II.E.2 Residential Exposure Scenarios Appendix

The Preliminary NMC CRA considered a variety of exposure scenarios for consumer applicator and post-application residential exposures. The data from multiple studies that measured various exposure values have been used in the residential portion of the residential risk assessment. In some cases, statistical distributions have been fitted to the datasets. For such datasets, exposure estimates were based on the fitted distributions. Brief descriptions of the studies and statistical details of the datasets used in the residential portion of the risk assessment are provided below.

1. Lawn Care Exposure Scenarios

<u>Unit Exposure Data</u>

Study Summaries

MRID 449722-01 (ORETF Turf Handler Studies): A report was submitted by the ORETF (Outdoor Residential Exposure Task Force) that presented data in which the application of various products used on turf by homeowners and lawncare operators (LCOs) was monitored. All of the data submitted in this report were completed in a series of studies. The two studies that monitored homeowner exposure using a granular spreader (ORETF Study OMA003) and a hose-end sprayer (ORETF Study OMA004) are summarized below.

OMA003: A total of 30 volunteer test subjects were monitored using passive dosimetry (inner and outer whole body dosimeters, hand washes, face/neck wipes, and personal inhalation monitors). Each test subject carried, loaded, and applied two 25-lb bags of fertilizer (0.89% active ingredient) with a rotary type spreader to a lawn (a turf farm in North Carolina) covering 10,000 ft^2 (one bag to each of the two 5000 ft^2 test plots). Application to each subplot continued until the hopper was empty. Each participant also disposed of the empty bags at the end of the replicate. The target application rate was 2 lb ai/acre (actual rate achieved was about 1.9 lb ai/acre). The average application time was 22 minutes, including loading the rotary push spreader and disposing of the empty bags. Approximately 0.45 lb ai was handled in each replicate. Dermal exposure was measured using inner and outer whole body dosimeters, hand washes, face/neck washes, and personal air monitoring devices with OVS tubes. Overall, residues were highest on the upper and lower leg portions of the dosimeters.

OMA004: Dermal and inhalation exposures were estimated using passive dosimetry techniques (biological monitoring data were not collected). A total of 60 replicates were monitored using 30 test subjects (two replicates each) during applications to residential lawns in Frederick, Maryland. Thirty applicator replicates were monitored using a ready-to-use (RTU) product (Bug-B-Gon) packaged in a 32 fl. oz. screw-on container. These containers were attached to

garden hose-ends. An additional 30 mixer/loader/applicator replicates were monitored using Diazinon Plus also packaged in 32 fl. oz. plastic bottles. This product required the test subjects to pour the product into dial-type sprayers (DTS) that were attached to garden hose-ends.

A nominal application rate of 4 lb ai/acre was used for all replicates. Each replicate monitored the test subject treating 5,000 ft^2 of turf and handling a total of 0.5 lb ai/replicate. The average time per replicate was 75 minutes. Dermal and inhalation exposure were measured using inner and outer whole body dosimeters (long pants and long sleeved shirt over long underwear), hand washes, face/neck washes, and personal air monitoring devices.

MRID 44459801 (Applications Of Carbaryl To Vegetable Gardens): The data collected reflect the dermal and respiratory exposure of homeowners mixing, loading and applying RP-2 Liquid (21%), a carbaryl end-use product. Applications were made by volunteers to two 18 foot rows of tomatoes and one 18 foot row of cucumber. The only test field was located in Florida. For this study, RP-2 Liquid (21%) exposures were monitored using hose-end sprayers and low-pressure hand wand sprayers. Exposures to Sevin® 10 Dust, using a separate duster device that required transfer from the package and Sevin® Ready To Use Insect Spray (RTU) in a trigger sprayer package were also monitored. Exposure for each spray method/product combination was monitored using 40 handlers (replicates). Of the 40 replicates per spray method/product combination, 20 wore household latex gloves and 20 performed tasks without gloves. The 20 dust product replicates loaded the dusters and applied without gloves only.

Each replicate opened the end-use product, added it to the application implement (except the RTU product), adjusted the setting and applied it to the vegetable rows. After application to the vegetable rows, dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of carbaryl from inner and outer 100 percent cotton dosimeters, face/neck wipes, and glove and hand washes. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso.

Dermal exposure was determined by adding the values from the bare hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the inner dosimeter front and rear torso, upper legs, lower legs, lower arms, and upper arms. This accounts for the residential handlers with barehands wearing short-sleeved shirt and short pants.

Statistical Details

Distributional parameters were estimated for the dermal and inhalation unit exposure (UE) values for the granular (Table II.E.2-1), dust (Table II.E.2-2), and liquid sprayable (Table II.E.2-3) formulations of Carbaryl. All dermal and inhalation UE values represent milligrams exposure per pound of active ingredient of a pesticide handled. All UEs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For each dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the UEs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The means, standard deviations, and p-values of the S-W statistics are provided in Table II.E.2-4. A small p-value indicates that logarithms of the UEs are not normally distributed, or equivalently, that the UEs are not lognormally distributed. Both the granular inhalation UE and dust inhalation UE datasets resulted in S-W statistics with p-values less than 0.05.

Table II.E.2-1 Granular Rotary Spreader UE Data (OMA003) Used for Lawn Care Scenario

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
0.529	0.0001
0.392	0.0008
0.668	0.0011
0.692	0.0027
0.329	0.0001
0.373	0.0007
0.363	0.0007
0.595	0.0014
0.339	0.0007
0.563	0.0014
0.712	0.0026
0.253	0.0006
0.787	0.0035
0.514	0.0033
0.999	0.0015
0.412	0.0008
0.427	0.0007
0.917	0.0011
0.757	0.0010
0.827	0.0008
0.620	0.0006
0.730	0.0003
0.551	0.0006
2.104	0.0011
1.363	0.0032
0.915	0.0025
0.522	0.0007
6.980	0.0008
0.462	0.0007
1.022	0.0003

Table II.E.2-2 Dust Shaker/Powder UE Data (MRID 44459801) Used for Lawn Care Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
673	2.27
588	0.60
276	1.38
129	2.23
176	0.30
94	0.61
236	4.87
229	0.01
85	2.11
69	0.38
82	2.14
258	0.66
51	1.99
1388	14.27
40	0.13
280	1.09
43	1.40
36	0.57
219	2.28
59	0.26

Table II.E.2-3 Hose End Sprayer on Turf UE Data (OMA004) Used for Lawn Care Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
0.21	0.019
6.76	0.026
32.61	0.065
1.84	0.013
3.09	0.030
3.16	0.037
1.22	0.027
1.36	0.030
1.29	0.003
0.99	0.019
9.38	0.034
1.16	0.006
3.20	0.021
9.69	0.045
5.42	0.061
12.89	0.005
1.92	0.002
8.93	0.004
3.68	0.017
11.05	0.008
0.08	0.001
23.03	0.001
4.51	0.003
0.22	0.015
2.83	0.029
1.20	0.003
8.60	0.007
0.41	0.003
23.66	0.014
0.17	0.004

Table II.E.2-4 Lognormal Distributions of UEs Used for Lawn Care Scenarios

Application Method	Exposure Route	Unit Exposure Distribution (mg/lb ai)	Shapiro-Wilk p-value
Granular Rotary Spreader	Dermal	LN(0.809, 0.570)	0.0011
	Inhalation	LN(0.0013, 0.0013)	0.0511
Dust Shaker/Powder	Dermal	LN(247, 333)	0.3691
	Inhalation	LN(2.94, 9.54)	0.0354
Hose End Sprayer (RTU) on Turf	Dermal	LN(8.44, 26.2)	0.3630
	Inhalation	LN(0.022, 0.040)	0.1890

NOTES:

LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.

For lawn scenarios, information was derived from chemical-specific data and studies conducted by the ORETF (Outdoor Residential Exposure Task).

Additionally, probability plots were used to qualitatively assess the appropriateness of the lognormal assumptions. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plots for the UE datasets are provided in Figures II.E.2-1 through 6. For the granular dermal UE dataset, the probability plot indicates that the small S-W p-value is due to one very high value; whereas for the dust inhalation UE dataset, one very low value results in a small S-W p-value. The other datasets are reasonably approximated by lognormal distributions.

Figure II.E.2-1 Lognormal Probability Plot of Granular Rotary Spreader Dermal UE Data (OMA003)

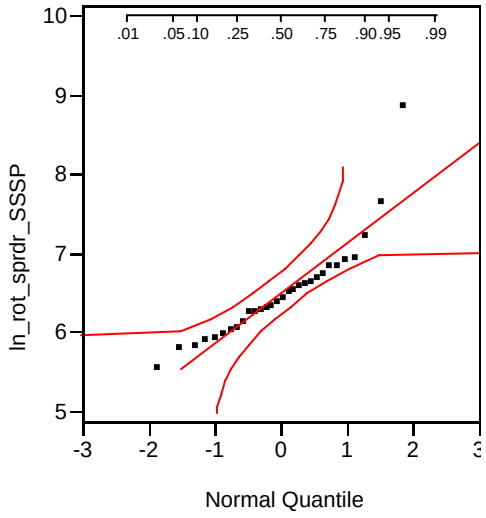


Figure II.E.2-2 Lognormal Probability Plot of Granular Rotary Spreader Inhalation UE Data (OMA003)

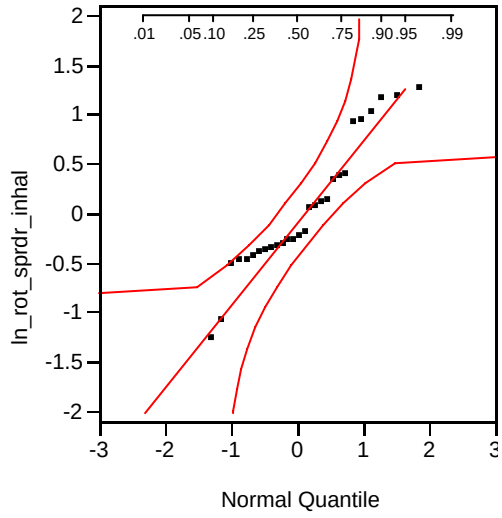


Figure II.E.2-3 Lognormal Probability Plot of Dust Shaker/Powder Dermal UE Data (MRID 44459801)

