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

FEB 7 1990

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: REVIEW OF PROPOXUR EXPOSURE STUDIES SUBMITTED BY MOBAY CORPORATION IN RESPONSE TO DATA-CALL-IN NOTICE (HED Project Nos. 9-1935, 9-1936 , 9-1937, 9-1938, 9-1939) AND CURRENT ESTIMATES OF EXPOSURE FOR OTHER SCENARIOS

TO: Dennis Edwards, PM 12
Registration Division (H7505C)

FROM: David Jaquith
Environmental Chemistry Review Section
Non-Dietary Exposure Branch
Health Effects Division (H7509C)

THRU: Michael Firestone, Ph.D., Section Head
Environmental Chemistry Review Section
Non-Dietary Exposure Branch
Health Effects Division (H7509C)

THRU: Charles L. Trichilo, Ph.D., Chief
Non-Dietary Exposure Branch
Health Effects Division (H7509C)

Please find below the NDEB review of ....

HED Project #: 9-1935, 9-1936 , 9-1937, 9-1938, 9-1939

RD or SRRD Record #: 243739

Caswell #: 508

Date Received: 8/10/89 Review Time: 50 days

Date Returned: 1/23/90

Deferral to: X Biological Analysis Branch/BEAD (see pp 9-10)

____ Science Analysis & Coordination Branch

____ TB - Insecticide/Rodenticide Support Section

____ TB - Herbicide Fungicide/Antimicrobial Support Section

1.0 INTRODUCTION

In January 1985 NDEB/EAB conducted an exposure assessment for a number of uses of the insecticide propoxur (1). The assessment addressed 18 different potential exposure scenarios. These exposure estimates are presented in Table 1. In many cases these exposure estimates were based on theoretical calculations or limited data from studies found in the scientific literature. NDEB requested additional studies with which to refine these assessments (2). In December 1987, the Agency issued a Data-Call-In Notice (DCI) requiring exposure studies for several of these scenarios and for other types of studies (3).

Mobay Corporation, one of the several registrants that received the DCI, responded with seven study protocols addressing various aspects of propoxur exposure. The studies addressed indoor applicator exposure during crack and crevice treatment, post-application exposures from those treatments, respiratory exposure from no pest strip use, and applicator exposures during aerosol spray, trigger pump sprayer, and granular bait treatments. The reviews of these studies are summarized in Section 3 of this document.

2.0 CONCLUSIONS

The original exposure assessment for propoxur, which was issued in 1985, addressed a number of different exposure scenarios. NDEB has re-examined these estimated exposures and revised these estimates where appropriate. Mobay Corporation, one of the registrants for this insecticide, has submitted several studies addressing some of these scenarios. These studies are summarized in Section 3. Whenever one of these studies was found to be acceptable, NDEB revised the earlier estimate based on the newer data. In some other cases newer, and more appropriate surrogate studies have become available and were used to update the exposure estimates. These analyses are presented in Section 4 of this report. The current estimates for these exposure scenarios are presented in Table 2. The types of exposure data that were required by the DCI and a listing of those scenarios that are considered by NDEB to remain data gaps are presented in Table 3.

3.0 REVIEW OF STUDIES SUBMITTED BY MOBAY CORPORATION IN RESPONSE TO THE DCI AND REVISION OF EXPOSURES

NDEB has reviewed six studies submitted by Mobay Corporation in response to a DCI issued in 1987. Three of these studies were rejected for technical reasons, such as failure to follow label instructions. Excepting where explained in the text below, the usage assumptions were the same as those from the previous assessment. Several of the studies submitted by Mobay were sent

to a contractor for review. The contractors report is attached as Appendix A and brief summaries of the studies are included in this assessment.

3.1 RESIDENTIAL CRACK AND CREVICE TREATMENT - APPLICATOR EXPOSURE

CITATION: Exposure of Mixer/loader-Applicators to Propoxur During Mixing/loading and Application of BAYGON 70W Insecticide as a Crack/Crevice & Limited Surface Treatment in Residences.
Mobay Corporation Report 99101.
MRID No. 410547-02.

Reviewed by: Contractor (see Attachment for study details)

Study Description and Results:

Dermal and respiratory exposures were monitored during the application of BAYGON 70W (containing 70% ai) to residences. The insecticide was applied as a 1.1 percent solution using compressed air sprayers. The material was applied as a crack and crevice and limited broadcast treatment. Monitoring was conducted during 15 applications using 3 different commercial pest control operators. The workers wore protective clothing consisting of cotton/polyester coveralls, leather boots, and chemical resistant nitrile gloves. These garments are in compliance with the label requirements. Dermal exposure was monitored using gauze patches attached at the locations described in the Agency's Pesticide Assessment Guidelines - Subdivision U. Two sets of patches were used, one located outside of the clothing and the other beneath the coveralls. Hand exposure was monitored by hand wash with ethanol. Inhalation exposure was measured by drawing air through QMA filters located in the breathing zone using personal sampling pumps. The geometric mean total exposure of applicators wearing protective clothing and gloves was 1.2 mg per replicate (4.7 mg/lb ai).

Exposure Estimate:

The assessment calculated in 1985 was derived from a surrogate study in which DDT was sprayed in homes. At the request of SRB/RD (4) this estimate was revised using updated surrogate data from studies found in the scientific literature (5). A second revision was requested adjusting these values for the wearing of short sleeve shirts and no gloves (6). This revision was completed in December 1987 (7). The current assessments were derived from the study described above and assumed 924 ounces of active ingredient are handled per year (8). Each of these documents addressed different clothing scenarios. Recalculated exposure estimates, based on the current submission, are presented in Table 4. It must be realized that extrapolation of the hand values to estimate exposures without gloves, which

assumed 90 percent protection, increases the uncertainty associated with this assessment.

3.2 RESIDENTIAL POST-APPLICATION EXPOSURE FROM CRACK AND CREVICE TREATMENT

CITATION: Exposure to Propoxur of Residents of Homes Treated with BAYGON 70% WP
Mobay Corporation Report 99102.
MRID No. 410547-03.

Reviewed by: NDEB (9)

Study Description and Results:

The amounts of propoxur found on surfaces and in the air of residences were measured following crack and crevice treatment. The study also measured the degree of transfer of the compound from treated surfaces to the skin. These data, along with several arbitrary assumptions, were used by the registrant and by NDEB to estimate the potential dermal and respiratory exposures of the inhabitants of these dwellings. 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 potential oral exposure resulting from residues on the surfaces of kitchen items.

The study was conducted in conjunction with an applicator exposure study designed to measure the exposure of commercial pest control operators. A formulation of propoxur, BAYGON 70-WP, was applied as a 1.1 percent solution by weight, as specified by the label, to five homes in the Kansas City, Missouri area. The material was applied as a coarse spray to cracks, crevices, baseboards, and other hiding areas commonly treated for insect control using a hand held compression sprayer. An average of 1.2 ounces (0.7-1.8 oz) of active ingredient was applied to each house. Application took 20-34 minutes to complete.

Surface residues and air levels of propoxur were measured at intervals of up to 48 hours after treatment. Both transferrable and total surface residues were sampled. Five types of surfaces were evaluated. A total of 18 samples of each type of medium were placed in each room. The media were distributed in the rooms prior to the treatment. Triplicate samples of each medium were collected before treatment, immediately after application and at intervals of 6, 12, 24, and 48 hours post-application. In the kitchens, vinyl tile squares were placed on the floor and on counter tops. Aluminum foil squares were used to represent cooking utensils and ceramic saucers (26 in^2) were placed on counters or tables to represent tableware. The living rooms and bedrooms were sampled using squares of nylon carpet with a 1 cm

nap placed on the floor and fabric squares located on the furniture. Each square used for wipe sampling had an area of 1 ft^2. Transferrable residues were determined by wiping one foot square areas of various media with gauze pads moistened with 1.9 ml of a pH 4 buffer solution to avoid basic decomposition of the compound. Additional 2 inch squares of the various media or additional saucers were placed adjacent to the dosimeters used for wipe sampling. These samples were used for total residue analysis. The squares were placed in wide-mouth jars and extracted with ethanol. The saucers were placed in zip-lock bags and wiped with gauze and ethanol. These gauze were then placed in wide-mouth jars. The jars were shaken for 30 minutes with a mechanical shaker after which the sampling media were removed. The jars were then stored on dry ice.

Airborne concentrations of propoxur were determined by drawing air, at a rate of 1 liter per minute, through sampling apparatus whose inlet was located 12 inches above the floor. The sampling tubes consisted of an initial 80 mg portion of XAD-4 resin, backed up by a second 40 mg portion. The personal sampling pumps were calibrated before and after the sampling interval and the mean used for calculation of sample volume. All sampling periods were at least one hour.

In addition to monitoring the residues of propoxur on household surfaces, the registrant conducted laboratory studies to measure the transfer of the insecticide from those surfaces to the skin. The resulting transfer coefficient was then used in the dermal exposure calculations. Pieces of vinyl tile, carpet, and upholstery fabric were treated with propoxur at the maximum label rate. After the surface had dried, wipe samples were taken from the treated media using gauze pads. Similar samples were taken using the bare hands of volunteers instead of the gauze pads. One factor that may possibly affect dermal exposure is effect of repeated contact of the skin with a treated surface. In order to evaluate this potential factor, the registrant investigated the effect of the ratio of the skin surface to the area contacted. Surface areas of 0.11, 9, and 18 ft^2 were sampled. Transfer coefficients, defined as the ratio of the residues obtained by hand wipe to those detected after wiping with a moistened gauze, were determined for each material (carpet, vinyl tile, and upholstery fabric) and for the different surface areas sampled. The ratios of skin surface to sample surface were 2, 0.024, and 0.012.

The reviewer found that there was no statistically significant difference in the residues found by wipe sampling a given material in different rooms (Kruskal-Wallace test, $p<0.05$). These data for a particular medium were then pooled to allow a more reliable estimate of the mean value. The data appeared to be lognormally distributed with relatively high values in a very few cases. Consequently, the geometric mean was used in the

exposure calculations. There was no discernible pattern of decay of propoxur over the 48 hour sampling period for any of the materials tested. NDEB used a conservative approach and used the highest geometric mean found over the sampling period, excluding the transient high residues found immediately after treatment, for exposure calculations. The transfer coefficient was determined by linear interpolation although the linearity of the relationship between skin to surface area ratio and transfer coefficient has not yet been confirmed.

NDEB made no assumptions of times spent in a specific location during active times of the day but rather assumed that contact times with carpet, vinyl tile flooring, and upholstery were equally divided. Adolescents and adults were assumed to be in the home 15 hours per day, 365 days per year. Infants were assumed to be in contact with one of these surfaces for 24 hours per day. NDEB further assumed that infants, 12 year old children, and adults spend 12, 8, and 6 hours asleep, respectively. During these sleeping hours the residents were assumed to be exposed to the levels found on upholstery. Dermal exposures were calculated assuming that the area touched in a four hour period was assumed to be 5 or 50 ft^2 and that exposure occurred over 50 percent of the body surface. Daily dermal exposures were calculated separately for active and sleep periods and were summed to yield daily exposures.

Propoxur levels in basement air were significantly higher than those found in other rooms of the homes. There was no significant change in the concentrations measured at the different sampling intervals (Analysis of Variance, $p<0.05$). Since it is unknown how much time an individual would spend in a particular room, the data for all rooms were pooled to yield an average air concentration to which a resident would be exposed. The resulting grand mean was 5.1 ug/m^3.

Revised Exposure Estimate:

The previous estimates of dermal and respiratory exposure of residents following treatment of homes with propoxur were derived from two studies found in the scientific literature (1). These studies did not address dermal exposure to residues and were restricted to the respiratory route only. The ambient concentrations measured in these studies were comparable to those obtained from the study described above. The recently submitted study was much more extensive and addressed both dermal and respiratory exposure. The estimated total exposures for infants, 12 year old children, and adults are presented in Table 5.

3.3 EXPOSURE DURING AEROSOL SPRAY APPLICATION - HOMEOWNER

CITATION: Exposure of Applicators to Propoxur During Residential Application of an Aerosol Spray Containing 1% Propoxur. Mobay Corporation Report 99132. MRID No. 410547-05.

Reviewed by: Contractor

Description of Study and Results:

Dermal and respiratory exposures were measured during the application of a 1 percent aerosol product, Laser Ant and Roach Killer II. The product was packaged in a 15 ounce can and contained 0.0094 pounds of propoxur as the active ingredient. The entire container was emptied in each of the 15 replicates monitored. The insecticide was sprayed into cracks, around baseboards, and around sinks and appliances. The treatments averaged 0.41 hours (0.22-0.55 hrs). The applicators wore cotton/polyester coveralls and nitrile gloves. THE LABEL FOR THIS PRODUCT DOES **NOT** REQUIRE THE USE OF PROTECTIVE CLOTHING AND PROTECTIVE GLOVES WERE NOT INCLUDED IN THE PROTOCOL REVIEWED BY NDEB (10). Dermal exposure of the body was measured using gauze pads attached to the clothing at locations defined in the Agency's Pesticide Assessment Guidelines - Subdivision U. Duplicate sets of patches were used, one located outside of the clothing and the other beneath the coveralls. The geometric mean dermal exposure was calculated by the contractor to be 0.49 mg per replicate (53 mg per lb ai). and exposure , measured inside of protective gloves, was 0.01 mg per replicate (0.96 mg per lb ai). The corresponding geometric mean respiratory exposure was calculated to be 39 mg per replicate (4.1×10^3 ug per lb ai). It is unlikely that a typical homeowner applying this product would wear protective gloves during treatment. It is NDEB's opinion that, although the study was scientifically valid, the exposure scenario addressed was not in compliance with the label or the approved protocol and does not represent typical homeowner exposures. Therefore, the study was not considered to be valid for the purposes of estimating the exposures of homeowners to aerosol products.

Exposure Estimates:

The previous assessment (1) estimated expoxures from aerosol application using a surrogate study from the literature in which the herbicide paraquat was applied using a hand held compressed-air sprayer. The current submission, which was intended to be used to revise this estimate, has been judged to be unaccepatable beacuse protective gloves were worn. In lieu of adequate updated information, NDEB must continue to use the exposure values from its previous assessment. However, it is NDEBs opinion that any exposure estimate for aerosol spray application derived from

treatment using compressed air apparatus may not accurately reflect actual exposures and must be interpreted carefully.

3.4 EXPOSURE DURING APPLICATION OF A TRIGGER-PUMP SPRAY PRODUCT

CITATION: Exposure of Applicators to Propoxur During Trigger-PumpSpray Application of a Liquid Product.
Mobay Corporation Report 99100.
MRID No. 410547-01.

Reviewed by: Contractor

Description of Study and Results:

Exposures were monitored during application of Raid Professional Strength Ant and Roach Killer with a hand-operated trigger pump hose sprayer. The ready-to-use product contains 0.95 percent propoxur as the active ingredient. The container holds a total of 0.0375 lbs of active ingredient. A total of 15 outdoor applications were conducted, ranging from 0.01 to 0.025 lbs ai per application. Application times ranged from 9 to 21 minutes. Exposures were monitored in the same manner as those decribed for the aerosol application study. The applicators wore cotton/polyester coveralls and protective nitrile gloves. THESE PROTECTIVE GARMENTS ARE **NOT** REQUIRED BY THE PRODUCT LABEL AND PROTECTIVE GLOVES WERE **NOT** INCLUDED IN THE APPROVED PROTOCOL. Geometric mean dermal exposures of the body, measured by patches located inside and outside of the coveralls were calculated to be 0.40 mg per replicate (20.1 mg per lb ai) and 1.8 mg per replicate (89 mg per lb ai), respectively. Geometric mean hand exposure, measured inside of the protective gloves, was 0.01 mg per replicate (0.49 mg per lb ai). The corresponding respiratory exposures were 2.4 mg per replicate and 123 mg per lb ai. As was the case with the aerosol study, NDEB does not believe that the exposure study, although scientifically valid, accurately represents the types of exposures that would be received by a homeowner using this product. Protective gloves are **NOT** required by the label and NDEB believes that these individuals are unlikely to wear protective gloves during application of this product.

