OP Case Study Group
Non-Dietary Subcommittee

REx

Residential Exposure Assessment
GENERIC METHODS

CASE STUDY:
Lawn Care Products

December 15, 1999

Acknowledgements:
infoscientific.com, Inc.
LS Consulting Service

TABLE OF CONTENTS

I. INTRODUCTION 3

II. DESCRIPTION OF GENERIC VARIABLES 5

III. EXPOSURE ASSESSMENT METHODS FOR RESIDENTIAL LAWN CARE PRODUCTS 11

A. LABEL DIRECTIONS AND PRODUCT USE INFORMATION 11
B. SUMMARY OF GENERIC EXPOSURE MONITORING DATA 11
C. DESCRIPTION OF METHODS 12
1. Potential Adult Inhalation and Dermal Exposures During Application 12
2. Potential Adult Post-Application Inhalation Exposure to Airborne Aerosols (not included) 13
3. Potential Adult Post-Application Dermal Exposure 13
4. Potential Post-Application Inhalation Exposure for Children and Infants 18
5. Potential Post-Application Dermal Exposure for Children and Infants 18
6. Potential Post-Application Incidental Ingestion Exposure for Children 19

IV. REFERENCES 22

ATTACHMENT A 24

ATTACHMENT B 46

ATTACHMENT C 48

I. INTRODUCTION

This case study presents an example of "generic" methods that can be used in the residential exposure assessment tool, **REx,** developed by the OP Case Study Group, Non-Dietary Subcommittee. The example or case study is based on surrogate data and generalized exposure algorithms. Specifically, this case study focuses on potential applicator and post-application "day-of-application" exposures (and absorbed doses) associated with the use of lawn care products. The generic methods described in this case study can be used to derive reasonable, albeit conservative, deterministic and/or probabilistic estimates of potential human residential exposures and absorbed doses to adults and children (of different age groups) on the day of application. Daily exposure estimates subsequent to the day of application can also be estimated using REx, based on user-supplied dissipation rates for each of the relevant exposure media, expressed as fraction lost per day.

This case study relies on publicly available data (see OP Case Study Group public literature review reports – www.infoscientific.com or www.fqpa.com) and on proprietary data generated by the Outdoor Residential Exposure Task Force (ORETF). Where proprietary exposure monitoring data are mentioned and used, only summary data or derived values from the underlying data are presented.

The residential uses of lawn care products involves a variety of product types and associated application methods. The example calculations presented in this case study are based on a hypothetical liquid formulation applied in a broadcast manner by a homeowner using a hose-end sprayer. However, the methods outlined in this case study can be easily modified in REx to estimate potential exposures using other types of application methods and formulations (e.g., drop spreader application of a granular formulation).

In contrast to mixer/loader/applicator or post-application exposure monitoring data developed by the ORETF, this case study also refers to default assumptions currently used by the U.S. EPA in their Standard Operating Procedures for Residential Exposure Assessment (SOPs). The EPA SOPs are based on publicly available data and professional judgement (EPA 1997, 1999a). For example, limited "unit exposure" data exist in the U.S. EPA's Pesticide Handlers Exposure Database (PHED), Version 1.1 (and Version 2.0). PHED was developed by the US EPA's Office of Pesticide Programs to provide surrogate data for specific application scenarios based on measured exposure values for a variety of active ingredients. PHED contains on the order of 2,000 replicates of worker data on measured dermal and inhalation exposures. PHED is commonly being used by registrants and regulatory agencies to supplement and validate field exposure data.

Adequate surrogate data are available to support the use of generic methods to estimate potential post-application exposures. Turf transferable residues (TTRs), for

example, can be based on existing surrogate data to provide generic estimates. The adoption of generic TTRs is based on very consistent measures of immediate post-application transferability (using roller methods, foliar washes or other techniques), across a wide variety of active ingredients and formulation types. In these generic methods dermal exposures, associated with post application activities on treated turf, are bounded, based on contact with treated surfaces and using generic body-part specific transfer factors derived from indoor (carpet) jazzercise passive dosimetry studies conducted by Ross et al. (1990, 1991) or proprietary ORETF turf jazzercise studies. Although these transfer factors are based on 20-minute contact-intensive Jazzercise routines, they have been determined to be sufficiently generic for use in assessing a full day of post-application exposure on turf for adults and children. Furthermore, generic transfer factors of Ross et al. (1990, 1991) are the basis for EPA's current methods for post-application dermal exposure estimation for a variety of scenarios addressed in the EPA's Residential Exposure Assessment Standard Operating Procedures (SOPs; EPA 1997, 1999a). In this case study, incidental ingestion by children associated with hand-to-mouth activity was also bounded based on a macro-activity approach using Jazzercise-based estimates of total hand loading data that probably overestimate hand loading for toddlers, and an assumption regarding the range (e.g., 1 to 10 percent) of the material on the hand that is removed via mouthing activities during the course of an entire day. Alternative micro-activity approaches (e.g., use of a jazzercise-based transfer coefficient and assumptions regarding surface-to-hand transferability, the frequency of hand-to-mouth events, hand surface area involved in mouthing and hand-to-mouth transfer efficiency) have also been proposed in EPA's SOPs (EPA 1999) based in part on videography data available for children (toddlers). The algorithms associated with these approaches are also available in REx, facilitating comparative calculations.

Homeowner applicator and post-application exposures following broadcast treatment of turf are based on consideration of potential adult applicator inhalation and dermal exposures, post-application dermal exposures for adults and children of age 1 to 6 years associated with contact activities on treated turf, and in the case of children 1 to 6 years of age, incidental ingestion resulting from hand-to-mouth activities on the treated turf.

The following sections provide detailed exposure assessment methods for each of the non-dietary exposure pathways and routes included in the lawn care product exposure assessment. The input variables are described in detail. The exposure assessment methods provide in the case study illustrate deterministic, point estimates; however, probability-based (stochastic) simulations using input distributions can also be developed using REx. Route-specific exposures and total (systemic) absorbed dose developed using the algorithms illustrated in this case study are likely to overestimate actual exposures and dose during use of the product under normal anticipated conditions and in compliance with label instructions. Input variables that are common across the non-dietary scenarios are presented in Section II, followed by a description of the exposure algorithms with explanation and documentation regarding the scenario-specific input variables for lawn care (see Sections III and IV, respectively).

II. DESCRIPTION OF GENERIC VARIABLES

The input variables that are common across many scenarios (e.g., lawn care, garden care) include the following (these are provided as part of the "**Inputs - General**" button on the REx "**Control**" panel):

1) Mixer/Loader/Applicator normalized exposure values;
2) Hand-to-mouth transfer fraction;
3) Pulmonary (applicators only), dermal and oral absorption factors;
4) Dermal (body part) surface areas;
5) Inhalation rates; and
6) Body weights.

Two human subpopulations are discussed in the context of the above noted "generic" input variables: adults (male and female, > 17 yrs) and children (male and female, ages 1 - 6 yrs; see "**Inputs – Age Specific**"button on the REx "**Control**" panel). The input variable values used for each of the above noted input variables are described below for each subpopulation, including references for the underlying data. See Attachment B for a printout of the value inputs from REx.

1) Mixer/Loader/Applicator Normalized Exposures for Spray Application to Turf

The Pesticide Handlers Exposure Database (PHED), Version 1.1 or 2.0, can be used to obtain publicly available surrogate exposure monitoring data and "unit exposure" values (i.e., µg or mg a.i. per lb a.i. handled). These data may be used to assess potential outdoor residential mixer/loader/applicator exposures during homeowner mixing/loading or application (M/L/A) of a product on residential turf.

PHED contains mixer/loader/applicator dermal exposure data for outdoor use of belly grinder/granule/open pour, push type granular spreader, low-pressure hand wand/wettable power/open pour, low pressure hand wand/liquid/open pour, backpack/liquid/open pour, liquid/open pour, hose-end sprayers and other application methods that may be relevant for the lawn product scenario. Default unit exposure values currently recommended for use in EPA's SOPs are presented in Appendix B of the draft SOP document (www.epa.gov/pesticides/science). ORETF has developed a proprietary database of M/L/A exposure monitoring data that can be used as alternatives to PHED default values.

2) Hand-To-Mouth Transfer Fraction (*unitless*)

In the current analysis a macro-event exposure modeling approach is used for estimation of potential incidental ingestion exposure amongst toddlers. The macro-event approach is illustrated in the calculations presented in Section III. The macro approach is based on calculating an upper-bound hand loading estimate (dermal exposure) using

jazzercise-based hand transfer factors and assuming that a fraction of hand residue is transferred from the hand to the mouth (incidental ingestion dose) over an entire day's worth of activity. It is important to note that this approach does not include object-to-mouth contribution to total incidental ingested dose. However, available data suggest that object-to-mouth contribution may be negligible for some product use scenarios (e.g., crack-and-crevice; Byrne et al. 1998). Further: 1) the EPA's SOPs do not currently address object-to-mouth contribution; and 2) it is anticipated that this macro hand-to-mouth approach is likely to overestimate actual incidental ingested dose.

As mentioned previously, an alternative, micro-event approach has been recommended as part of the proposed revisions to EPA's SOPs and is based: 1) the use of either a jazzercise-based transfer factors or transfer coefficients; 2) an assumed surface-to-hand residue transfer (expressed as a % of application rate, e.g., 5%); 3) an assumed range of hand-to-mouth events per hour of activity (default = 20 events/hr) based on videography data for toddlers; 4) an assumed range of hand surface area involved in each event (default = 20 cm^2/event); 5) an assumed transfer efficiency for each hand-to-mouth event based on consideration of the water and surfactant solubility of the compound of interest (e.g., 0.1 to 10% for lipophilic, water-insoluble compounds); and 6) an assumed average body weight for toddlers, i.e., 15 kg. The algorithms associated with this approach are also available in REx.

