

Appendix C. Development of Empirical Input Distributions Required for the Residential Exposure Assessment

I. Development of Empirical Distributions for Parametric Distributions Used in the June 11 Assessment

LifeLine™ Version 2.0 allows the user to enter distributions for inputs that reflect variation in parameters across exposure events. These distributions are expressed in terms of cumulative empirical distributions. The input of parametrically described distributions is not permitted. As a result, it was necessary to convert the input distributions in the June 11 assessment that were parametrically defined into their equivalent empirical distributions.

The conversion was performed using @Risk™, an Excel™ add-on program that allows the conversions of a variety of parametric forms into equivalent empirical distributions. The parametric distributions converted were:

1. Unit Exposure for dermal exposure to granular pesticides (Trichlorfon and Bensulide) applied to lawns, a lognormal distribution, mean 0.69 mg/lb, std. dev. 0.36 mg/lb, truncated at 1.93 mg/lb.
2. Unit Exposure for inhalation exposure to granular pesticides (Trichlorfon and Bensulide) applied to lawns: a uniform distribution, minimum value 0.00019 mg/lb and maximum value 0.0096 mg/lb.
3. Unit Exposure for dermal exposure to liquid pesticides (Malathion and Acephate) applied to ornamentals and vegetable gardens, a lognormal distribution, mean 78 mg/lb, std. dev. 76 mg/lb, truncated at 372 mg/lb.
4. Unit Exposure for inhalation exposure to liquid pesticides (Malathion and Acephate) applied to ornamentals and vegetable gardens: a uniform distribution, minimum value 0.003 mg/lb and maximum value 0.0142 mg/lb.
5. Unit Exposure for dermal exposure to granular pesticides (Disulfoton) applied to ornamentals, a lognormal distribution, mean 0.18 mg/lb, std. dev. 0.29 mg/lb, truncated at 1.31 mg/lb.

Based upon this data the following empirical distributions were created. Note the values for the inhalation unit exposure were adjusted to reflect the chemical specific DOI factors. See Chapter 2 for additional information. In addition, the units of the distribution have been changed to fit the input requirement of LifeLine™ Version 2.0. Finally, in creating the cumulative empirical distributions, the percentiles were not evenly spaced. The selection of the percentiles was biased to capture the upper ends of the distributions more accurately.

Table C. 1. Cumulative Distributions of Unit Exposures						
	Trichlorfon Lawns Granular	Bensulide Lawns Granular	Acephate Ornamentals	Malathion Ornamentals	Malathion Vegetable Gardens	Disulfoton Ornamentals Granular
Percentile	Dermal (ug/lb ai)					
0	0	0	0	0	0	0
10	330	330	17200	17200	17200	15
50	610	610	53100	53100	53100	94
90	1120	1120	150000	150000	150000	380
95	1320	1320	197000	197000	197000	550
99	1540	1540	257000	257000	257000	800
100	1930	1930	372000	372000	372000	1310
Percentile	Inhalation (ng/lb ai)					
0	2090	2090	165333	360	360	140
100	105600	105600	1173867	2556	2556	140

II. Development of Cumulative Distributions that Reflect the Variation in Multiple Inputs

LifeLine™ Version 2.0 does not allow the user to enter distributions for certain inputs such as the amount of pesticide applied. In other instances the June 11 assessment chose to consider factors that are not explicitly considered in LifeLine™ Version 2.0. To address these inputs LifeLine™ includes two “modifying distributions,” one that is applied to the applicator exposures and the second to the oral exposures. In addition, the unit exposures for dermal and oral applicator exposures can be entered as distributions that reflect variation from factors other than the unit exposures.

In this analysis these modifying distributions were used to capture the impact of variation in multiple inputs. For example the June 11 assessment used uniform distributions with minimum and maximum values of 0 and 20 for the number of mouthing events per hour and 10 and 50% for the saliva dislodgeability. LifeLine™ only allows the user to enter single values for mouthing events and for saliva dislodgeability. However, the same effect can be achieved by entering a value of 20 for the number of mouthing events, 50% for saliva dislodgeability and an appropriate distribution for the oral modifying factor. This distribution is developed in the following process.