Estimation of exposure:

The current submission was judged to be unacceptable because protective gloves, which are not specified on the label, were worn during application. NDEB believes that homeowners would not wear such equipment, even if it were required by the label. Until a valid study is submitted for this type of application equipment, NDEB cannot provide an reliable or defendable exposure value for this scenario.

3.5 EXPOSURE FROM APPLICATION OF BAYGON 2% BAIT INSECTICIDE AROUND FOUNDATIONS, PATIOS, DRIVEWAYS, OR SIDEWALKS

CITATION: Exposure of Applicators to Propoxur During Trigger-Pump Spray Application of a Liquid Product.
Mobay Corporation Report 99100.
MRID No. 410547-01.

Reviewed by: Contractor

Description of Study and Results:

Dermal and respiratory exposure of 16 mixer/loader/applicator replicates was measured during application of a 2 percent granular bait formulation of propoxur. This formulation is for use by commercial applicators only. The material was applied using a "Whirlybird" hand-operated spreader to sidewalks, patios, and flower beads surrounding private residences. The study protocol specified hand application, **NOT** hand operated mechanical equipment. The applicators wore cotton/polyester coveralls and protective nitrile gloves. Such equipment is **NOT** specified by the product label. The use of protective gloves was proposed in the study protocol which also specified hand application rather than any specific apparatus. NDEB accepts the use of gloves for this formulation since it is only for commercial application and commercial applicators commonly wear gloves. However, in order to assure that gloves are worn, the requirement for protective gloves should be added to the label. Exposures were monitored as previously described for aerosol and trigger-pump sprayer application. The duration of the replicates ranged from 0.07 hours to 0.18 hours, during which an estimated 0.0088 to 0.043 pounds of active ingredient were applied. The resulting geometric mean dermal exposures, measured using patches located inside of the coveralls, were 0.34 mg per replicate (29 mg/lb ai) and 0.06 mg per replicate (4.8 mg/lb ai) for the body and hands, respectively. The geometric mean inhalation exposure was 1.6 mg per replicate (132 mg/lb ai).

Estimation of Exposure:

The previous assessment did not address the potential exposure during bait application. The current submission is judged to be valid for the specific hand-operated dispensing equipment, provided a label change is made to reflect the use of protective gloves. The study may not adequately reflect exposures during application by hand. Also the study does not address the potential exposures of homeowners to similar granular products, if any are currently registered since gloves were worn. Homeowners are unlikely to wear gloves during application or use this type of dispensing equipment and therefore reflect a different exposure scenario. NDEB defers to BEAD to determine the amount of material that would be handled by a pest control

operator using this material. When such information is obtained, NDEB will provide an exposure value as an addendum to this review.

3.6 EXPOSURE RESULTING FROM THE USE OF PEST STRIPS

CITATION: Post-Application Exposure from Indoor Pest Strips Containing Propoxur.
Mobay Corporation Report 99189.
MRID No. 411036-01.

Reviewed by: NDEB (11, 12)

Description of Study and Results:

An indoor pest strip was placed the cupboards of 5 homes (Hercon Insectape). The locations of the strip in the individual houses are presented in Table 4. Ambient air concentrations of propoxur were measured prior to application , immediately after application and at intervals of 24 hours, 48 hours after application. Additional samples were collected at periods of 4, 7, 14, 21, and 28 days post-treatment. It is NDEB's belief that a single strip does **NOT** reflect typical use patterns for this formulation.

Estimation of Exposures:

The current submission measured air concentrations of propoxur under conditions that were judged to be unacceptable by NDEB. Specifically, the number of strips used does not reflect a typical use pattern. In lieu of a valid study, NDEB continues to use the exposure estimate, derived from a study in which label maximum 36 strips were used in a room (13), that was employed in the original exposure assessment of 1985 (1). The air exchange rate in the room used for that study was reported to be 8-10 air changes per hour, far more than would be expected in a typical home. The resulting value therefore likely underestimates the exposures that would occur with use of this product in the home. Although this study may underestimate air concentrations somewhat, without additional information, NDEB must consider it to be the best information available.

4.0 REVISED EXPOSURE ESTIMATES FOR OTHER SCENARIOS

NDEB has no data addressing exposures of individuals applying propoxur to lawns and shrubs. Previous assessments provided by NDEB/EAB for pest control operators for these scenarios were based on surrogate data from studies found in the scientific literature. Since that time additional surrogate data has become available. These assessments were derived using this newer information, either instead of or in conjunction with, the previous studies.

4.1 Pest Control Operators - Hand Held Power Spray Application to Lawns

The previous assessment conducted by NDEB/EAB estimated exposures of workers applying propoxur using a surrogate study in which exposures were measured during applications of diazinon and trichlorfon to golf course turf. The study was seriously flawed because hand exposures were not measured. Since that time, a more appropriate surrogate has been received and reviewed by NDEB (14). This propriatary study monitored worker exposure during commercial treatment of residential turf with chlorpyrifos. The resulting dermal exposures when extrapolated for propoxur use patterns, are presented in Table 6. It was assumed that a 0.5 percent spray mix is applied for 22.1 hours per year (based on 221 hrs per year total spray time and 10 percent market penetration). The study is summarized in Appendix B.

4.2 Pest Control Operators - Outdoor Application with Compressed Air Sprayers

A previous assessment considered the exposure of workers using compressed air sprayers to treat outdoor residential sites with propoxur (5). The surrogate study used for that assessment measured exposure of homeowners during application of the insecticide diazinon (16). The study is summarized in Appendix C. The current assessment includes an additional study measuring the exposure of home gardeners to carbaryl during application to corn and beans in a home garden (17). A summary of this study is also included in Appendix C. The data from these two studies have been used in order to increase the reliability of the estimate. It was assumed that clothing offered 90 percent protection in these calculations. Although an exposure estimate for this scenario has been provided by NDEB, it is likely that this type of equipment would actually be used only for spot treatment rather than treatment of large areas. In this case it would seem likely that the number of hours spent applying the material would be less than that used in the estimate. The pooled results from the surrogate studies and the resulting estimate of exposure are presented in Table 7. Since both studies found respiratory exposure to be minimal compared to dermal, this route has not been included.

Table 1. Exposure Scenarios and Estimated Annual Exposures to Propoxur as calculated by EAB in 1985 (1).

Scenario Addressed Exposure	Total Annual	
Pest Control Operators:		
Domestic Indoor Use	180	mg/kg/yr
Domestic Outdoor Use	510	mg/kg/yr
Commercial Indoor Use	230	mg/kg/yr
Food Establishment - Indoor Use	300	mg/kg/yr
Residential Mosquito Control	120	mg/kg/yr
Aerial Mosquito Control (Pilot)	7.20	ug/kg/yr
Aerial Mosquito Control (Mixer/loader)	120	ug/kg/yr
Lawn Application	6.90	mg/kg/yr
Kennel Worker - Pet Shampoo	2.30	mg/kg/yr
Home Owner Application:		
Pet Shampoo	30	ug/kg/yr
Flea Collars	2.30	ug/kg/yr
Aerosol Spray and Residue	44	ug/kg/yr
Non-Applicator Residue Exposure:		
Residential Crack and Crevice Spray	460	ug/kg/yr
Commercial Crack and Crevice Spray	0.98	ug/kg/yr
Residential Pest Strips	39	ug/kg/yr
Canine:		
Shampoo	0.95	mg/kg/yr
Flea Collar	380	mg/kg/yr
Other:		
Food Residue from Pest Strips	0.38	ppb

Table 2. Exposures Studies for Propoxur Required by the Data-Call-In Notice of 14 December 1987.

Scenario	Type of Data Required	Study Received	Data Gap
Mixing/loading and Application:			
Indoor Aerosols	Dermal and Inhalation	yes[1]	yes
Outdoor Aerosols	Dermal and Inhalation	no	yes
Indoor Crack and Crevice	Dermal and Inhalation	yes	no
Flea and Tick Dips and Shampoos	Dermal	no[2]	yes
Flea and Tick Aerosols	Dermal and Inhalation	no	yes
Flea and Tick Dab-ons	Dermal	no	yes
Outdoor Sprays	Dermal and Inhalation	yes[3]	yes
Outdoor Dusts	Dermal and Inhalation	no	yes
Outdoor Granules	Dermal and Inhalation	yes[4]	no[4]
Mosquito Control (Fogs and Mists)	Dermal and Inhalation	no	yes
ULV Ground Aerosols	Dermal and Inhalation	no	yes
Post-Application Exposure:			
Indoor Fogger	Dermal and Inhalation	no[5]	yes
Indoor Crack and Crevice	Inhalation	yes	no
Outdoor Sprays to Lawns	Dermal	no	yes
Indoor Pest Strips	Inhalation	yes[1]	yes

1 Study received, judged unacceptable by NDEB.
2 Protocol received, currently undergoing review.
3 Study received for trigger-pump sprayer only, judged unacceptable by NDEB.
4 Study acceptable if label change requiring gloves is added.
5 Protocol received and approved, study not submitted.

Table 3. Exposure Scenarios and Estimated Annual Exposures to Propoxur.

Scenario Addressed	Route	Total Annual Exposure (mg/kg/yr)	Reference
Pest Control Operators:			
Indoor Uses (Residential/Commercial/ Food Handling establishments:			
Long sleeves, long pants, gloves	Dermal	3.8	This review
Long sleeves, long pants, no gloves	Dermal	11	This review
Short sleeves, long pants, gloves	Dermal	8.1	This review
Short sleeves, long pants, no gloves	Dermal	15	This review
Domestic Lawn Use - Hand-held Power Spray:			
Long sleeves, gloves	Dermal	11	This review
Long sleeves, no gloves	Dermal	38	This review
Short sleeves, gloves	Dermal	49	This review
Short sleeves, no gloves	Dermal	77	This review
Domestic Lawn Use - Compressed-Air Sprayer:			
Long sleeves, long pants, gloves	Dermal	1.2	This review
Long sleeves, long pants, no gloves	Dermal	1.3	This review
Short sleeves, long pants, gloves	Dermal	1.2	This review
Short sleeves, long pants, no gloves	Dermal	1.9	This review
Residential Mosquito Control		120	(1)
Aerial Mosquito Control (Pilot)		7.2×10^{-3}	(1)
Aerial Mosquito Control (Mixer/loader)		0.120	(1)
Kennel Worker - Pet Shampoo		2.3	(1)

Table 3 (Continued). Exposure Scenarios and Estimated Annual Exposures to Propoxur.

Scenario Addressed	Route	Total Annual Exposure (mg/kg/yr)	Reference
Home Owner Application:			
Pet Shampoo		3.0×10^{-2}	(1)
Flea Collars		2.3×10^{-3}	(1)
Aerosol Spray and Residue		4.4×10^{-2}	(1)
Non-Applicator Residue Exposure:			
Residential Crack and Crevice Spray			
10 Month old child		$28 - 1.6 \times 10^{2}$	(9)
12 year old child		5.6 - 20	(9)
Adult		4.0 - 12	
Residential Pest Strips		3.9×10^{-2}	(1)
Canine:			
Shampoo		0.95	(1)
Flea Collar		3.8×10^{-2}	(1)
Other:			
Food Residue from Pest Strips		0.38 ppb	

Table 4. **Assumptions** Used and Estimated Dermal Exposures of Pest Control Operators Treating Indoor Sites with Propoxur.

Clothing Scenario	Dermal Exposure (mg/lb ai)	(mg/kg/yr)
Short sleeves, long pants, gloves	9.8	8.1
Long sleeves, long pants, gloves	4.7	3.8
Short sleeves, long pants, no gloves	18	15
Long sleeves, long pants, no gloves	13	11

(this used during study) OREB rec. to use lowest exposure

Assumptions:

1) Body Weight = 70 kg
2) Gloves provide 90 percent protection
3) A PCO handles 924 oz. ai/yr. This includes residential indoor, commercial indoor, and food establishments (8).

Table 7. Estimation of Dermal Exposures of Pest Control Operators Applying Propoxur to Residential Turf Using Compressed-Air Sprayers Clothing is assumed to offer 90 percent protection

Clothing Scenario	Estimated Dermal Exposure to Propoxur at 0.1% from Davis et al.		from Kurtz & Bode		Weighted Mean Exposure		
	(mg/hr)	No. Reps	(mg/hr)	No. Reps	(mg/hr)	(mg/kg/hr)	(mg/kg/yr)
Long sleeves, gloves	--	--	3.70	24	3.7	0.053	1.2
Long sleeves, no gloves	--	--	3.95	24	4.0	0.056	1.2
Short sleeves, gloves	1.4	6	4.30	24	3.7	0.053	1.3
Short sleeves, no gloves	12.4	6	4.55	24	6.1	0.087	1.4

REFERENCES

1) Memorandum from C. Lunchick (EAB) to J. Ellenberger (RD) and R. Zendzian (TB) titled "Exposure Assessment for Propoxur (Baygon)", dated 8 January 1985.

2) Memorandum from C. Lunchick (EAB) to D. Edwards (RD) titled "Exposure Data Required for 3(c)2(b) Data Call-In Notice for Propoxur", dated 9 November 1987.

3) Data-Call-In Notice for Propoxur, dated 14 December 1987.

4) Memorandum from B. Kapner (SRB) to C. Lunchick (EAB) dated 30 October 1987.

5) Memorandum from K. Warkentien (EAB) to B. Kapner (SRB) titled "Revised PCO Exposure Assessment for Propoxur", dated 9 November 1987.

6) Memorandum from B. Kapner (SRB) to K. Warkentien (EAB) dated 30 November 1987.

7) Memorandum from K. Warkentien (EAB) to B. Kapner (SRB) titled "PCO Exposures for Propoxur", dated 3 December 1987.

8) BEAD report for Baygon 70% WP Residential Buildings (Clean Out Application), dated 1 March 1989.

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

10) Memorandum from M. Firestone (EAB) to D. Edwards (RD) titled "Protocol Review for Exposure Study - Applicator Exposure During Use of Pressurized Aerosol Products", dated 29 April 1989.

11) Memorandum from S. Knott (NDEB) to D. Edwards (RD) titled "Review of Post Application Exposure from Indoor Pest Strips Containing Propoxur (HED Project No. 9-1540), dated 2 August 1989.

12) Memorandum from S. Knott (NDEB) to D. Edwards (RD) titled "Review of Post Application Exposure from Indoor Pest Strips Containing Propoxur (HED Project No. 9-1540), dated 2 August 1989.

13) Jackson, M.D. and R.G. Lewis (1981) Insecticide Concentrations in Air after Application of Pest Control Strips. Bull. Environm. Contam. Toxicol. 27,122-125.

14) Memorandum from D. Jaquith (NDEB) to D. Edwards (RD) titled "Re-Evaluation of Chlorpyrifos Lawn Care Exposure Study (HED Project No. 9-0609)", dated 10 January 1990.

15) EPA (1989) Dinocap Position Document 4.

16) Davis, J.E., E.R. Stevens, D.C. Staiff, and L.C. Butler (1983) Potential Exposure to Diazinon During Yard Applications. Environmental Monitoring and Assessment 3:23-28.

17) Kurtz, D.A. and W.M. Bode (1985) Application Exposure to the Home Gardener IN:R.C. Honeycutt, G. Zweig, and N.N. Ragsdale (Eds.), Dermal Exposure Related to Pesticide Use, Discussion of Risk Assessment, ACS Symposium Series #273, (pp 139-161). American Chemical Society, Washington D.C.

Attachments: Appendix A-C

Tables 1-7

cc: Propoxur file (with tables, without attachments)
Circulation (with tables, without attachments)
SACB/Jack Quest (with tables, without attachments)
SRB (With tables and attachments)
Correspondence file (With tables and attachments)

Table 5. Estimates of Total Daily and Annual Exposure of Residents of Homes to Propoxur Following Crack and Crevice Treatment.

