp x 11) + (Adult exp x 53)]/70 years

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Table 3. Summary of Respiratory Exposures, Unadjusted and Adjusted for Dissipation Over Time, Following Crack and Crevice Treatment of Homes.

Age Category	Exposure Time (hrs/day)	Respiratory Volume m^3/hr)	Daily Respiratory Exposure (mg/kg)		Annual Respiratory Exposure (mg/kg)[1]	
			Unadjusted	Adjusted[2]	Unadjusted	Adjusted
Infant	24	0.5	0.0083	0.00332	3.0	1.2
12 Year old	15	0.9	0.0017	0.00068	0.62	0.25
Adult	15	1.0	0.0011	0.00044	0.40	0.16

1 Residents are assumed to be exposed for 365 days per year.

2 Adjusted for the dissipation of propoxur over time. The adjustment factor is 0.40 as described in the text.

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3.0 DESCRIPTION OF LITERATURE STUDIES

CITATION: Braness, G.A. and G.W. Bennett (1990) Residual Effectiveness of Insecticides for Control of German Cockroaches (Dictyoptera: Blattellidae) in Food-Handling Establishments.
J. Econ. Entomol. 83:1907-1911.

Three sites within kitchens at university buildings were treated for cockroach control. The locations included a dishwashing site with a commercial dishwasher, a food preparation site where foods were prepared, and a food storage room. A laboratory site in the entomology building was used as a control. Dilute aqueous sprays containing either chlorpyrifos (0.5%), propoxur (1.1%), or a mixture of the two, were applied to 15.2 cm^2 stainless steel plates using a spray tower. The tower was calibrated to deliver 0.95 ml of spray solution per 232 cm^2 of surface area, equivalent to the label application rate. The residues on 7 panels were analyzed immediately after treatment to determine the amount of active ingredient(s) delivered. Spray solutions were also analyzed to determine the amounts of active ingredients at the beginning of the experiment.

The panels were allowed to dry for 24 hours after which they were transported in insulated coolers to the test sites. Three panels were randomly placed on plywood sheets which were positioned vertically along walls or behind equipment. In studies designed to simulate crack and crevice treatment the treated surface faced the plywood. Those intended to represent treatment of exposed surfaces were placed so that the treated surface faced away from the plywood. The treated panels were returned to the laboratory for chemical sampling and efficacy testing at intervals of 1, 14, 21, and 28 days after placement at the field sites. Air temperatures and relative humidity were monitored daily at each site.

The insecticidal efficacy of the materials on the treated panels was determined using German cockroaches, 5 of each sex. The insects were confined on the panels with a plexiglas ring greased with a petrolatum/mineral oil mixture. The animals were exposed for periods of 15 minutes, 20 minutes, or 1 hour for chlorpyrifos with propoxur, propoxur alone, and chlorpyrifos, respectively. These times had been previously been determined to be the minimum required to kill all of the insects on panels 1 day after treatment. Previous studies had also determined that the surface residues of these compounds were not appreciably reduced by insect activity on the panels during the bioassay. After exposure, the insects were returned to untreated jars and mortality recorded after 1, 24, and 48 hours. Evaluation of the mortality data is not included in this review.

Surface residues were measured within 2 hours after the bioassay; 0 day panels being monitored immediately after drying of the spray mixture. The panels were rinsed twice with 12 ml portions of acetone. The rinsates were collected in a 100 ml graduated cylinder and transferred to a glass bottle. Total volume, after rinsing of the transfer funnel and graduated cylinder, was 40 ml. Samples were kept under cold storage until analysis which was carried out within 3 weeks of collection. Residues were quantified by gas-liquid chromatography with a flame ionization detector.