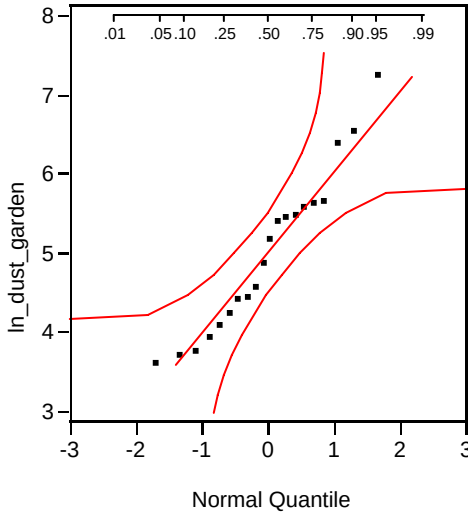


Figure II.E.2-4 Lognormal Probability Plot of Dust Shaker/Powder Inhalation UE Data (MRID 44459801)

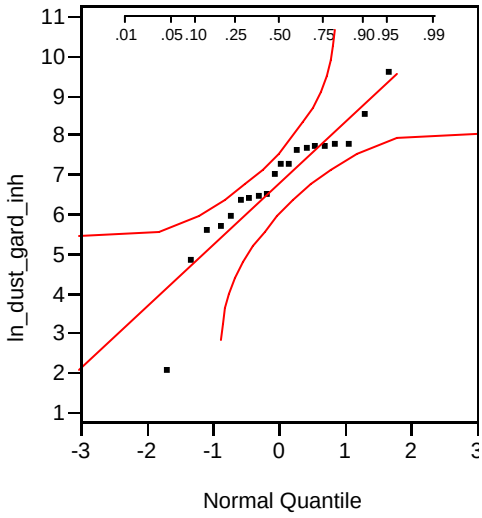


Figure II.E.2-5 Lognormal Probability Plot of HES Sprayer on Turf Dermal UE Data (OMA004)

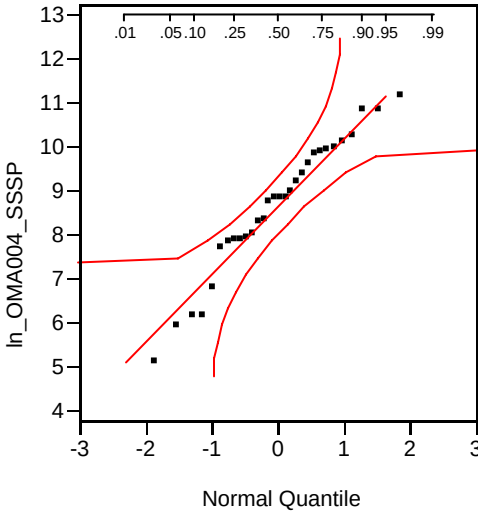
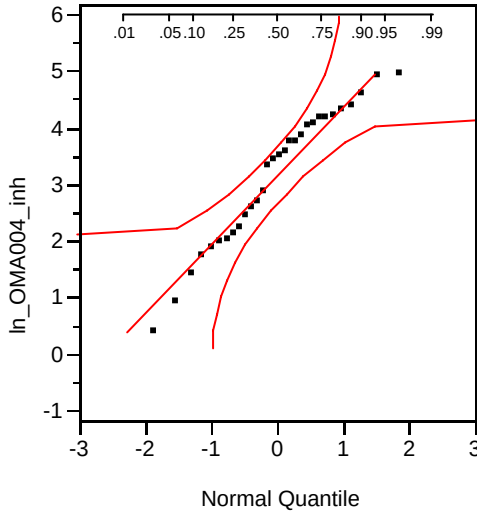


Figure II.E.2-6 Lognormal Probability Plot of Hose End Sprayer on Turf Inhalation UE Data (OMA004)



Residue Data

Study Summaries

MRID 451143-01 (Carbaryl Turf Transferable Residue Study): A TTR study was conducted at individual sites in three states using the ORETF roller sampling method. The data used in this assessment was from the Georgia site. Bermudagrass was the variety of turfgrass treated at the Georgia site. Field work took place over three week intervals at each site. Applications were made and

samples were collected essentially in October of 1998 Georgia. Two applications were made 7 days apart at each site. All applications in this study were completed at a rate of 8.17 lb ai/acre. Applications were made with typical groundboom sprayers using approximately 55 and 31 gallons of water per acre, respectively. All applications were made using Dragon Sevin Liquid which is a flowable concentrate formulation that contains carbaryl at a nominal concentration of 21 percent by weight or 2 lb ai/gallon.

There was approximately from 1 inch up to 2.7 inches of irrigation water on the day of the final application. Additionally, on the day of the final application, rain was noted that ranged in accumulations of 0.36 inches. Mowing events were not noted in the data from the Georgia site. Triplicate TTR samples were collected using the ORETF roller method at 8 intervals out to 14 days after the last application. All but two samples were collected during the 1st week of the study. In all cases, residue levels exceeded the LOQ at 14 days after application.

Statistical Details

Turf transferable residues (TTR) values are assumed to degrade exponentially over time (i.e. degrade by a constant proportion for any given time interval). In order to estimate the initial TTR value (i.e. TTR value at day zero) and the half-life of the liquid formulation of carbaryl, the natural logarithms of the 27 (3 samples X 9 days) individual TTR samples (Table II.E.2-5) from the Georgia site were linearly regressed on the day of sample collection. The form of the linear regression is given below.

$$\ln(y) = \beta_0 + \beta_1 t$$

The linear regression parameters were then used to calculate initial DFR value (**A_0**) and the half-life (**$T_{1/2}$**) using formulae given below.

$$A_0 = \beta_0$$

$$T_{1/2} = -\frac{\ln(2)}{\beta_1}$$

Table II.E.2-5 Liquid Formulation TTR Data (MRID # 451143-01, Georgia site) Used for Lawn Care Scenario

Day	TTR Values (mg/cm^2)
0	0.00130
	0.00122
	0.00152
0.5	0.00067
	0.00073
	0.00147
1	0.00041
	0.00042
	0.00047
2	0.00020
	0.00028
	0.00023
3	0.00014
	0.00027
	0.00050
5	0.00040
	0.00023
	0.00010
7	0.00011
	0.00013
	0.00031
10	0.00003
	0.00015
	0.00022
14	0.00007
	0.00002
	0.00015

Transfer Coefficient Data

Study Summaries

Black, 1993: A study by Black (1993), which investigated dermal exposure values of young children who were exposed to a non-toxic substance, was used to represent the spray application scenario. In this study, children performed unscripted activities on turf treated with a non-toxic substance used as a whitening agent in fabrics. The subjects of the study were 14 children aged four to nine years old. In this study, children were provided toys and their activities were recorded as they performed unscripted activities for a period of one half hour. Activities recorded were grouped into the following classifications:

- ❑ Upright (standing, walking, jumping and running)

- ❑ Sitting (straight-up, cross legged, kneeling, crouching and crawling)
- ❑ Lying (prone or supine)

Dermal exposure was measured by fluorescent measurement technology described in Fenske et al., (1986). Measurements on various body parts were expressed as ug/body part (e.g., hand, face, etc.) and as concentration (ug/cm^2).

Vaccaro, 1993: In a second study (Vaccaro, 1993) in which a liquid formulation was used, eight adults performed structured activities intended to mimic a child's activities (including walking/running, sleeping, crawling, and sitting on turf). The subjects performed these activities for a period of four hours beginning four hours after the turf had dried. Turf had been treated earlier with a sprayable form of chlorpyrifos and exposure was estimated in the study by monitoring the amount of a chlorpyrifos metabolite – excreted over the following period of 6 days. This method directly measured internal dose and was used to back-calculate a generic "to the skin" transfer coefficient by using chemical specific dermal absorption data for chlorpyrifos (Nolan et al., 1984).

Statistical Details

Distributional parameters were estimated for the combined children transfer coefficient (TC) values from the Black and Vaccaro studies and the adult TC values from the Vaccaro study (Table II.E.2-6). All TC values were expressed as square centimeters per hour (cm^2/hr). Both children and adult TCs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For each dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the TCs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The means, standard deviations, and p-values of the S-W statistics are provided in Table II.E.2-7. A small p-value indicates that logarithms of the TCs are not normally distributed, or equivalently, that the TCs are not lognormally distributed. For both children and adult TC datasets, the S-W p-values are greater than 0.05.

Table II.E.2-6 Liquid Formulation TC Data Used for Lawn Care Scenarios

Population	Study	TC Values (cm^2/hr)
Children	Vaccaro	1240
		2507
		2673
		3251
		3665
		4164
		4877
		4905
	Black	2844
		3594
		3776
		4051
		4103
		4357
		4902
		6812
		8395
		8746
		9119
		9885
		10713
		16008
Adult	Vaccaro	3348
		6770
		7217
		8779
		9895
		11243
		13169
		13243

Table II.E.2-7 Lognormal Distributions of TCs Used for Lawn Care Scenarios

Application Method	Exposure Route	Population	Transfer Coefficient Distribution (cm^2/hr)	Shapiro-Wilk p-value
Hose End Sprayer*	Dermal	Children	LN(5709, 3634)	0.6127
	Dermal	Adult	LN(9445, 4509)	0.2035

NOTES:
LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.

*Liquid formulation data was used for granular exposure scenarios.

Additionally, probability plots were used to qualitatively assess the appropriateness of the lognormal assumptions. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plots for the TC datasets are provided in Figures II.E.2-7 and 8. The probability plots indicate the both children and adult TC datasets are reasonably approximated by lognormal distributions.