Age Category	Contact Area (ft^2)[1]	Exposure Time (hr/day)[2]	Daily Exposure		Annual Exposure		Total Exposure	
			Dermal (mg/kg/day)	Respiratory (mg/kg/day)	Dermal (mg/kg/yr)	Respiratory (mg/kg/yr)	(mg/kg/day)	(mg/kg/yr)
Infant	5	24	0.067	8.2×10^{-3}	25	3.0	0.08	28
	50	24	0.43	8.2×10^{-3}	1.6×10^{2}	3.0	0.44	1.6×10^{2}
12 Year old	5	15	0.013	1.7×10^{-3}	5	0.62	0.015	5.6
	50	15	0.053	1.7×10^{-3}	19	0.62	0.05	20
Adult	5	15	0.010	1.1×10^{-3}	3.6	0.40	0.014	4.0
	50	15	0.033	1.1×10^{-3}	12	0.40	0.034	12
LIFETIME DAILY AVG EXPOSURE[3]	5		0.015	1.8×10^{-3}			2.0×10^{-2}	
	50		0.070	1.8×10^{-3}			7.1×10^{-2}	

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

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

3 Assumes infant exposure during age 0-6, 12 year old exposure during age 7-17, and Adult exposure during age 18-70. The equation is:

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

Table 6. Estimated Dermal Exposures of Lawn Care Pest Control Operators to Propoxur Applied Using Hand-Held Power Sprayers. A spray concentration of 0.5 percent is assumed. Clothing is assumed to offer 90 percent protection when chronic toxicological end points are considered (15).

Clothing Scenario	Chlorpyrifos (0.1% spray)	Propoxur Exposure (0.5% spray)	
	mg/hr	mg/kg/hr	mg/kg/yr
Short sleeves, no gloves	49	3.5	77
Short sleeves, gloves	31	2.2	49
Long sleeves, no gloves	24	1.7	38
Long sleeves, gloves	7.1	0.5	11

Calculations:

$$\text{Propoxur Exposure (mg/kg/hr)} = \text{Chlorpyrifos (mg/hr)} \times \frac{0.5\%}{0.1\%} \times \frac{1}{70\ \text{kg}}$$

for example with short sleeves, no gloves:

Propoxur Exposure (mg/kg/hr) = 49 mg/hr x 0.5%/0.1% x 1/70 kg

= 3.5 mg/kg/hr

Annual Exposure (mg/kg/yr) = mg/kg/hr x 22.1 hr/yr

= 3.5 mg/kg/hr x 22.1 hr/yr

= 77 mg/kg/yr

HED Projects 9-1935 to 9-1939 Appendix A

Final Report

Review of Propoxur Exposure Studies

EPA Contract No. 68-02-4254
Task No. 220

Prepared for

U.S. Environmental Protection Agency
Office of Toxic Substances
Exposure Evaluation Division
Exposure Assessment Branch
401 M Street, SW
Washington, DC 20460

Prepared by

Versar Inc.
6850 Versar Center
Springfield, Virginia 22151

September 29, 1989

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

1. INTRODUCTION

The purpose of this report is to review the four mixer/loader-applicator Propoxur exposure studies submitted to the Environmental Protection Agency by Mobay Corporation. Each study is reviewed in a separate chapter. The review of the studies includes (1) evaluating the validity of the quality assurance, application and sampling procedures; (2) recalculating exposures for workers wearing protective clothing; and (3) calculating exposures for outside patches only. Any variations in exposure between the study report and Versar's calculations are discussed in each chapter.

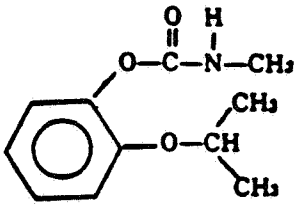
The exposure estimates calculated by Versar represent the methodology specified in Subdivision U guidelines (e.g., use of 1/2 the quantification limit for nondetects; body surface areas; surrogate patches for some body locations). Exposures are given in this report as geometric mean values because (1) majority of exposure distributions are lognormal; (2) consistency among results for comparison of exposures; and (3) environmental data in general are lognormal. The exposure estimates calculated are for the following exposure studies:

- Exposures of Applicators to Propoxur During Residential Application of an Aerosol Spray Containing 1% Propoxur.
- Exposure of Applicators to Propoxur During Trigger-Pump Spray Application of a Liquid Product.
- Exposure of Mixer/Loader-Applicators to Propoxur During Mixing/Loading and Application of Baygon 70-WP Insecticide as a Crack/Crevice & Limited Surface Treatment in Residences.
- Exposure of Applicators to Propoxur During Application of Baygon 2% Bait Insecticide Around Foundations, Patios, Driveways, or Sidewalks.

2. BACKGROUND INFORMATION ON PROPOXUR

The chemical identity of propoxur, 2-(1-methylethoxy) phenyl methylcarbamate, includes:

- molecular weight: 207.24 g/mol[a]
- empirical formula: $C_{11}H_{15}NO_3$
- chemical structure:



- CAS number: 114-26-1
- trade name: Baygon
- water solubility: 1.86 mg/l (25°C)[b]
- propoxur is soluble in all polar organic solvents[c]
- vapor pressure: $<10^{-5}$ mbar at 20°C[d]
- uses: insecticide for control of cockroaches, ants, flies, mosquitos, other lawn and turf insects
- formulations: emulsifiable concentrate, wettable powder, bait, and dust

[a] Windholz et al. 1976. Merck Index. Rahway, NJ: Merck and Co., Inc.
[b] Bowman BT, Sans WW. 1983. Further water solubility determination of insecticidal compounds. J. Environ. Sci. Health.
[c] Sax NI, Lewis RJ. 1989. Dangerous properties of industrial materials (7th ed.). Van Nostrand Reinhold, NY.
[d] Polpyk. 1989. Farm chemical handbook. Willoughby, OH: Meister Publishing Co.

Vapor pressure is the best indicator of how rapidly a chemical will volatilize from a dry surface. At a given temperature, the higher the vapor pressure the more rapidly a substance will volatilize. The vapor pressure of propoxur is $<10^{-5}$ mbar (at 20°C) or $<9.86 \times 10^{-6}$ atm or $<7.51 \times 10^{-3}$ mm of mercury. This is an extremely low vapor pressure and thus propoxur is expected to volatilize at a very slow rate (note: for comparison purposes, the vapor pressure of water at 20°C is 17.5 mm of Hg).

3. REVIEW OF THE STUDY, "EXPOSURES OF APPLICATORS TO PROPOXUR DURING RESIDENTIAL APPLICATION OF AN AEROSOL SPRAY CONTAINING 1% PROPOXUR"

This chapter reviews the inhalation, dermal, and hand exposures a homeowner receives while applying an aerosol spray (Laser Ant and Roach Killer II) containing 1 percent propoxur. The chapter includes a review of the study's quality assurance, application procedures, exposure monitoring techniques, and exposure estimates, as well as a concluding discussion.

Versar concluded that the exposure scenarios (i.e., protective clothing and gloves; no clothing/no hand data) monitored by the registrant are not consistent with the product's label requirements. The product label does not require the use of protective clothing or gloves. Versar calculated the exposure of a worker wearing no clothing (i.e., outside patches, hand exposure not monitored) as 2.0 mg/replicate and 220.0 mg/lb ai handled. Surrogate hand exposure must be added to these exposures before they can represent total exposure. Versar also calculated the total exposure for a homeowner wearing protective clothing and gloves--0.54 mg/replicate and 58.0 mg/lb ai.

Deviations from Subdivision U guidelines include the following. The registrant did not monitor hand exposure without gloves. The use of gloves is not considered normal use for this product. In addition, field recovery experiments were not performed concurrently with the exposure monitoring. Furthermore, the registrant only used two samples each for laboratory and storage stability recovery experiments (seven required by Sub. U). Only one fortification level was used to spike air and dermal sampling media for both laboratory and storage stability experiments.

3.1 Quality Assurance Review

3.1.1 Method Validation

The analytical methodologies for determining the trapping efficiencies of propoxur on the quartz microfiber (QMA) filter, gauze pads, and ethanol hand rinses were validated in the laboratory by the registrant prior to sampling. The sampling media were fortified with propoxur at levels

anticipated during application. The samples were extracted and analyzed to determine laboratory recovery and storage stability at the maximum storage time expected.

Propoxur was separated and quantified by HPLC using post column reaction. This is the method used for the separation and quantification of carbamates. All the samples and matrices were analyzed according to the set of chromatographic conditions explained in the study report, except for the dermal pads. In the analysis of dermal pads, the chromatographic conditions were changed and consequently the retention time of the peak of interest was shifted to approximately 3.7 minutes rather than the 7.09 minutes in the analysis of the other sampling media. In some of the chromatograms there were peaks at 3.23 minutes while the propoxur peak eluted at 7.09 minutes. When the conditions were changed and the propoxur peak was moved to a 3.7 minutes retention time there was no indication that the 3.23 minutes peak was isolated. It is possible that the peak at 3.23 minutes was coeluted with the propoxur and caused positive interferences.

Field recovery experiments were not performed because the registrant determined that there was no significant degradation of propoxur during laboratory recovery experiments. The registrant assumed that the environmental conditions (i.e., temperature and humidity) of the indoor study site would be similar to the conditions in the laboratory.

Quantification limits (QMA filter 0.1 μg, gauze pads 0.03 $\mu g/cm^2$, hand rinse 10 μg) were within ranges specified in Subdivision U guidelines.

3.1.2 Laboratory Recovery Experiments

The spiking solutions for the laboratory recovery experiments were prepared using the formulation in the aerosol can (i.e., Laser Ant and Roach Killer II). A can tap was used to release the pressure from the aerosol can, and the formulation was poured into glass bottles. The formulation was then diluted with ethanol before spiking the three sampling media.

The QMA filters and gauze pads were spiked at only one fortification level corresopnding to 1 μg of propoxur. In comparison, the uncorrected inhalation exposures ranged from 0.22 μg to 3.03 μg; the uncorrected dermal exposures ranged from ND to 56.55 μg per pad. A higher fortification level would have been more appropriate for the upper range of dermal values.

The absolute ethanol hand rinse solution was spiked at two fortification levels--200 μg and 1,000 μg. In comparison, the uncorrected hand exposures ranged from ND to 97.6 μg.

Subdivision U guidelines state that seven determinations must be made for each sampling media at each fortification level to determine efficiency of extraction. In accordance with Subdivision U, seven fortified (1-μg) samples were used for each of the QMA filters and gauze pads. However, only two hand rinse solution samples at each of the fortification levels (200 μg and 1,000 μg) were used to determine the recovery.

The laboratory recovery values for the three sampling media are as follows:

Media	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	101	3.1	7
Gauze pads	98.8	3.5	7
Absolute ethanol (200 μg)	103	0.9	2
Absolute ethanol (1,000 μg)	101	3.5	2

3.1.3 Field Recovery Experiments

Field recovery experiments were not performed concurrently with this specific study. The registrant assumed that the indoor laboratory conditions were similar to the indoor environmental conditions of the study houses. However, temperature and humidity were not reported for the laboratory or the study houses to allow comparison of the indoor environments. Furthermore, the study report does not specify the length of time that the media used in the laboratory recovery experiments were exposed to the laboratory conditions.

Field blanks for each sampling media were used to measure possible contamination during field sampling and laboratory analysis. All field blank samples were nondetects.

Field recoveries of Baygon technical are reported for two separate sets of gauze pads in another propoxur exposure study for method validation. In that study, gauze pads were spiked with Baygon technical at a fortification level of 1.0 μg. The spiked pads were exposed to unspecified field conditions for 5 hours. The results of these field recoveries are as follows:

Media	Average recovery (%)	Standard deviation (%)	No. of samples
Gauze pads	101 $\bar{X} = 92.7$	3.5	7
Gauze pads	84.5	3.6	7

3.1.4 Storage Stability Experiments

Spiking solutions for the storage stability experiments were prepared in the same manner as in the laboratory recovery experiments. In addition, the fortification levels used for the storage stability experiments were the same as those used for the laboratory recovery experiments.

The storage stability experimental results are as follows:

Media	Days stored	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	36	81.7	4.1	7
	53	96.0	11	7
	103	100	5.2	7
Gauze pads	18	107 101	2.5	7
	43	102	6.5	7
	59	94	3.6	7
Absolute ethanol (200 μg)	10	69.2	2.2	2
	22	96.2	0.7	2
	29	96.5	4.1	2
	125	99.1	2.8	2
Absolute ethanol (1,000 μg)	10	90.3	1.6	2
	22	97.5	1.9	2
	29	102	0.8	2
	125	101	3.4	2

In addition to the storage stability experiments listed above, another set of storage stability samples was fortified in the Kansas City, Missouri, laboratory each week of sampling and shipped with the exposure samples to the Pittsburgh, Pennsylvania, laboratory for analysis. These storage stability samples represent the stability of propoxur during the same shipping, storage, and handling conditions as those of the exposure samples. These storage stability samples were analyzed immediately after the exposure samples of that sampling week. The gauze pad values were used to correct dermal exposures. The results of these storage stability experiments are as follows:

Media	Week	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	1	96.6	7.3	5
	2	102	3.9	5
Gauze pads	1	81.5	2.2	5
	2	103	2.9	5
Absolute ethanol (200 μg)	1	110	0.6	2
	2	109	0.8	2

3.2 Application Procedures

Fifteen indoor application replicates (one replicate/house) were performed to measure exposure to propoxur using a 1 percent propoxur spray. The product, Laser Ant and Roach Killer II, was packaged in a ready-to-use aerosol can for homeowners, and no mixing/loading was necessary. The product's label does not specify the use of protective clothing or gloves.

Each applicator (three different workers) sprayed an entire 15-ounce can of Laser Ant and Roach Killer II per replicate into cracks, around baseboards, under sinks, and behind appliances. The application rate for each of the 15 replicates was 0.0094 lb ai ((15 oz product ÷ 16 oz/lb)(1% ai)). Application times ranged from 0.22 to 0.55 hour. Individual replicate sampling times are given in Table 3-1.

Table 3-1. Inhalation Exposure

Rep no.	Hours worked	lb ai handled[a]	Amount of chemical collected (µg)[b]	Volume collected (L)[c]	Inhalation exposure µg/ replicate[d]	Inhalation exposure µg/ lb ai[e]
1	0.5	0.0094	1.7	31.5	47.2	5,021
2	0.47	0.0094	0.22	29.4	6.2	660
3	0.55	0.0094	2.67	34.65	74.2	7,894
4	0.5	0.0094	2.03	32.7	54.3	5,777
5	0.42	0.0094	2.6	27.25	70.1	7,457
6	0.38	0.0094	2.62	25.07	69.5	7,394
7	0.5	0.0094	2.25	32.7	60.2	6,404
8	0.52	0.0094	1.89	34.1	50.4	5,362
9	0.47	0.0094	3.03	30.8	80.9	8,606
10	0.25	0.0094	0.89	16.2	24.0	2,553
11	0.31	0.0094	1.39	19.44	38.8	4,128
12	0.35	0.0094	1.25	22.68	33.8	3,596
13	0.32	0.0094	1.37	19.76	38.8	4,128
14	0.43	0.0094	0.58	27.04	16.1	1,713
15	0.22	0.0094	0.78	13.52	22.2	2,362

[a] lb ai handled = (15 oz formulation ÷ 16 oz/lb)(1% ai).

[b] Amount of chemical collected is not corrected for recoveries; recoveries >90%.

[c] Volume collected = average flow rate (l/min) x sampling time (min).

[d] $\text{Exposure } (\mu g/\text{replicate}) = \frac{\text{amount chemical collected } (\mu g) \times 1{,}000\ l/m^3}{\text{air volume sampled}} \times \text{average respiration rate } (1.75\ m^3/hr) \times \text{sampling time (hr)}.$

[e] $\text{Exposure } (\mu g/\text{lb ai}) = \frac{\text{Exposure } \mu g/\text{replicate}}{0.0094 \text{ lb ai/replicate}}.$

34 12

3.3 Exposure Monitoring

3.3.1 Inhalation Monitoring

Inhalation exposure was monitored by a personal air sampler. The collection medium used was a quartz microfiber (QMA) filter in a polystyrene cassette attached to each worker's lapel (in the breathing zone). The average flow rate for each personal air pump was approximately 1 liter/minute. Flow rate was measured and calibrated prior to and after each sampling period.

3.3.2 Dermal Monitoring

Dermal exposure monitoring followed the procedures of Durham and Wolfe. Each dermal pad was constructed of 12-ply gauze surgical sponge enclosed in an aluminized paperboard holder. The dosimeters were 3 in. by 3 in. with a 5.6 cm diameter circular opening (24.63 cm^2).