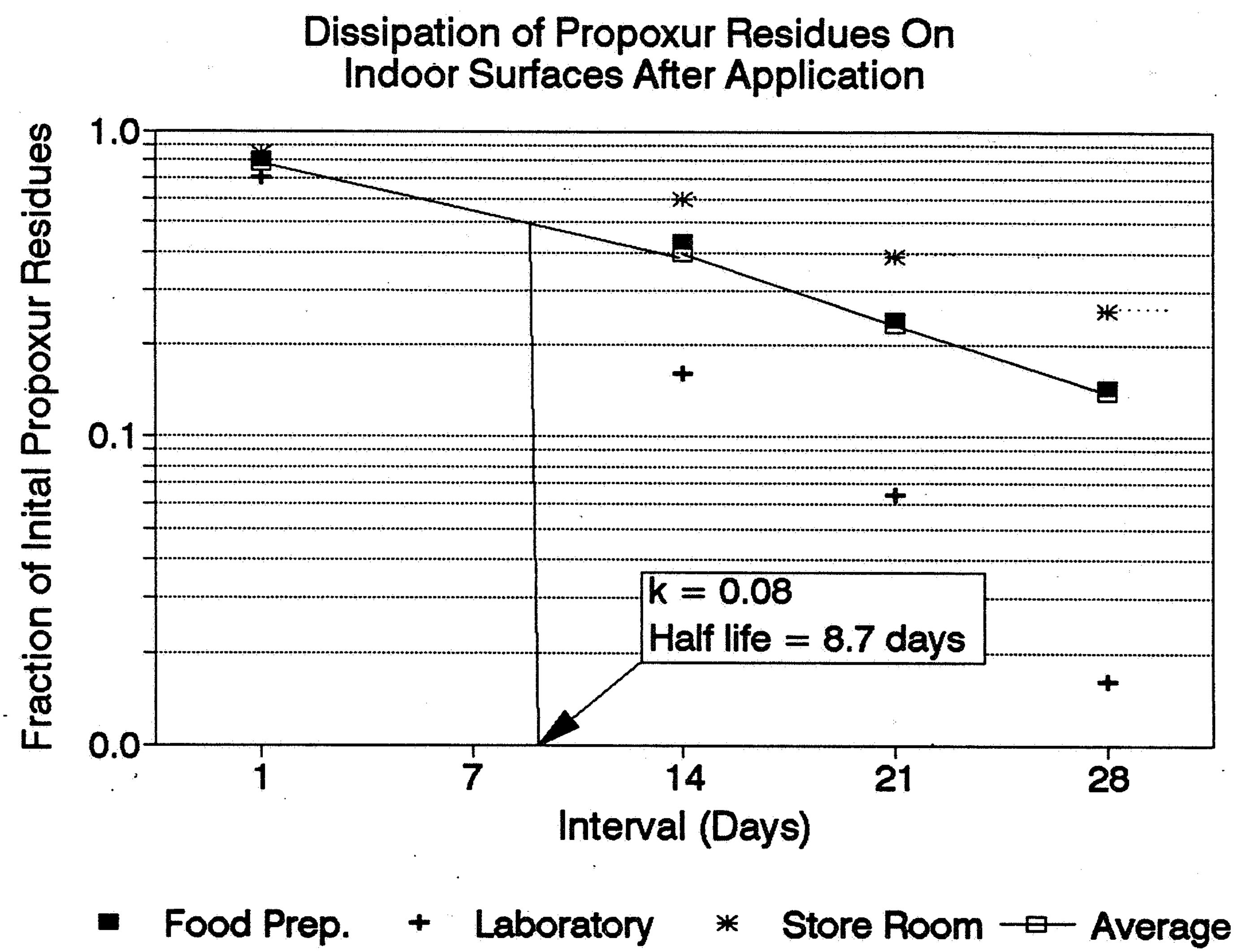
The amount of insecticide recovered from 0 day panels was considered to be the baseline to which subsequent samples were compared. The recovery data for panels analyzed immediately after the drying of the spray mixture are presented in Table 4. More insecticide was recovered from the panels representing crack and crevice treatment than those for exposed surfaces. Greater than 48 percent of the propoxur was recovered from the crack and crevice areas but less than 24 was recovered from the exposed surfaces after 28 days. The dissipation data was presented in a graphic format only and the original data points were not presented in the report. The fractions of the original amounts remaining on treated surfaces are presented in Figure 1.