Figure II.E.2-7 Lognormal Probability Plot of Liquid Formulation Child TC Data

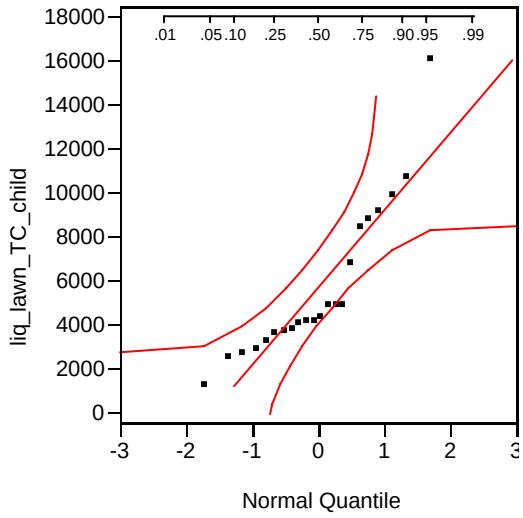
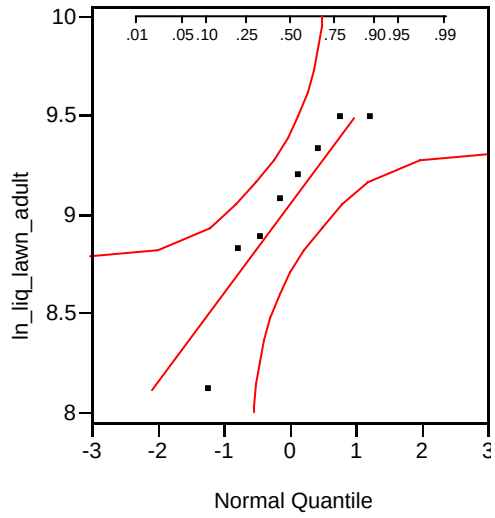


Figure II.E.2-8 Lognormal Probability Plot of Liquid Formulation Adult TC Data



2. Vegetable Garden Exposure Scenarios

<u>Unit Exposure Data</u>

Study Summaries

MRID 444598-01 (Carbaryl Applications To Vegetables Gardens): The data collected reflect the dermal and respiratory exposure of homeowners mixing, loading and applying RP-2 Liquid (21%), a Carbaryl end-use product. Applications were made by volunteers to two 18 foot rows of tomatoes and one 18 foot row of cucumber. The only test field was located in Florida. For this study, RP-2 Liquid (21%) exposures were monitored using hose-end sprayers and low-pressure hand wand sprayers. Exposures to Sevin® 10 Dust, using a separate duster device that required transfer from the package and Sevin® Ready To Use Insect Spray (RTU) in a trigger sprayer package were also monitored. Exposure for each spray method/product combination was monitored using 40 handlers (replicates). Of the 40 replicates per spray method/product combination, 20 wore household latex gloves and 20 performed tasks without

gloves. The 20 dust product replicates loaded the dusters and applied without gloves only.

Each replicate opened the end-use product, added it to the application implement (except the RTU product), adjusted the setting and applied it to the vegetable rows. After application to the vegetable rows, dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of carbaryl from inner and outer 100 percent cotton dosimeters, face/neck wipes, and glove and hand washes. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso.

Dermal exposure was determined by adding the values from the bare hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the inner dosimeter front and rear torso, upper legs, lower legs, lower arms, and upper arms. This accounts for the residential handlers with barehands wearing short-sleeved shirt and short pants.

Statistical Details

Distributional parameters were estimated for the dermal and inhalation unit exposure (UE) values for dust (Table II.E.2-8), trigger pump sprayer (Table II.E.2-9), and liquid hose-end sprayer (Table II.E.2-10) applications of Carbaryl. All dermal and inhalation UE values represent milligrams exposure per pound of active ingredient of a pesticide handled. All UEs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For each dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the UEs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The means, standard deviations, and p-values of the S-W statistics are provided in Table II.E.2-11. A small p-value indicates that logarithms of the UEs are not normally distributed, or equivalently, that the UEs are not lognormally distributed. Both the dust inhalation UE and trigger pump inhalation UE datasets resulted in S-W statistics with p-values less than 0.05.

Table II.E.2-8 Dust Shaker/Powder UE Data (MRID 44459801) Used for Vegetable Garden Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
673	2.27
588	0.60
276	1.38
129	2.23
176	0.30
94	0.61
236	4.87
229	0.01
85	2.11
69	0.38
82	2.14
258	0.66
51	1.99
1388	14.27
40	0.13
280	1.09
43	1.40
36	0.57
219	2.28
59	0.26

Table II.E.2-9 Trigger Pump Sprayer UE Data (MRID 44459801) Used for Vegetable Garden Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
129	0.275
59	0.255
250	0.104
132	0.168
145	0.180
91	0.032
165	0.180
77	0.200
24	0.033
50	0.032
24	0.033
100	0.086
23	0.032
24	0.110
20	0.035
218	0.032
9	0.032
18	0.032
41	0.032
23	0.032

Table II.E.2-10 Hose End Sprayer UE Data (MRID44459801) for Vegetable Garden Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
31	0.0022
47	0.0009
21	0.0016
77	0.0028
58	0.0014
76	0.0030
25	0.0032
31	0.0044
19	0.0017
17	0.0013
33	0.0010
84	0.0041
24	0.0023
56	0.0009
8	0.0027
199	0.0044
163	0.0014
11	0.0007
21	0.0044
7	0.0028

Table II.E.2-11 Lognormal Distributions of UEs Used for Vegetable Garden Scenarios

Application Method	Exposure Route	Unit Exposure Distribution (mg/lb ai)	Shapiro-Wilk p-value
Dust Shaker/Powder	Dermal	LN(247, 333)	0.3691
	Inhalation	LN(2.94, 9.54)	0.0354
Trigger Pump Sprayer	Dermal	LN(86, 107)	0.2191
	Inhalation	LN(0.104, 0.137)*	0.0003
Hose-End Sprayer	Dermal	LN(51, 58)	0.8266
	Inhalation	LN(0.0024, 0.0015)	0.2075

NOTES:
LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.
*The mean and standard deviation represent MLE-based estimates.

Additionally, probability plots were used to qualitatively assess the appropriateness of the lognormal assumptions. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual

values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plots for the UE datasets are provided in Figures II.E9 through 14. For the dust inhalation UE dataset, the probability plot indicates that the small S-W p-value is due to one very low value; whereas for the trigger pump inhalation UE dataset, several low values account for the small S-W p-value. The other datasets are reasonably approximated by lognormal distributions.

Figure II.E.2-9 Lognormal Probability Plot of Dust Shaker/Powder Dermal UE Data (MRID 44459801)

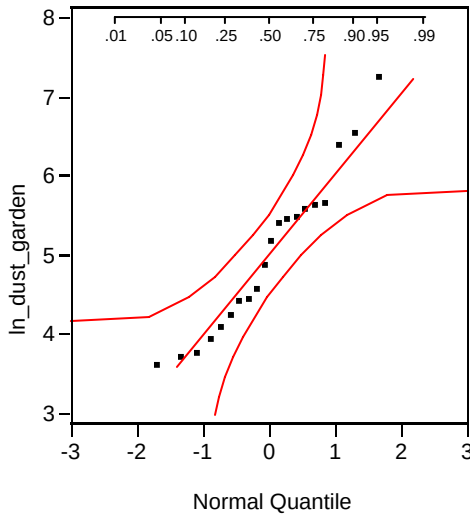


Figure II.E.2-10 Lognormal Probability Plot of Dust Shaker/Powder Inhalation UE Data (MRID 44459801)

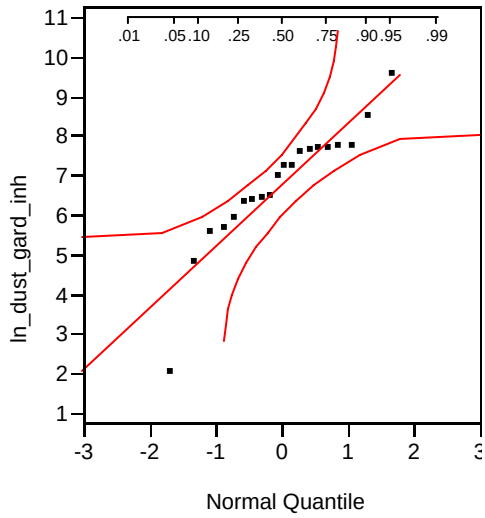


Figure II.E.2-11 Lognormal Probability Plot of Trigger Pump Sprayer UE Dermal Data (MRID 44459801)

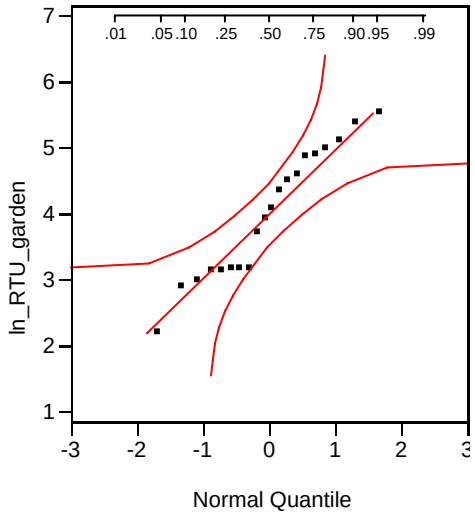


Figure II.E.2-12 Lognormal Probability Plot of Trigger Pump Sprayer UE Inhalation Data (MRID 44459801)

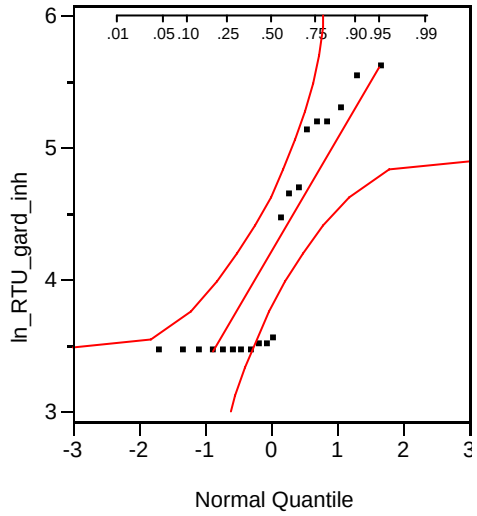


Figure II.E.2-13 Lognormal Probability Plot of Hose End Sprayer Dermal UE Data (MRID44459801)

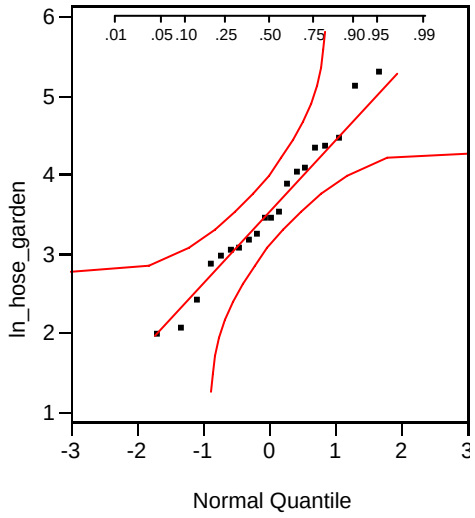
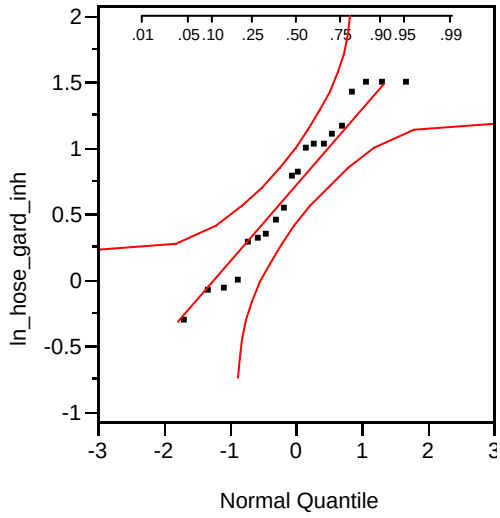


Figure II.E.2-14 Lognormal Probability Plot of Hose End Sprayer Inhalation UE Data (MRID44459801)



For the trigger pump inhalation UE dataset, 11 out of 20 samples were reported as approximately the same value. All 11 samples from the inhalation monitors were reported as 0.07 µg with slightly different amounts of active ingredient handled by the study subjects, which resulted in slightly different UE (mg/lb ai) values. The value 0.07 µg was assumed to be half the LOQ. The mean and standard deviation estimated for the trigger pump inhalation UE dataset are based on maximum likelihood estimation (MLE) procedures assuming the dataset represents a sample from a censored lognormal distribution.

