6-6-85

157

Shaughnessy #: 109702

Due Date: JUN 06 1985

Init: SH for SC

To: A. Heyward
Product Manager #17
Registration Division (TS-767)

From: Joseph C. Reinert, Ph.D., Chief
Special Review Section
Exposure Assessment Branch
Hazard Evaluation Division (TS-769C)

Attached please find the EAB review of...

Reg./File No.: 10182-TR

Chemical: Cypermethrin

Type Product: Insecticide

Product Name: Demon®

Company Name: ICI

Submission Purpose: Applicator and Resident Exposure Analysis

ZBB Code: _____ ACTION CODE: 116

Date In: 06/04/85 EAB # 5599

Date Completed: 6/05/85 TAIS (level II) Days

_____ _____

Deferrals To:

_____ Ecological Effects Branch

_____ Residue Chemistry Branch

_____ Toxicology Branch

_____ Benefits and Use Division

1/16

1.0 INTRODUCTION

ICI Americas Inc. has requested registration of their Demon WP® insecticide as a crack and crevice spray for cockroaches, ants, and other insect pests. Demon WP® is a wettable powder formulation of cypermethrin containing 40 percent active ingredient. A 0.1-0.2 percent aqueous suspension is applied as a coarse, low pressure spray to areas where insects hide. Application is to be restricted to licensed pest control operators (PCO) only. A survey study, outlining the times spent by PCOs performing various tasks, was also submitted. EAB has no data estimating exposure of PCOs or inhabitants of structures treated with cypermethrin. The exposure assessment was based on data from surrogate studies found in the literature. A number of assumptions were required:

1) An average worker weighs 70 kg with a standard surface area (1).

2) Exposure is dependent on the amount of active ingredient mixed and applied.

3) The same worker performs both the mixing/loading and application tasks.

4) Exposures are not adjusted for dermal absorption.

5) The exposure from application of a wettable powder formulation is the same as that obtained from liquid formulations.

6) A PCO works an average of 220 days per year and uses cypermethrin for all crack and crevice applications. EAB realizes that this is probably not the case, but BUD has not been able to provide data to allow a more accurate estimate.

7) The volume of an average house is 340 m^3 (2).

8) Cypermethrin is applied at a frequency of 10 times per year (3).

9) Residents are exposed for 15 hours per day, 365 days per year.

10) The average breathing volume for a 70 kg male is 7.4 liters per minute at rest and 29 liters per minute during light activity. Assuming that an individual spends 2/3 of his time at rest and 1/3 at light activity, the weighted average breathing volume is 14.6 liters per minute or 13 m^3 per day.

2.0 SUMMARY OF PCO SURVEY STUDY

Telephone interviews were conducted by the registrant and reviewed by BUD to determine the times PCOs spend on various tasks. A total of 101 PCOs were interviewed. The results are summarized below:

1) Average months worked per year is 11.96.

2) Average number of gallons of liquid residual insecticide used per day is 3.7.

3) Average amount of time spent mixing one gallon of insecticide is 3.5 minutes.

4) An average of 11.1 accounts are handled per day.

5) The average time per account is 34.2 minutes.

6) Percent of time spent doing specific tasks:
   a) inspecting 25.8
   b) applying insecticide for general pest control 43.8 (EAB assumes that this includes the mixing/loading tasks)
   c) applying rodenticide 11.6
   d) talking to customer 11.6
   e) paperwork and collecting 6.1
   f) other 1.1

7) Fifty two percent of accounts are residential.

8) Percent of non residential accounts requiring food handling labeled insecticide is 37.2.

9) An average firm employs 8.7 technicians and handles 1592.8 accounts.

3.0 SUMMARY OF SURROGATE STUDIES

3.1 Exposure of Applicators and Inhabitants to Dichlorvos

Gold et al. (5) measured the exposure of applicators and occupants to dichlorvos (DDVP) following treatment of single family homes for cockroach control. DDVP was applied with a hand sprayer to baseboards, around doors, and other areas normally treated for cockroaches. The pesticide was applied at an average reate of 0.189 g (37.8 ml) per m^2. The average area treated per house was 103 m^2 and took 25.5 minutes. An average house received a total of 19 g (0.042 lb) of active ingredient.

Applicators wore long sleeved polyester jumpsuits with an open collar, hard hats, respirators, and rubber gloves.