First, by simple algebra the uniform distribution for mouthing events, minimum value of 4 and a maximum value of 25.7, can be simulated by sampling a uniform distribution with values between 0.4/20 and 25.7/20 and multiplying the sampled values by 20. Second, the uniform distribution for the saliva factor (expressed as a percentage) can be generated by sampling a

uniform distribution between 0.2 and 1.0 and multiplying the sampled values by 50. Third, a single distribution can be created that is equivalent to the product of the two uniform distributions by sampling the first and second uniform distributions and multiplying the two sampled values together. Using @Risk™, an Excel™ add-on program it is possible to create cumulative empirical distributions that characterize these distributions. The samples from this combined distribution when multiplied times 20 and then by 50 will yield a distribution that is equivalent to one produced by sampling the original two distributions of 0.4-25.7 and 10 to 50%. The combined distribution is entered into LifeLine™ as a modifying factor.

The following are the distributions created in the assessment of organophosphates. In all of these examples, the number of iterations used to generate the final distributions was 20,000.

Post Application Oral Absorption Factors

In the post application assessment of pesticides applied to turf the OMF is used to enter a cumulative distribution that reflects:

1. The variation in the mouthing frequency;
2. The variation in the average fraction of the hand placed in the mouth by the modeled individual;
3. The impact of wet hands;
4. The range of values for the saliva dislodgeability factor; and
5. The pesticide-specific dermal to oral (DTO) factor.

In LifeLine™ Version 2.0, a single mouthing frequency is entered for each NHAPS activity. In this assessment a single value of 20 events/hr is entered for all activities, see Appendix E. In the June 11 assessment, EPA used a uniform distribution of 0.4 to 25.7 events/h. Therefore, this distribution includes a factor with a uniform distribution of 0.4/20 to 25.7/20 to capture the variation in mouthing frequency.

In LifeLine™ Version 2.0, the area of the hand placed in the mouth is estimated by entering a fraction of the hand placed in the mouth rather than a specific area. This fraction of hand is multiplied times the surface area of the child's hands. (LifeLine™ estimates the area of the child's hands based on the child's gender, height and weight and age. See the LifeLine™ Technical Manual for additional information). A single fraction of the hand is defined for each NHAPS activity. In this assessment a single value of 0.063 was entered for all NHAPS activities. This value when multiplied times the total surface area of the hands of children age two corresponds to an area of 20 cm², see Appendix E. In the June 11 assessment, EPA used a uniform distribution of 0 to 20 cm². Therefore, this distribution includes a factor with a uniform distribution of 0 to 1.0 to capture the variation in the fraction of the hand. Finally, a wet hand factor is included that has an uniform distribution of 1.5 to 3.0.

The distribution for the saliva dislodgeability factor used in the June 11 assessment was sampled directly. The product of each set of sampled value was determined and multiplied times the DTO factor. The distribution of the resulting values is given in Table C.2.

Table C.2. Cumulative Distribution for Turf Oral Post Application (Captures the Variation in the Number of Events/h, Area of Hand, Wet vs. Dry Hand, and Saliva Dislodgeability, and Pesticide Specific DTO Factors)					
Percentile	Bensulide	Trichlorfon	Fenthion	Malathion	Naled
0	2.8E-05	5.5E-06	2.8E-04	2.6E-06	1.4E-05
1	0.034	0.0065	0.33	0.0030	0.017
5	0.29	0.056	2.8	0.026	0.14
75	0.63	0.123	6.2	0.057	0.32
90	1.07	0.21	10.6	0.097	0.54
95	1.4	0.27	14	0.127	0.71
99	2.0	0.40	20	0.18	1.02
100	3.2	0.63	32	0.29	1.61

Cumulative Distribution of Applicator Modifying Factor for Acephate and Malathion Pesticides Applied to Ornamentals

This distribution expresses the variation in the following inputs:

1. Variation in the amount of pesticide applied in a given area.
2. Variation in the area treated.

The amount of pesticide applied per given area is defined as a single input of 2 lb/a., see Table 5.8. In the June 11 assessment EPA used a uniform distribution of 0.9 to 2 lb/a. Therefore, this distribution includes a factor with a uniform distribution of 0.45 to 1.0 to capture the variation in dose.