As per Subdivision U, ten dosimeters were attached to the following outside locations: both upper arms, both palmar forearms, right chest, left back, front of both thighs, and both shins. Ten additional patches were worn under 65 percent polyester/35 percent cotton coveralls. These inside dosimeters were worn at the same general locations as the outside dosimeters; care was taken not to overlap outside and inside patches. The use of the protective clothing is not specified on the product label. Therefore, the inside exposures calculated for this study report do not represent homeowner use. Along with the above-mentioned dosimeters, one patch was worn on the outside of a baseball-type cap just above the bill.

At the end of each replicate all patches were removed, placed in appropriate glass bottles, and stored on dry ice.

3.3.3 Hand Monitoring

Each worker wore chemical-resistant (nitrile, Best No. 730) gloves. The product label did not specify the use of gloves. Thus, there are no hand exposures representing homeowner use.

Upon completion of each work cycle, the gloves were removed and hand exposures were determined using a 200-ml absolute ethanol hand rinse

solution. Each hand was rinsed twice by shaking the hand 50 times in a 42-oz. Whirl-Pak bag containing absolute ethanol. All four hand rinse solutions (i.e., one replicate) were mixed together, and a portion was poured into two 1-ounce bottles and stored on dry ice. The remaining rinse solution was discarded.

3.4 Exposure Calculations

3.4.1 Inhalation Exposure

Inhalation exposures were calculated by Versar as μg/replicate and μg/lb ai handled. Since laboratory and storage stability recovery values are >90 percent, the data were not corrected for recoveries. Table 3-1 lists the inhalation exposure calculations, inhalation exposures for each replicate, and associated data (i.e., hours worked, lb ai handled, amount of chemical collected, and air volume collected).

3.4.2 Dermal Exposure

Dermal exposure values were calculated by both the registrant and Versar using body surface areas from Subdivision U. Dermal exposures (excluding hands) are reported as mg/replicate and mg/lb ai handled. Dermal exposure data were corrected for storage stability.

Geometric mean total dermal exposures for a worker wearing protective coveralls as calculated in the study report and by Versar are:

	mg/replicate	mg/lb ai
Study report	0.39	41.6
Versar	0.49	53.0

Geometric mean total dermal exposures (excluding hands) for a worker with no clothing (i.e., outside patches only) are 2 mg/replicate and 215.8 mg/lb ai as calculated by Versar.

3.4.3 Hand Exposure

All reported hand exposure data represent exposure to workers wearing protective gloves even though gloves are not a label requirement. Since laboratory and storage stability recovery values are >90 percent, Versar

made no data corrections for recovery. However, the study report corrected the data using 109 percent storage recovery. Geometric mean hand exposures are as follows:

	mg/replicate	mg/lb ai
Study report	0.014	1.3
Versar	0.01	0.96

3.4.4 Total Exposure

Total exposure represents inhalation, dermal, and hand exposures. The geometric mean total exposures for a worker wearing protective clothing and gloves (not consistent with label requirements) are as follows:

	mg/replicate	mg/lb ai
Study report	0.44	46.4
Versar	0.54	58.0

Table 3-2 lists the total exposures and each body location exposure in mg/replicate and mg/lb ai for a worker wearing protective clothing and gloves as calculated by Versar.

The geometric mean total exposures (hand data not determined) as calculated by Versar for a worker wearing no clothing (outside patches only) are 2.0 mg/replicate and 220 mg/lb ai. However, these outside exposure values are most likely significantly underestimated because outside hand exposures were not monitored. Table 3-3 list the exposures for outside patch total exposure in μg/replicate and μg/lb ai, as calculated by Versar.

3.5 Discussion

The analytical procedures for preparing laboratory and storage stability experiments used only one fortification level to spike the QMA filters and dermal pads. The QMA filters were spiked at 1.0 μg, which closely approximated the inhalation exposures monitored (0.22 μg to 3.03 μg). The dermal pads were also spiked at 1.0 μg; however, uncorrected dermal exposures ranged from <0.15 μg to 97.6 μg. A higher fortification level would have been more appropriate for the upper range of dermal values.

Table 3-2. Total Exposure (Geometric Mean) for a Worker Wearing Protective Clothing and Gloves

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	15	0.21	22.3
Neck front	15	0.01	1.3
Neck back	15	0.01	1.4
Upper arms	15	0.04	4.6
Chest	15	0.05	5.7
Back	15	0.05	5.7
Forearms	15	0.02	1.9
Thighs	15	0.06	6.1
Lower legs	15	0.04	3.9
Hands	15	0.01	0.96
Inhalation	15	0.04	4.1
Total Exposure	15	0.54	58.0

[a] Body surface areas used to calculate exposures are from Subdivision U.

38 16

Table 3-3. Total Exposure (Geometric Mean) for a Worker Wearing No Clothing (Outside Patches Only), Excluding Hands

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	15	0.21	22.3
Neck front	15	0.01	1.3
Neck back	15	0.01	1.4
Upper arms	15	0.51	54.0
Chest	15	0.28	30.0
Back	15	0.42	45.0
Forearms	15	0.28	29.0
Thighs	15	0.21	22.0
Lower legs	15	0.1	11.0
Hands	15	--	--
Inhalation	15	0.04	4.1
Total Exposure	15	2.0[b]	220.0[b]

[a] Body surface areas used to calculate exposures are from Subdivision U.
[b] Total exposure does not include hand exposures.

The fortification levels used for the hand rinse recovery experiments were 200 μg and 1,000 μg. These fortification levels are higher than (uncorrected) hand exposures monitored, which ranged from <8 μg to 97.6 μg. Furthermore, only two experimental samples at each hand rinse fortification level were used for laboratory recovery and storage stability. Subdivision U guidelines specify the use of seven experimental samples for each fortification level.

Field recovery efficiencies were not performed. The registrant assumed that the laboratory conditions would be similar to the conditions at the study site since both locations were indoors and propoxur is non-volatile. However, the conditions (i.e., temperature and humidity) were not reported for either location to support this assumption.

The geometric mean dermal exposures calculated in the study report for workers wearing protective clothing (0.39 mg/replicate and 41.6 mg/lb ai) are very similar to the geometric mean exposures calculated by Versar (0.49 mg/replicate and 53.0 mg/lb ai). The slight difference in exposure is attributed to the study report's data being based on use of one-half the detection limit (rather than the quantification limit) for nondetects and the assumption of a 35 percent protection factor for the baseball-type cap. The protection factor was calculated by dividing inner dosimeter exposure by outer dosimeter exposure for the same body location. In comparison, Versar used one-half the limit of quantification for nondetects and assumed no protection factor for the baseball-type cap.

The geometric mean hand exposures calculated in the study report (0.014 mg/replicate and 1.3 mg/lb ai) are slightly higher than the values calculated by Versar (0.01 mg/replicate and 0.96 mg/lb ai). The discrepancy resulted because the study report's data were based on use of 109 percent recovery to correct exposure data and the use of the detection limits (8 to 16 μg) for nondetects. In contrast, Versar did not use corrected exposure data and used one-half the limit of quantification for nondetects.

The total exposure (geometric mean) for a worker using protective clothing and gloves reported by the study report (0.44 mg/replicate and

46.4 mg/lb ai) is slightly less than the total exposure (geometric mean) calculated by Versar (0.54 mg/replicate and 58.0 mg/lb ai). The difference in exposure is attributed to the manner in which dermal exposure was calculated, as described above.

4. REVIEW OF THE STUDY, EXPOSURE OF APPLICATORS TO PROPOXUR DURING TRIGGER-PUMP SPRAY APPLICATION OF A LIQUID PRODUCT

This chapter reviews the inhalation, dermal, and hand exposure that a homeowner applicator receives while applying Raid Professional Strength Ant and Roach Killer outdoors with a hand-operated trigger-pump hose sprayer. The insecticide contains 0.95 percent propoxur. The chapter includes a review of the study's quality assurance, application procedures, exposure monitoring techniques, and exposure estimates, as well as a concluding discussion.

Versar concluded that the exposure scenarios (i.e., protective clothing and gloves; no clothing/no hand data) monitored by the registrant are not consistent with the product's label requirements. The product label does not require the use of protective clothing or gloves. Versar calculated the exposure of a worker wearing no clothing (i.e., outside patches, hand exposure not monitored) as 1.8 mg/replicate and 89.0 mg/lb ai handled. Surrogate hand exposure must be added to these exposures before they can represent total exposure. Versar also calculated the total exposure for a homeowner wearing protective clothing and gloves--0.43 mg/replicate and 20.7 mg/lb ai.

Deviations from Subdivision U guidelines include the following. The registrant did not monitor hand exposure without gloves. Wearing of gloves is not considered normal use for this product. In addition, the registrant only used two samples each for laboratory and storage stability recovery experiments (seven required by Subdivision U). Only one fortification level was used to spike air and dermal sampling media for both laboratory and storage stability experiments.

4.1 Quality Assurance Review

4.1.1 Method Validation

The analytical methodology for determining the trapping efficiencies of propoxur on the sampling media and its storage stability is the same as that reported in Section 3.1.1.

Field recovery experiments were performed with Baygon technical on gauze pads and Baygon 2 percent bait on QMA filters prior to the exposure study. The gauze pads were exposed in the field for 5 hours. The average field recovery for 14 gauze pad samples was 93 percent (C.V. = 3.9). The QMA filters were exposed in the field for 3 hours. The average field recovery was 91.5 percent (C.V. = 15.3).

4.1.2 Laboratory Recovery Experiments

The spiking solutions for the laboratory recovery experiments were prepared by diluting the Raid formulation with ethanol.

The QMA filters and gauze pads were spiked at only one fortification level. Each of these sampling media was spiked with 1 μg of propoxur. In comparison, the uncorrected inhalation exposures ranged from 0.02 μg to 0.28 μg; the uncorrected dermal exposures ranged from ND to 25.02 μg per pad.

The absolute ethanol hand rinse solution was spiked at two fortification levels--200 μg and 1,000 μg. In comparison, the uncorrected hand exposures ranged from ND to 36.0 μg, suggesting that inappropriate fortification levels may have been used.

Subdivision U guidelines state that seven determinations must be made for each sampling media at each fortification level to determine efficiency of extraction. In accordance with Subdivision U, seven fortified (1 μg) samples were used for each of the QMA filters and gauze pads. However, only two hand rinse solution samples at each of the fortification levels (200 μg and 1,000 μg) were used to determine the efficiency of extraction.

The laboratory recovery values for the three sampling media are as follows:

Media	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	100	3.3	7
Gauze pads	109	18	7
Absolute ethanol (200 μg)	99.2	2.9	2
Absolute ethanol (1,000 μg)	103	1.8	2

4.1.3 Field Recovery Experiments

Field recovery experiments were performed by the registrant for four of the five sampling days. Seven field recovery samples were prepared for each media each day to represent three replicates per day. Field blank samples were used for measuring possible contamination. All field blank samples were nondetects.

The field fortified samples were exposed to the same field conditions for approximately the same length of time as the exposure samples. Separate field recoveries were performed for inside and outside dermal dosimeters. The results of the field recoveries for the three sampling media are as follows:

Media	Fortification level (μg)	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	0.2	90.3	2.7	28
Gauze pads (outside)	1.0	100.5	2.1	28
Gauze pads (outside)	50	91.9	4	28
Gauze pads (inside)	1.0	99.1	6.9	27
Ethanol*	200	102.2	1.8	8

* The ethanol solution was placed in a plastic bag, shaken, and bottled.

4.1.4 Storage Stability Experiments

The spiking solutions and fortification levels used for the storage stability samples were the same as those used for the laboratory samples.

The storage stability results are as follows:

Media	Days stored	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters (1 μg)	10	98.9	3.2	7
	38	72.2	9.6	7
	55	89.9	14	7
	100	95.6	2.5	7
Gauze pads (1 μg)	14	118	5.7	7
	58	100	7.1	7
	101	98.2	6.0	7
Ethanol (200 μg)	10	97.4	0.7	2
	28	104	2.0	2
	125	99.6	0.1	2
Ethanol (1,000 μg)	10	97.6	0.6	2
	28	100	0.0	2
	125	97.3	1.0	2

4.2 Application Procedures

Fifteen outdoor application replicates were performed by three Mobay employees representing homeowner applicators. Each replicate (one house/replicate) consisted of spraying a portion of a one-half-gallon can of liquid ready-to-use Raid to outside areas of a private residence in Kansas City, Missouri. The container consisted of a hand-operated trigger-pump sprayer with an 18-inch hose.

The amount of insecticide sprayed during each replicate ranged from 0.01 to 0.025 lb ai. The total amount of insecticide in each container was 0.0375 lb ai. Therefore, 27 to 67 percent of the container was used. There are no maximum application rates listed on the product label. Application times ranged from 9 to 21 minutes. The product label states that the insecticide cannot be sprayed for more than 1.5 minutes in the average room.

4.3 Exposure Monitoring

Inhalation, dermal, and hand exposure monitoring methods were the same as those described in Section 3.3. The use of protective clothing and gloves is inconsistent with label requirements. Furthermore, exposure to hands without gloves was not monitored.

4.4 Exposure Calculations

4.4.1 Inhalation Exposure

Inhalation exposures were calculated as μg/replicate and μg/lb ai handled. Even though field recovery values are >90 percent, the data were corrected for field recovery. Table 4-1 lists the inhalation exposure calculations, inhalation exposures for each replicate, and associated data (i.e., hours worked, lb ai handled, amount of chemical collected, and air volume collected).

4.4.2 Dermal Exposure

Dermal exposure values were calculated by both the registrant and Versar using body surface areas from Subdivision U. Dermal exposures (excluding hands) are reported as mg/replicate and mg/lb ai handled. Dermal exposure data were corrected for field recovery (>90 percent).

Geometric mean dermal exposures for a worker wearing protective coveralls (protective clothing not required by label) as calculated in the study report and by Versar are:

	mg/replicate	mg/lb ai
Study report	0.25	12.8
Versar	0.40	20.1

Geometric mean dermal exposures (excluding hands) for a worker with no clothing (i.e., outside patches only) are 1.8 mg/replicate and 89.0 mg/lb ai as calculated by Versar.

4.4.3 Hand Exposure

All reported hand exposure data represent exposure to workers wearing protective gloves (inconsistent with label requirements). Even though field recovery values are >90 percent, the hand data were corrected for recovery. Geometric mean hand exposures are as follows:

	mg/replicate	mg/lb ai
Study report	0.013	0.66
Versar	0.01	0.49

Table 4-1. Inhalation Exposure

Rep no.	Hours worked	lb ai handled[a]	Amount of chemical collected (µg)[b]	Volume collected (L)[c]	Inhalation exposure µg/ replicate[d]	Inhalation exposure µg/ lb ai[e]
1	0.32	0.0188	0.153	19.95	4.3	229
2	0.35	0.0188	0.098	22.05	2.7	144
3	0.30	0.025	0.098	18.9	2.7	108
4	0.35	0.025	0.112	22.89	3.0	120
5	0.32	0.025	0.314	20.71	8.5	340
6	0.27	0.0188	0.112	17.44	3.0	160
7	0.28	0.0188	0.08	18.7	2.1	112
8	0.35	0.025	0.171	23.1	4.5	180
9	0.30	0.025	0.114	19.8	3.0	120
10	0.20	0.0206	0.091	12.96	2.5	121
11	0.20	0.01	0.023	12.96	0.6	60
12	0.15	0.0188	0.046	9.72	1.2	64
13	0.20	0.0188	0.054	12.48	1.51	80.3
14	0.20	0.0131	0.086	12.48	2.4	183
15	0.22	0.025	0.054	13.52	1.5	60

[a] lb ai handled = (# oz ai ÷ 16 oz/lb).

[b] Amount of chemical collected is corrected for recovery.

[c] Volume collected = average flow rate (l/min) x sampling time (min).

[d] Exposure (µg/replicate) = $\frac{\text{amount chemical collected (µg) x 1,000 l/m}^3}{\text{air volume sampled}}$ x average respiration rate (1.75 m^3/hr) x sampling time (hr).

[e] Exposure (µg/lb ai) = $\frac{\text{Exposure µg/replicate}}{\text{lb ai/replicate}}$.