Residue Data

Study Summaries

MRID 450059-09 (Carbaryl Sunflower DFR Study): The field phase of this study was conducted at a single site near Northwood, North Dakota. The field phase of the study was conducted during the period from July 20 to August 25, 1998. Sample analyses were completed by December 1998. A fixed-wing aircraft was used to make 2 applications of Sevin XLR Plus, a liquid flowable formulation, 7 days apart at an application rate of 1.5 lb ai/acre. Spray volume was 3 gallons of water per acre. The sunflower plants were approximately 4 feet tall and were spaced approximately 0.5 feet within each row while the rows were spaced 2.5 feet apart (i.e., ~35000 plants/acre). No significant precipitation was observed in this study until at least 14 days after application.

DFR samples were collected out to 28 days after the last application using the Iwata method (i.e., a total surface area sampled of 400 cm2/sample collected with a 1 inch diameter Birkestrand leaf punch and dislodged with a 0.01 percent Aerosol solution). There were still measurable residues 28 days after

application. The percent transferability of the 0 day sample was 32 percent of the application rate.

Statistical Details

Dislodgeable foliar residue (DFR) values are assumed to degrade exponentially over time (i.e. degrade by a constant proportion for any given time interval). In order to estimate the initial DFR value (i.e. DFR value at day zero) and the half-life of the liquid formulation of Carbaryl, the natural logarithms of the 30 (3 samples X 10 days) individual DFR samples (Table II.E.2-12) from the sunflower study were linearly regressed on the day of sample collection. The form of the linear regression is given below.

$$\ln(y) = \beta_0 + \beta_1 t$$

The linear regression parameters were then used to calculate initial DFR value (**A_0**) and the half-life (**$T_{1/2}$**) using formulae given below.

$$A_0 = \beta_0$$

$$T_{1/2} = -\frac{\ln(2)}{\beta_1}$$

Table II.E.2-12 Liquid Formulation DFR Data (MRID 45005909) Used for Vegetable Garden Scenarios

Day	DFR Values (mg/cm^2)
0	0.00503
	0.00615
	0.00488
1	0.00425
	0.00515
	0.00508
2	0.00415
	0.00295
	0.00380
3	0.00393
	0.00330
	0.00483
4	0.00498
	0.00463
	0.00418
5	0.00241
	0.00205
	0.00310
6	0.00308
	0.00308
	0.00320
7	0.00283
	0.00213
	0.00288
14	0.00139
	0.00116
	0.00108
28	0.00020
	0.00010
	0.00005

Transfer Coefficient Data

Study Summaries

MRID 45344501 (Chrysanthemum Pinching): This study was conducted with volunteer workers pinching buds from greenhouse chrysanthemums after two treatments with the active ingredient (ai) diazainon, formulated as an emulsifiable concentrate called Diazinon AG600 WBC®. Dermal and inhalation data were collected, together with concurrent dislodgeable foliar residue (DFR) data. Potential exposures were measured using whole-body dosimeters (outer and inner dosimetry), hand washes, and face/neck wipes for dermal exposure and personal sampling pumps for inhalation exposure. Transfer coefficients were calculated for potential and total dermal exposure.

MRID 451917-01 (Cabbage Weeding Study): This study was conducted with volunteer workers weeding commercially grown cabbage after two treatments with the active ingredient (ai) carbaryl, formulated as the emulsifiable concentrate Sevin® XLR Plus. The potential dermal and respiratory exposure during reentry was assessed at an established commercial cabbage field in San Joaquin Valley of California by using whole-body dosimetry, hand washes, face/neck wipes, and a personal air sampling pump. Transfer coefficients for potential and total dermal exposure were calculated.

3. Ornamental Plants and Shrubs Exposure Scenarios

Unit Exposure Data

Study Summaries

MRID 444598-01 (Carbaryl Applications To Vegetable Gardens): The data collected reflect the dermal and respiratory exposure of homeowners mixing, loading and applying RP-2 Liquid (21%), a Carbaryl end-use product. Applications were made by volunteers to two 18 foot rows of tomatoes and one 18 foot row of cucumber. The only test field was located in Florida. For this study, RP-2 Liquid (21%) exposures were monitored using hose-end sprayers and low-pressure hand wand sprayers. Exposures to Sevin® 10 Dust, using a separate duster device that required transfer from the package and Sevin® Ready To Use Insect Spray (RTU) in a trigger sprayer package were also monitored. Exposure for each spray method/product combination was monitored using 40 handlers (replicates). Of the 40 replicates per spray method/product combination, 20 wore household latex gloves and 20 performed tasks without gloves. The 20 dust product replicates loaded the dusters and applied without gloves only.

Each replicate opened the end-use product, added it to the application implement (except the RTU product), adjusted the setting and applied it to the vegetable rows. After application to the vegetable rows, dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of carbaryl from inner and outer 100 percent cotton dosimeters, face/neck wipes, and glove and hand washes. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso.

Dermal exposure was determined by adding the values from the bare hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the inner dosimeter front and rear torso, upper legs, lower legs, lower arms, and upper arms. This accounts for the residential handlers with barehands wearing short-sleeved shirt and short pants.

MRID 445185-01 (Carbaryl Applications To Trees And Shrubs Study): Applications of Sevin Liquid® Carbaryl insecticide [RP-2 liquid (21%)] were made by volunteers to two young citrus trees and two shrubs in each replicate that was monitored in the study. The test field was located only in Florida. Twenty (20) replicates were monitored using hose-end sprayer (Ortho® DIAL or Spray® hose end sprayer), and 20 replicates were monitored using hand held pump sprayers (low-pressure hand wands).

Each replicate opened the end-use product, added it to the hose-end sprayer or hand held pump and then applied it to the trees and shrubs. After application to two trees and two shrubs dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of Carbaryl from inner and outer 100 percent cotton dosimeters. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso. No gloves were worn therefore hand exposure was assessed with 400 ml handwash with 0.01 percent Aerosol OT-75 sodium dioctyl sulfosuccinate (OTS). One hundred (100) percent cotton handkerchiefs wetted with 25 ml OTS were used to wipe face and neck to determine exposure.

The dermal exposure was calculated by adding the values from the hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the inner dosimeter front and rear torso, upper legs, lower legs, lower arms, and upper arms. This accounts for the residential handlers with barehands wearing short-sleeved shirt and short pants.

Statistical Details

Distributional parameters were estimated for the dermal and inhalation unit exposure (UE) values for dust (Table II.E.2-13), trigger pump sprayer (Table II.E.2-14), and liquid hand wand sprayer (Table II.E.2-15) applications of carbaryl. All dermal and inhalation UE values represent milligrams exposure per pound of active ingredient of a pesticide handled. All UEs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For each dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the UEs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The means, standard deviations, and p-values of the S-W statistics are provided in Table II.E.2-16. A small p-value indicates that logarithms of the UEs are not normally distributed, or equivalently, that the UEs are not lognormally distributed. The dust inhalation UE, trigger pump inhalation UE, and hand wand UE datasets resulted in S-W statistics with p-values less than 0.05.

Table II.E.2-13 Dust Shaker/Powder UE Data (MRID 44459801) Used for Ornamental Plants and Shrubs Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
673	2.27
588	0.60
276	1.38
129	2.23
176	0.30
94	0.61
236	4.87
229	0.01
85	2.11
69	0.38
82	2.14
258	0.66
51	1.99
1388	14.27
40	0.13
280	1.09
43	1.40
36	0.57
219	2.28
59	0.26

Table II.E.2-14 Trigger Pump Sprayer UE Data (MRID #44459801) Used for Ornamental Plants and Shrubs Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
129	0.275
59	0.255
250	0.104
132	0.168
145	0.180
91	0.032
165	0.180
77	0.200
24	0.033
50	0.032
24	0.033
100	0.086
23	0.032
24	0.110
20	0.035
218	0.032
9	0.032
18	0.032
41	0.032
23	0.032

Table II.E.2-15 Hand Wand Sprayer UE Data (MRID 44518501) Used for Ornamental Plants and Shrubs Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
25	0.004
52	0.005
129	0.004
27	0.004
348	0.005
56	0.005
118	0.004
176	0.016
44	0.009
41	0.016
46	0.004
15	0.004
36	0.004
83	0.004
78	0.025
78	0.012
46	0.004
36	0.022
25	0.004
63	0.018

Table II.E.2-16 Lognormal Distributions of UEs Used for Ornamental Plants and Shrubs Scenarios

Application Method	Exposure Route	Unit Exposure Distribution (mg/lb ai)	Shapiro-Wilk p-value
Dust Shaker/Powder	Dermal	LN(247, 333)	0.3691
	Inhalation	LN(2.94, 9.54)	0.0354
Trigger Pump Sprayer	Dermal	LN(86, 107)	0.2191
	Inhalation	LN(0.104, 0.137)*	0.0003
Hand Wand Sprayer	Dermal	LN(74, 64)	0.7478
	Inhalation	LN(0.0089, 0.0102)*	0.0005

NOTES:
LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.
*The mean and standard deviation represent MLE-based estimates.

Additionally, probability plots were used to qualitatively assess the appropriateness of the lognormal assumptions. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual

values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plots for the UE datasets are provided in Figures II.E.2-15 through 20. For the dust inhalation UE dataset, the probability plot indicates that the small S-W p-value is due to one very low value; whereas for the trigger pump inhalation and hand wand inhalation UE datasets, several low values account for the small S-W p-values. The other datasets are reasonably approximated by lognormal distributions.