The area treated for ornamentals is entered in LifeLine™ as a single value of 186 m² (2000 ft²). In the June 11 assessment EPA used a uniform distribution of 50 to 2000 ft². Therefore, this distribution includes a factor with a uniform distribution of 0.025 to 1.0 to capture this variation in the area treated.

The distribution that is the product of these two distributions was created by sampling the two distributions and multiplying the two sampled values and saving the value. The result is presented in Table C.3.

Percentile	Values
0	0.115
10	0.222
50	0.430
90	0.726
95	0.801
99	0.907
1	0.994

Applicator Doses for TCVP Products

Applicator exposures of pet products are determined using the same approach as other homeowner applied pesticides. The inhalation and dermal doses are determined by multiplying a unit exposure times the amount of the pesticide applied. However, the amount applied is defined as a function of three factors, the application rate (normalized to the body weight of the dog), the size of the dog, and the number of dogs treated.

The application rate was characterized by three product-specific uniform distributions:

- For powder, the application rate was represented by a uniform distribution bounded by 21 and 25 mg ai handled/lb of animal;
- For aerosol, the application rate was represented by a uniform distribution bounded by 11 and 15 mg ai handled/lb of animal; and
- For pump spray, the application rate was represented by a uniform distribution bounded by 9 and 10 mg ai handled/lb of animal.

Animal weight and number of pets were each represented by an empirical cumulative distribution. Animal weights were drawn from an empirical distribution represented in Table C.4.

Percentile	Dog Weight (lbs)
1	3
10	11
20	16
30	20
40	23
50	30
60	43
70	55
80	70
90	80
95	89
99	108
100	148

Pet owners were assumed to treat between one and four pets of identical size on a single day. The probability associated with each number of dogs is presented in Table C.5.

Cumulative Percent Probability	Number of Dogs
50%	1
75%	2
90%	3
100%	4

The distribution of the unit exposures used in the June 11 assessment is presented in Table C.6.

Cumulative Percent Probability	Powder		Aerosol & Pump Spray	
	Dermal (mg/mg ai handled)	Inhalation (mg/mg ai handled)	Dermal (mg/mg ai handled)	Inhalation (mg/mg ai handled)
6.7	0.0016667	0.0000004	0.00287	0.0000001
13.3	0.0017328	0.0000005	0.00434	0.0000080
20	0.0021848	0.0000007	0.00503	0.0000090
26.7	0.0022796	0.000001	0.00533	0.0000110
33.3	0.0023325	0.000003	0.00544	0.0000150
40	0.0023699	0.000003	0.0056	0.0000150
46.7	0.0024669	0.000003	0.00588	0.0000170
53.3	0.0028417	0.000005	0.00617	0.0000230
60	0.0030423	0.000005	0.00773	0.0000230
66.7	0.0034921	0.000007	0.00938	0.000028
73.3	0.0040102	0.000008	0.00984	0.0000280
80	0.0040917	0.000011	0.00996	0.0000280
86.7	0.0050375	0.0000114	0.01022	0.0000460
93.3	0.0052139	0.000022	0.01432	0.0000470
100	0.0149053	0.0000238	0.02709	0.000055

LifeLine™ Version 2.0 enters a single value for the amount of pesticide applied to one dog weighing 30 lbs. This single amount is multiplied times the dermal unit exposure and divided by the applicator's body weight to give the dermal dose¹.

To accommodate this variation in the amount applied used in the June 11 assessment, the unit exposures is redefined as the variation in dose that occurs normalized to the amount of TCVP that is applied to a 30 lb dog. The cumulative distributions for these redefine unit exposures reflects:

- The variation in dog weights relative to a 30 lb dog;
- The variation in the number of dogs;
- The variation in the amount of each product applied per lb of dog body weight; and
- The variation in the original unit exposures.

When multiplied times that amount applied to a 30 lb dog the distribution will reconstruct the variation in applicator doses used in the July 11 assessment.