Dermal exposure was measured using dermal pads located on the head, forearms, on the leg just above the ankle, chest, and back. Gauze pads were attached to the outer clothing or taped to the skin beneath the coveralls. Exposure of the hands was measured by hand rinse with 50 percent ethanol-water. Respiratory exposure of applicators was measured by drawing air through midget impingers containing ethylene glycol.

Potential exposure of inhabitants was measured using pads located on environmental surfaces and air samplers with a double impinger system. Pads were positioned prior to treatment and removed 2 hours post treatment. Pads were located on the refrigerator, kitchen table, and kitchen floor. Pads were combined prior to extraction and analysis. Air samples were taken for 24 hours prior to treatment and again at 2 and 24 hours post application. All samples were analyzed by gas chromatography using a nitrogen-phosphorous thermionic detector.

Indirect monitoring methods were also used to estimate applicator and resident exposure. Serum and erythrocyte cholinesterase was measured for 2 applicators and 20 residents at intervals before and after application. Urinary levels of DDVP and dichloroacetic acid were also measured. These indirect measurements were not used by the reviewer for this assessment.

Dermal exposure was calculated by multiplying the surface area of a body part by the amount of DDVP on the appropriate pad. For areas normally covered by clothing, the mean value for interior pads, 0.102 ug/cm^2/hr was used. For unprotected areas the average value for exterior pads, 0.499 ug/cm^2/hr was used. The hands were protected by the rubber gloves and received 0.024 ug/cm^2/hr as determined by hand rinse. Respiratory exposure levels were 0.021 ug/l. In order to compare the exposure values from this study with others in EAB's database the reviewer adjusted the exposures to a 70 kg worker with standard surface areas and by the total amount of material handled. The calculations are described in Appendix A. The applicator exposures, both unadjusted and adjusted are presented in Table 1. The exposure of environmental surfaces, as measured by environmental pads, was 0.319 ug/cm^2/hr. Air levels of DDVP declined after application and are summarized in Table 2.

Table 1. Applicator Exposure to DDVP from Treatment of Homes for Cockroaches

Body Part	Surface Area (SA) in cm^2	Exposure Calculation	Exposure[1] (ug/kg/hr)	Standard[2] SA (cm^2)	Adj. Exposure[3] (ug/kg/hr)	Adj. Exposure ug/kg/lb DDVP
Dermal:						
Face, front "V" of neck	910	SA x exterior pads	5.4	800	5.7	57
Head (minus face)	460	SA x interior pads	0.56	460[4]	0.67	6.7
Back of Neck	120	SA x exterior pads	0.71	110	0.78	7.8
Back Trunk	3420	SA x interior pads	4.2	3500	5.1	51
Front Trunk (minus "V" of chest)	3790	SA x interior pads	4.6	3550	5.2	52
Upper Arms	1340	SA x interior pads	1.6	1320	1.9	19
Forearms	1390	SA x interior pads	1.7	1210	1.8	18
Thighs	3660	SA x interior pads	4.4	2250	3.3	33
Legs and Feet	3760	SA x interior pads	4.6	2380	3.5	35
Hands	930	SA x hands	0.32	820	0.28	2.8
Total Dermal			28		28	2.8×10^2
Respiratory:			0.44		0.36	3.6

1 84 kg worker with respiratory volume of 1740 l/hr.
2 from reference (1)
3 70 kg worker with respiratory volume of 1200 l/hr.
4 no standard value available, same value used.

5

Table 2. Environmental Exposure to DDVP Following Application to Homes.

Room Pads	0.319 ug/cm^2/hr
Air Sample	Concentration (ug/m^3)
0-2 hour	548
2-24 hour	183

3.2 Exposure of Applicators to Chlorpyriphos

Heath and Spittler (6) monitored applicator exposure to chlorpyriphos during treatment of a dormitory building. Two liters of a 0.5 percent emulsion were applied to areas normally treated for insect pests. Pesticide application was by hand sprayer using pin or fan type nozzles at high, meduim, or low pressure and at various distances from target. Dermal exposure was measured with gauze patches and cotton gloves. The four dermal patches were located on the exterior of the clothing on the chest, back, and outside of each leg just below the knee. A 26 cm^2 circular subsample of each patch was used for analysis. Respiratory exposure was determined by drawing air through a glass tube containing silica gel at a rate of 100 cm^3 per minute. Dermal patches, cotton gloves, and air sampling tubes were extracted with acetone, concentrated, and quantified by gas chromatography using a flame photometric detector in the phosphorus mode. Recoveries of spiked samples were 106 percent, 106 percent, and 88 percent for air samples, gloves, and gauze patches, respectively. Unfortunately there were no dermal pads located on the thighs or arms. The reviewer made the assumption that the rate of exposure for the arms was the same as that for the chest and that the exposure was uniform for all parts of the leg. The exposure for a body part is:

$$\text{Exposure (ug/body part)} = \text{amount on pad or glove (ug/cm}^2\text{)} \times \text{Surface area (cm}^2\text{)}$$