CITATION: Wright, C.G., R.B. Leidy, and H.E. Dupree (1981) Insecticides in the Ambient Air of Rooms Following Their Application for Control of Pests. Bull. Environm. Contam. Toxicol. 26:548-553.

Concentrations of several insecticides were measured in the air of university dormitory rooms following crack and crevice treatment. The pesticides were applied using hand sprayers or dusters. The compounds and formulations are listed in Table 5. Air was monitored using personal samplers located near the center of the room. Midget impingers containing hexylene glycol were used to trap bendiocarb, carbaryl, chlorpyrifos, diazinon, fenitrothion, and propoxur. Polyurethane foam was used to trap acephate. Air was sampled for 4 hours before application; immediately after application; and at 1, 2, and 3 day intervals. Samples were extracted with an appropriate solvent and quantified by GLC or HPLC.

The airborne concentrations of insecticides are summarized in Table 6. Air levels of all insecticides, except acephate, reached a maximum immediately after application, followed by a decrease to less than 1 $\mu g/m^3$ after 3 days. Bendiocarb was not detected on the second or third day. The

Figure 1.


Dissipation of Propoxur Residues On
Indoor Surfaces After Application
Fraction of Inital Propoxur Residues
1.0
0.1
0.0
1
7
14
21
28
Interval (Days)
k = 0.08
Half life = 8.7 days
Food Prep.
Laboratory
Store Room
Average

air levels were correlated with the amount of material applied per 100 m^3 of room volume. This correlation increased with elapsed time. The air concentrations of propoxur alone are presented in Figure 2.

4.0 ADJUSTMENT OF SURFACE RESIDUES OF PROPOXUR

The literature study emphasized the insecticidal efficacy of the applications rather than the levels of residues detected on the environmental surfaces. In order to adjust the values from OREB's previous evaluations it was necessary to determine the relative dissipation of the residues on these surfaces. Four indoor areas, each with crack and crevice and exposed surface scenarios, were monitored during the study. The fraction remaining on the surfaces, as determined by OREB from the graphs presented in the published article, are presented in Figures 1 and 2 for crack and crevice and exposed surface scenarios, respectively. **It must be emphasized that these numbers were <u>visually</u> obtained from the graphs presented in the publication and therefore no mathematical basis has been established by the Agency.** A table of these values are presented in Table 7. Four types of indoor surfaces were monitored. OREB has judged that areas around a dishwasher and in storerooms, which respectively exhibited the most rapid and least rapid breakdown of propoxur, were not living areas and are not comparable to the surfaces monitored during the study previously submitted by Mobay Corporation. It is also evident that the crack and crevice scenarios evaluated in the published literature study, where the treated surfaces were faced toward the plywood sheets, were not representative of the areas monitored by the registrant. OREB has used the average of the values obtained from the store room, food preparation areas and the laboratory, which more accurately reflect living areas of a home, to adjust the residue levels measured in the registrant's study.

In lieu of adequate residue data addressing dissipation of propoxur on indoor surfaces it was assumed that the dissipation pattern of surface residues measured on stainless steel plates could represent that found on other materials. **There are NO data available to support such a relationship.** It was further assumed that dissipation of propoxur residues follows first order kinetics and can be described by an equation of the form:

$$C_t = C_o e^{-kt}$$

The fraction of propoxur remaining on the surface at time, t, is:

$$\frac{C_t}{C_o} = e^{-kt}$$

Regression analysis of the mean values for propoxur on stainless steel plates exposed to the environment in the store room, laboratory, and food preparation areas yielded a value of 0.08 for the rate constant, k. The resulting equation is therefore:

$$\frac{C_t}{C_o} = e^{-0.08t}$$

The estimated half life, $t_{1/2}$, for propoxur on stainless steel plates is:

$$t_{1/2} = \frac{0.693}{k} = 8.7\, days$$

Since the rate constant of a first order decay equation is independent of the initial value (C_0), the equation was applied to the other initial residue levels measured by the registrant. OREB's previous review of the registrant's indoor post-application study used the maximum geometric mean of all of the measured surface residues, from wipe samples taken between 6 and 48 hours for a given material, to represent that material. These values were assumed to be the initial residue levels in the first order decay equation and are presented in Table 8.

The memorandum from BEAD indicated that propoxur would be applied a maximum of 12 times per year in an apartment with chronic cockroach problems. OREB assumed that the material is applied every 30 days. Integrating the decay equation between these boundaries and dividing by 30 yields an average daily residue level for propoxur.

$$\int_0^{30} C_o e^{-kt} dt = -\frac{1}{k} C_o e^{-kt} \Big|_0^{30}$$

$$= -\frac{1}{k} C_o e^{-k(30)} - (-\frac{1}{k} C_o e^{-k(0)})$$

$$= \frac{1}{k} C_0 (1 - e^{-0.08(30)})$$

$$= \frac{1}{k} C_0 (1 - e^{-2.4})$$

$$= \frac{1}{k} C_0 (1 - 0.091)$$

Dividing this value by 30 gives a mean daily surface residue level with which to estimate dermal exposures:

$$= \frac{1}{0.08} C_0 (0.91)$$

$$= 11.4 \; C_o$$

The values for dermal exposure that were calculated in OREB's previous review can be adjusted by this correction

$$= \frac{11.4\ C_o}{30} = 0.38\ C_o$$

factor to account for dissipation of the propoxur on treated surfaces. **OREB cautions that this correction factor was based on minimal data and was obtained after spraying stainless steel plates, not carpets, tile or upholstery. These results may not be indicative of the dissipation on other surface material.** Since there is a linear relationship between surface residues and other factors used for exposure assessment (such as body weight, surface area, etc.) it was possible to multiply the previously calculated dermal exposure values by 0.38 to yield adjusted exposures. The adjusted values for dermal exposure are presented in Table 1.

5.0 ADJUSTMENT OF AIR CONCENTRATIONS OF PROPOXUR

The air monitoring study briefly summarized above was used to adjust the air concentrations measured by the registrant to allow for dissipation of propoxur. Only the data from that study that relates to propoxur was used for the adjustment. These values are presented in Figure 2. It was assumed that the dissipation of the air concentrations, like the surface residues, followed first order kinetics. The calculations were the same as those cited in the previous section. The calculated adjustment factor for air concentrations was 0.40. The respiratory exposures of the residents of homes, both unadjusted and adjusted, are presented in Table 2.

Figure 2.