4.4.4 Total Exposure

Total exposure represents inhalation, dermal, and hand exposures. The geometric mean total exposures for a worker wearing protective clothing and gloves (inconsistent with label requirements) are as follows:

	mg/replicate	mg/lb ai
Study report	0.27	13.6
Versar	0.43	20.7

Table 4-2 list the exposures in mg/replicate and mg/lb ai for a worker wearing protective clothing and gloves as calculated by Versar.

The geometric mean total exposures (hand data not determined) as calculated by Versar for a worker wearing no clothing (outside patches only) are 1.8 mg/replicate and 89.0 mg/lb ai. However, these outside exposure values are most likely significantly underestimated because outside hand exposures were not monitored. Table 4-3 list the exposures calculated by Versar for outside total exposure in mg/replicate and mg/lb ai.

4.5 Discussion

The analytical procedures for preparing laboratory and storage stability experiments used only one fortification level to spike the QMA filters and dermal pads. The QMA filters were spiked at 1.0 μg; the inhalation exposures monitored were 0.02 μg to 0.28 μg. The dermal pads were also spiked at 1.0 μg; dermal exposures ranged from <0.15 μg to 25.02 μg. A range of fortification levels would have been more appropriate.

The fortification levels used for the hand rinse recovery experiments were 200 μg and 1,000 μg. These fortification levels are much higher than actual hand exposures monitored, which ranged from <8 μg to 36.0 μg. Furthermore, only two experimental samples at each hand rinse fortification level were used for laboratory recovery and storage stability. Subdivision U guidelines specify the use of seven experimental samples for each fortification level.

The small amount of insecticide handled (0.01 to 0.025 lb ai), along with an average sampling time of only 16 minutes, may have contributed to

Table 4-2. Total Exposure (Geometric Mean) for a Worker Wearing Protective Clothing and Gloves

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	15	0.12	5.9
Neck Front	15	0.01	0.33
Neck Back	15	0.01	0.66
Upper Arms	15	0.04	2.2
Chest	15	0.05	2.7
Back	15	0.05	2.7
Forearms	15	0.02	0.91
Thighs	15	0.06	2.9
Lower Legs	15	0.04	1.8
Hands	15	0.01	0.49
Inhalation	15	0.02	0.12
Total Exposure	15	0.43	20.7

[a] Body surface areas used to calculate exposures are from Subdivision U.

Table 4-3. Total Exposure (Geometric Mean) for a Worker Wearing No Clothing (Outside Patches Only), Excluding Hands

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	15	0.12	5.9
Neck Front	15	0.01	0.33
Neck Back	15	0.01	0.66
Upper Arms	15	0.44	22.0
Chest	15	0.16	7.9
Back	15	0.42	21.0
Forearms	15	0.20	9.9
Thighs	15	0.24	12.0
Lower Legs	15	0.18	8.9
Hands	--	--	--
Inhalation	15	0.002	0.12
Total Exposure	15	1.8[b]	89.0[b]

[a] Body surface areas used to calculate exposures are from Subdivision U.
[b] Total exposure does not include hand exposures.

50 28

the result of no detectable levels of propoxur on inside dermal dosimeters. However, label requirements state that the insecticide cannot be sprayed more than 1.5 minutes in an average room; therefore, these sampling times are appropriate.

The geometric mean dermal exposures calculated in the study report for workers wearing protective clothing (0.25 mg/replicate and 12.8 mg/lb ai) differ slightly from the geometric mean exposures calculated by Versar (0.40 mg/replicate and 20.1 mg/lb ai). The difference in exposure is attributed to the study report's use of the detection limit for nondetects and the assumption that the baseball-type cap provides 100 percent protection to the head. In comparison, Versar used one-half the limit of determination for nondetects and assumed that the baseball-type cap offered no protection to the head.

The geometric mean hand exposures calculated in the study report (0.013 mg/replicate and 0.66 mg/lb ai) are slightly higher than the values calculated by Versar (0.01 mg/replicate and 0.49 mg/lb ai). The discrepancy is attributed to the study report's use of the detection limits (8 to 12 μg) for nondetects. In contrast, Versar used one-half the limit of quantification for nondetects.

The total exposure (geometric mean) for a worker using protective clothing and gloves reported by the study report (0.27 mg/replicate and 13.6 mg/lb ai) is slightly less than the total exposure (geometric mean) calculated by Versar (0.43 mg/replicate and 20.7 mg/lb ai). The differences in exposure are attributed to the manner in which dermal exposures were calculated, as described above.

5. REVIEW OF THE STUDY, EXPOSURE OF MIXER/LOADER-APPLICATORS TO PROPOXUR DURING MIXING/LOADING AND APPLICATION OF BAYGON 70 WP INSECTICIDE AS A CRACK/CREVICE & LIMITED SURFACE TREATMENT IN RESIDENCES

This chapter reviews the inhalation, dermal, and hand exposure a commercial applicator receives while applying Baygon 70% WP indoors with a hand compression sprayer. The insecticide is a wettable-powder and contains 70 percent propoxur. The chapter includes a review of the study's quality assurance, application procedures, exposure monitoring techniques, and exposure estimates, as well as a concluding discussion.

Versar concluded that the registrant's exposure scenario of a pest control operator (PCO) wearing protective clothing and gloves represent the requirements of the product label. Maximum label application rates were also used in the study. Versar calculated the total exposure of a PCO wearing protective clothing and gloves as 1.2 mg/replicate or 4.7 mg/lb ai.

Deviations from Subdivision U guidelines include the following. Field recovery experiments were not performed concurrently with the exposure monitoring. In addition, the registrant only used two samples each for laboratory and storage stability recovery experiments (seven are required by Subdivision U). Only one fortification level was used to spike air and dermal sampling media for both laboratory and storage stability experiments.

5.1 Quality Assurance Review

5.1.1 Method Validation

The same method validation procedures for the aerosol exposure study (Section 3.1.1) were also used in the Baygon 70 WP exposure study.

5.1.2 Laboratory Recovery Experiments

The spiking solutions for the laboratory recovery experiments were prepared by diluting the Baygon 70 WP formulation with ethanol.

The QMA filters and gauze pads were spiked at only one fortification level. Each of these sampling media was spiked with 1 μg of propoxur.

Because the uncorrected inhalation exposures ranged from 1.33 μg to 2.51 μg, this was an appropriate spike level. The uncorrected dermal exposures ranged from ND to 594.71 μg per pad, suggesting that higher fortification levels should have been used.

The ethanol hand rinse solution was spiked at two fortification levels--200 μg and 1,000 μg. In comparison, the uncorrected hand exposures ranged from 22 to 1735.2 μg.

Subdivision U guidelines state that seven determinations must be made for each sampling media at each fortification level to determine efficiency of extraction. In accordance with Subdivision U, seven fortified (1 μg) samples were used for each of the QMA filters and gauze pads. However, only two hand rinse solution samples at each of the fortification levels (200 μg and 1,000 μg) were used to determine the efficiency of extraction.

The laboratory recovery values for the three sampling media are as follows:

Media	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	92.5	5.4	7
Gauze pads	108	3.6	7
Absolute ethanol (200 μg)	99.2	0.5	2
Absolute ethanol (1,000 μg)	97.3	0.8	2

5.1.3 Field Recovery Experiments

As with the aerosol exposure study, field recovery experiments were not performed for this specific study. The registrant assumed that the indoor laboratory conditions were similar to the indoor environmental conditions of the study houses. However, temperature and humidity were not reported for the laboratory or the study houses to allow comparison of the indoor environments. Furthermore, the study report does not specify the length of time the gauze pads and hand rinse solutions were exposed to the laboratory conditions.

There are, however, recoveries for the QMA filters spiked in the lab and sampled at one liter/minute for four hours. These surrogate "field" recoveries for QMA filters are:

Fortification level (μg)	Average recovery (%)	Standard deviation (%)	No. of samples
1.0	73.5	18	7
1.0	91.1	6.5	7

Field blank samples were used to measure possible contamination of exposure samples. Only one dermal pad blank sample out of sixteen had a positive detection. The field blank detected 1.91 μg (0.078 $\mu g/cm^2$).

5.1.4 Storage Stability Experiments

The spiking solutions and fortification levels used for the storage stability samples were the same as for the laboratory samples.

The storage stability results are as follows:

Media	Days stored	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters (1 μg)	15	58.4	6.4	7
	19	102	4.0	4
	20	79.7	1.3	5
	20	103	7.5	4
	85	99.6	4.6	7
	113	97.4	7.4	7
Gauze pads (1 μg)	18	95.2	6.2	7
	63	110	7.9	7
	103	148	9.9	7
	110	110	3.4	7
Ethanol (200 μg)	10	61.1	1.3	2
	22	95.5	1.9	2
Ethanol (1,000 μg)	10	88.4	3.8	2
	22	97.5	2.0	2

In addition to the storage stability experiments listed above, another set of storage stability samples was fortified in the Kansas City, Missouri, laboratory each week of sampling and shipped with the exposure samples to the Pittsburgh, Pennsylvania, laboratory for analysis. These storage

stability samples represent the stability of propoxur under the same shipping, storage, and handling conditions as those of the exposure samples. The storage stability samples were analyzed immediately after the exposure samples of that sampling week. There were five shipments of samples but only the last three shipments except for the QMA filters contained storage stability samples. The results of these storage stability experiments are as follows:

Media	Shipment	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters (0.2 μg)	1	92.2	9.3	5
	3	69.1	12	5
	4	94.2	1.2	4
	5	77.4	4.1	5
Gauze pads (1.0 μg)	3	94.1	6.1	5
	4	100	3.3	5
	5	88.5	0.8	5
Absolute ethanol (200 μg)	3	106	4.9	2
	4	70.4	1.4	2
	5	62.6	7.0	2

5.2 Application Procedures

Sixteen mixer/loader/applicator (MLA) replicates (more than one house/replicate) were performed indoors by three different workers representing pest control operators (PCO). Each replicate consisted of mixing the wettable powder in a one gallon hand compression sprayer (the amounts of ai handled per replicate are given in Table 5-1). The sprayer was then shaken and pressurized to 50 psi by hand.

The maximum label rate of 1.1 percent Baygon for a sprayer was used to treat indoor private residences. The label also states that a 4.5 percent solution can be used for sand flies when applied with a paint brush.

5.3 Exposure Monitoring

Inhalation, dermal, and hand exposure monitoring methods are the same as described in Section 3.3. The product label states that "in case of prolonged exposure, wear natural rubber gloves, protective clothing, and goggles." Therefore, the exposure scenario of workers wearing protective

Table 5-1. Inhalation Exposure

Rep no.	Hours worked	lb ai handled[a]	Amount of chemical collected (µg)[b]	Volume collected (L)[c]	Inhalation exposure µg/ replicate[d]	Inhalation exposure µg/ lb ai[e]
1	2.0	0.275	26.085	121.9	749	2,724
2	1.6	0.1688	36.395	96.9	1,052	6,232
3	1.4	0.3313	21.808	86.2	620	1,871
4	1.0	0.1313	11.44	60.1	333	2,536
5	1.6	0.3	26.622	94.3	790	2,633
6	1.7	0.2438	3.03	104.0	87	357
7	2.6	0.3938	5.661	162.6	158	401
8	1.5	0.2	1.476	94.7	41	205
9	2.2	0.4813	4.873	135.8	138	287
10	2.0	0.1813	2.897	135.1	75	414
11	2.3	0.2125	2.619	146.2	72	339
12	2.2	0.2875	1.819	139.7	50	174
13	1.3	0.2188	1.858	141.8	30	137
14	2.0	0.5	7.701	125.0	216	432
15	2.5	0.2188	4.799	152.5	138	631
16	1.3	0.3063	10.591	79.8	302	986

[a] lb ai handled = (# oz ai formulation ÷ 16 oz/lb).

[b] Amount of chemical collected is corrected for recovery.

[c] Volume collected = average flow rate (l/min) x sampling time (min).

[d] $$\text{Exposure (µg/replicate)} = \frac{\text{amount chemical collected (µg)} \times 1{,}000\ \text{l/m}^3}{\text{air volume sampled}} \times \text{average respiration rate (1.75 m}^3\text{/hr)} \times \text{sampling time (hr)}.$$

[e] $$\text{Exposure (µg/lb ai)} = \frac{\text{Exposure µg/replicate}}{\text{\# lb ai/replicate}}.$$

52 34

clothing and gloves represents the label requirements for PCOs with prolonged exposure.

5.4 Exposure Calculations

5.4.1 Inhalation Exposure

Inhalation exposures were calculated by Versar as μg/replicate and μg/lb ai handled. Inhalation exposures were corrected for storage stability as determined for each shipment of samples. Table 5-1 lists the inhalation exposure calculations, inhalation exposures for each replicate, and associated data (i.e., hours worked, lb ai handled, amount of chemical collected, and air volume collected).

5.4.2 Dermal Exposure

Dermal exposure values were calculated by both the registrant and Versar using body surface areas from Subdivision U. Dermal exposures (excluding hands) are reported as mg/replicate and mg/lb ai handled. Dermal exposure data were corrected for storage stability.

Geometric mean dermal exposures for a worker wearing protective coveralls as calculated in the study report and by Versar are:

	mg/replicate	mg/lb ai
Study report	1.0	4.0
Versar	0.81	3.1

Geometric mean dermal exposures (excluding hands) for a worker with no clothing (i.e., outside patches only) are 11.2 mg/replicate and 43.1 mg/lb ai as calculated by Versar.

5.4.3 Hand Exposure

All reported hand exposure data represent exposure to workers wearing protective gloves. Hand exposures were corrected for storage stability. Geometric mean hand exposures are as follows:

	mg/replicate	mg/lb ai
Study report	0.21	0.8
Versar	0.23	0.87

5.4.4 Total Exposure

Total exposure represents inhalation, dermal, and hand exposures. The geometric mean total exposures for a worker wearing protective clothing and gloves are as follows:

	mg/replicate	mg/lb ai
Study report	1.3	5.0
Versar	1.2	4.7

Table 5-2 list the exposures in mg/replicate and mg/lb ai for a worker wearing protective clothing and gloves as calculated by Versar.

The geometric mean total exposures (hand data not determined) as calculated by Versar for a worker wearing no clothing (outside patches only) are 11.2 mg/replicate and 43.0 mg/lb ai. However, these outside exposure values are most likely significantly underestimated because outside hand exposures were not monitored. Table 5-3 lists the exposures for outside total exposure in mg/replicate and mg/lb ai as calculated by Versar.

5.5 Discussion

The analytical procedures for laboratory and storage stability experiments used only one fortification level to spike the QMA filters and dermal pads. The QMA filters were spiked at 1.0 μg; the inhalation exposures monitored ranged from 1.33 μg to 25.1 μg, suggesting that an appropriate spike level was used. The dermal pads were also spiked at 1.0 μg, however; dermal exposures ranged from <0.15 μg to 594.71 μg, suggesting that a broader range of fortification levels would have been more appropriate.

The fortification levels used for the hand rinse recovery experiments were 200 μg and 1,000 μg. These fortification levels are higher than some of the actual hand exposures monitored, which ranged from 22 μg to 1735.2 μg. Furthermore, only two experimental samples at each hand rinse fortification level were used for laboratory recovery and storage stability. Subdivision U guidelines specify the use of seven experimental samples for each fortification level.

Table 5-2. Total Exposure (Geometric Mean) for a Worker Wearing Protective Clothing and Gloves

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	16	0.17	0.67
Neck front	16	0.02	0.1
Neck back	16	0.02	0.07
Upper arms	16	0.05	0.19
Chest	16	0.06	0.24
Back	16	0.06	0.22
Forearms	16	0.03	0.13
Thighs	16	0.35	1.3
Lower legs	16	0.05	0.19
Hands	15[b]	0.23	0.87
Inhalation	16	0.18	0.7
Total Exposure	16	1.2	4.7

[a] Body surface areas used to calculate exposures are from Subdivision U.
[b] One hand sample lost.