Figure II.E.2-15 Lognormal Probability Plot of Dust Shaker/Powder Dermal UE Data (MRID 44459801)

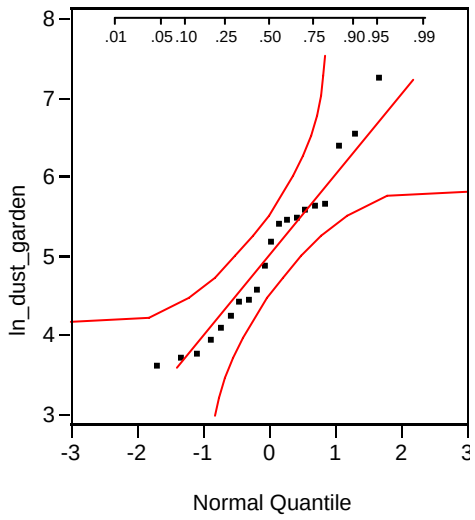


Figure II.E.2-16 Lognormal Probability Plot of Dust Shaker/Powder Inhalation UE Data (MRID 44459801)

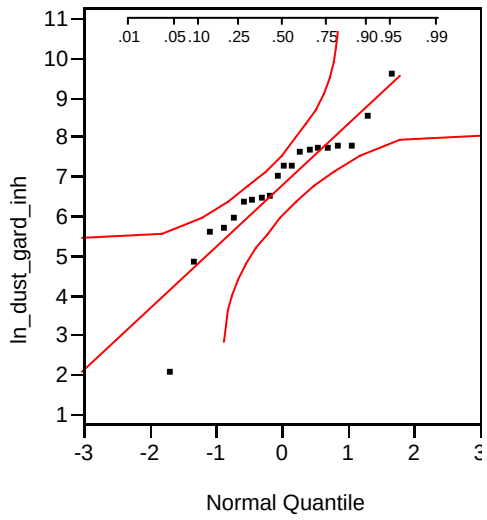


Figure II.E.2-17 Lognormal Probability Plot of Trigger Pump Sprayer Dermal UE Data (MRID #44459801)

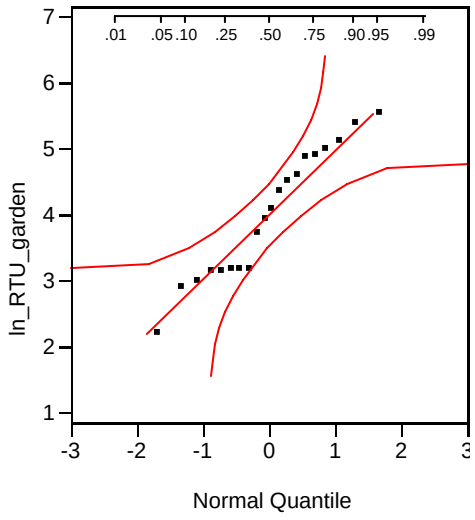


Figure II.E.2-18 Lognormal Probability Plot of Trigger Pump Sprayer Inhalation UE Data (MRID #44459801)

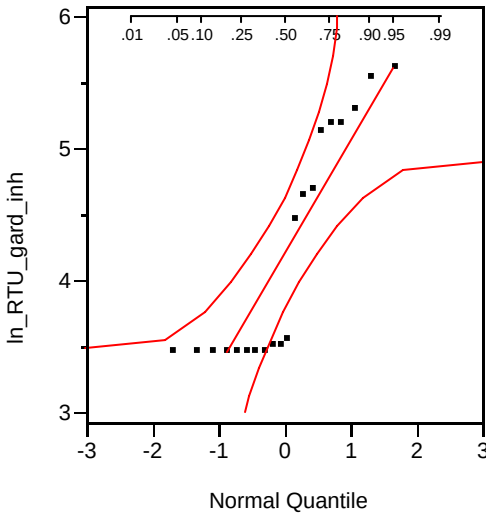


Figure II.E.2-19 Lognormal Probability Plot of Hand Wand Sprayer Dermal UE Data (MRID 44518501)

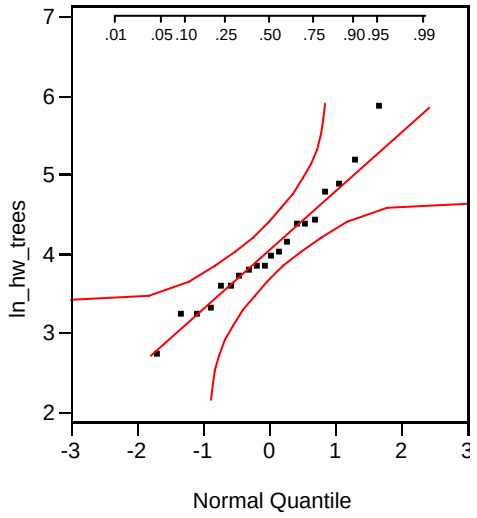
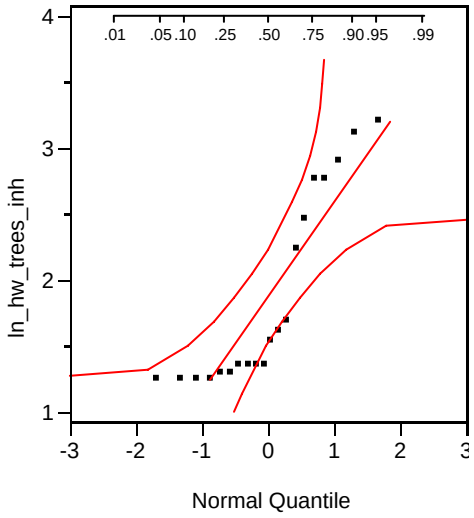


Figure II.E.2-20 Lognormal Probability Plot of Hand Wand Sprayer Inhalation UE Data (MRID 44518501)



For the trigger pump inhalation and hand wand inhalation UE datasets, 11 and 13 (respectively) out of 20 samples were reported as approximately the same value. All 24 samples from the inhalation monitors were reported as 0.07 µg with slightly different amounts of active ingredient handled by the study subjects, which resulted in slightly different UE (mg/lb ai) values. The value 0.07 µg was assumed to be half the LOQ. The means and standard deviations estimated for the trigger pump inhalation UE and hand wand inhalation UE datasets are based on maximum likelihood estimation (MLE) procedures assuming the datasets represent samples from censored lognormal distributions.

Transfer Coefficient Data

Study Summaries

MRID 45344501 (Chrysanthemum Pinching): This study was conducted with volunteer workers pinching buds from greenhouse chrysanthemums after two treatments with the surrogate active ingredient (ai) diazainon, formulated as an emulsifiable concentrate called Diazinon AG600 WBC®. Dermal and inhalation data were collected, together with concurrent dislodgeable foliar residue (DFR) data. Potential exposures were measured using whole-body dosimeters (outer and inner dosimetry), hand washes, and face/neck wipes for dermal exposure and personal sampling pumps for inhalation exposure. Transfer coefficients were calculated for potential and total dermal exposure.

MRID 454695-01 (Pruning in Nursery Stock): This study was conducted with volunteer workers pruning in a citrus nursery stock after one treatment with the surrogate active ingredient (ai) malathion, formulated as the emulsifiable concentrate. The potential dermal and respiratory exposure during reentry was

assessed at a citrus nursery in Arizona by using whole-body dosimetry, hand washes, face/neck wipes, and a personal air sampling pump. Dermal and inhalation data were collected, together with concurrent dislodgeable foliar residue (DFR) data. Transfer coefficients were calculated for both potential and total dermal exposure.

Residue Data

Study Summaries

MRID 450059-09 (Carbaryl Sunflower DFR Study): The field phase of this study was conducted at a single site near Northwood, North Dakota. The field phase of the study was conducted during the period from July 20 to August 25, 1998. Sample analyses were completed by December 1998. A fixed-wing aircraft was used to make 2 applications of Sevin XLR Plus, a liquid flowable formulation, 7 days apart at an application rate of 1.5 lb ai/acre. Spray volume was 3 gallons of water per acre. The sunflower plants were approximately 4 feet tall and were spaced approximately 0.5 feet within each row while the rows were spaced 2.5 feet apart (i.e., ~35000 plants/acre). No significant precipitation was observed in this study until at least 14 days after application.

DFR samples were collected out to 28 days after the last application using the Iwata method (i.e., a total surface area sampled of 400 cm2/sample collected with a 1 inch diameter Birkestrand leaf punch and dislodged with a 0.01 percent Aerosol solution). There were still measurable residues 28 days after application. The percent transferability of the 0 day sample was 32 percent of the application rate.

Statistical Details

Dislodgeable foliar residue (DFR) values are assumed to degrade exponentially over time (i.e. degrade by a constant proportion for any given time interval). In order to estimate the initial DFR value (i.e. DFR value at day zero) and the half-life of the liquid formulation of carbaryl, the natural logarithms of the 30 (3 samples X 10 days) individual DFR samples (Table II.E.2-17) from the sunflower study were linearly regressed on the day of sample collection. The form of the linear regression is given below.

$$\ln(y) = \beta_0 + \beta_1 t$$

The linear regression parameters were then used to calculate initial DFR value (**A_0**) and the half-life (**$T_{1/2}$**) using formulae given below.

$$A_0 = \beta_0$$

$$T_{1/2} = -\frac{\ln(2)}{\beta_1}$$

Table II.E.2-17 Liquid Formulation DFR Data (MRID #45005909) Used for Ornamental Plants and Shrubs Scenarios

Day	DFR Values (mg/cm^2)
0	0.00503
	0.00615
	0.00488
1	0.00425
	0.00515
	0.00508
2	0.00415
	0.00295
	0.00380
3	0.00393
	0.00330
	0.00483
4	0.00498
	0.00463
	0.00418
5	0.00241
	0.00205
	0.00310
6	0.00308
	0.00308
	0.00320
7	0.00283
	0.00213
	0.00288
14	0.00139
	0.00116
	0.00108
28	0.00020
	0.00010
	0.00005

4. Fruit Tree Exposure Scenarios

<u>Unit Exposure Data</u>

Study Summaries

MRID 445185-01 (Carbaryl Applications To Trees And Shrubs): Applications of Sevin Liquid® Carbaryl insecticide [RP-2 liquid (21%)] were made by volunteers to two young citrus trees and two shrubs in each replicate that was

monitored in the study. The test field was located only in Florida. Twenty (20) replicates were monitored using hose-end sprayer (Ortho® DIAL or Spray® hose end sprayer), and 20 replicates were monitored using hand held pump sprayers (low pressure hand wands).