In the case of the macro-event exposure estimation approach, it is assumed that a uniform range of hand-to-mouth removal efficiency for lipophilic compounds can be represented as 0.1 to 10% of residues on hands. Thus, 0.1 to 10% of hand residues would be transferred to the mouth and subsequently ingested as a result of hand-to-mouth behavior among toddlers (1 - 6 years) during the course of an entire day. Hand-to-mouth transfer or removal efficiency (associated with mouthing) for children and infants can be estimated based on available data from hand wash removal efficiency studies. Hand wash removal efficiency data for relatively lipophilic compounds, e.g., alachlor, PCBs, chlorpyrifos, suggest that "water-only" rinsing of media such as powdered stratum corneum results in less than 1 to 5% removal (Wester *et al.*, 1990, Bucks *et al.*, 1989). In contrast, more rigorous solvent-based extraction/rinsing of human skin, using either ethanol or isopropanol/water, can remove approximately 20 to 40% (average is approximately 30%) of low-level hand contamination with chlorpyrifos (Fenske and Lu, 1994). Therefore, based on these collective data, deterministic estimates of potential incidental oral exposures were based on the assumption that up to 10% of residues on hands would be transferred to the mouth and subsequently ingested as a result of multiple hand-to-mouth events during the day among children (1 - 6 years). This value is considered reasonably conservative based on the above noted data and consideration of the relatively low water solubility of most pesticides. This is further supported by consideration of: 1) hand rinse data (and potential ingestion) from children living on farms where pesticides are used (Geno et al. 1996) wherein all measurements were reported to be below 1 ug; 2) adult hand rinse data following structured activities on chlorpyrifos-treated turf (4 lbs a.i. - liquid formulation - per acre application rate; Vaccaro et al 1996) wherein the estimated oral dose contribution, assuming all residues on hands were ingested, was 2.3 ug/kg for infants; and 3) aggregate (total multi-pathway,

multi-route) dose as measured in EPA's National Human Exposure Assessment Survey - preliminary data for children in Minnesota - wherein the maximum value observed for chlorpyrifos was 1.4 ug/kg (SRA Annual Conference Symposium - Implementation of the Food Quality Protection Act of 1996: Development and Validation of Advanced Methods for Assessing Potential Residential Exposures, December 8, 1998, Phoenix, AZ).

3) Pulmonary, Dermal and Oral Absorption Factors (*unitless*)

Absorption of chemicals through biological membranes such as the stratum corneum can be estimated based on molecular weight and other properties, e.g., log Kow; however, it is preferable to have empirical data for at least the dermal route, i.e., measurements of percutaneous absorption. This is often expressed in a simplistic manner as the "fraction absorbed" under specified conditions (formulation, duration of skin contact). Often, as a default assumption in the absence of data, absorption via the lungs and gastrointestinal tract is assumed to be nearly complete, i.e., 100%.

In addition to absorption factors, if toxicokinetic data are available, the elimination half-lives of a chemical should be evaluated and included in advanced tier assessments. The time period relevant for estimation of body burden depends on the exposure and dose metric relevant to the toxicological endpoint(s) of interest. The case study presented in Section III below focuses on estimation of route-specific exposure and total systemic absorbed dose on the day of application.

Pulmonary Absorption. In contrast to potential applicator inhalation exposures, post-application inhalation exposures have been shown to be negligible for many residential pesticides and product use scenarios. If post-application inhalation exposures are being considered for a particular compound, the chemical-specific or chemical class-specific data for pulmonary absorption should be used, if available. In the absence of specific data, a default *point value* of 100% absorption is used. In the context of a stochastic analysis, it is important to note that a *triangular distribution* can be used, which consist of a minimum of 50%, a most likely of 90% and a maximum of 100%. These parameters are based on Raabe (1988) and professional judgement, to acknowledge that deposition and bioavailability will vary depending on the diffusivity and reactivity of the chemical; as well as particle and molecular size, and adsorption to organic matter associated with other airborne particles (which would effectively lower bioavailability and pulmonary absorption).

Dermal Absorption. Chemical- or chemical class-specific data regarding percutaneous absorption can be used if it is available for neat material or for the relevant end-use formulation. For purposes of the current case study, it is assumed that percutaneous absorption data in humans indicates an average "fraction absorbed" during a relevant time frame (i.e., 8 hours) as 3% of the applied dose. If percutaneous absorption rate values, e.g., percent per hour, or permeability coefficients (i.e., cm^2/hr) are available, these are used preferentially to simple "absorption fraction" values. If chemical- or class-specific data are available, a *distributional representation* should be

evaluated to capture variability and uncertainty. For purposes of the stochastic simulation, a hypothetical *uniform distribution* is used consisting of values ranging from 0.025 to 0.035 (2.3 to 3.5%).

Oral (Gastrointestinal) Absorption. Chemical- or chemical class-specific data for oral absorption should be used if available. In the absence of specific data, a default *point value* of 100% absorption can be used. If chemical- or class-specific data are available, a *distributional representation* should be evaluated to capture variability and uncertainty. For purposes of the deterministic (point estimate) calculations included in this case study, the default value of 100% oral absorption is used. For purposes of the stochastic simulation, a hypothetical *triangular distribution* is used consisting of a minimum of 60%, a most likely of 80% and a maximum of 100%.

4) Dermal (Body Part) Surface Areas (cm^2)

Dermal surface area values are specified below for body part areas and correspond to passive dosimeters that are used in exposure monitoring studies (i.e., upper body -- shirt, lower body -- pants, hands -- gloves and feet -- socks). Further, a conservative clothing scenario was assumed for this case study, i.e., sleeveless shirts, short pants, no socks or shoes and no gloves. The body part dermal surface area values used in this lawn care case study were derived from EPA (1999b) and are as follows:

Table 1. Dermal (Body Part) Surface Areas.

		SURFACE AREA (cm^2)	
SCENARIO	**BODY PART**	Adult (male and female)	Child (1-6)
Lawn Care	Upper Body – Uncovered (arms)	2190	1085
	Upper Body – Covered (sleeveless shirt; 2/3 of trunk)	3705	1615
	Lower Body – Uncovered (4/5 legs)	3972	1650
	Lower Body – Covered (short pants; 1/3 trunk + 1/5 legs)	2845	1220
	Hands – Uncovered	793	452
	Feet – Uncovered	1048	553

5) Inhalation Rates (m^3/hr)

Inhalation rates are affected by a variety of individual characteristics. These include age, gender, weight, health status, and levels of activity (e.g., sleeping, walking, running, jogging, etc.). The current EPA Exposure Factors Handbook (1996; 1999b) reviews a variety of studies that provide inhalation rates based on key factors, such as activity level. It summarizes the average hours per day for all age groups spent performing resting-, sedentary-, light-, moderate- and heavy-level activities. This evaluation suggests that both indoors and outdoors, an approximately equal amount of time is spent at resting and light activity levels. For each of the exposure scenarios

evaluated in the current case study, inhalation rates should be selected based on consideration of representative time-activity patterns. In the case of lawn care, post-application inhalation exposure calculations were based on use of an average hourly inhalation rate for *moderate* activity level (across males and females), corresponding to jazzercise (Layton 1993 as cited in EPA 1996). Moderate-level activities also include, for example, heavy indoor cleanup, performance of major indoor repairs and alterations and climbing stairs (EPA 1996). Table 2 provides the point estimate inhalation rates used in the example deterministic and stochastic assessments presented in Section III. Tables 3 and 4 provide the underlying values as reported in EPA (1996) which can be used to establish uniform distributions, i.e., ranges of values for purpose of stochastic simulations, wherein a range of activity levels are assumed to occur during the time period of interest.

Table 2. Summary of Post-Application Inhalation Rates (m^3/hr).

SCENARIO / activity level	Adult	Child (1-6)
LAWN CARE: Moderate activity level (m^3/hr) – deterministic (grand mean)	1.44	0.93
Moderate activity level (m^3/hr) – stochastic (min to max range)	1.2 – 1.74	0.90 – 0.96

SOURCE: EPA 1996; values represent arithmetic averages or ranges across males and females.

Table3. Inhalation Rates for Adults (m^3/hr).
(Source: p. 5-6, Table 5-5, Layton, 1993 as cited in EPA, 1996)

	RESTING	SEDENTARY	LIGHT	MODERATE
Male				
18 - <30	0.43	0.52	0.84	1.74
30 - <60	0.42	0.50	0.84	1.68
60+	0.34	0.41	0.66	1.38
Female				
18 - <30	0.33	0.40	0.66	1.32
30 - <60	0.32	0.39	0.66	1.32
60+	0.30	0.36	0.59	1.2
GRAND MEAN – males and females (m3/hr)	**0.36**	**0.43**	**0.71**	**1.44**

Table 4. Inhalation Rates for Children (m^3/hr).
(Source: p. 5-6, Table 5-5, Layton, 1993 as cited in EPA, 1996).
CHILDREN 1 - 6 YRS[1]

	RESTING	SEDENTARY	LIGHT	MODERATE
Male				
3 - <10	0.24	0.29	0.49	0.96
Female				
3 - <10	0.23	0.27	0.45	0.9
GRAND MEAN – males and females				
	0.24	**0.28**	**0.47**	**0.93**

[1]Based on data for children 3 - <10 years old (EPA, 1996)

6) Body Weight (*kg*)

The mean body weight across male and female adults (18 < 75 years old) is 71.8 kg (male average is 78.1 kg; female average is 65.4 kg) (EPA 1996). Thus, for purposes of screening-level calculations, 71.8 kg is used as a point estimate to represent an adult average value (male and female). Adult (male and female) body weight can also be represented as a lognormal distribution with a mean of 70.6 and a geometric mean of 1.22 (EPA 1996).