Table 5-3. Total Exposure (Geometric Mean) for a Worker Wearing No Clothing (Outside Patches Only), Excluding Hands

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	16	0.17	0.67
Neck front	16	0.02	0.1
Neck back	16	0.02	0.07
Upper arms	16	0.48	1.8
Chest	16	0.59	2.3
Back	16	0.57	2.2
Forearms	16	1.3	5.2
Thighs	16	7.1	27.0
Lower legs	16	0.95	3.7
Hands	--	--	--
Inhalation	16	0.18	0.7
Total Exposure	16	11.4[b]	43.7[b]

[a] Body surface areas used to calculate exposures are from Subdivision U.
[b] Total exposure does not include hand exposures.

The geometric mean dermal exposures calculated in the study report for workers wearing protective clothing (1.0 mg/replicate and 4.0 mg/lb ai) are approximately the same as the geometric mean exposures calculated by Versar.

The geometric mean hand exposures calculated in the study report (0.21 mg/replicate and 0.87 mg/lb ai) were approximately the same as the values calculated by Versar (0.23 mg/replicate and 0.87 mg/lb ai).

The total exposures (geometric means) for a worker using protective clothing and gloves reported by the study report (1.3 mg/replicate and 5.0 mg/lb ai) were approximately the same as the total exposures (geometric means) calculated by Versar (1.2 mg/replicate and 4.7 mg/lb ai). The study report incorrectly reported the total exposure as 1.5 mg/replicate and 5.8 mg/lb ai. The error resulted from including the hand exposure twice in calculating total exposure.

The field notes for the exposure study indicated that during replicate number one the worker mixed the wrong concentration of Baygon 70 WP and had to remix the solution. The same worker also rinsed his rubber gloves with water before removing them. Driving times between work sites (i.e., houses) were included in the sampling times.

6. REVIEW OF THE STUDY, EXPOSURE OF APPLICATORS TO PROPOXUR DURING APPLICATION OF BAYGON 2% BAIT INSECTICIDE AROUND FOUNDATIONS, PATIOS, DRIVEWAYS, OR SIDEWALKS

This chapter reviews the inhalation, dermal, and hand exposure a commercial applicator receives while applying Baygon 2% Bait outdoors with a Whirlybird hand-operated granular spreader. The insecticide is a granular bait and contains 2 percent propoxur. The chapter includes a review of the study's quality assurance, application procedures, exposure monitoring techniques, and exposure estimates, as well as a concluding discussion.

Versar concluded that the exposure scenarios (i.e., protective clothing and gloves, and no clothing/no hand data) monitored by the registrant are not consistent with the product's label requirements. The product label does not require the use of protective clothing or gloves. Versar calculated the exposure of a worker wearing no clothing (i.e., outside patches, hand exposure not monitored) as 3.7 mg/replicate and 305.0 mg/lb ai handled. Surrogate hand exposure must be added to these exposures before they can represent total exposure. Versar also calculated the total exposure for a homeowner wearing protective clothing and gloves--0.39 mg/replicate and 33.0 mg/lb ai.

Deviations from Subdivision U guidelines include the following. The registrant did not monitor hand exposure without gloves. The use of gloves is not considered normal use for this product. In addition, the registrant only used two samples each for laboratory and storage stability recovery experiments (seven required by Subdivision U). Furthermore, only one fortification level was used to spike air and dermal sampling media for both laboratory and storage stability experiments.

6.1 Quality Assurance Review

6.1.1 Method Validation

The analytical methodology for determining the trapping efficiencies of propoxur on the sampling media and its storage stability is the same as that reported in Section 3.1.1.

Field recovery experiments were performed with Baygon technical on gauze pads and with Baygon 2 percent bait on QMA filters prior to the exposure study. The gauze pads were exposed in the field for 5 hours. The average field recovery for 14 gauze pad samples was 93 percent (C.V. = 3.9). The QMA filters were exposed in the field for 3 hours. The average field recovery was 91.5 percent (C.V. = 15.3).

6.1.2 Laboratory Recovery Experiments

The spiking solutions for the laboratory recovery experiments were prepared by diluting the Baygon 2% Bait formulation with ethanol.

The QMA filters and gauze pads were spiked at only one fortification level. Each of these sampling media was spiked with 1 μg of propoxur. In comparison, the uncorrected inhalation exposures ranged from 0.04 μg to 0.13 μg; the uncorrected dermal exposures ranged from ND to 211.85 μg per pad.

The absolute ethanol hand rinse solution was spiked at two fortification levels--200 μg and 1,000 μg. In comparison, the uncorrected hand exposures ranged from 4.3 to 668.8 μg.

Subdivision U guidelines state that seven determinations must be made for each sampling media at each fortification level to determine efficiency of extraction. In accordance with Subdivision U, seven fortified (1 μg) samples were used for each of the QMA filters and gauze pads. However, only two hand rinse solution samples at each of the fortification levels (200 μg and 1,000 μg) were used to determine the efficiency of extraction.

The laboratory recovery values for the three sampling media are as follows:

Media	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	103	1.9	7
Gauze pads	117	7.7	7
Absolute ethanol (200 μg)	116	1.5	2
Absolute ethanol (1,000 μg)	122	3.8	2

6.1.3 Field Recovery Experiments

Seven field recovery experiments were performed for each replicate. The field fortified samples were exposed to the same field conditions for approximately the same length of time as the exposure samples. Separate field recoveries were performed for inside and outside dermal dosimeters. The results of the field recoveries for the three sampling media are as follows:

Media	Fortification level (μg)	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters	0.2	95	4.4	110
Gauze pads (outside)	1.0	105	2.9	112
Gauze pads (outside)	50	90	4.5	112
Gauze pads (inside)	1.0	103	3.5	112
Ethanol*	200	102	1.4	32

* The ethanol solution was placed in a plastic bag, shaken, and bottled.

Field blank samples were used for measuring possible contamination. All field blank samples were nondetects.

6.1.4 Storage Stability Experiments

The spiking solutions and fortification levels used for the storage stability samples were the same as for the laboratory samples.

The storage stability results are as follows:

Media	Days stored	Average recovery (%)	Standard deviation (%)	No. of samples
QMA filters (1 μg)	11	97.5	6.5	7
	50	105	3.4	7
	55	95.6	9.0	7
	100	97.4	2.2	7
Gauze pads (1 μg)	13	130	9.5	7
	58	117	8.3	7
	101	106	3.6	7
Ethanol (200 μg)	10	78.3	2.4	2
	22	115	2.1	2
	29	117	0.4	2
	127	118	2.3	2

Media	Days stored	Average recovery (%)	Standard deviation (%)	No. of samples
Ethanol (1,000 μg)	10	106	6.8	2
	22	114	0.1	2
	29	121	2.6	2
	127	111	3.7	2

6.2 Application Procedures

Sixteen mixer/loader/applicator (MLA) replicates were performed outdoors by three different workers representing commercial applicators. Each replicate consisted of filling the Whirlybird spreader with granules and strapping the hand-operated spreader on the workers' shoulders. The workers then walked around the perimeter of the house while turning the spreader handle to dispense the insecticide. Each replicate was performed at a single house (total sixteen houses).

The amount of insecticide handled for each replicate could not be accurately measured because of the Whirlybird's design (i.e., some insecticide remained in the trap and could not be measured). Instead, the amount of ai handled was estimated by the following procedure given in the exposure study report.

- The total amount of product used was determined at the end of the study (two five-pound cartons of bait were consumed, and 1 pound, 2 ounces of a third five-pound carton were used); i.e., a total of 11 pounds, 2 ounces, or 178 ounces, were used during the entire study.
- The area treated at each house was determined (from the field notes), and the total treated area was calculated.
- Total ounces/total square feet was used to determine "Ounces/Square Foot;" i.e., 178 oz./31,200 $ft.^2$ = 0.0057 $oz/ft.^2$.
- Applying this unit, the total product used per house/replicate (based upon its individual treated area) was calculated.

The estimated amount of ai handled per replicate and sampling times are given in Table 6-1. The amount of propoxur handled per replicate ranged from 0.0069 to 0.0425 lb ai; sampling times ranged from 4 to 11 minutes. The recommended maximum label application rate of 4 oz of

Table 6-1. Inhalation Exposure

Rep no.	Hours worked	lb ai handled[a]	Amount of chemical collected (µg)[b]	Volume collected (L)[c]	Inhalation exposure µg/ replicate[d]	Inhalation exposure µg/ lb ai[e]
1	0.13	0.0288	0.142	8.1	4.0	139
2	0.08	0.0425	0.066	5.1	1.8	42
3	0.17	0.0125	0.095	10.0	2.8	224
4	0.08	0.0088	0.042	5.0	1.2	136
5	0.08	0.0106	0.046	5.0	1.3	123
6	0.07	0.01	0.111	4.0	3.4	340
7	0.17	0.0125	0.044	10.3	1.3	104
8	0.08	0.0075	0.043	5.2	1.2	160
9	0.17	0.0169	0.038	10.3	1.1	65
10	0.17	0.0088	0.039	11.4	1.0	114
11	0.18	0.0081	0.042	11.6	1.1	136
12	0.1	0.0069	0.04	6.3	1.1	159
13	0.15	0.0138	0.063	9.5	1.7	123
14	0.1	0.0119	0.121	6.3	3.4	286
15	0.07	0.0081	0.044	4.0	1.3	160
16	0.13	0.015	0.04	8.1	1.1	73

[a] lb ai handled = (# oz ai formulation ÷ 16 oz/lb).

[b] Amount of chemical collected is corrected for recovery.

[c] Volume collected = average flow rate (l/min) x sampling time (min).

[d] $$\text{Exposure (µg/replicate)} = \frac{\text{amount chemical collected (µg)} \times 1{,}000\ \text{l/m}^3}{\text{air volume sampled}} \times \text{average respiration rate (1.75 m}^3\text{/hr)} \times \text{sampling time (hr)}.$$

[e] $$\text{Exposure (µg/lb ai)} = \frac{\text{Exposure µg/replicate}}{\text{\# lb ai/replicate}}.$$

bait/1,000 ft^2 was planned prior to the study. However, an estimated 5.7 oz of bait/1,000 ft^2 was used during the study.

6.3 Exposure Monitoring

Inhalation, dermal, and hand exposure monitoring methods are the same as described in Section 3.3. The product label does not specify the use of protective clothing or gloves. Therefore, the protective clothing scenario does not represent exposure which would occur under normal use. Furthermore, outside hand exposure was not monitored.

6.4 Exposure Calculations

6.4.1 Inhalation Exposure

Inhalation exposures were calculated by Versar as µg/replicate and µg/lb ai handled. Inhalation exposures were corrected for recoveries between 86 and 111 percent. Table 6-1 lists the inhalation exposure calculations, inhalation exposures for each replicate, and associated data (i.e., hours worked, lb ai handled, amount of chemical collected, and air volume collected).

6.4.2 Dermal Exposure

Dermal exposure values were calculated by the registrant and Versar using body surface areas from Subdivision U. Dermal exposures (excluding hands) are reported as mg/replicate and mg/lb ai handled. Dermal exposure data were corrected for recoveries between 93 and 110 percent.

Geometric mean dermal exposures for a worker wearing protective coveralls as calculated in the study report and by Versar are:

	mg/replicate	mg/lb ai
Study report	0.38	32.0
Versar	0.34	29.0

Geometric mean dermal exposures (excluding hands) for a worker with no clothing (i.e., outside patches only) are 3.7 mg/replicate and 305.0 mg/lb ai as calculated by Versar.

6.4.3 Hand Exposure

All reported hand exposure data represent exposure to workers wearing protective gloves. The use of these gloves is not specified on the product label. Hand exposures were corrected for recoveries between 85 and 115 percent. Geometric mean hand exposures are as follows:

	mg/replicate	mg/lb ai
Study report	0.099	8.2
Versar	0.06	4.8

6.4.4 Total Exposure

Total exposure represents inhalation, dermal, and hand exposures. The geometric mean total exposures for a worker wearing protective clothing and gloves (not specified on product label) are as follows:

	mg/replicate	mg/lb ai
Study report	0.38	32.0
Versar	0.40	34.0

Table 6-2 lists exposures calculated by Versar in mg/replicate and mg/lb ai for a worker wearing protective clothing and gloves.

The geometric mean total exposures (hand data not determined) as calculated by Versar for a worker wearing no clothing (outside patches only) are 3.7 mg/replicate and 305.0 mg/lb ai. However, these outside exposure values are most likely underestimated because outside hand exposures were not monitored. Table 6-3 lists the exposures for outside total exposure in mg/replicate and mg/lb ai as calculated by Versar.

6.5 Discussion

The analytical procedures for preparing laboratory and storage stability experiments used only one fortification level to spike the QMA filters and dermal pads. The QMA filters were spiked at 1.0 μg, while the uncorrected inhalation exposures monitored ranged from 0.04 μg to 0.13 μg. The dermal pads were also spiked at 1.0 μg, however; uncorrected dermal exposures ranged from <0.15 μg to 211.85 μg. A range of fortification levels would have been more appropriate.

Table 6-2. Total Exposure (Geometric Mean) for a Worker Wearing Protective Clothing and Gloves

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	16	0.02	1.9
Neck front	16	0.01	0.81
Neck back	16	0.01	0.46
Upper arms	16	0.04	3.6
Chest	16	0.07	5.4
Back	16	0.05	4.5
Forearms	16	0.02	1.9
Thighs	16	0.08	7.0
Lower legs	16	0.04	3.4
Hands	14[b]	0.06	4.8
Inhalation	16	0.002	0.13
Total Exposure	16	0.40	34.0

[a] Body surface areas used to calculate exposures are from Subdivision U.
[b] Two hand exposure samples were lost.

Table 6-3. Total Exposure (Geometric Mean) for a Worker Wearing No Clothing (Outside Patches Only), Excluding Hands

Body location[a]	Number of replicates	mg/ replicate	mg/ lb ai
Head	16	0.02	1.9
Neck front	16	0.01	0.81
Neck back	16	0.01	0.46
Upper arms	16	0.23	19.0
Chest	16	0.23	19.0
Back	16	0.18	15.0
Forearms	16	0.95	78.0
Thighs	16	1.8	150.0
Lower legs	16	0.25	21.0
Hands	--	--	--
Inhalation	16	0.002	0.13
Total Exposure	16	3.7[b]	305.0[b]

[a] Body surface areas used to calculate exposures are from Subdivision U.
[b] Total exposure does not include hand exposures.

The fortification levels used for the hand rinse recovery experiments were 200 μg and 1,000 μg. These fortification levels are higher than some of the uncorrected hand exposures monitored, which ranged from 4.3 μg to 668.8 μg. Furthermore, only two experimental samples at each hand rinse fortification level were used for laboratory recovery and storage stability. Subdivision U guidelines specify the use of seven experimental samples for each fortification level.

The geometric mean dermal exposures calculated in the study report for workers wearing protective clothing (0.38 mg/replicate and 32.0 mg/lb ai) are essentially the same as the geometric mean exposures calculated by Versar. However, the study report used a protection factor of 0.17 for the baseball-type cap and used the detection limit for nondetects.

The geometric mean hand exposures calculated in the study report (0.099 mg/replicate and 8.2 mg/lb ai) were slightly different from the values calculated by Versar (0.06 mg/replicate and 4.8 mg/lb ai). The difference in hand exposure is attributed to the study report using surrogate data for two hand samples which were lost.

The total exposure (geometric mean) for a worker using protective clothing and gloves reported by the study report (0.38 mg/replicate and 32.0 mg/lb ai) were approximately the same as the total exposure (geometric mean) calculated by Versar (0.40 mg/replicate and 34.0 mg/lb ai). The difference in total exposure is attributed to the study report's use of a protection factor for the baseball-type cap and the use of the detection limit for nondetects.

All exposure data were corrected by the registrant for recoveries between 85 and 115 percent. It was not possible to determine which type of recovery (i.e., lab, field, or storage) was used for data corrections.

Appendix B. Surrogate Study Used for Estimation of Exposure of Lawn Care Pest Control Operators Using Hand-Held Power Sprayers to Propoxur.

CITATION: Vaccaro, J.R. (1986) Evaluation of Airborne and Whole Body Exposure of Lawn Care Specialists to Chlorpyrifos During Routine Treatment of Turf. Accession No. 400260-01.