Each replicate opened the end-use product, added it to the hose-end sprayer or hand held pump and then applied it to the trees and shrubs. After application to two trees and two shrubs dosimeters were collected. Inhalation exposure was monitored with personal air sampling pumps with OVS tubes attached to the shirt collar in the breathing zone. Dermal exposure was assessed by extraction of Carbaryl from inner and outer 100 percent cotton dosimeters. The inner and outer dosimeters were segmented into: lower and upper arms, lower and upper legs, front and back torso. No gloves were worn therefore hand exposure was assessed with 400 ml handwash with 0.01 percent Aerosol OT-75 sodium dioctyl sulfosuccinate (OTS). One hundred (100) percent cotton handkerchiefs wetted with 25 ml OTS were used to wipe face and neck to determine exposure.

The dermal exposure was calculated by adding the values from the hand rinses, face/neck wipes to the outer dosimeter lower legs and lower arms plus the inner dosimeter front and rear torso, upper legs, lower legs, lower arms, and upper arms. This accounts for the residential handlers with barehands wearing short-sleeved shirt and short pants.

Statistical Details

Distributional parameters were estimated for the dermal and inhalation unit exposure (UE) values for liquid hand wand sprayer (Table II.E.2-18) applications of Carbaryl. Dermal and inhalation UE values represent milligrams exposure per pound of active ingredient of a pesticide handled. All UEs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For each dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the UEs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The means, standard deviations, and p-values of the S-W statistics are provided in Table II.E.2-19. A small p-value indicates that logarithms of the UEs are not normally distributed, or equivalently, that the UEs are not

lognormally distributed. The hand wand UE dataset resulted in an S-W statistic with a p-value less than 0.05.

Table II.E.2-18 Hand Wand Sprayer UE Data (MRID #44518501) Used for Fruit Tree Scenarios

Dermal UE Values (mg/lb ai)	Inhalation UE Values (mg/lb ai)
25	0.004
52	0.005
129	0.004
27	0.004
348	0.005
56	0.005
118	0.004
176	0.016
44	0.009
41	0.016
46	0.004
15	0.004
36	0.004
83	0.004
78	0.025
78	0.012
46	0.004
36	0.022
25	0.004
63	0.018

Table II.E.2-19 Lognormal Distributions of UEs Used for Fruit Tree Scenarios

Application Method	Exposure Route	Unit Exposure Distribution (mg/lb ai)	Shapiro-Wilk p-value
Hand Wand Sprayer	Dermal	LN(74, 64)	0.7478
	Inhalation	LN(0.0089, 0.0102)*	0.0005

NOTES:
LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.
*The mean and standard deviation represent MLE-based estimates.

Additionally, probability plots were used to qualitatively assess the appropriateness of the lognormal assumptions. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plots for the UE datasets are provided in Figures II.E.2-21 and 22. For the hand wand inhalation UE dataset, several low values result in a small S-

W p-value. The other dataset is reasonably approximated by a lognormal distribution.

Figure II.E.2-21 Lognormal Probability Plot of Hand Wand Sprayer Dermal UE Data (MRID #44518501)

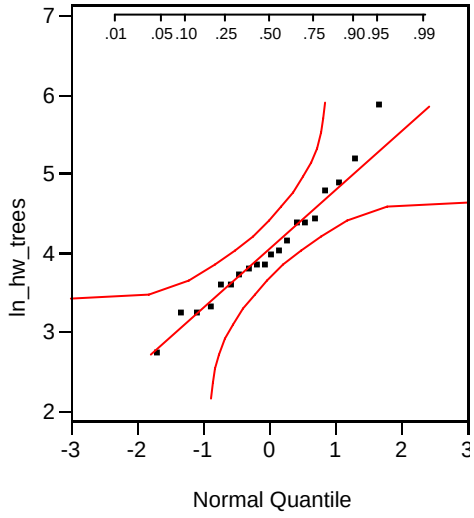
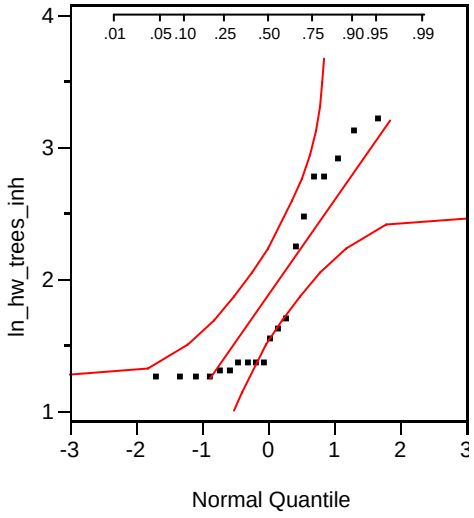


Figure II.E.2-22 Lognormal Probability Plot of Hand Wand Sprayer Inhalation UE Data (MRID #44518501)



For the hand wand inhalation UE dataset, 13 out of 20 samples were reported as approximately the same value. All 13 samples from the inhalation monitors were reported as 0.07 μg with slightly different amounts of active ingredient handled by the study subjects, which resulted in slightly different UE (mg/lb ai) values. The value 0.07 μg was assumed to be half the LOQ. The mean and standard deviation estimated for hand wand inhalation UE dataset are based on maximum likelihood estimation (MLE) procedures assuming the dataset represents a sample from a censored lognormal distribution.

Residue Data

Study Summaries

MRID 451751-02 (Carbaryl Olive DFR Study): The field phase of this study was conducted at a single site near Terra Bella, California which is in a major growing region for olives. The field phase of the study was conducted during the period from November 2 to November 17, 1998. Sample analyses were completed by January, 1999. A typical airblast sprayer was used to make a single application of Sevin XLR Plus, a liquid flowable formulation, at an application rate of 7.65 lb ai/acre. Spray volume was 758 gallons of water per acre. The olive trees were approximately 20 feet tall and were spaced approximately 28 feet within each row while the rows were spaced 28 feet apart (i.e., ~56 trees/acre). No significant precipitation was observed in this study until at least 7 days after application.

Triplicate DFR samples were collected out to 14 days after application using the Iwata method (i.e., a total surface area sampled of 400 cm2/sample collected

with a 1 inch diameter Birkestrand leaf punch and dislodged with a 0.01 percent Aerosol solution). There were still measurable residues 14 days after application. The percent transferability of the 0 day sample was 3.6 percent of the application rate.

Statistical Details

Dislodgeable foliar residue (DFR) values are assumed to degrade exponentially over time (i.e. degrade by a constant proportion for any given time interval). In order to estimate the initial DFR value (i.e. DFR value at day zero) and the half-life of the liquid formulation of carbaryl, the natural logarithms of the 30 (3 samples X 10 days) individual DFR samples (Table II.E.2-20) from the olive study were linearly regressed on the day of sample collection. The form of the linear regression is given below.

$$\ln(y) = \beta_0 + \beta_1 t$$

The linear regression parameters were then used to calculate initial DFR value (**A_0**) and the half-life (**$T_{1/2}$**) using formulae given below.

$$A_0 = \beta_0$$

$$T_{1/2} = -\frac{\ln(2)}{\beta_1}$$

Table II.E.2-20 Liquid Formulation DFR Data (MRID 45175102) Used for Fruit Tree Scenarios

Day	DFR Values (mg/cm^2)
0	0.0035
	0.0027
	0.0030
1	0.0028
	0.0023
	0.0028
2	0.0027
	0.0024
	0.0025
3	0.0042
	0.0029
	0.0027
4	0.0028
	0.0024
	0.0028
5	0.0023
	0.0019
	0.0018
6	0.0026
	0.0023
	0.0022
7	0.0028
	0.0023
	0.0020
10	0.0012
	0.0010
	0.0010
14	0.0009
	0.0008
	0.0007

Transfer Coefficient Data

Study Summaries

MRID 45480302 (Hand Pruning Apples): This study was conducted with volunteer workers pruning commercially grown apple trees after two treatments with the surrogate active ingredient (ai) carbaryl, formulated as the flowable insecticide Sevin® XLR PLUS. Dermal and inhalation data were collected, together with concurrent dislodgeable foliar residue (DFR) data. Potential

exposures were measured using whole-body dosimeters (outer and inner dosimetry), hand washes, and face/neck wipes for dermal exposure and personal sampling pumps for inhalation exposure. Transfer coefficients for potential and total dermal exposure were calculated.

Statistical Details

Distributional parameters were estimated for the adult TC transfer coefficient (TC) values (Table II.E.2-21) from the apple pruning study. TC values were expressed as square centimeters per hour. Adult TCs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For the TC dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the TCs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The mean, standard deviation, and p-value of the S-W statistic are provided in Table II.E.2-22. A small p-value indicates that logarithms of the TCs are not normally distributed, or equivalently, that the TCs are not lognormally distributed. For the adult TC dataset, the S-W p-value is greater than 0.05.

Table II.E.2-21 Liquid Formulation TC Data (MRID 45480302) Used for Fruit Tree Scenarios

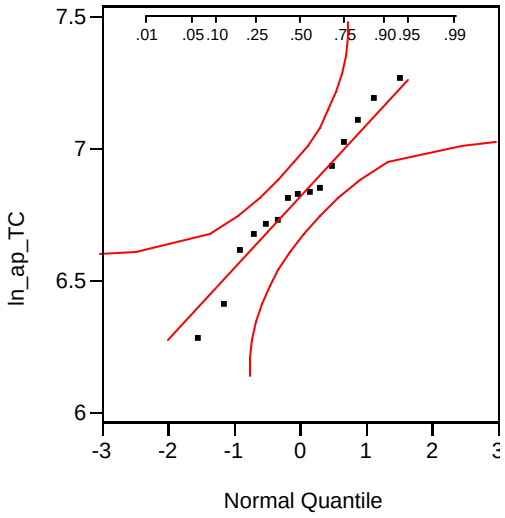
TC Values (cm^2/hr)
1119
920
903
787
534
1421
1316
940
1217
740
821
928
831
1020
606

Table II.E.2-22 Lognormal Distribution of TCs Used for Fruit Tree Scenarios

Application Method	Exposure Route	Population	Transfer Coefficient Distribution (cm^2/hr)	Shapiro-Wilk p-value
Hand Wand Sprayer	Dermal	Adult	LN(943, 258)	0.9300
NOTES: LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.				

Additionally, a probability plot was used to qualitatively assess the appropriateness of the lognormal assumption. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plot for the TC dataset is provided in Figure II.E.2-23. The probability plot indicates that the TC dataset is reasonably approximated by a lognormal distribution.