The distribution of the weight of dogs was created by taking the weights of the dogs in Table C.4. and dividing them by 30 lbs. The distribution of the number of dogs was taken directly from Table C.5. The variation in the amount applied per lb of dog was a uniform distribution with minimum and maximum values of 0.84 and 1.0 for powder, 0.73 and 1.0 for aerosol, and 0.9 and 1 for the pump spray. Finally, the distribution of the unit exposures in Table C.6, were sampled.

@Risk was used to sample each of the four distributions and determine the product of the four sampled values. This was done for the dermal and oral routes of each of the three products. The resulting six cumulative distributions are presented in Table C7.

¹Note, since there is no inhalation RPF for TCVP the dermal RPF is used to evaluate the inhalation exposures.

Table C.7. Cumulative Distribution of Applicator Unit Exposures that Reflects Variation in Unit Exposures, Amount of TCVP Applied, Size of Dog, and Number of Dogs						
	Powder		Pump Spray		Aerosol	
Percentile	Dermal (ug/lb ai applied to single dog weighing 30 lbs)	Inhalation (ng/lb ai applied to single dog weighing 30 lbs)	Dermal (ug/lb ai applied to single dog weighing 30 lbs)	Inhalation (ng/lb ai applied to single dog weighing 30 lbs)	Dermal (ug/lb ai applied to single dog weighing 30 lbs)	Inhalation (ng/lb ai applied to single dog weighing 30 lbs)
0	0	0	0	0	0	0
10	0	0.000001	0.000005	0.000006	0.00001	0.000006
50	0.00001	0.000012	0.000024	0.000062	0.000022	0.000057
75	0.000021	0.000035	0.000050	0.000143	0.000045	0.000129
90	0.000039	0.000082	0.000095	0.000279	0.000086	0.000249
95	0.000055	0.000131	0.000132	0.000402	0.00012	0.000364
99	0.000107	0.000275	0.000244	0.000744	0.000217	0.000670
100	0.000405	0.000598	0.000760	0.0017	0.000848	0.001884

Development of a Distribution of an Oral Modifying Factor for Pet Products

Oral exposures to residues on pets are estimated using the same approach as for residues on turf. The inputs to the dose equation are;

- The transferable residue values;
- The duration of interaction with the dog;
- Frequency of contacts with the dog followed by a mouthing event;
- Fraction of the hand placed in the mouth; and
- The dislodgeability of the residues by saliva.

In the June 11 assessment EPA defined distributions for these terms. In order to address the variation described in these distributions a distribution was created based on these factors and the Dermal To Oral (DTO) factor for each product. These distributions are entered as the oral modifying factor for each product.

The entered distribution was created in the following process. The variation in the residue values was included by taking the range of dislodgeable residues reported for each product and divided them by the residue concentration used to derive the dislodgeable fraction (the upper end of the distribution of dislodgeable residues). The resulting empirical distributions are then sampled.

The distribution of durations is described by a triangular distribution (min.= 0.0333, mode 0.108 and max1.025 hr is entered directly². The frequency of contacts used in the June 11 assessment is a triangular distribution. In this assessment the distribution is normalized to the maximum value of 26. This value is entered in OPcumulative.acd as the number of mouthing events. Thus the distribution sampled from is a triangular distribution with a minimum value of 0.4/26 and mode of 9/24 and a maximum value of 24/24. The saliva distribution is entered directly. Each distribution is sampled and the sampled values are multiplied. Finally the DTO factor for TCVP of 1.5 is multiplied times this product to produce of the sampled values. Table C.8. present the resulting distributions for the oral modification factor for each of the TCVP products.

Table C.8. Distribution for Variation in Hand Area, Frequency of Mouthing Events, Duration, and DTO Factor			
Percentile	Powder	Pump Spray	Aerosol
0	0	0	0
1	0.00330	0.00312	0.00284
5	0.0226	0.0214	0.0194
75	0.0510	0.0483	0.0442
90	0.0980	0.0936	0.0858
95	0.137	0.130	0.119
99	0.235	0.225	0.201
100	0.483	0.446	0.45

² Note the user should set the duration of time “playing with pet” to 1 hour in the LifeLine™ User Preferences window.

Plot of $-\ln(C_0/CT)$ vs. Time for Malathion in Gardens