Exposures of the potential dermal and respiratory exposures of lawn care pest control operators to chlorpyrifos were measured during the application of the insecticide to residential turf. The material was applied, at the normal industry application concentrations (0.07-0.1 percent), using power hose end sprayers attached to reservoirs located on trucks. Spray tank mix concentrations were not reported.

Exposures were monitored during twelve applications, 2 each with 6 different workers. Each application cycle consisted of a work period of approximately 30 minutes of actual spray time. Spray time was defined as the time the hose was uncoiled to the time the hose was rewound onto the truck. Exposures during the mixing/loading procedure were not measured. Dermal exposure of the body was monitored using 2 inch by 2 inch gauze patches, located outside of the clothing, on the sternum, groin, thighs (front and back), and calves (also front and back). Dermal exposure of the hands was measured using cotton gloves. No protective gloves were reported to be worn during this study. Respiratory exposure concentrations were measured by drawing air through glass tubes, at a rate of 200 cc per minute, using calibrated personal sampling pumps. Chromosorb 102 was used as the trapping agent. The dosimeters were used for a 30 minute work period, after which they were replaced by a second series for the next trial. The dosimeters were desorbed with hexane and residues quantified by gas chromatography using an electron capture detector.

CALCULATION OF EXPOSURES

The study design included dermal dosimeters at 10 different locations on the body. Patches on the back and arms were not included as recommended by the Pesticide Assessment Guidelines - Subdivision U. These omissions required additional extrapolations in order to estimate exposures to these body areas. The assumptions used by NDEB to estimate exposures of these workers are presented below:

1) Workers are assumed to weigh 70 kg and have standard surface areas as presented in the Pesticide Assessment Guidelines - Subdivision U.

2) Gloves are assumed to offer 90 percent protection to the hands. Fifty percent protection is assumed for other areas covered by clothing when assessing acute toxicity endpoints. Four different clothing scenarios were examined in this assessment; assuming the wearing of either long or short sleeve shirt, and with or without gloves.

3) Workers are assumed to have a respiratory volume of 1.7 m^3 per hour while applying the pesticide.

4) Dermal exposures are not corrected for dermal absorption.

5) Chlorpyrifos is applied for 5 hours per day.

In order to adjust for missing dosimeters on the arms and back, the previous reviewer used values from existing dosimeters for estimation of exposures to these areas. NDEB believes that these adjustments were reasonable and included the same types of adjustments in this review.

Hand Exposure

The values measured on the hands were used to estimate each forearm exposure. The equation used is:

$$\text{Forearm Exposure (ug)} = \frac{\text{Hand Exposure (ug)}}{410\ cm^2} \times 605\ cm^2$$

Upper Arm Exposure

The mean of the sternum pad and hand values was used to calculate upper arm exposures. The equation used for estimation of the exposure each upper arm is:

$$\text{Upper Arm Exposure (ug)} = \frac{\text{Mean of Sternum and Hand (ug)}}{\text{Patch surface area } (cm^2)} \times 1455\ cm^2$$

Back Exposure

Exposure of the back was estimated by adjusting the values obtained from the chest measurement (mean of sternum pad and groin pad) by the ratio of the residues measured on the front and back of the legs. The correction factor is:

$$CF = \frac{\text{(Sum of exposures on back of legs, both calves and thighs)}}{\text{(Sum of exposures on front of legs, both calves and thighs)}}$$

The mean value of the chest and groin patches was then calculated. This value was then adjusted by the correction factor, CF. The equation used for estimation of back exposure was:

$$\text{Back exposure (ug)} = \frac{\text{Mean of Sternum and Groin pads (ug)}}{\text{Patch Surface Area (cm}^2\text{)}} \times \text{CF} \times 3550\ \text{cm}^2$$

The mean dermal exposures of the applicators for the four clothing scenarios are presented in Tables 2-5.

Respiratory Exposure

The estimated respiratory exposures of these workers are presented in Table 6. It was assumed that the workers have a respiratory volume of 1.7 m^3 per hour. Exposure was calculated for the spray time only, the contribution due to air levels in the truck were not included.

REFERENCES

1) Freeborg, R.P., W.H. Daniel, and V.J. Knonopinski (1985) Applicator Exposure to Pesticides Applied to Turfgrass IN R.C. Honeycutt, G. Zweig, and N.N. Ragsdale (Eds.), Dermal Exposure Related to Pesticide Use, Discussion of Risk Assessment, ACS Symposium Series #273, (pp287-295). American

Table B-1. Summary of Exposures of Workers to Chlorpyrifos (Dursban) Applied to Turf Using Hand-Held Power Spray Equipment.

	Long sleeves, no gloves	Long sleeves, gloves	Short Sleeves no gloves	Short sleeves gloves	Respiratory
mg/hr	44.84	27.81	58.00	41.00	3.3×10^{-3}
mg/day	224.19	139.07	290.00	205.00	1.7×10^{-2}
mg/kg/hr	0.64	0.40	0.83	0.59	4.7×10^{-5}
mg/kg/day	3.20	1.99	4.1	2.93	2.4×10^{-4}

Table B-2. Dermal Exposures of Workers Applying Chlorpyrifos (Dursban) to Turf Using Powered Hand-Spray. Workers are assumed to wear long sleeve shirts, long pants, and no gloves.

Body Area	Surface Area (cm^2)	Clothing Factor	ug per patch	Spray Time (min)	Dermal Exposure			
					Unadjusted		Adjusted for Clothing	
					(ug)	(ug/hr)	(ug)	(ug/hr)
Front of Neck	110	1.0	0.75	28.4	3.2	6.8	3.2	6.8
Chest	1775	0.5	0.75	28.4	52	109	26	55
Groin	1775	0.5	4.0	28.4	278	607	139	303
Back	3550	0.5	1.8[1]	28.4	243	512	122	256
Left Thigh Front	562.5	0.5	39	28.4	850	1725	425	863
Right Thigh Front	562.5	0.5	29	28.4	625	1357	312	678
Right Thigh Back	562.5	0.5	28	28.4	601	1267	300	634
Left Calf Front	595	0.5	135	28.4	3105	6567	1553	3283
Left Calf Back	595	0.5	27	28.4	623	1300	312	650
Right Calf Front	595	0.5	186	28.4	4290	8954	2145	4477
Right Calf Back	595	0.5	19	28.4	446	932	223	466
Left Upper Arm	1455	0.5	2.1	28.4	119	245	60	123
Right Upper Arm	1455	0.5	9.6	28.4	543	1145	272	573
Left Forearm	605	0.5	NA[2]	28.4	2100	3426	1050	1713
Right Forearm	605	0.5	NA	28.4	11207	23683	5604	11841
Left Hand	410	1.0	NA	28.4	1423	2914	1423	2914
Right Hand	410	1.0	NA	28.4	7595	16001	7595	16001
TOTAL DERMAL EXPOSURE					34103	70751	21564	44837

1 Extrapolated from chest values and ratio of residues on front and back of legs.

2 Not Applicable. No dosimeter used, exposure based on hand value.

Table B-3. Dermal Exposures of Workers Applying Chlorpyrifos (Dursban) to Turf Using Powered Hand-Spray. Workers are assumed to wear long sleeve shirts, long pants, and gloves.

Body Area	Surface Area (cm^2)	Clothing Factor	ug per patch	Spray Time (min)	Dermal Exposure			
					Unadjusted		Adjusted for Clothing	
					(ug)	(ug/hr)	(ug)	(ug/hr)
Front of Neck	110	1.0	0.75	28.4	3.2	6.8	3.2	6.8
Chest	1775	0.5	0.75	28.4	52	109	26	55
Groin	1775	0.5	4.0	28.4	278	607	139	303
Back	3550	0.5	1.8[1]	28.4	243	512	122	256
Left Thigh Front	562.5	0.5	39	28.4	850	1725	425	863
Right Thigh Front	562.5	0.5	29	28.4	625	1357	312	678
Right Thigh Back	562.5	0.5	28	28.4	601	1267	300	634
Left Calf Front	595	0.5	135	28.4	3105	6567	1553	3283
Left Calf Back	595	0.5	27	28.4	623	1300	312	650
Right Calf Front	595	0.5	186	28.4	4290	8954	2145	4477
Right Calf Back	595	0.5	19	28.4	446	932	223	466
Left Upper Arm	1455	0.5	2.1	28.4	119	245	60	123
Right Upper Arm	1455	0.5	9.6	28.4	543	1145	272	573
Left Forearm	605	0.5	NA[2]	28.4	2100	3426	1050	1713
Right Forearm	605	0.5	NA	28.4	11207	23683	5604	11841
Left Hand	410	0.1	NA	28.4	1423	2914	142	291
Right Hand	410	0.1	NA	28.4	7595	16001	760	1600
TOTAL DERMAL EXPOSURE					34103	70751	13448	27813

1 Extrapolated from chest values and ratio of residues on front and back of legs.

2 Not Applicable. No dosimeter used, exposure based on hand value.

77

55

Table B-4. Dermal Exposures of Workers Applying Chlorpyrifos (Dursban) to Turf Using Powered Hand-Spray. Workers are assumed to wear short sleeve shirts, long pants, and no gloves.

Body Area	Surface Area (cm^2)	Clothing Factor	ug per patch	Spray Time (min)	Dermal Exposure			
					Unadjusted		Adjusted for Clothing	
					(ug)	(ug/hr)	(ug)	(ug/hr)
Front of Neck	110	1.0	0.75	28.4	3.2	6.8	3.2	6.8
Chest	1775	0.5	0.75	28.4	52	109	26	55
Groin	1775	0.5	4.0	28.4	278	607	139	303
Back	3550	0.5	1.8[1]	28.4	243	512	122	256
Left Thigh Front	562.5	0.5	39	28.4	850	1725	425	863
Right Thigh Front	562.5	0.5	29	28.4	625	1357	312	678
Right Thigh Back	562.5	0.5	28	28.4	601	1267	300	634
Left Calf Front	595	0.5	135	28.4	3105	6567	1553	3283
Left Calf Back	595	0.5	27	28.4	623	1300	312	650
Right Calf Front	595	0.5	186	28.4	4290	8954	2145	4477
Right Calf Back	595	0.5	19	28.4	446	932	223	466
Left Upper Arm	1455	0.5	2.1	28.4	119	245	60	123
Right Upper Arm	1455	0.5	9.6	28.4	543	1145	272	573
Left Forearm	605	1.0	NA[2]	28.4	2100	3426	2100	3426
Right Forearm	605	1.0	NA	28.4	11207	23683	11207	23683
Left Hand	410	1.0	NA	28.4	1423	2914	1423	2914
Right Hand	410	1.0	NA	28.4	7595	16001	7595	16001
TOTAL DERMAL EXPOSURE					34103	70751	28217	58392

1 Extrapolated from chest values and ratio of residues on front and back of legs.

2 Not Applicable. No dosimeter used, exposure based on hand value.

Table B-5. Dermal Exposures of Workers Applying Chlorpyrifos (Dursban) to Turf Using Powered Hand-Spray. Workers are assumed to wear short sleeve shirts, long pants, and gloves.

Body Area	Surface Area (cm^2)	Clothing Factor	ug per patch	Spray Time (min)	Dermal Exposure			
					Unadjusted		Adjusted for Clothing	
					(ug)	(ug/hr)	(ug)	(ug/hr)
Front of Neck	110	1.0	0.75	28.4	3.2	6.8	3.2	6.8
Chest	1775	0.5	0.75	28.4	52	109	26	55
Groin	1775	0.5	4.0	28.4	278	607	139	303
Back	3550	0.5	1.8	28.4	243	512	122	256
Left Thigh Front	562.5	0.5	39	28.4	850	1725	425	863
Right Thigh Front	562.5	0.5	29	28.4	625	1357	312	678
Right Thigh Back	562.5	0.5	28	28.4	601	1267	300	634
Left Calf Front	595	0.5	135	28.4	3105	6567	1553	3283
Left Calf Back	595	0.5	27	28.4	623	1300	312	650
Right Calf Front	595	0.5	186	28.4	4290	8954	2145	4477
Right Calf Back	595	0.5	19	28.4	446	932	223	466
Left Upper Arm	1455	0.5	2.1	28.4	119	245	60	123
Right Upper Arm	1455	0.5	9.6	28.4	543	1145	272	573
Left Forearm	605	1.0	NA	28.4	2100	3426	2100	3426
Right Forearm	605	1.0	NA	28.4	11207	23683	11207	23683
Left Hand	410	1.0	NA	28.4	1423	2914	142	291
Right Hand	410	1.0	NA	28.4	7595	16001	760	1600
TOTAL DERMAL EXPOSURE					34103	70751	20101	41368

1 Extrapolated from chest values and ratio of residues on front and back of legs.

2 Not Applicable. No dosimeter used, exposure based on hand value.

62

57

Table B-6. Respiratory Exposure of Workers Applying Chlorpyrifos (Dursban) to Turf Using Power Hand Spray Equipment. Respiratory volume is assumed to be 1.7 m^3 per hour.

Rep.	Spray Time	Flow Rate (ml/min)	Volume Sampled (L)	ug Found	Conc. (ug/cu m)	Exposure (ug)	Exposure (ug/hr)	Exposure (ug/day)	Exposure (ug/kg/day)
1	30.0	197	7.9	0.020	2.53	2.15	4.30	21.52	0.31
2	30.0	197	14.2	0.040	2.82	2.39	4.79	23.94	0.34
3	27.7	205	14.1	0.016	1.13	0.89	1.93	9.65	0.14
4	28.7	205	16.0	0.037	2.31	1.88	3.93	19.66	0.28
5	29.9	206	20.6	0.024	1.17	0.99	1.98	9.90	0.14
6	26.9	NS[1]	NS	NS	NS	NS	NS	NS	NS
7	26.3	205	7.8	0.015	1.92	1.43	3.27	16.35	0.23
8	27.0	205	9.2	0.027	2.93	2.25	4.99	24.95	0.36
9	29.5	202	11.1	0.013	1.17	0.98	1.99	9.95	0.14
10	27.7	202	10.3	0.009	0.87	0.69	1.49	7.43	0.11
11	25.8	206	9.7	0.020	2.06	1.51	3.51	17.53	0.25
12	31.3	206	11.3	0.027	2.39	2.12	4.06	20.31	0.29
MEAN	28.4	203	12.0	0.02	1.94	1.57	3.29	16.47	0.24

1 No Sample.

88

85

Appendix C. Surrogate Studies Used for Estimation of Exposures of Lawn Care Pest Control Operators to Propoxur While Using Compressed Air Sprayers.

CITATION: Davis, J.E., E.R. Stevens, D.C. Staiff, and L.C. Butler (1983) Potential Exposure to Diazinon During Yard Applications. Environmental Monitoring and Assessment 3:23-28.

Description of Study:

Dermal and respiratory exposures of applicators were measured during treatment of lawns and shrubs with diazinon. The insecticide was applied to lawns using either a compressed air sprayer (3 gal./11.4 L) or a hose end application unit attached to a garden hose. Shrubs (30 cm to 3.1 m height) were treated using compressed air sprayers only. A total of three applicators took part in the study, each performing all of the three types of application. Each replicate consisted two cycles of filling and applying the spray and took an average of about 30 minutes to complete.

The formulation used was an emulsifiable concentrate containing 25 percent diazinon. The compressed air sprayers were loaded by dispensing the appropriate amount of formulation into the sprayer using kitchen measuring spoons, followed by 2.5 gallons (9.5 L) of water. The sprayers were then pumped by hand to generate the necessary pressure. Hose end units were filled to the desired mark and diluted to a second mark with water. The mean spray concentrations are presented in Table C-1.

Table C-1. Concentration of Finished Spray Applied During Study to Determine Exposure to Diazinon During Yard Applications.

Sprayer	Object Sprayed	Concentration of Diazinon (ug/ml)
Compressed Air	Lawn	469
	Shrubs	625
Hose-end	Lawn	618

Dermal exposure of the body was monitored using alpha-cellulose pads attached, outside of the clothing, to the shoulders, upper back, chest, outside of forearms, front of thighs, and ankles. Hand exposure was measured by hand rinse with ethanol. Respiratory exposures were determined using modified respirators with gauze-faced filters as the trapping medium.