Figure II.E.2-23 Lognormal Probability Plot of Liquid Formulation TC Data (MRID 45480302)



5. Ornamental Garden- Snail and Slug Bait Scenario

<u>Unit Exposure Data</u>

Study Summaries

MRID 453334-01 (Dermal and Inhalation Exposure to Disulfoton Resulting from Residential Application to Shrubs and Flower Beds): The purpose of this study was to quantify potential dermal (forearm and hand) and inhalation exposure for residential applicators a granular disolfoton formulation, which contains 1.04 percent disulfoton as the active ingredient. The maximum application rate for flower beds (4 ounces formulated product per 12 square feet) and for shrubs, which includes rosebushes, (4 ounces formulated product per 1 foot shrub height) was used in this study.

The field study was conducted at the Bayer Corporation Research Farm, Vero Beach, Florida. A total of 15 volunteers were monitored using passive dosimetry (hand/forearm wash solutions and personal air monitors). Application of the product was made by pouring the granules into the measuring cup/lid attached to the product package, and then distributing the granules onto the soil around the base of a shrub or onto a flower bed. The granules were then soil-incorporated with a garden rake. Each volunteer applied granular disulfoton around shrubs while wearing gloves and then again without gloves. A total of 60 (i.e., 15 volunteers x 4 exposure scenarios) replicates were monitored. Only exposure data from the 30 replicates who did <u>not</u> wear gloves were reported. The test site was a fallow test field, approximately 1 acre in size. Two sets of sub-plots were established: (1) shrub test-plots, each containing 10 oleander shrubs (approximately 48 inches high); and (2) flower-bed sub-plots, each containing <u>simulated</u> plants, (e.g., 12 to 14 inch high stakes placed on approximately 24 inch centers).

Each volunteer applied approximately 10 pounds of formulated product per application. Shrubs were treated by spreading 16 ounces of granules (i.e., 4 ounces per 1 foot of shrub) in a circle around each shrub's base. The granules were then incorporated into the top 1-2 inches of soil using a new garden rake. Flower beds were treated by sprinkling 4 ounces of granules to each 12 square feet of a total 480 square feet area, and incorporating the product into the top 1-2 inches of soil using a new garden rake.

All of the inhalation exposure data were either non-detect or less than the limit of quantitation (LOQ). Most of the hand/forearm dermal washing samples returned results greater than the LOQ. The author reported that the time it took to treat shrubs ranged between 18 and 29 minutes. The time that it took to treat flowerbeds ranged between 20 and 40 minutes.

Statistical Details

Distributional parameters were estimated for the dermal unit exposure (UE) values (Table II.E.2-23) for the granular formulation of chemical H based on surrogate chemical data. Dermal UE values represent milligrams exposure per pound of active ingredient of a pesticide handled. All UEs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For the dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the UEs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

The Shapiro-Wilk (S-W) normality test statistic was used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The mean, standard deviation, and p-value of the S-W statistic are provided in Table II.E.2-24. A small p-value indicates that logarithms of the UEs are not normally distributed, or equivalently, that the UEs are not lognormally distributed. The granular dermal UE dataset resulted in an S-W statistic with a p-value less than 0.05.

Table II.E.2-23 Granular UE Data (MRID 45333401) Used for Ornamental Garden Scenarios

Dermal UE Values (mg/lb ai)
0.001
0.029
0.019
0.206
0.085
0.001
0.001
0.001
0.042
0.050
0.012
0.032
0.119
0.001
0.082

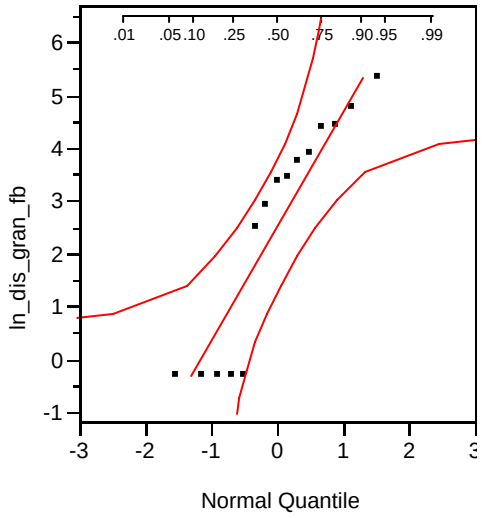
Table II.E.2-24 Lognormal Distribution of UEs Used for Ornamental Garden Scenarios

Application Method	Exposure Route	Unit Exposure Distribution (mg/lb ai)	Shapiro-Wilk p-value
Granular	Dermal	LN(0.23, 5.8)*	0.0087

NOTES:
LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.
*The mean and standard deviation represent MLE-based estimates.

Additionally, a probability plot was used to qualitatively assess the appropriateness of the lognormal assumption. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plot for the UE dataset is provided in Figure II.E.2-24. For the granular dermal UE dataset, several low values result in a small S-W p-value.

Figure II.E.2-24 Lognormal Probability Plot of Granular Dermal UE Data (MRID 45333401)



For the granular dermal UE dataset, 5 out of 15 samples were reported as half the LOQ. The mean and standard deviation estimated for hand wand dermal UE dataset are based on maximum likelihood estimation (MLE) procedures assuming the dataset represents a sample from a censored lognormal distribution. Since all inhalation samples were either non-detect or less than the LOQ, half the LOQ (0.00001 mg/lb aihandled) was used as an estimate of inhalation UE.

6. Indoor Crack and Crevice Scenario

<u>Unit Exposure Data</u>

Study Summaries

MRID 410547-05 (Exposures of Applicators to Propoxur during Residential Application of an Aerosol Spray Containing 1% Propoxur): Applicators in the study each applied one 16-ounce aerosol can in each of the 15 residences situated in Vero Beach, Florida. The entire contents were applied to each house. The volunteers sprayed to cracks, crevices along baseboards and other woodwork, under sinks and behind appliances. The majority of the exposure was to the hands, neck and head (~85).

Statistical Details

Distributional parameters were estimated for the (dermal) transferable residue (Table II.E.2-25) and (inhalation) air concentration (Table II.E.2-26) values for pressurized can sprayer applications of Chemical G. Transferable residue (TR) values represent milligrams exposure per square centimeter and air concentration (AC) values represent milligrams per cubic meter. The average TR values across houses were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution); whereas the individual AC values within a house

were assumed to be lognormally distributed. For TR and AC datasets, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) the TR and AC values, respectively. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

Shapiro-Wilk (S-W) normality test statistics were used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The means, standard deviations, and p-values of the S-W statistics are provided in Table II.E.2-27. A small p-value indicates that logarithms of the TRs (or the ACs) are not normally distributed, or equivalently, that the TRs (or ACs) are not lognormally distributed. For both TR (dermal) and AC (inhalation) pressurized can datasets, the S-W p-values are greater than 0.05.

Table II.E.2-25 Deposition Data (MRID 41054705) Used for Crack and Crevice Scenarios

Hard Surfaces Deposition Values (mg/cm2)
0.590
0.414
0.020
0.002
0.080

Table II.E.2-26 Air Concentration Data (MRID 41054705) Used for Crack and Crevice Scenarios

Air Concentration Values (mg/m3)
5.3
5.8
5.3
5.4
4.2
3.4
3.9
2.4
4.0
2.4
6.5
5.7
7.5
6.9
5.4
6.2
8.6
8.6
2.5
4.4

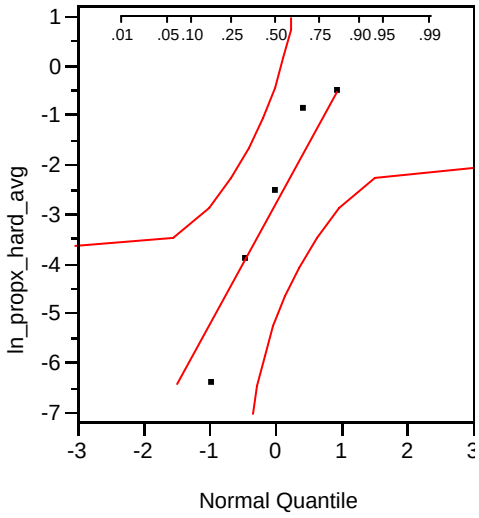
Table II.E.2-27 Lognormal Distributions of Surface Deposition and Air Concentrations Used for Crack and Crevice Scenarios

Application Method	Exposure Route	Deposition (mg/cm^2) and Air Concentration (mg/m^3) Distributions	Shapiro-Wilk p-value
Handheld Compression Sprayer	Dermal	LN(0.0010, 0.0185)	0.5962
	Inhalation	LN(0.0053, 0.0021)	0.1770

NOTES:
LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.

Additionally, probability plots were used to qualitatively assess the appropriateness of the lognormal assumptions. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plots for the TR and AC datasets are provided in Figures II.E.2-25 and 26. The probability plots indicate that both datasets are reasonably approximated by lognormal distributions.

Figure II.E.2-25 Lognormal Probability Plot of Deposition Data (MRID 41054705)



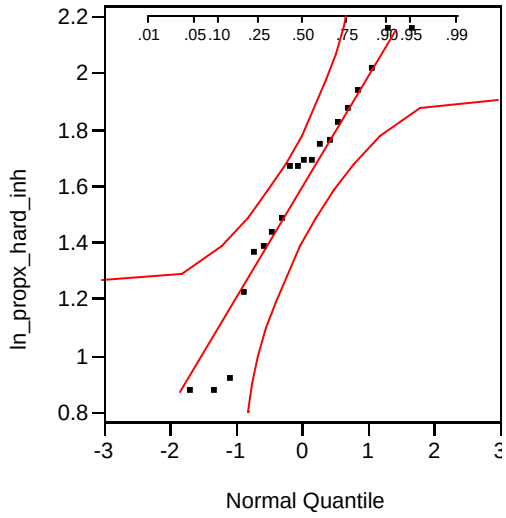


Figure II.E.2-26 Lognormal Probability Plot of Air Concentration Data (MRID 41054705)

Residue Data

Study Summaries

MRID 410547-03 (Exposure to Propoxur for Residents of Homes Treated with BAYGON 70% WP): A formulation of Propoxur, BAYGON 70WP, was applied as a coarse spray to cracks and crevices, baseboards, and other small areas commonly treated for insect control using a handheld compression sprayer. An average of 1.2 ounces (0.7 - 1.8) of ai was applied to each of the five houses monitored. Applications took 2- to 34 minutes to complete.

Surface residues and air levels of propoxur were measured at intervals of up to 48 hours after treatment. Five types of surfaces were evaluated. The media were distributed in the rooms prior to treatment. Triplicate samples of each medium were collected, before treatment, immediately after applications, 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. The living rooms and bedrooms were sampled using squares of nylon carpet with a 1 cm nap placed on the floor and fabric squares were located on the furniture. These samples were used for total residue analysis. Air concentrations of propoxur were determined by drawing air, at a rate of 1 L/minute, through a sampling apparatus whose inlet was located 12 inches above the floor. All sampling periods were at least one hour.