Since 2 liters of a 0.5 percent emulsion were applied, the total amount of chlorpyriphos applied was:

$$\text{Amount applied (lb)} = \frac{2 \text{ liters}}{\text{application}} \times \frac{5.0 \text{ g}}{\text{liter}} \times \frac{1 \text{ lb}}{454 \text{ g}}$$

$$= 2.2 \times 10^{-2} \text{ lb/application}$$

Table 3. Exposure of Applicators to Chlorpyriphos from Crack and Crevice Treatment for Cockroaches. Values are in ug/kg/hr.

Exposure Regimen			Body Part[1]					
Nozzle	Range	Pressure	Chest[2]	Back[3]	Legs	Hands	Total Dermal	Respiratory
Pin	Long	Standard	0.89	0.66	1.3	7.8	11	0.29
Pin	Med.	Low	1.4	0.52	1.5	7.0	10	0.041
Pin	Med.	High	1.7	0.80	3.4	9.3	15	0.20
Pin	Close	Standard	2.4	0.56	1.5	4.9	9.4	0.26
Fan	Long	Standard	3.6	2.3	15	53	74	0.45
Fan	Med.	Low	3.3	1.9	4.4	27	37	0.090
Fan	Med.	High	4.1	2.2	4.6	58	69	0.61
Fan	Close	Standard	5.4	1.7	7.0	3.7	18	0.0
Extend-A-Wand			0.0	0.21	0.86	3.9	5.0	0.0
MEAN			2.5	1.2	4.4	19.4	28	0.22
Mixing Only			0.0	0.0	0.0	5.2	5.2	0.0

[1] Exposure of head not measured.

[2] Value for Chest also includes arms and front of neck.

[3] Value for Back also includes back of neck.

Table 4. Exposure of Applicators to Chlorpyriphos from Crack and Crevice Treatment for Cockroaches. Values in ug/kg/lb applied.

Exposure Regimen			Body Part[1]					
Nozzle	Range	Pressure	Chest[2]	Back[2]	Legs	Hands	Total Dermal	Respiratory
Pin	Long	Standard	28	21	42	2.5×10^2	3.4×10^2	9.1
Pin	Med.	Low	45	16	45	2.2×10^2	3.3×10^2	1.3
Pin	Med.	High	45	21	91	2.5×10^2	4.1×10^2	5.0
Pin	Close	Standard	59	14	38	1.2×10^2	2.3×10^2	6.4
Fan	Long	Standard	55	33	2.2×10^2	7.7×10^2	1.1×10^3	6.4
Fan	Med.	Low	50	28	64	3.9×10^2	5.3×10^2	1.3
Fan	Med.	High	55	28	59	7.3×10^2	8.7×10^2	7.7
Fan	Close	Standard	68	21	91	4.5×10^1	2.3×10^2	0.0
Extend-A-Wand			0	4.5	20	9.1×10^1	1.2×10^2	0.0
MEAN			45	21	74	3.2×10^2	3.5×10^2	4.1

[1] Exposure of face not measured.

[2] Value for Chest also includes arms and front of neck.

[3] Value for Back also includes back of neck.

The exposure per pound of chlorpyriphos applied is:

$$\text{Exposure (ug/kg/lb applied)} = \frac{\text{exposure (ug/kg)}}{2.2 \times 10^{-2} \text{ lb applied}}$$

The exposure data, adjusted for time, and adjusted for amount of active ingredient applied, are summarized in Tables 3 and 4, respectively.

3.3 Pesticide Levels in Ambient Air

Wright et al. (7) measured the concentration of pesticides in room air following crack and crevice treatment with insecticides. The pesticides were applied to rooms in a university dormitory using hand sprayers or dusters. The compounds and formulations are listed in Table 5.