The mean body weight across male and female children (2 - 7 years old) is 18.9 kg (EPA 1996). Thus, this point estimate can be used to represent average values for male and female children, 1 - 6 yrs old. Children's (male and female, 1 – 6 yrs of age) body weight can also be represented as a lognormal distribution with a mean of 16.15 kg and a geometric mean of 1.22 kg (EPA 1996).

III. EXPOSURE ASSESSMENT METHODS FOR RESIDENTIAL LAWN CARE PRODUCTS

This section presents methods used to assess potential multi-pathway, multi-route applicator and post-application exposure and absorbed dose to a hypothetical lawn care chemical associated with homeowner application of a liquid formulation product using a hose-end sprayer application for broadcast treatment. Methods are presented to address potential adult applicator exposure and absorbed dose, and post-application exposures and absorbed doses to adults and children (1-6 years old). Consistent with a first "tier" or "screening-level" assessment, various conservative biases are included in the methodology. Deterministic calculations are presented. Attachment B presents a printout of the value inputs from REx. REx also supports probability-based or stochastic simulations using Monte Carlo methods. Attachment C presents the inputs and results of a "stochastic" version of the deterministic calculations presented in this section.

A. Label Directions and Product Use Information

Hypothetical use directions, as instructed on the label are assumed as follows:

> Can be applied to turfgrass using a hose-end sprayer. Repeat at 7 to 10 days as necessary. Do not exceed 2 applications per year. Apply no more than 4 lbs a.i. per acre, per application. Apply prior to anticipated pest infestation.

B. Summary of Generic Exposure Monitoring Data

Surrogate field study data relevant to residential lawn treatment are used to support generic methods for estimation of potential applicator and post-application exposures. For the applicator exposure estimation, inhalation and dermal unit exposure data developed by the ORETF or from PHED can be used. For the post-application dermal and incidental ingestion exposure estimation, adequate surrogate data exist in the public domain and from ORETF representing turf transferable residues and passive dosimetry relevant to initial periods of reentry (day 0 post-application). The publicly available data include those described by EPA (1999). For example, these include Hurto and Prinster (1993) and Ross et. al (1990, 1991). These studies are summarized in the OP Case Study Group's Tier I and II reports and in EPA (1999). Hurto and Prinster (1993), for example, provide a generic understanding of dislodgeable foliar residues (used as a surrogate for transferable residues) immediately following application, i.e., 3 to 6% of application rate. The proposed default value for turf transferable residues to be used in the EPA's SOPs is 5% of the application rate (assuming a roller method is used to measure transferability). Ross et. al. (1990, 1991) provide a means for derivation of body-part specific transfer factors to estimate dermal exposure. Transfer factors (TFs) derived for chlorpyrifos were used in the turf case study presented herein.

C. Description of Methods

The following section provides a description of the equations and key input variables used for assessing potential applicator and post-application exposures associated with the use of a hypothetical liquid hose-end spray product for treating lawns. Only non-generic variables are discussed, given that the generic variables were presented in Section II.

1. Potential Adult Inhalation and Dermal Exposures During Application

Potential inhalation and dermal adult homeowner applicator exposures can be based on the use of default "unit exposures", which are derived from the Pesticide Handlers Exposure Database (PHED). For purposes of the example calculation shown below, hypothetical geometric mean unit exposure value for hose-end sprayer application are used; these values are consistent with other data sources. The equations, which are analogous to those recommended in the EPA's Standard Operating Procedures (SOPs) for Residential Exposure Assessment for screening-level, point estimates of absorbed dose can be expressed as follows (average adult):

Equation 1.

$$Exposure = \frac{(UnitExposure)_{inh} \times (Application) \times (CorrectionFactor) \times (AreaTreated) \times (mg/1{,}000ug)}{(ReferenceDuration) \times (BodyWeight)}$$

Table 5. Variables for Estimating Adult (average adults – male and female and females of reproductive age) Inhalation Absorbed Dose During Application.

VARIABLES	UNITS	VALUE
Unit Exposure (Inhalation) (Applicator) (Area treated)	*mg/lb ai*	**0.000004**
Application (Amount A.I. Applied)	*lb ai/acre*	**4.0**
Correction Factor (To Unit exposure, Inhalation)	*Unitless*	**1**
Area Treated	*Acre*	**0.92**
Reference Duration	*Day*	**1**
Body Weight (adult)	*Kg*	**71.8**
Pulmonary Absorption Factor	*Unitless*	**1**
Exposure	*mg/kg/day*	**0.000000205**
Absorbed Dose	*mg/kg/day*	**0.000000205**

Equation 2.

$$Exposure = \frac{(UnitExposure)_{der} \times (Application) \times (CorrectionFactor) \times (AreaTreated) \times (mg/1{,}000ug)}{(ReferenceDuration) \times (BodyWeight)}$$

Table 6. Variables for Estimating Adult (average adults - male and female and females of reproductive age) Dermal Absorbed Dose During Application.

VARIABLES	UNITS	VALUE
Unit Exposure (Dermal) (Applicator) (Area treated)	*mg/lb ai*	**0.075**
Application (Amount A.I. Applied)	*lb ai/acre*	**4.0**
Correction Factor (To Unit exposure, Dermal)	*Unitless*	**1**
Area Treated	*Acre*	**0.92**
Reference Duration	*Day*	**1**
Body Weight (adult)	*Kg*	**71.8**
Dermal Absorption Factor	*Unitless*	**0.03**
Exposure	*mg/kg/day*	**0.00384401**
Absorbed Dose	*mg/kg/day*	**0.00011532**

In addition to the inhalation and dermal unit exposure values used, another key input variable is area of lawn treated. A central tendency estimate of 0.92 acres has been reported by Vinlove and Torla (1995) based on data collected for ten states by the Federal Housing Authority (FHA). This value can be used as a default assumption; however, this value is likely to be an overestimate based on alternative data from the 1995 American Housing Survey and lawn care companies. For purpose of the example calculations provided above it was assumed that 0.92 acres were treated.

2. Potential Adult Post-Application Inhalation Exposure to Airborne Aerosols (not included)

In the case of consumer-applied hose-end sprayer formulations containing non-volatile chemicals, potential post-application inhalation exposures are considered to be negligible and thus, are not included in this assessment. If chemical-specific or surrogate chemical air monitoring data are available (particle- and/or vapor-phase), algorithms provided in REx can be used to evaluate inhalation exposures. It is important to note that in the case of using surrogate air monitoring data, appropriate adjustments should be considered for factors such as differences in application rates between the product being evaluated and the product used in the monitoring study, vapor pressure and molecular weight.

3. Potential Adult Post-Application Dermal Exposure

For estimating potential post-application dermal contact with treated residential turf, as noted above, surrogate data can be used (see Appendix A – study reviews for Hurto and Prinster, 1993; Ross et al., 1990, 1991; also see EPA 1999 for proposed revisions to EPA's SOP). These surrogate data provide a means for conservatively estimating potential post-application dermal exposures.

A substantial database regarding turf transferable residues (TRs) has been developed by the ORETF. These data indicate remarkable comparability during initial post-application time periods (i.e., day 0), across active ingredients, formulation types and methods of measurement. Taken as a weight-of-evidence, the data indicate that liquid formulation TRs are typically 1% or less and granular formulation TRs are typically 0.1% or less. Figures 1 and 2 present percentile distributions of TRs (expressed as a percentage of application rate) for liquid and granular formulations, respectively. For purposes of the example deterministic dermal exposure calculations presented below, the TR is assumed to be 5% of the application rate. In the case of the stochastic simulation, TRs can typically be represented by a user-specified geometric mean and geometric standard deviation provided the underlying data fit a lognormal distribution.

FIGURE 1. LIQUID FORMULATIONS - Percentile distribution of turf transferable residues (TTRs; includes drag sled, California roller, ORETF roller and shoe shuffle measurement methods).