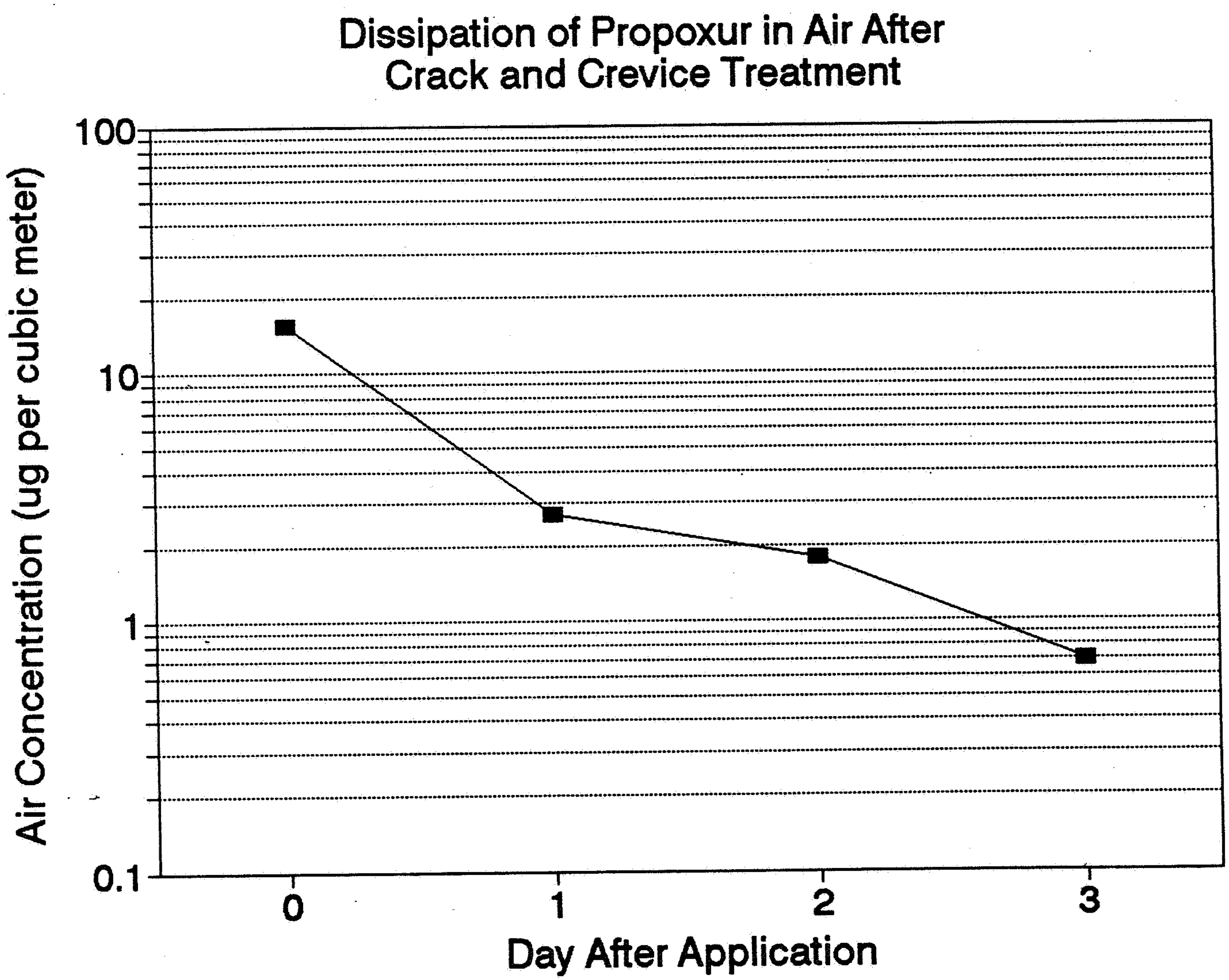

Dissipation of Propoxur in Air After
Crack and Crevice Treatment
100
10
1
0.1
Air Concentration (ug per cubic meter)
0
1
2
3
Day After Application

Table 4. Recovery of Chlorpyrifos and Propoxur from Stainless Steel Panels (15.2 cm^2) Immediately After the Drying of the Spray Solution (0 day samples).

Treatment Regimen	Results of Day 0 Sampling Percent	mg Recovered	ug/cm2 (mg rec/15.2 cm^2 x 1000)
Chlorpyrifos	87.1	4.55	299.34
Propoxur	99.3	12.50	822.37
Mixture			
Chlorpyrifos	80.20	4.98	327.63
Propoxur	99.10	12.49	821.71

Table 5. Formulations Applied to Dormitory Rooms for Insect Control.