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

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

Air was monitored using a personnel type sampler located near the center of the room. Midget impingers containing hexylene glycol were used to trap bendiocarb, carbaryl, chlorpyriphos, 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, 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 ug/m^3 after 3 days. Bendiocarb was not detected on the 2nd or 3rd day. The air levels

were correlated with the amount of material applied per 100 m^3 of room volume. This correlation increased with elapsed time.

Table 6. Airborne Concentrations of Insecticides Following Application to Rooms. Values are in ug/m^3.

Insecticide	Applic. Rate ($g/100\ m^3$)	Pretreatment	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
Chlorpyriphos	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.

4.0 Calculation of Exposures

4.1 Applicators

The average PCO works an estimated 220 days per year and applies an average of 3.7 gallons of insecticide per day. Forty eight percent of accounts are non residential and 37.2 percent of these require food handling labeled pesticides. Cypermethrin is not approved for food handling situations. Cypermethrin could potentially be used on 82 percent of a PCO's accounts. If all accounts use the same amount of insecticide the daily use of cypermethrin would be:

$$\frac{\text{lbs of cypermethrin}}{\text{day}} = \frac{3.7 \text{ gal}}{\text{day}} \times 0.82 \times \frac{0.002 \text{ lb cypermethrin}}{\text{gal}}$$

$$= 0.0061 \text{ lbs cypermethrin per day}$$

The annual use is:

$$\frac{\text{lbs of cypermethrin}}{\text{year}} = \frac{0.0061 \text{ lbs}}{\text{day}} \times \frac{220 \text{ days}}{\text{year}}$$

$$= \frac{1.3 \text{ lbs}}{\text{year}}$$

In order to estimate applicator exposure to cypermethrin the exposures from the surrogate studies were adjusted by the relative amounts of material handled. The estimate, based on the data from Gold et al., was:

$$\text{Dermal exposure} = 1.3 \text{ lbs ai/yr} \times 2.8 \times 10^2 \text{ ug/kg/lb ai}$$

$$= 3.6 \times 10^2 \text{ ug/kg/yr}$$

$$\text{Respiratory exposure} = 1.3 \text{ lbs ai/yr} \times 3.6 \text{ ug/kg/lb ai}$$

$$= 4.7 \text{ ug/kg/yr}$$

This estimate assumes that a degree of protection is provided by wearing normal work clothing, gloves, and a respirator. An estimate for a completely unprotected worker can be obtained from the data of Heath and Spittler. This study measured dermal exposure using external patches only. Based on this surrogate the annual exposure is:

$$\text{Dermal exposure (ug/kg/yr)} = 1.3 \text{ lb ai/yr} \times 4.6 \times 10^2 \text{ ug/kg/lb ai}$$

$$= 6.0 \times 10^2 \text{ ug/kg/yr}$$

Respiratory exp. (ug/kg/yr) = 1.3 lb ai/yr x 4.1 ug/kg/lb ai

= 5.3 ug/kg/yr

4.2 Calculation of Exposure of Residents

Residues of DDVP were found on environmental surfaces. A method is not available to estimate dermal exposure of residents of treated houses from wipe tests . This assessment was confined to respiratory exposure only. Concentrations of airborne insecticides reached a maximum soon after application, followed by a decrease with time. An applicator services 11.1 accounts per day, 82 percent of which could receive cypermethrin or 9.1 accounts per day. If an applicator dispenses 0.0061 lbs of cypermethrin per day the average account would receive:

$$\text{lbs cypermethrin per account} = \frac{0.0061 \text{ lb/day}}{9.1 \text{ accounts/day}} \times \frac{454 \text{ g}}{\text{lb}}$$

= 0.30 g/account

If an average volume for an account is 340 m^3 then the application rate per 100 m^3 is:

$$\text{Application rate } (g/100\ m^3) = \frac{0.30 \text{ g/account}}{340\ m^3/\text{account}} \times 100\ m^3$$

= 0.088 g/100 m^3

The concentrations presented by by Wright et al. can be adjusted by the application rate:

$$\text{Cypermethrin conc.} = \text{surrogate conc.} \times \frac{\text{g cypermethrin}/100\ m^3}{\text{surrogate g}/100\ m^3}$$

A 70 kg resident breathing an average volume of 14.6 liters per minute would breathe 13 m^3 per day. The daily exposure would be:

$$\text{Daily exposure (ug/kg/da)} = \text{air concentration } (ug/m^3) \times \frac{13\ m^3}{\text{day}} \times \frac{1}{70 \text{ kg}}$$

The adjusted concentrations and daily exposures are presented in Table 7.