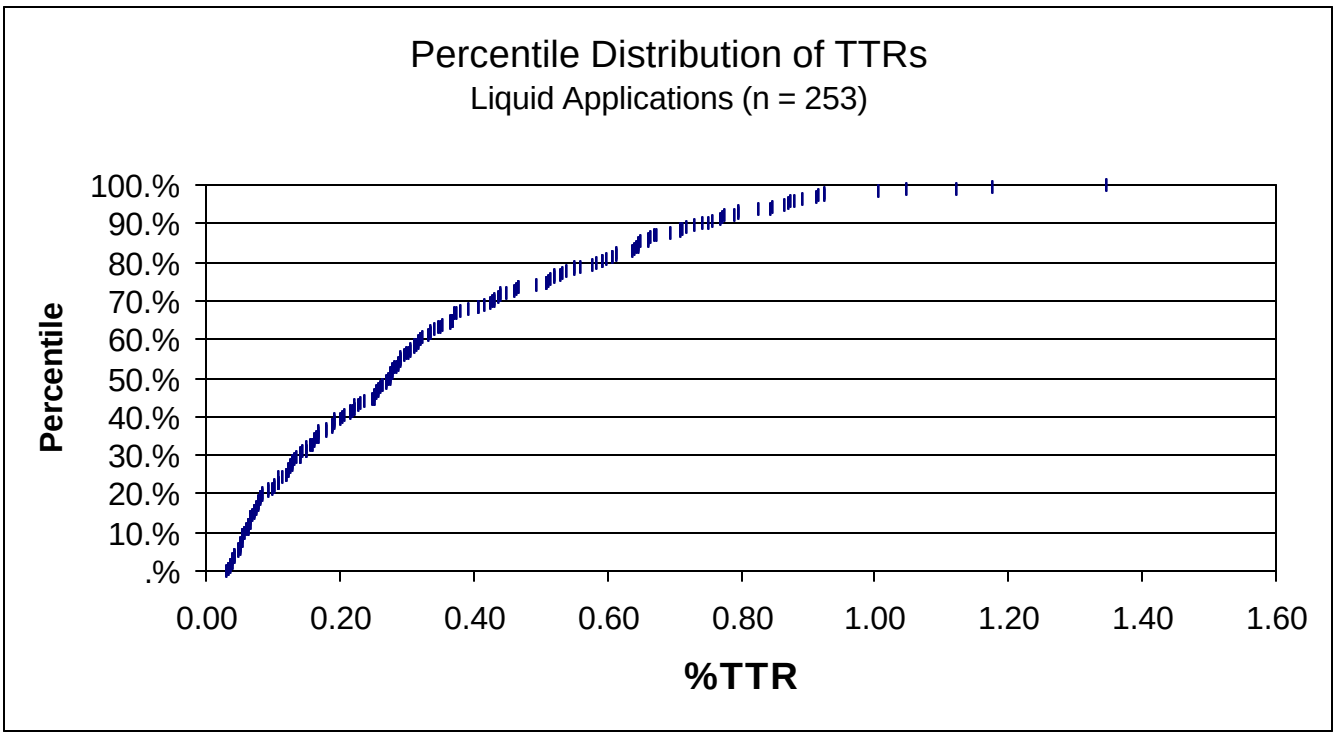
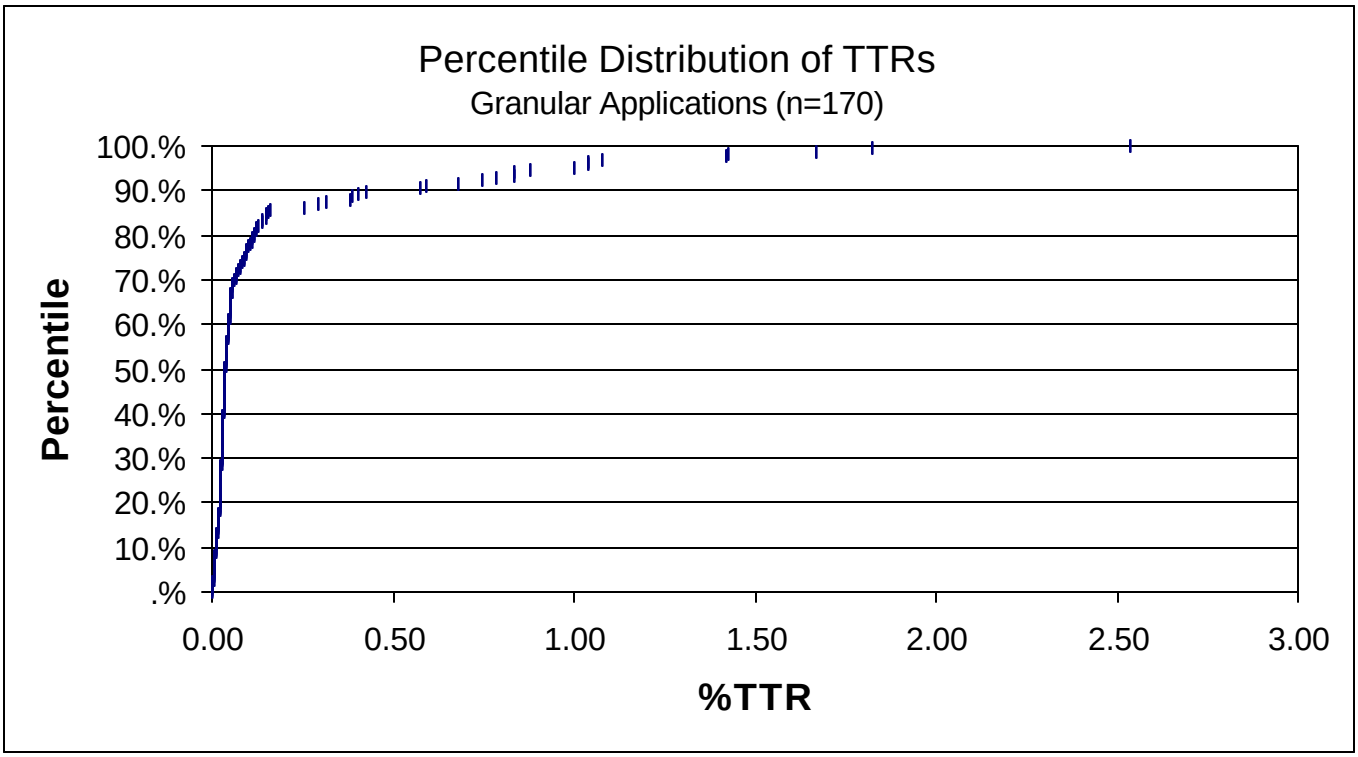


FIGURE 2. GRANULAR FORMULATIONS - Percentile distribution of turf transferable residues (TTRs; includes drag sled, California roller, ORETF roller and shoe shuffle measurement methods).



The procedure for estimating potential dermal exposure is based on the use of generic "transfer factors" or TFs, in this case, derived from Ross et al. 1990, 1991. The unitless TFs represent an activity-specific basis for estimating dermal loading ($\mu g/cm^2$) for various anatomical regions based on transferable residue data ($\mu g/cm^2$). The transferable residues are measured using the CDPR roller method (Ross *et al.*, 1990, Ross *et al.*, 1991). This method results in upper-bound estimates of potential dermal exposure, given that jazzercise represents a "high contact" activity, relative to more typical activities that occur on residential turf. Distributional data for body-part-specific TFs have been collected by the ORETF across four jazzercise-based turf exposure monitoring studies. Similar to TRs across chemicals and formulations, TFs are also "generic" during initial periods of re-entry (i.e., day 0). Thus, for purposes of stochastic simulations, the "day 0" body-part-specific TF distributions can be expressed as geometric means and geometric standard deviations.

Using the TF approach, potential dermal absorbed dose estimates for adults can be calculated as follows (average adult - male and female presented):

Equation 3.

Post-Application Dermal Absorbed Daily Dose$_{\text{lawn care}}$ =

$$Exposure = \frac{(Transferable\ Residue) \times (Correction\ Factor) \times \Sigma[(Transfer\ Factor) \times (Surface\ Area)]}{(Reference\ Duration) \times (Body\ Weight)}$$

Table 7. Variables for Estimating Adult Post-Application Dermal Absorbed Daily Dose.

VARIABLE	UNITS	VALUE
Transferable Residue (5% of application rate)	*mg/cm^2*	**0.00224**
Correction Factor (To Transferable Residue)	*Unitless*	**1.0**
Σ (Transfer Factor x Surface Area)	*cm^2*	**47054.95**
Reference Duration	*day*	**1**
Body Weight (adult)	*kg*	**71.8**
Dermal Absorption Fraction	*Unitless*	**0.03**
Exposure	*mg/kg/day*	**1.468010**
Absorbed Dose	*mg/kg/day*	0.0440403

a. Transferable Residue (mg/cm^2)

A conservative representation of mean transferable residues are assumed to be 5% (0.00224 mg/cm^2) of the application rate, i.e., 4.0 lbs a.i./acre or 44.8 µg/cm^2, at time = 0 hrs (approximately 2 hours post application when residues were dry) through day 1 (approximately 24 hours post application) based on Hurto and Prinster (1993), other data cited in EPA 1999, and ORETF proprietary data. As noted above, alternatively, many empirical TR data sets have been shown to fit a lognormal distribution and thus, could be represented by a geometric mean and geometric standard deviation.

b. Dermal Experimental Correction Factor

This factor was not necessary given that transferable residues are expressed as a percentage of application rate. If relevant, it is used to adjust the "mg" of dermal exposure derived summation calculations described above, based on the amount of active ingredient applied from the product used in the dermal monitoring study versus the amount of active ingredient applied from the product being evaluated.

c. Summation of Body-Part Specific Exposures

This exposure summation is a representation of the combination of body-specific transfer factors, transferable residue, and body-part surface area. The

generic TFs were calculated from the jazzercise dermal passive dosimetry and transferable residue studies of Ross et al. (1990, 1991). Attachment A (see Ross et al. 1990, 1991 study reviews) provides a detailed description of the TF derivation. Table 8 provides the body part surface areas and TFs used in the dermal exposure calculations for adults.

Table 8. Body Part Surface Areas and Transfer Factors Used for Dermal Exposure Calculations.

ADULT Body Parts*	***Surface Area (cm^2)***	**Transfer Factors (unitless)**
Upper Body – Uncovered (arms)	2190	3.1
Upper Body - Covered (sleeveless shirt; 2/3 of trunk)	3705	0.31**
Lower Body – Uncovered (4/5 legs)	3972	3.2
Lower Body – Covered (short pants; 1/3 trunk + 1/5 legs)	2845	0.32**
Hands (gloves)	793	11.8
Feet (socks)	1048	15.4

* It was assumed that adults are wearing sleeveless shirts, short pants and no shoes, socks, or gloves.

** Dosimeter clothing penetration was assumed to be 10% relative to uncovered body part loading; thus, covered TFs were assumed to be 10-fold lower than uncovered TFs. This accounts for differences in the amount of chemical residue (dermal loading) that penetrates a single layer of clothing and potentially contacts the skin surface versus the loading on the outside of dermal dosimeters, which is assumed to be the loading on bare, uncovered skin. Proprietary data indicate that inner dosimeter-based TFs are approximately 100-fold lower than uncovered TFs.