Compound	Type of Formulation	Spray Concentration (%)
Bendiocarb	Wettable Powder	0.5
Chlorpyrifos	Emulsifiable Conc.	0.5
Acephate	Emulsifiable Conc.	1.0
Diazinon	Emulsifiable Conc.	1.0
Fenitrothion	Emulsifiable Conc.	1.0
Propoxur	Emulsifiable Conc.	1.1
Carbaryl	Dust	5.0

Table 6. Airborne Concentrations of Insecticides Following Application to Rooms. Values are in $\mu g/m^3$.

Insecticide	Application Rate (g/100 m^3)	Pre-treatment	Day				
			0	1	TWA[1]	2	3
Acephate	18.5	ND[2]	1.3	2.9	2.6	0.5	0.3
Bendiocarb	9.5	ND	7.7	1.3	2.4	ND	ND
Carbaryl	6.3	ND	1.3	0.2	0.38	0.1	0.01
Chlorpyrifos	8.2	0.1	1.1	1.1	1.1	0.8	0.3
Diazinon	18.0	0.2	1.6	0.6	0.77	0.5	0.4
Fenitrothion	21.9	ND	3.3	1.1	1.5	0.8	0.5
Propoxur	20.4	ND	15.4	2.7	4.8	1.8	0.7
MEAN		--	4.5	1.4	1.9	0.64	0.31
Correlation Coefficient (r)		--	0.31	0.53	--	0.59	0.82

1 Time Weighted Average for Day 1.

2 ND = none detected, value of 0 used for calculations.

Table 7. Summary of Proportion of Propoxur Residues Detected on Stainless Steel Plates After Spraying Under Controlled Conditions. Values are compared to residues measured immediately after spraying which was given a value of 1.0.

Location	Scenario	Day 1	Day 14	Day 21	Day 28
Dishwashing	CC[1]	0.84	0.45	0.27	0.11
Food Prep.	CC	0.94	0.66	0.58	0.50
Laboratory	CC	0.92	0.74	0.50	0.37
Storeroom	CC	0.97	0.79	0.76	0.74
Dishwashing	ES[2]	0.66	0.05	0.03	0.00
Storeroom	ES	0.84	0.60	0.39	0.26
Food Preparation	ES	0.81	0.44	0.24	0.15
Laboratory	ES	0.71	0.16	0.06	0.02
Mean of Store room, Food Preparation, and Laboratory	ES	0.79	0.40	0.23	0.14

[1] CC = Crack and Crevice Scenario, Treated surface facing plywood board.

[2] ES = Exposed Surface Scenario, Treated surface facing away from plywood board.

Table 8. Mean Surface Wipe Residues of Propoxur On Surfaces Following Crack and Crevice Treatment. Means were calculated using pooled data from the Kitchens, Bedrooms, and Basements.

Material Sampled	Sampling Interval	Residues (ug/sq ft) Arithmetic Mean	Geometric Mean
Vinyl Tile	Immediately After Treatment	2649	288
	6 Hours	1979	57
	12 Hours	5851	41
	24 Hours	3287	165
	48 Hours	2707	101
Carpet	Immediately After Treatment	21	7.6
	6 Hours	8.0	3.1
	12 Hours	9.8	3.6
	24 Hours	2.8	1.3
	48 Hours	1.1	0.66
Upholstery	Immediately After Treatment	1.2	0.96
	6 Hours	0.94	0.64
	12 Hours	1.2	0.79
	24 Hours	0.70	0.48
	48 Hours	0.74	0.52

REFERENCES

1) Memorandum from D. Jaquith (NDEB/OREB) to D. Edwards (RD) titled "Review of Study Estimating Resident Exposure to Propoxur Following Crack and Crevice Treatment (HED Project No. 9-1936), dated November 15, 1989.

2) Memorandum from M. Lorber (OHEA) to V. Prunier titled "Review of OPP's Assessment of Exposure to Propoxur", dated November 9, 1990.

3) Memorandum from D. Brassard (BAB/BEAD) to J. Gallagher (SRB) titled "Comments on Matt Lorber's Critique of OPP's Propoxur Exposure Assessment", dated November 16, 1990.

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