The worst case, in which the airborne cypermethrin concentrations level off at day 3 and remain constant until the next treatment and the insecticide is applied 10 times per year, was used by the reviewer. The annual exposure would be:

Annual exposure (ug/kg/yr) = 10 days/yr x exposure on day 1

+ 10 days/yr x exposure on day 2

+ 345 days/yr x exposure on day 3

= 10 days/yr x 2.2×10^{-3} ug/kg/day

+ 10 days/yr x 6.8×10^{-4} ug/kg/day

+ 345 days/yr x 3.1×10^{-4} ug/kg/yr

= 1.4×10^{-1} ug/kg/yr

David Jaquith

David Jaquith
Special Review Section
Exposure Assessment Branch
Hazard Evaluation Division

Table 7. Estimated Cypermethrin Concentrations and Daily Exposures of Residents After Treatment of Home. Concentrations are in ug/m^3 and exposures are in ug/kg/day.

Surrogate Compound	Day 1		2		3	
	Concentration	Exposure	Concentration	Exposure	Concentration	Exposure
Acephate	1.2×10^{-2}	2.2×10^{-3}	2.4×10^{-3}	4.5×10^{-4}	1.4×10^{-3}	2.6×10^{-4}
Bendiocarb	2.2×10^{-2}	4.1×10^{-3}	0	0	0	0
Carbaryl	5.3×10^{-3}	9.8×10^{-4}	1.4×10^{-3}	2.6×10^{-4}	1.4×10^{-4}	2.6×10^{-5}
Chlorpyriphos	1.2×10^{-2}	2.2×10^{-3}	8.6×10^{-3}	1.6×10^{-3}	3.2×10^{-3}	5.9×10^{-4}
Diazinon	3.8×10^{-3}	7.1×10^{-4}	2.4×10^{-3}	4.5×10^{-4}	2.0×10^{-3}	3.7×10^{-4}
Fenitrothion	6.0×10^{-3}	1.1×10^{-3}	3.2×10^{-3}	5.9×10^{-4}	2.0×10^{-3}	3.7×10^{-4}
Propoxur	2.1×10^{-2}	3.9×10^{-3}	7.8×10^{-3}	1.4×10^{-3}	3.0×10^{-3}	5.6×10^{-4}
MEAN	1.2×10^{-2}	2.2×10^{-3}	3.7×10^{-3}	6.8×10^{-4}	1.9×10^{-3}	3.1×10^{-4}

Appendix A. Adjustment of Exposures by Amount of Active Ingredient Applied.

DDVP was applied at an average rate of 0.189 g/m^2. The average treatment area was 103 m^2 per house with a treatment time of 25.5 minutes (0.43 hr). The average amount of DDVP applied per house was:

$$\text{Amt applied per house (lb)} = \frac{0.189\ g}{m^2} \times \frac{103\ m^2}{house} \times \frac{1\ lb}{454\ g} = \frac{0.043\ lb}{house}$$

The exposure values may be adjusted by the amount of material applied. For example the adjusted dermal exposure of the hands would be:

$$\text{Adj. Exposure per lb DDVP applied} = 0.32\ ug/kg/hr \times \frac{0.43\ hr/applic}{0.043\ lb/applic}$$

$$= 3.2\ ug/kg/lb\ DDVP\ applied$$

References

(1) Davis, J.E. (1980) Minimizing Occupational Exposure to Pesticides: Personnel Monitoring. Residue Reviews, Vol 75 pp 33-49.

(2) Becker, A.P. and Lachajaczyk, T.M. (1984) Evaluation of Waterborne Radon Impact on Indoor Air Quality and Assessment of Control Options. Environmental Protection Agency, Washington D.C.

(3) Bill Gross personal communication.

(4) Memo of March 6, 1985 from Bill Gross to David Jaquith titled "Use Information for Cypermethrin (Demon®).

(5) Gold, R.E., Holcslaw, T., Tupy, D. and Ballard, J.B. (1984) Dermal and Respiratory Exposure to Applicators and Occupants of Residences Treated with Dichlorvos (DDVP). Journal of Economic Entomology, Vol 77, pp 430-436.

(6) Heath, J.L. and Spittler, T.D. (1985) Determination of the Technique of Using a Compressed Air Sprayer that Optimizes Applicator Safety and Cockroach Efficacy. Pest Management, Vol. 4(2), pp 12-18.

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