Table 9. Example of Adult Dermal Exposure Calculations by Body Part Region

Body Part Region	TF	TR (mg/cm^2)	SA (cm^2)	Dermal Exposure (mg)
Upper Body (uncovered)	3.1	0.00224	2,190	15.21
Upper Body (covered)	0.31	0.00224	3,705	2.57
Lower Body (uncovered)	3.2	0.00224	3,972	28.47
Lower Body (covered)	0.32	0.00224	2,845	2.04
Hands	11.8	0.00224	793	20.96
Feet	15.4	0.00224	1,048	36.15
TOTAL EXPOSURE (mg)				**105.4**

TF = Transfer Factor TR = Transferable Residue SA = Surface Area

4. Potential Post-Application Inhalation Exposure for Children and Infants

As noted previously, in the case of homeowner-applied hose-end sprayer formulations containing non-volatile chemicals, potential post-application inhalation exposures are considered to be negligible and thus, are not included in this assessment.

5. Potential Post-Application Dermal Exposure for Children and Infants

As described above, for estimating potential adult post-application dermal contact with treated lawns, the Hurto and Prinster (1993) and Ross et al. (1990, 1991) studies were used. These studies provide a means for conservatively estimating potential post-application dermal exposures to treated lawn surfaces for children and adults. As noted previously, the procedure for estimating potential dermal exposure is based on the use of "transfer factors."

The general equation for estimating potential dermal absorbed dose is as follows:

Equation 4.

Post-Application Dermal Absorbed Daily $Dose_{lawn\ care}$ =

$$Exposure = \frac{(Transferable\ Residue) \times (Correction\ Factor) \times \Sigma[(Transfer\ Factor) \times (Surface\ Area)]}{(Reference\ Duration) \times (Body\ Weight)}$$

Table 10. Variables for Estimating Post-Application Dermal Absorbed Daily Dose to Children and Infants.

CHILDREN:

VARIABLE	UNITS	VALUE
Transferable Residue from Derm Monit Study	mg/cm^2	**0.00224**
Correction Factor (To Transferable Residue)	*unitless*	**1.0**
Σ (Transfer Factor x Surface Area)	cm^2	**23384.35**
Reference Duration	*day*	**1**
Body Weight (child: age < 1 year)	*kg*	**18.9**
Dermal Absorption Factor	*unitless*	**0.03**
Exposure	*mg/kg/day*	**2.771479**
Absorbed Dose	*mg/kg/day*	**0.08314437**

a. Transferable Residue (mg/cm^2)

As noted previously, the mean arithmetic transferable residue was conservatively assumed to be 3% of the application rate, i.e. 0.00144 mg/cm^2, at times 0 hr to 24 hr, based on data from a "surrogate" study conducted by Hurto and Prinster (1993), EPA (1999) and ORETF TR monitoring data.

b. Dermal Experimental Correction Factor

As noted previously, this factor is not necessary.

c. Summation of Body-Part Specific Exposures

As noted previously, this exposure summation is a representation of the combination of body-specific transfer factors, transferable residues, and surface area. Body part areas used for children and infants were as follows:

Table 11. Body Part Surface Areas for Dermal Exposure Calculations.

Body Part	**Surface Area** (cm^2) ***Children 1-6 yrs***
Upper Body – Uncovered (arms)	1085
Upper Body – Covered (sleeveless shirt; 2/3 of trunk)	1615
Lower Body – Uncovered (4/5 legs)	1650
Lower Body – Covered (short pants; 1/3 trunk + 1/5 legs)	1220
Hands (gloves)	452
Feet (socks)	553

In the case of potential post-application dermal exposures to children following turf treatment, the "clothing scenario" that was used conservatively assumed sleeveless shirts, short pants and no shoes, socks, or gloves.

6. Potential Post-Application Incidental Ingestion Exposure for Children

Potential post-application incidental ingestion exposures are assumed to result from dermal contact (hands) with treated lawns, followed by "hand-to-mouth" transfer for children (1 - 6 years). For purposes of this assessment, a conservative method was developed for estimating potential upper-bound incidental ingestion exposure and absorbed dose based on transferable residue data from the Ross et al. (1990, 1991) jazzercise study. As noted previously, these studies provide a means for conservatively estimating potential post-application dermal (hand) exposures from treated lawns and subsequent hand-to-mouth transfer. Jazzercise represents a "high-level contact" activity that results in much higher exposures than would likely result from typical activities performed by children and infants, e.g., walking, running, crawling, etc. Given the conservative nature of using hand transferable residue data from 20 minutes of jazzercise, the resulting estimates are considered to bound potential incidental oral exposure/absorbed dose for the entire day following application of a lawn care product.

As described previously, the procedure for estimating potential dermal exposure to the hands is based on the use of "transfer factors" or TFs derived from Ross et al.

(1990, 1991). The general equation for estimating potential dermal exposure to hands and subsequent incidental oral absorbed dose is as follows:

Equation 5.

Post-Application Incidental Ingestion Absorbed Daily Dose$_{\text{lawn care}}$=

$$Exposure = \frac{(Transferable\ Residue) \times (Correction\ Factor) \times (Transfer\ Factor)_{Hand} \times (Surface\ Area)_{Hand} \times (Hand\ to\ Mouth\ Transfer)}{(Reference\ Duration) \times (Body\ Weight)}$$

Table 12. Variables for Estimating Incidental Ingestion Absorbed Daily Dose.

CHILDREN:

VARIABLE	UNITS	VALUE
Transferable Residue from Derm Monit Study	*mg/cm^2*	**0.00224**
Correction Factor (To Transferable Residue)	*unitless*	**1.0**
Transfer Factor – hands	*unitless*	**11.8**
Dermal Surface Area - hands (uncovered) (child: 1 < age < 6)	*cm^2*	**452**
Hand to Mouth Transfer Fraction	*unitless*	**0.1**
Reference Duration	*day*	**1**
Body Weight (child: 1 year < age < 6 years)	*kg*	**18.9**
Oral Absorption Fraction	*unitless*	**1**
Exposure	*mg/kg/day*	**0.06321304**
Absorbed Dose	*mg/kg/day*	**0.06321304**

a. Transferable Residue (mg/cm^2)

As noted previously, the mean arithmetic transferable residue was assumed to be 5% of the application rate, i.e., 0.00224 mg/cm^2, at times 0 hr to 24 hr, based on data from a "surrogate" study conducted by Hurto and Prinster (1993), EPA (1999) and ORETF TR monitoring data.

b. Dermal Experimental Correction Factor

As noted previously, this factor is not necessary.

c. Transfer Factor - Hands & Dermal Surface Area - Hands

The hand TF, i.e., 11.8, is described in Attachment A (see Ross et al. 1990, 1991 study reviews). Average hand surface area is 452 cm^2 for children (Layton, 1993 as cited in EPA, 1996).

d. Hand-to-Mouth Transfer Fraction (unitless)

Total daily hand-to-mouth transfer for children can be estimated based on available data from hand wash removal efficiency studies. These studies are described in Section II. For purposes of screening-level estimates, it was assumed that approximately 10% of residues on hands would be transferred to the mouth

and subsequently ingested as a result of hand-to-mouth behavior among children (1 - 6 years). This can also be represented as a *triangular distribution* to illustrate variability and uncertainty, using a minimum of 0.01%, a most likely of 1% and a maximum of 10%.

IV. REFERENCES

Bucks, D.A.W., R.C. Wester, M.M. Moyaben, D. Yang, H.I. Maibach and D.L. Coleman. 1989. *In vitro* percutaneous absorption and stratum corneum binding of alachlor: effect of formulation dilution with water. Toxicol. Appl;. Pharmacol. 100:417-423.

EPA (U.S. Environmental Protection Agency). 1997. SOPs for Residential Exposure Assessments. 6/12/97.

EPA (U.S. Environmental Protection Agency). 1999a. Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessment. Presented to the EPA Science Advisory Panel for the meeting on September 21, 1999. U.S. EPA, OPP, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1999b. Exposure Factors Handbook. U.S. Environmental Protection Agency, National Center for Environmental Assessment, Washington, D.C. EPA/C-99/001 (February 1999 CD Rom version).

EPA (U.S. Environmental Protection Agency). 1996. *Exposure Factors Handbook*. Washington, DC: Exposure Assessment Group, Office of Health and Environmental Assessment, Office of Research and Development. USEPA Publication No. 600/8-89/043. P 5-20 Table 5-19, p 5-6 Table 5-5, p 7-1 Table 7-1, p 7-1 Table 7-2.

Fenske, R. and C. Lu. 1994. Determination of handwash removal efficiency: incomplete removal of chlorpyrifos from skin by standard handwash techniques. Am. Ind. Hyg. Assoc. J. 55:425-432.

Geno, P. W., Camann, D. E., Harding, H. J., Villabos, K., and Lewis, R. G. 1996. "Handwipe Sampling and Analysis Procedure for the Measurement of Dermal Contact with Pesticides." *Archives of Environmental Contamination and Toxicology*(30), 132-138.

Hurto, K.A. and M.G. Prinster. 1993. Dissipation of turfgrass foliar dislodgeable residues of chlorpyrifos, DCPA, diazinon, isophenfos and pendimethalin. In: Pesticides in Urban Environments, Chapter 9, pp. 86 - 99. American Chemical Society, Washington, D.C.

Raabe, O.G. 1988. Inhalation Uptake of Xenobiotic Vapors by People. Contract No. CARB A 5-155-33 (March 1988). University of California, Davis California.

Ross, J. H.R. Fong, T. Thongsinthusak, S. Margetich and R. Krieger. 1991. Measuring potential dermal transfer of surface pesticide residue generated from indoor fogger use: using the CDFA roller method - interim report II. Chemosphere 22:975-984.

Ross, J., T. Thongsinthusak, H.R. Fong, S. Margetich, R. Krieger. 1990. Measuring potential dermal transfer of surface pesticide residue generated from indoor fogger use: an interim report. Chemosphere 20:349-360.

Vaccaro, J.R., R.J. Nolan, P.G. Murphy and D.B. Berbrich. 1996. The use of unique study design to estimate exposure of adults and children to surface and airborne chemicals. ASTM Publication 1287.