The dosimeters, either entire respirator filters or 25 cm^2 portion of a dermal patch, were extracted with hexane:acetone (41:59). The residues in dosimeter extracts of hand washes were quantified

by gas chromatography using either a flame photometric detector (hand washes) or an electron capture detector (dosimeter extracts). Residue measurements were corrected for losses during extraction and storage.

Calculation of Exposures

Potential exposures were estimated considering 2 different clothing scenarios; one assuming short sleeve shirts and long pants (normal clothing) and the other assuming the wearing of only swim trunks and shoes (minimal clothing). The resulting exposure estimates for normal and minimal clothing are presented in Tables C-2 and C-3, respectively. Dermal exposure of the hands the largest component of dermal exposure, about 90 percent of the total exposure when minimal clothing was worn and virtually all under the normal clothing scenario. Since the contribution of the parts other than hands was so small, values were not adjusted for the protective effects of clothing. Adjustments of the exposures for the application rate used for propoxur are presented in Table C-4.

Table C-2. Estimated Dermal and Respiratory Exposures of Individuals Treating Lawns or Shrubs With Diazinon While Wearing Minimal Clothing (Swimm trunks and shoes).

Sprayer	Object Sprayed	Exposure (ug/hour)			
		Respiratory	Dermal		
			Hands	Other	Total
Compressed Air	Lawn	1.9	5500	210	5700
	Shrubs	2.9	6800	1800	7600
Hose-end	Lawn	7.4	25000	4100	29000

Table C-3. Estimated Dermal and Respiratory Exposures of Individuals Treating Lawns or Shrubs With Diazinon While Wearing Short Sleeve Shirt and Long Pants.

Sprayer	Object Sprayed	Exposure (ug/hour) Respiratory	Dermal Hands	Dermal Other	Dermal Total
Compressed Air	Lawn	1.9	5500	21	5500
	Shrubs	2.9	6800	120	7000
Hose-end	Lawn	7.4	25000	540	26000

Table C-4. Estimated Dermal Exposures of Individuals to Propoxur Applied Outdoors Using Compressed Air Sprayers. Estimates were derived from a measurements of home gardeners using diazinon ().

Clothing Scenario	Item Sprayed	Estimated Dermal Exposure (ug/hr)				
		Diazinon At 0.05 percent		Propoxur At 0.1 percent		Total
		Hands	Body	Hands	Body	(mg/hr)
Short Sleeves, no gloves	Lawn	5500	21	11000	42	11.0
Short Sleeves, no gloves	Shrubs	6800	120	13600	240	13.8
MEAN		6150	70.5	12300	141	12.4

CITATION: Kurtz, D.A. and W.M. Bode (1985) Application Exposure to the Home Gardener IN: Dermal Exposure Related to Pesticide Use American Chemical Society Symposium Series 273, R.C. Honeycutt, G. Zweig, and N.N. Ragsdale Eds, American Chemical Society , Washington, D.C.

Dermal exposure of home gardeners was monitored during application of the insecticide carbaryl. The investigation included evaluation of dust, wettable powder, and aqueous suspension formulations containing 5, 50, and 43 percent active ingredient, respectively. The dust was applied using either a shaker or a dust pump. The wettable powder and aqueous suspension were both applied using hand held pressurized tank equipment. The insecticide was applied to two representative crops, corn (1.0-1.3 m height) and beans (0.2-0.3 m high).

Applicators were volunteers selected from the community. The volunteers were told to apply the pesticide according to the label instructions. Each applied all three formulations to corn and/or beans. A total of 24 replicates, 12 with each crop, were monitored for each formulation. An exposure replicate included filling the unit, applying the compound, and emptying the equipment after treatment. Fifteen minutes, timed by an observer, were allowed for each replicate. Two of the treatments with dust were conducted using a ready-to-use shaker can. One tablespoon of the wettable powder or aqueous suspensions was used with one gallon of water in the compressed air sprayers.

Dermal exposure of the body was measured using gauze pads attached to the outside of a Tyvek suit. A description of the patch locations is presented in Table C-5. Dermal exposure of the hands was measured by hand rinse with 200 ml of 0.03% NaOH in ethanol. A 20 ml aliquot was selected for analysis. Twenty milliliter samples were also collected from the spray wand before and after application to confirm the amount of active ingredient handled. The mean amounts of active ingredient applied during the treatments are presented in Table C-6.

The pads were extracted with methanol containing 0.03 percent NaOH. Ethanol was used in the hand washes to avoid the toxicity problems that could arise with methanol. Samples were analyzed within 6 hours of collection to minimize breakdown of carbaryl. Recoveries from six gauze pads, fortified in the field at levels of 10 ug and 50 ug, were 101 and 98 percent, respectively. Similar recoveries from ethanol solutions spiked at 50 and 200 ug levels were 144 and 189 percent, respectively.

Dermal exposures were estimated for six different clothing scenarios ranging from no clothing at all to maximum clothing protection. Respiratory exposure was not measured. The underlying assumption was that clothing offered complete protection to covered areas. The residue levels found on dermal

pads or on the hands are presented in Tables C-7, 8, and 9. The NDEB reviewer has also presented adjusted values assuming 50 percent protection from garments and 90 percent from gloves and shoes. These estimates for,different clothing scenarios, are presented in Tables C-10 and C-11 for the dust formulation, and the compressed air sprayers, respectively. Due to the similarities in the exposure scenarios and the data obtained the results of the trials with the wettable powder and aqueous suspension were averaged before exposure calculations were conducted.

Table C-5. Body Areas Monitored for Dermal Exposure to Carbaryl During Home Garden Application.

Body Part	Pad Location/ Dosimeter	Pad Area (cm^2)
Face, front of neck	Face mask	120
Shoulder, upper arms	Top of shoulders	50
Back	Upper back	25
Chest	Upper chest	25
Forearms	Forearms	25 each
Hand	Hand wash	Entire hand
Thigh	Thighs	25 each
Lower leg	Cuff	25 each
Ankle	Shoe vamps	2.5 each
Foot	Top of feet	25 each

Table C-6. Mean Amounts of Cabaryl Applied to Gardens in 15 Minutes

Formulation	Crop	Amount Applied	
		Formulation	Active Ingredient (g)
Dust	Corn	190 g	9.5
	Beans	220 g	11
Wettable powder	Corn	2.8 L	2.1
	Beans	2.9 L	2.8
Aqueous suspension	Corn	2.8 L	3.2
	Beans	2.9 L	3.0

Table C-7. Potential Dermal Exposures of Individuals to Carbaryl Dust Applied to Home Gardens. No Protection from Clothing is Assumed.

Body Part	Surface Area (cm^2)	Corn Exposure (ug) ug found[1]	Corn Exposure (ug)	Beans Exposure (ug) ug found[1]	Beans Exposure (ug)	Mean for Both Crops
Face	1300	14.9	775	10.5	546	660
Shoulders	2910	3.3	384	2.9	338	361
Back	3550	3.2	454	3.6	511	483
Chest						
Right	1775	9.2	653	5.8	412	533
Left	1775	8.0	568	3.9	277	422
Forearms						
Right	605	14.2	344	3.6	87	215
Left	605	4.4	106	5.5	133	120
Hands						
Right	410	11.8	194	3.8	62	128
Left	410	7.9	130	5.3	87	108
Thighs						
Right	1910	13.2	1008	4.6	351	680
Left	1910	24.0	1834	5.6	428	1131
Lower leg						
Right	1190	22.0	1047	36.0	1714	1380
Left	1190	25.0	1190	52.0	2475	1833
Shoe						
Right	655	37.0	969	53.0	1389	1179
Left	655	39.0	1022	66.0	1729	1376
TOTAL DERMAL EXPOSURE (ug/15 minutes):			1.1×10^4		1.1×10^4	1.1×10^4
ug/hr:			4.4×10^4		4.4×10^4	4.4×10^4
mean ug handled:			9.5		11	10
ug/lb ai			2.1×10^6		1.8×10^6	2.0×10^6
mg/lb ai			2.1×10^3		1.8×10^3	2.0×103

[1] ug found, adjusted to a 25 cm^2 dosimeter.

88

96

Table C-8. Potential Dermal Exposures of Individuals to a Wettable Powder Formulation No Protection from Clothing is Assumed.

Body Part	Surface Area (cm^2)	Corn ug found[1]	Corn Exposure (ug)	Beans ug found[1]	Beans Exposure (ug)	Mean for Both Crops
Face	1300	2.8	146	2.5	130	138
Shoulders	2910	1.9	221	1.0	116	169
Back	3550	1.9	270	1.7	241	256
Chest						
Right	1775	1.8	128	0.9	64	96
Left	1775	3.8	270	1.0	71	170
Total	3550	5.6	398	1.9	135	266
Forearms						
Right	605	1.6	39	0.7	17	28
Left	605	5.2	126	0.6	15	70
Total	1210	6.8	165	1.3	31	98
Hands						
Right	410	3.0	49	2.2	36	43
Left	410	2.7	44	1.3	21	33
Total	820	5.7	93	3.5	57	75
Thighs						
Right	1910	22.0	1681	0.8	61	871
Left	1910	17.0	1299	2.3	176	737
Total	3820	39.0	2980	3.1	237	1608
Lower leg						
Right	1190	12.0	571	34.0	1618	1095
Left	1190	23.0	1095	28.0	1333	1214
Total	2380	35.0	1666	62.0	2951	2309
Shoe						
Right	655	32.0	838	44.0	1153	996
Left	655	40.0	1048	28.0	734	891
Total	1310	72.0	1886	72.0	1886	1886
TOTAL DERMAL EXPOSURE (ug/15 minutes):			7.8×10^3		5.8×10^3	6.8×10^3
ug/hr:			3.1×10^4		2.3×10^4	2.7×10^4
mean ug handled:			2.1		2.8	2.5
ug/lb ai			1.7×10^6		9.4×10^5	1.3×10^6
mg/lb ai			1.7×10^3		9.4×10^2	1.3×10^3

1 ug found, adjusted to a 25 cm^2 dosimeter.

Table C-9. Potential Dermal Exposures of Individuals to an Aqueous Suspension Formulation. No Protection from Clothing is Assumed.

Body Part	Surface Area (cm^2)	Corn Exposure (ug) ug found[1]	Corn Exposure (ug)	Beans Exposure (ug) ug found[1]	Beans Exposure (ug)	Mean for Both Crops
Face	1300	1.9	99	2.0	104	101
Shoulders	2910	1.4	163	2.7	314	239
Back	3550	10.6	1505	1.7	241	873
Chest						
Right	1775	3.9	277	0.8	57	167
Left	1775	2.0	142	1.4	99	121
Total	3550	5.9	419	2.2	156	288
Forearms						
Right	605	9.1	220	0.8	19	120
Left	605	8.7	211	0.8	19	115
Total	1210	17.8	431	1.6	39	235
Hands						
Right	410	2.2	36	1.4	23	30
Left	410	2.4	39	1.5	25	32
Total	820	4.6	75	2.9	48	62
Thighs						
Right	1910	26.0	1986	1.2	92	1039
Left	1910	22.0	1681	5.2	397	1039
Total	3820	48.0	3667	6.4	489	2078
Lower leg						
Right	1190	39.0	1856	38.0	1809	1833
Left	1190	28.0	1333	34.0	1618	1476
Total	2380	67.0	3189	72.0	3427	3308
Shoe						
Right	655	41.0	1074	45.0	1179	1127
Left	655	41.0	1074	51.0	1336	1205
Total	1310	82.0	2148	96.0	2515	2332
TOTAL DERMAL EXPOSURE (ug/15 minutes):			1.2×10^4		7.3×10^3	9.5×10^3
ug/hr:			4.8×10^4		2.9×10^4	3.9×10^4
mean ug handled:			3.2		3.0	3.1
ug/lb ai			1.7×10^6		1.1×10^6	1.4×10^6
mg/lb ai			1.7×10^3		1.1×10^3	1.4×10^3

[1] ug found, adjusted to a 25 cm^2 dosimeter.

89 06

Table C-10. Potential Dermal Exposures of Home Gardeners to a Dust Formulation of Carbaryl in 15 minutes of treatment.

Body Part	Clothing Factor	Surface Area (cm^2)	Dermal Exposure (micrograms)		
			No Protection	Long sleeves, gloves	Short sleeves no gloves
Face	1.0	1300	660	660	660
Shoulders	0.5	2910	361	180	180
Back	0.5	3550	483	241	241
Chest					
Right	0.5	1775	533	266	266
Left	0.5	1775	422	211	211
Forearms					
Right	0.5	605	215	108	215
Left	0.5	605	120	60	120
Hands					
Right	0.9	410	128	13	128
Left	0.9	410	108	11	108
Thighs					
Right	0.5	1910	680	340	340
Left	0.5	1910	1131	565	565
Lower leg					
Right	0.5	1190	1380	690	690
Left	0.5	1190	1833	916	916
Shoe					
Right	0.9	655	1179	118	118
Left	0.9	655	1376	138	138
TOTAL DERMAL EXPOSURE (ug/15 min.)			1.1×10^4	4.5×10^3	4.9×10^3
ug per hr:			4.4×10^4	1.8×10^4	2.0×10^4
Mean g ai handled:			1.0	1.0	1.0
ug per lb ai:			2.0×10^6	2.0×10^6	2.2×10^6
mg per lb ai:			2.0×10^3	2.0×10^3	2.2×10^3

Table C-11. Potential Dermal Exposures of Home Gardeners to Wettable Powder and Aqueous Suspension Formulations of Carbaryl.

Body Part	Surface Area	Clothing Factor	Wettable Powder	Aqueous Suspension	Mean (No Protection)	Long sleeves, gloves	Short sleeves gloves
Face	1300	0.0	138	101	120	120	120
Shoulders	2910	0.5	169	239	204	102	102
Back	3550	0.5	256	873	565	282	282
Chest							
Right	1775	0.5	96	167	132	66	66
Left	1775	0.5	170	121	146	73	73
Forearms							
Right	605	0.5	28	120	74	37	74
Left	605	0.5	70	115	93	46	93
Hands							
Right	410	0.9	43	30	37	4	37
Left	410	0.9	33	32	33	3	33
Thighs							
Right	1910	0.5	871	1039	955	478	478
Left	1910	0.5	737	1039	888	444	444
Lower leg							
Right	1190	0.5	1095	1833	1464	732	732
Left	1190	0.5	1214	1476	1345	673	673
Shoe							
Right	655	0.9	996	1127	1062	106	106
Left	655	0.9	891	1205	1048	105	105
TOTAL DERMAL EXPOSURE (ug/15 min.)					8.2×10^3	3.3×10^3	3.4×10^3
ug per hr:					3.3×10^4	1.2×10^4	1.4×10^4
Mean g ai handled:					2.8	2.8	2.8
ug per lb ai:					1.3×10^6	5.4×10^5	5.5×10^5
mg per lb ai:					1.3×10^3	5.4×10^3	5.5×10^3

Table C-12. Home Gardener Exposures to Carbaryl Applied Outdoors Using Compressed-Air Sprayer While Wearing Different Types of Clothing

Body Part	Dermal Exposure					
	No Protection (ug/15 min)	No Protection	Long Sleeves, gloves	Long Sleeves, no gloves	Short sleeves gloves	Short sleeves no gloves
Face	120	0.48	0.48	0.48	0.48	0.48
Shoulders	204	0.82	0.08	0.08	0.08	0.08
Back	565	2.26	0.23	0.23	0.23	0.23
Chest						
Right	132	0.53	0.05	0.05	0.05	0.05
Left	146	0.58	0.06	0.06	0.06	0.06
Forearms						
Right	74	0.30	0.03	0.03	0.30	0.30
Left	93	0.37	0.04	0.04	0.37	0.37
Hands						
Right	37	0.15	0.01	0.15	0.01	0.15
Left	33	0.13	0.01	0.13	0.01	0.13
Thighs						
Right	955	3.82	0.38	0.38	0.38	0.38
Left	888	3.55	0.36	0.36	0.36	0.36
Lower legs						
Right	1464	5.86	0.59	0.59	0.59	0.59
Left	1345	5.38	0.54	0.54	0.54	0.54
Shoes						
Right	1062	4.25	0.42	0.42	0.42	0.42
Left	1048	4.19	0.42	0.42	0.42	0.42
TOTAL DERMAL EXPOSURE			3.70	3.95	4.30	4.55