7. Pet Collar Exposure

Residue Data

Study Summaries

MRID # 45792201 (Carbaryl Pet Flea Collar Study): Sixteen dogs were fitted with 16% carbaryl flea collars. The dogs were of various breeds and sizes. All dogs that had previously worn any type of flea collar or had been in contact with any flea killing material were thoroughly washed prior to placement of the collars. All dogs were allowed to follow their normal daily habits. The dogs were petted at 24 hours, 96 hours and 1 week. During each petting session, each dog was petted for one 10 minute period followed by another 10 minute period, each time petters wore a new pair of pre-washed white cotton gloves. All dogs were petted in such a manner that contact with all portions of their bodies resulted. The four gloves from each 20 minute session were considered a single sample and were placed in individual plastic bags for analysis.

Transfer Coefficient Data

Study Summaries

MRID 446584-01 (Carbaryl Dog Groomer Study): The data collected reflect the dermal and respiratory exposure of commercial pet groomers applying the end use product, Adams® Carbaryl Flea and Tick Shampoo containing 0.50 percent carbaryl. In this study, applications of Adams® Carbaryl Flea and Tick Shampoo were made by professional pet groomers to 8 dogs at 2 sites in Georgia. A total of 16 replicates were monitored for dermal and inhalation exposure. Eight dogs of various sizes and hair lengths were shampooed during each replicate. Dermal exposure was monitored with face and neck swabs, 100 percent cotton union suit dosimeter worn underneath a short-sleeved t-shirt, long pants and a 65/35 polyester cotton long-sleeved smock (i.e., represents a short-sleeved shirt under a long-sleeved coat/smock). Hand exposure was quantified using handwash rinses (no protective gloves were worn). Inhalation exposure was monitored using personal air pumps with XAD2 resin tubes.

The dogs were wetted, shampooed to a lather (lather remained on dogs for 5 minutes) and rinsed. After completing 8 dog shampoos the dosimeters were collected. Face/neck swabs and 2 hand rinses were performed along with collection of the 100 percent cotton union suit.

Table II.E.2-28 TC Data Used for Pet Collar Scenario (Empirical Distribution)1

Groomer µg exposure	Duration: hours	µg/hour	ai deposited µg/cm^2*	Dislodged: 2.97 % efficiency assumed µg/cm^2	Transfer Coefficient (adults) cm^2/hour	Transfer Coefficient (children) cm^2/hour /3
8796	2.88	3054	37.5	1.114	2742	1016
6199	2.58	2403	31.0	0.921	2610	967
1408	3.07	459	18.6	0.552	831	308
2914	2.48	1175	36.4	1.081	1087	403
5667	3.08	1840	32	0.950	1936	717
2527	3.18	795	19	0.564	1409	522
2,348	2.93	801	15.9	0.472	1696	628
2961	2.72	1089	7.75	0.230	4731	1752
1135	4.03	282	14.8	0.440	642	238
14872	3.88	3833	28.8	0.855	4481	1660
1026	3.17	324	16.6	0.493	657	243
13490	4.05	3331	56.98	1.692	1968	729
4275	4.92	869	25	0.743	1170	433
4461	3.45	1293	42.25	1.255	1030	382
1511	3.03	499	8.87	0.263	1894	702
777	3.00	259	48.6	1.443	179	66
				Average	1817	673

1 Source Carbaryl Groomer Exposure Study (activity - wash/dip/groom). Each vet tech treated/handled 8 dogs: held small dogs w/arms and torso; some dogs climbed on person's shoulders while grooming etc.
2 Average transfer efficiency 2.97% =(powder (0.62%) + aerosol (3.3%) +pump spray (5%))/3; .
3 The transfer coefficients derived from this study were adjusted by an allometric scaling factor based on the relative size of children to adults to derive an appropriate transfer coefficient for children Adult:Child surface area ratio - 2.7:1 (avg. Adult 3169: avg child 1174)
*The amount ai per dog was measured in the study along with the animal's weight. The suface areas of the dogs were estimated using an equation for estimating mammal surface area described in the Wildlife Exposure Factors Handbook.

8. Golf Course Exposure

Residue Data

Study Summaries

MRID 451143-01 (Carbaryl Turf Transferable Residue Study): A TTR study was conducted at individual sites in three states using the ORETF roller sampling method. The data used in this assessment was from the Georgia site. Bermudagrass was the variety of turfgrass treated at the Georgia site. Field work took place over three week intervals at each site. Applications were made and samples were collected essentially in October of 1998 Georgia. Two applications were made 7 days apart at each site. All applications in this study were completed at a rate of 8.17 lb ai/acre. Applications were made with typical groundboom sprayers using approximately 55 and 31 gallons of water per acre, respectively. All applications were made using Dragon Sevin Liquid which is a flowable concentrate formulation that contains carbaryl at a nominal concentration of 21 percent by weight or 2 lb ai/gallon.

There was approximately from 1 inch up to 2.7 inches of irrigation water on the day of the final application. Additionally, on the day of the final application, rain was noted that ranged in accumulations of 0.36 inches. Mowing events were not noted in the data from the Georgia site. Triplicate TTR samples were collected using the ORETF roller method at 8 intervals out to 14 days after the last application. All but two samples were collected during the 1st week of the study. In all cases, residue levels exceeded the LOQ at 14 days after application.

Statistical Details

Turf transferable residues (TTR) values are assumed to degrade exponentially over time (i.e. degrade by a constant proportion for any given time interval). In order to estimate the initial TTR value (i.e. TTR value at day zero) and the half-life of the liquid formulation of Carbaryl, the natural logarithms of the 27 (3 samples X 9 days) individual TTR samples (Table II.E.2-29) from the Georgia site were linearly regressed on the day of sample collection. The form of the linear regression is given below.

$$\ln(y) = \beta_0 + \beta_1 t$$

The linear regression parameters were then used to calculate initial TTR value (**A_0**) and the half-life (**$T_{1/2}$**) using formulae given below.

$$A_0 = \beta_0$$

$$T_{1/2} = -\frac{\ln(2)}{\beta_1}$$

Table II.E.2-29 Liquid Formulation TTR Data (MRID # 45114301) Used for Carbaryl Golf Scenarios

Day	TTR Values (mg/cm^2)
0	0.00130
	0.00122
	0.00152
0.5	0.00067
	0.00073
	0.00147
1	0.00041
	0.00042
	0.00047
2	0.00020
	0.00028
	0.00023
3	0.00014
	0.00027
	0.00050
5	0.00040
	0.00023
	0.00010
7	0.00011
	0.00013
	0.00031
10	0.00003
	0.00015
	0.00022
14	0.00007
	0.00002
	0.00015

Transfer Coefficient Data

Study Summaries

Ballee, 1990 (chlorothalonil TC data) and Moran et al., 1987 (flurprimidol TC data): The data used to derive transfer coefficients were based on two measurements of four individuals playing golf on two golf courses treated with chlorothalonil (Ballee, 1990), and the exposure of golfers (four volunteers) to flurprimidol (Moran et al., 1987). For both studies, an assumed transfer efficiency of 1% was used to calculate the transfer coefficients, since the studies were conducted using sprayable formulations.

Statistical Details

Distributional parameters were estimated for the adult TC transfer coefficient (TC) values (Table II.E.2-30) from the Ballee and Moran studies. TC values were expressed as square centimeters per hour. Adult TCs were assumed to be lognormally distributed (i.e. fitted with a lognormal distribution). For the TC dataset, the shape (α) and scale (β) lognormal parameters were estimated by calculating the mean and standard deviation of the natural logarithms (base *e*) of the TCs. Parametric estimates of the arithmetic mean (μ) and standard deviation (σ) of the lognormal distribution were then calculated based on the shape and scale parameter estimates. The formulae used to calculate the mean and standard deviation are given below.

$$\mu = \exp(\alpha + \tfrac{1}{2}\beta^2)$$

$$\sigma = \mu\sqrt{\exp(\beta^2) - 1}$$

The Shapiro-Wilk (S-W) normality test statistic was used to assess the lognormal assumption implicit in the parametric calculations of the mean and standard deviation. The mean, standard deviation, and p-value of the S-W statistic are provided in Table II.E.2-31. A small p-value indicates that logarithms of the TCs are not normally distributed, or equivalently, that the TCs are not lognormally distributed. For the adult TC dataset, the S-W p-value is greater than 0.05.

Table II.E.2-30 Liquid Formulation TC Data Used for Golf Scenarios

TC Values (cm^2/hr)
391
329
561
547
592
533
385
508
756
522
264
278

Table II.E.2-31 Lognormal Distribution of TCs Used for Golf Scenarios

Application Method	Exposure Route	Population	Transfer Coefficient Distribution (cm^2/hr)	Shapiro-Wilk p-value
Liquid Broadcast	Dermal	Adult	LN(475, 158)	0.4068
NOTES: LN(μ, σ) represents a lognormal distribution with mean=μ and standard deviation=σ.				

Additionally, a probability plot was used to qualitatively assess the appropriateness of the lognormal assumption. Generally a probability plot displays the actual values of a dataset (represented as points) and their expected values (represented as a line) for the specified distribution. The closer the actual values are to their expected values (i.e. the more the actual values approximate a straight line), the more likely the dataset is of the specified distribution. The probability plot for the TC dataset is provided in Figure II.E.2-27. The probability plot indicates that the TC dataset is reasonably approximated by a lognormal distribution.

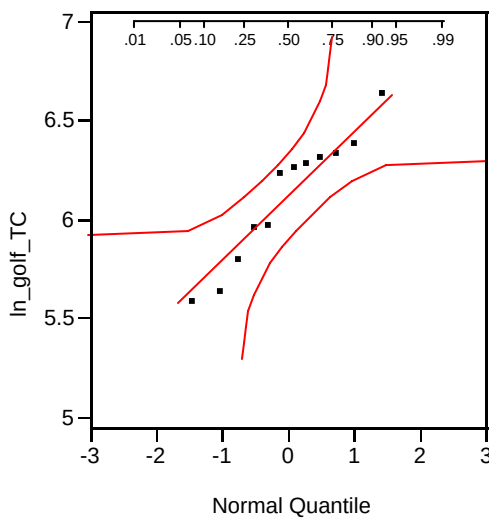



Figure II.E.2-27 Lognormal Probability Plot of Liquid Formulation TC Data Used for Golf Scenarios