Vinlove, F.K. and R.F. Torla. 1995. Comparative estimations of U.S. home lawn area. J. Turfgrass Management. 1(1): 83-97.

Wester, R.C., H.I. Maibach, D.A.W. Bucks, J. McMaster and M. Mobayen. 1990. Percutaneous absorption and skin decontamination of PCBs: in vitro studies with human skin and in vivo studies in the rhesus monkey. J. Toxicol. Environ. Health 31:235-246.

ATTACHMENT A

Review of Surrogate Post-Application Exposure Monitoring Data – Lawn Care

I. STUDY CITATION

STUDY TITLE: Dissipation of turfgrass foliar dislodgeable residues of chlorpyrifos, DCPA, diazinon, isophenfos and pendimethalin

AUTHOR(S): Hurto, K.A. and M.G. Prinster

DATE: 1993

SOURCE: In: Pesticides in Urban Environments, Chapter 9, pp. 86 - 99. American Chemical Society, Washington, D.C.

II CORE CRITERIA (TIER I)

PRODUCT USE SCENARIO:

Field studies were conducted to determine the influence of post-treatment irrigation on dislodgeable foliar residues (DFRs) following commercial applications to Kentucky bluegrass turf (typical of well-maintained residential lawn area).

FORMULATION TYPE:

Commercial formulations of Dacthal 75WP (pendimethalin; ISK Biotech), Dursban 4EC (chlorpyrifos; Dow Elanco), Diazinon AG-500 (diazinon; Prentiss Drug and Chemical Co.) And Oftanol 2F (isophenfos; Miles, Inc.).

APPLICATION METHOD:

A CO_2-propelled small plot sprayer equipped with a Lesco/Chemlawn spray gun and 4GPM nozzle.

SITE OF APPLICATION:

Treatments were applied to a 4-yr-old stand of "Baron:Merion:Glade Kentucky bluegrass growing on Blount silt loam soil (32% sand, 36% silt, 32% clay) in Delaware, Ohio that was mowed weekly at 7.6 cm, irrigated as needed to avoid usual drought stress, and was fertilized four times per growing season to supply 195 kg N/hectare from a complete fertilizer source. The turf quality and density was reported as typical of a well-maintained residential lawn. Three days before treatments were applied, the site was mowed and irrigated. The lawn treatment plots were 3.8 x 6.1 m.

ACTIVITY DESCRIPTION & CONDITIONS:

An applicator certified in the use of Lesco/Chemlawn spray guns, applied the treatments in a manner consistent with "normal use" practices. The gun is held at waist height and angled down toward the turf. To treat the gun is swept parallel to the ground with a left-to-right-to-left arm swing motion as the applicator moves forward across the turf. The effective spray swath is 4 m. The spray is uniformly applied across the treatment area using a 50% overly spray pattern. Wind speed, air temperature, relative humidity and soil temperature at 8 cm were recorded at the time of application. Rainfall occurrence and irrigation were recorded for the duration of the study (see Table 1, Hurto and Prinster, 1993).

APPLICATION REGIMEN:

Each pesticide treatment was prepared as a tank mixture with fertilizer solution. The spray gun was calibrated to deliver 63 ml/sec flow rate of formulation. Exactly 3.8 liters of spray mixture was applied per plot. The application rate for each active ingredient/formulation was as follows:

DATE APPLIED	6-June-88	23-June-88
APPLICATION RATE	DCPA 75WP - 11.8 kg/ha	chlorpyrifos 4EC - 1.1 kg/ha
	Isophenfos 2F - 2.2 kg/ha	diazinon 4EC - 6.2 kg/ha

PPE:

Not specified (purpose of study was to measure DFRs, not mixer/loader/applicator exposures).

SAMPLING & ANALYTICAL METHODS:

SAMPLE TYPE

Foliar Surface Area:

Dislodgeable foliar residue was measured as the weight of pesticide residue per foliar surface area. Turfgrass foliar surface area was determined from leaf blade lamina dissected from tillers collected in 10.8 cm diameter turf cores removed from the treated plots for each study date. Grass clippings were positioned on a 10 cm x 10 cm template and weighed to determine weight of grass blades per 200 sq. cm of foliar surface area (both sides of leaves).

DFR:

Grass clippings to be analyzed for pesticide residues were collected from treatment plots using a rotary mower set at 5 cm cutting height. Subsamples of 50 gm foliage were removed for residue analysis. Subsamples were wrapped in aluminum foil, enclosed in a sealable bag and refrigerated until the next morning when residues were extracted.

Grass clipping samples and residue extraction was typically completed at 12 hours post-application and 1, 2, 3, 7 or 8, and 14 days post-application. Dislodgeable pesticide residues were estimated using a detergent stripping procedure developed by Gunther et al. (1973; Bull. Environ. Contam. Toxicol. 9:243-249) and modified by Iwata et al. (1977; Bull. Environ. Contam. Toxicol. 18:649-655).

DETECTION LIMIT(S):

Not specified.

RESULTS AND CONCLUSIONS:

Pesticide concentration retained in the upper canopy of lawn turf immediately after treatment varied among treatments. Normalized for application rate (equivalent to 1.1 kg/ha), concentration of total residues at 1 hour post-application were similar for pendimethalin, chlorpyrifos and diazinon (0.60 ± 0.07 $\mu g/cm^2$), while levels were almost twice as high for DCPA and isophenfos (1.18 ± 0.09 $\mu g/cm^2$). It is important to note that irrigation was withheld from plots until 4 days after treatment or longer. Thus, applied formulation was not "watered in" or irrigated immediately following application and thus, the post-application samples do not reflect typical or normal practices.

Total residue on foliage dissipated rapidly within 2 days for all pesticide treatments. Irrigation reduced total residue of pesticides evaluated. DCPA levels decreased 65.7% and 24.6%, respectively 2 days post-application for irrigated and non-irrigated treatments.

Dislodgeable residues as a percent of targeted application rate ranged from a low of 0.6% for chlorpyrifos to a high of 10.7% for isophenfos two hours post-application (see exemplary results in Table 1 below). Irrigation after treatments had dried on the foliage did not have a significant affect on reducing concentration of diazinon or chlorpyrifos dislodged from foliage at any sampling date after application.

TABLE 1. Effects of irrigation on concentration of pesticide residues found in clippings harvested over time from a Kentucky bluegrass lawn turf: dislodgeable residues as percentage (%) of nominal application rates.

Post-Application Sampling Interval	Chlorpyrifos 4EC		Diazinon 4EC		Isophenfos 2F	
	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated
2 hrs	0.96 ± 0.01	0.62 ± 0.22	7.98 ± 0.91	5.56 ± 2.50	6.61 ± 0.76	10.65 ± 4.1
1 day	0.46 ± 0.07	0.40 ± 0.11	2.66 ± 0.94	2.97 ± 1.12	3.63 ± 0.53	8.62 ± 4.15
2 days	0.39 ± 0.03	0.36 ± 0.11	2.00 ± 0.77	1.61 ± 0.71	2.40 ± 0.17	5.36 ± 2.04
3 days	0.33 ± 0.02	0.22 ± 0.03	1.83 ± 0.23	1.68 ± 0.37	1.99 ± 0.22	3.67 ± 0.77
7 days	0.23 ± 0.02	0.20 ± 0.06	0.64 ± 0.16	0.58 ± 0.33	1.04 ± 0.25	1.74 ± 0.93
14 days	0.12 ± 0.04	0.08 ± 0.00	0.16 ± 0.06	0.10 ± 0.01	0.47 ± 0.16	0.48 ± 0.13

Predicted dissipate rates of foliar dislodgeable residues estimated using the following linear regression equation:

$Y = 10^{a+bX}$

Where Y = concentration of residue ($\mu g/cm^2$) at each sampling time (X).

Regression equations and correlation coefficients for isophenfos, diazinon and chlorpyrifos dissipation were as follows:

ACTIVE INGREDIENT	IRRIGATION DISSIPATION RATE	NON-IRRIGATION DISSIPATION RATE
Isophenfos	$Y = 10^{-0.39 - 0.08 X}$; $r^2 = -0.953$	$Y = 10^{-0.12 - 0.09 X}$; $r^2 = -0.958$
Diazinon	$Y = 10^{-0.07 - 0.12 X}$; $r^2 = -0.964$	$Y = 10^{-0.06 - 0.13 X}$; $r^2 = -0.988$
Chlorpyrifos	$Y = 10^{-1.53 - 0.07 X}$; $r^2 = -0.990$	$Y = 10^{-1.63 - 0.08 X}$; $r^2 = -0.978$

The results of this study suggest that foliar dislodgeable residues, based on the measurement method used, dissipate "naturally" at a rapid rate, dropping to less that 10% of target application rate within 1 day post-application, to less that 5% and 2%, respectively at 3 and 7 days post-application, and to below 1% by 14 days post-application. Further, irrigation significantly reduces levels of pesticides in some formulation types (e.g., dry or aqueous-based formulations), but not as much with others (e.g., EC formulations).

III OTHER CONSIDERATIONS (TIER II)

QUALITY ASSURANCE DATA:

Non-GLP study.

ANALYTICAL RECOVERIES:

Not specified.

RECOVERY EFFICIENCY CORRECTION:

Not specified.

FIELD FORTIFICATION SAMPLES:

Not specified.

NUMBER OF REPLICATES:

Replicate samples were analyzed; however, number of replicates is not specified.

I. STUDY CITATION

STUDY TITLE: Measuring potential dermal transfer of surface pesticide residue generated from indoor fogger use: an interim report.

AUTHOR(S): Ross, J., T. Thongsinthusak, H.R. Fong, S. Margetich and R. Krieger

DATE: 1990

SOURCE: Chemosphere 20:349-360

II CORE CRITERIA (TIER I)

PRODUCT USE SCENARIO:

Post-application exposure monitoring involving choreographed Jazzercize™ routines performed by human adult volunteers following total release indoor fogger application.

FORMULATION TYPE:

Indoor fogger; aerosol canister (7.5 oz); K-RID Brand; EPA Reg. No. 9688-63; 0.5% chlorpyrifos and 0.05% d-trans allethrin; K-Mart Stores distributors; fogger units were formulated and packaged by Chemsico, St. Louis, MO;

APPLICATION METHOD:

Indoor total release fogger.

SITE OF APPLICATION:

The study was conducted in a large, recently constructed hotel in Sacramento, CA. Rooms on the second floor were isolated from each other with exit doors facing a common interior hallway. The rooms were cleared of as much furniture as possible, to optimize floor surface area. Polyethylene film was also used to seal the small entry vestibule that connected the rooms to the exit door and to seal off a small desk set into the wall. This sealing made the room walls a more uniform flat surface. Available floor surface area and volume were 21.2 ± 0.1 m^2 and 51.8 ± 1.6 m^3, respectively. FIGURE ONE in Ross et al. 1990 illustrates the room configuration and location of human subjects (n = 5). The rooms had uniform carpeting of 100% nylon. Temperature and relative humidity were recorded prior to fogger activation and upon label-reentry and then hourly thereafter.

ACTIVITY DESCRIPTION & CONDITIONS:

Five volunteers from State service participated in the study. Each has baseline cholinesterase levels established. All subjects were healthy. The subjects descriptions were as follows:

Subject A: Male - 79 kg
Subject B: Female - 70 kg
Subject C: Male - 65 kg
Subject D: Male - 84 kg
Subject E: Female - 53 kg
(mean age of subjects: 36 ± 4 years)

Each subject wore the following pre-laundered dosimeter clothing:

1) one pair of 54% cotton, 36% polyester and 10% spandex fabric tights (footless, white, #262 large, Glida Marx Industries, Inc.
2) one white HANES brand, 100% cotton, medium long-sleeved "T-shirt"
3) thin, 100% cotton gloves
4) white "athletic" socks of 100% cotton

The subjects had preassigned areas of the room in which they were to conduct their choreographed activities. This location did not vary from room to room. Subjects were led through a series of Jazzercise routines by a certified instructor (Subject A). There were four separate routines and stretches, which allowed for substantial contact of different body parts with the floor. The total time for contact was 18.2 minutes, plus entry and exit time, resulting in a total exposure duration period of approximately 20 minutes.

APPLICATION REGIMEN:

Foggers were set-up according to label directions. A polyethylene-covered cinder block (40 cm) was used to elevate the fogger above the floor in the center of the room. Newspaper was placed between the cinder block and the fogger, as per label instructions. Air conditioners were set to "OFF" during the application phase. However, both before and after application, the air conditioners were set to "ON" (continuous fan operation) and "COOL" (intermittent compressor cycling). Two hours after activation, the rooms were vented by opening the two bay windows and activating the fan only of the air conditioner (the exit doors were not opened to prevent contamination of the hallway). Each room was vented for 30 minutes after which the windows were closed again. Eight rooms were used so that duplicate reentry intervals were included: two rooms at 0 hrs post-application, two rooms at 6 hrs post-application and two rooms at 12 and 13 hrs post-application, respectively.

PPE:

Clothing scenario included tights, long-sleeved shirt, socks and gloves.

SAMPLING & ANALYTICAL METHODS:

SAMPLE TYPE

Clothing, Foil, Gauze:

Samples were extracted using ethyl acetate using mechanical rollers for 30 minutes. The extract was analyzed by gas chromatography equipped with electron capture detector (conditions specified in Ross et al. 1990).

DETECTION LIMIT(S):

	Chlorpyrifos	d-trans Allethrin
Shirt:	5 µg/sample	25 µg/sample
Tights:	5 µg/sample	25 µg/sample
Socks:	5 µg/sample	5 µg/sample
Gloves:	1 µg/sample	5 µg/sample
Gauze:	1 µg/sample	5 µg/sample
Foil:	0.1 µg/sample	1 µg/sample
XAD:	20.1 µg/sample	1 µg/sample

RESULTS AND CONCLUSIONS:

Videotape and on-site observation of foggers being activated showed the tendency of the aerosol plume to angle (5 - 10^N right of vertical) in the direction that the initiating tab was depressed. The preferential distribution of fogger contents can be observed in the results of the deposition pads located in the corners of the rooms (see TABLES FIVE and SIX of Ross et al. 1990, for chlorpyrifos and d-trans allethrin deposition measurements, respectively, on either aluminum foil or gauze). Mean gauze dosimeter deposition for chlorpyrifos, for example, was 2.36, 2,31 and 2.02 µg/cm^2 at 0 hrs, 6 hrs and 12.5 hrs post-application, respectively.

Mean accumulated chlorpyrifos residues (µg/article; n = 5) on dosimeter clothing is reported as follows:

TIME POST-VENTING AND ROOM ID	TIGHTS	SHIRT	SOCKS	GLOVES
0 hr / Rm A	1229 ± 514	1043 ± 631	754 ± 253	459 ± 253
0 hr / Rm B	1192 ± 647	946 ± 617	1025 ± 479	570 ± 352
6 hr / Rm A	857 ± 559	664 ± 453	563 ± 289	320 ± 188
6 hr / Rm B	853 ± 648	557 ± 287	706 ± 541	372 ± 308
12 hr / Rm A	497 ± 146	319 ± 84	381 ± 77	163 ± 53
13 hr / Rm B	298 ± 97	274 ± 59	268 ± 96	117 ± 46

The jazzercise study conducted by Ross *et al.* (1990, 1991) can be used for estimating potential post-application dermal contact with floor surfaces on which aerosols have been deposited. Further, these studies can be used as a generic basis for conservatively estimating potential post-application dermal exposures to treated surfaces, such as carpet or turf (in the absence of site-specific data).

The stepwise procedures for deriving generic body-part specific transfer factors (or TFs) from Ross et al. 1990, 1991 are provided below. Generic TFs provide a conservative basis for estimating dermal loading mg/cm^2 for various anatomical regions from compound-specific transferable residue data (mg/cm^2). Thus, in cases where only transferable residue data exist, body-part-specific dermal loading can be estimated (or modeled) using generic TFs. The transferable residue data used in this "surrogate" estimation procedure are ideally based on the same CDPR or ORETF roller methods used to initially derive the generic TFs (Ross *et al.*, 1990, Ross *et al.*, 1991).

Procedures for deriving and using TFs are described as follows (for completeness, methods for adults, children and infants are discussed below):

STEP 1. Ross *et al.* (1990, TABLE SEVEN., p. 355) provides "Mean Accumulated Chlorpyrifos Residue on Dosimeter Clothing" (µg/dosimeter article; n=5) following the use of total release fogger and reentry activity, i.e., 20 minute jazzercise routine. Average accumulated residues can be estimated by simply calculating the arithmetic mean of the two mean values reported for Rooms A and B at 0 hr (e.g., Tights: (1229 + 1192)/2 = 1210.5 µg).

STEP 2. The mean residue values (µg) for each dosimeter section from above (i.e., tights, shirt, socks and gloves) can then be divided by adult body surface areas (cm^2) (EPA, 1996) corresponding to each respective dosimeter section to obtain dermal loading estimates (µg/cm^2) as follows:

Adult Body Part/Dosimeter Areas

	Surface Area (cm^2)
Upper Body (Shirt dosimeter; 2/3 trunk + arms)	5895
Lower Body (Tights dosimeter; 1/3 trunk + legs)	6817
Hands (Gloves)	793
Feet (Socks)	1048

EXAMPLE LOADING ESTIMATES:
944.5 µg on upper body (shirt) / 5895 cm^2

1210.5 µg on lower body (tights) / 6817 cm^2

STEP 3. Divide dermal loading estimate (µg a.i./cm^2 body surface area) by mean "0 hr" transferred residue measurement (µg a.i. /cm^2 surface area sampled; i.e., 0.055 µg chlorpyrifos / cm^2) reported in Ross *et al.* (1991, TABLE TWO, p. 978) to obtain activity-specific unitless Transfer Factor (TF). The unitless TFs represent an "adjustment factor" which can be used to estimate dermal loading to specific body part surface areas associated with jazzercise activities from transferable residue measurements made using techniques such as the CDPR roller method. The TFs for upper-body, lower-body, hands and feet are reported in the following table. Transferable residue estimates of a particular chemical using methods comparable to the CDPR roller method can be multiplied by the TF to obtain reasonable estimates of skin surface area loading (dermal exposure) associated with jazzercising for each body area. Jazzercising is a high contact activity which conservatively "bounds" potential exposure associated with more typical indoor residential activities (e.g., walking, crawling, sitting).

Jazzercise / CDPR Roller Transfer Factors

	TF - chlorpyrifos	**TF - d-trans-allethrin**
Upper Body	3.1	2.4
Lower Body	3.2	2.4
Hands (gloves)	11.8	12.6
Feet (socks)	15.4	13.6

STEP 4 Based on dosimeter clothing penetration data from another proprietary jazzercise study, adjust TFs to account for differences in the amount of chemical residue (dermal loading) that penetrates a single layer of clothing and potentially contacts the skin surface versus the loading on the outside

of dermal dosimeters (which represents the loading on bare, uncovered skin):

Jazzercise/CDPR Roller Transfer Factors for Uncovered and Covered Body Areas

	TF – chlorpyrifos
Upper Body – Uncovered (arms)	3.1
Upper Body – Covered (sleeveless shirt: 2/3 trunk)	A
Lower Body – Uncovered (4/5 legs)	3.2
Lower Body – Covered (short pants: 1/3 trunk + 1/5 legs)	A
Hands (gloves)	11.8
Feet (socks)	15.4

a - assumption was conservatively made that covered TFs are 10-fold lower than uncovered TFs. Proprietary data indicate that covered TFs are actually approximately two orders of magnitude lower than TFs for uncovered areas

TF ADJUSTMENT CALCULATIONS FOR COVERED AREAS:

Upper Body - Covered = [µg/cm^2 inside dosimeter from turf study / (µg/cm^2 from inside dosimeter from turf study + µg/cm^2 from outside dosimeter from turf study)] x 2.4 (fogger upper body - uncovered TF) = * (proprietary)

Lower Body - Covered = [µg/cm^2 inside dosimeter from turf study / (µg/cm^2 from inside dosimeter from turf study + µg/cm^2 from outside dosimeter from turf study)] x 2.4 (fogger lower body - uncovered TF) = * (proprietary)

STEP 5 Apply TFs to compound-specific or surrogate transferable residue data and body surface areas to obtain dermal exposure estimates. Body surface areas for covered and uncovered body parts were developed using data sources cited in the EPA's *Exposure Factors Handbook* (1996a) and were designated as follows (for purposes of comparison, the body part surface areas are provided for adults, children and infants):

Body Part Areas

	Infants < 1 year cm^2	***Children 1-6 years***[1] cm^2	***Adults*** cm^2
Upper Body (Shirt dosimeter; 2/3 trunk + arms)	2037	2700	5895
Lower Body (Tights dosimeter; 1/3 trunk + legs)	1765	2870	6817
Hands (gloves)	288	452	793
Feet (socks)	355	553	1048

[1]Based on data for children 3 - 6 years old (EPA 1996).

Body Areas for Exposure Calculations

	Children < 1 year cm^2	***Children 1-6 years*** cm^2	***Adults*** cm^2
Upper Body – Uncovered (arms)	744	1085	2190
Upper Body - Covered (sleeveless shirt; 2/3 of trunk)	1293	1615	3705
Lower Body - Uncovered (4/5 legs)	895	1650	3972
Lower Body - Covered (short pants; 1/3 trunk + 1/5 legs)	870	1220	2845
Hands (gloves)	288	452	793
Feet (socks)	355	553	1048

The general equation for estimating potential dermal exposure and absorbed dose is as follows:

Post-Application Dermal Absorbed Daily Dose:

$$\text{Daily Dose} = \frac{\sum [(\text{Trans Fact}) \times (\text{Trans Residue}) \times (\text{Surface Area})] \times (\text{Correction Factor}) \times (\text{Dermal Absorption})}{(\text{Body Weight})}$$

Example Variables for Estimating Post-Application Dermal Absorbed Daily Dose

VARIABLE	UNITS	VALUE
SUM (Trans Fact x Trans Resid x S.A.)	*mg*	2.5
Dermal Absorption Fraction	*unitless*	0.03
Body Weight (adult)	*kg*	71.8
Dermal Daily Exposure	*mg/kg/day*	3.5E-02
Dermal Daily Dose	*mg/kg/day*	1.0E-03

VARIABLE INPUT VALUES

Summation of [Body-Part Specific TF x TR (transferable residue) x SA (surface area)]

This exposure summation is a representation of the combination of body-specific transfer factors, transferable residues (TR), and surface area. The TFs for each body part, and the mean transferable residue estimates are used from the Ross *et al.* (1991) study. In this study, carpet samples were collected using the CDPR carpet roller device to measure "transferable" residues. Roller sample results for d-trans Allethrin were reported at 0 hrs for each quadrant of the room sampled as follows:

Mean Transferable Residues of Chlorpyrifos from Ross *et al.* (1991)

Carpet Sample – LOCATION	TR at 0 hrs (µg/cm^2)
Right Quadrant I	0.048
Right Quadrant II	0.106
Left Quadrant I	0.040
Left Quadrant II	0.027
MEAN (std dev)	0.055 (± 0.035)

The arithmetic mean across mean values for each quadrant is 0.055 µg/cm^2 or 0.000055 mg/cm^2; this mean value can be used for *point estimation* procedures. Finally, body part surface areas (SAs) used in the summation equation are those noted above in the discussion regarding TF derivation.

The clothing scenario used in the calculations for adults was as follows:

Surface Areas for Clothing Scenarios Used in Dermal Adult Exposure Calculations

Body Part Region	Surface Area (cm^2)	Assumption
Arms	2,190 cm^2	Uncovered arms by sleeveless shirt
Upper Body	3,705 cm^2	Covered trunk area by sleeveless shirt
Legs	3,972 cm^2	Uncovered legs by short pants
Lower Body	2,845 cm^2	Covered trunk area by short pants
Hands	793 cm^2	Uncovered hands, no gloves
Feet	1,048 cm^2	Uncovered feet, no shoes

Thus, the total dermal exposure (mg) *summation* calculation (summed across "TF x TR x SA" for each body part) for adults is as follows:

Total Dermal Exposure (mg) = Sum $(TF \times TR \times SA)_{\text{all body regions}}$

Example of Adult Dermal Exposure Calculations by Body Part Region for Chlorpyrifos

BODY AREA	TF	TR (mg/cm^2)	SA (cm^2)	Dermal Exposure (mg)
Arms uncovered	3.1	0.000055	2,190	0.373
Upper Body - covered	*0.31	0.000055	3,705	0.0611
Legs - uncovered	3.2	0.000055	3,972	0.699
Lower Body - covered	*0.32	0.000055	2,845	0.0469
Hands - uncovered	11.8	0.000055	793	0.515
Feet - uncovered	15.4	0.000055	1,048	0.888
TOTAL EXPOSURE (mg)				**2.58**

* 10% clothing penetration was conservatively assumed.

For purposes of a stochastic case study, a distribution of TRs can be derived from the above TR data for 0 time measurements from Ross *et al.* (1991), in conjunction with 6- and 12.5-hr measurements. Thus, the data set consists of a total of 12 residue measurements corresponding to the 4 quadrants of a room in which a fogger was discharged, at three time intervals, 0 hours, 6 hours and 12.5 hours post application. Preliminary distributional analysis suggested that the data [the four quadrant observations for each time interval) were better fitted by a log-normal distribution compared to a normal distribution (the lack of fit to a log-normal was non-significant (P=0.29), while the lack of fit to a normal was highly significant (P=0.01)]. For example, an analysis of variance (AOV) of log-transformed d-trans-allethrin concentrations across time showed that there were no significant differences in concentrations across the three time intervals. Thus for this distribution all 12 observations are combined as a single sample from a

log-normal distribution. The resulting geometric mean and standard deviation were 4.88 x 10^{-3} µg/cm^2 (0.00000488 mg/cm^2) and 1.705, respectively.

Analysis of Variance (AOV) for d-trans allethrin transferable residue measurements

One-way AOV for log transformed allethrin concentration by time:

SOURCE	DF	SS	MS	F	P
BETWEEN (Time Intervals)	2	0.32062	0.16031	0.51	0.6151
WITHIN (Quadrants)	9	2.81157	0.31240		
TOTAL	11	3.13218			

	CHI-SQ	DF	P
BARTLETT'S TEST OF EQUAL VARIANCES	0.09	2	0.9545

CASES INCLUDED 12 MISSING CASES 0

In conclusion, Ross et al. (1990), in conjunction with Ross et al. (1991) provide a basis for the derivation of "transfer factors" that represent alternatives to the default "transfer coefficients" recommended in the U.S. EPA's draft Residential Exposure Assessment SOPs for estimating potential dermal exposure associated with pesticide treatment of surfaces such as carpets or turf. Further, the utility and validation of the representativeness of the transfer factors derived from Ross et al. (1990 and 1991) can be demonstrated via comparison to exposure estimates based on the results of other "broadcast application" exposure and biomonitoring monitoring studies, such as those available for residential turf (e.g., Vaccaro et al. 1996, Harris 1991, Stephenson et al. 1996).

III OTHER CONSIDERATIONS (TIER II)

QUALITY ASSURANCE DATA:

Control rooms and sampling media were included. Non-GLP study.

ANALYTICAL RECOVERIES:

Spiking of clothing and floor dosimetry media during the actual fogger study demonstrated excellent recoveries under the conditions of collection, storage and analysis.

RECOVERY EFFICIENCY CORRECTION:

Recovery efficiency corrections are presumed to have been included in all reported results.

FIELD FORTIFICATION SAMPLES:

Not specified.

NUMBER OF REPLICATES:

Two rooms, with five subjects at each time interval post-venting.

I. STUDY CITATION

STUDY TITLE: Measuring potential dermal transfer of surface pesticide residue generated from indoor fogger use: using the CDFA roller method - Interim Report II

AUTHOR(S): J. Ross, H.R. Fong, T. Thongsinthusak, S. Margetich and R. Krieger

DATE: 1991

SOURCE: Chemosphere 22:975-984

II CORE CRITERIA (TIER I)

PRODUCT USE SCENARIO:

Post-application exposure monitoring involving choreographed Jazzercize™ routines performed by human adult volunteers following total release indoor fogger application.

FORMULATION TYPE:

Indoor fogger; aerosol canister; K-RID Brand; EPA Reg. No. 9688-63; 0.5% chlorpyrifos and 0.05% d-trans allethrin; K-Mart Stores distributors; fogger units were formulated and packaged by Chemsico, St. Louis, MO.

APPLICATION METHOD:

Indoor total release fogger.

SITE OF APPLICATION:

The study was conducted in a large, recently constructed hotel in Sacramento, CA. (see Ross et al. 1990 review for details)

ACTIVITY DESCRIPTION & CONDITIONS:

Five subjects performed a choreographed jazzercise routine for 20 minutes at 0, 6, and 12 hrs post-application (and venting per label instructions) (see Ross et al. 1990 review for details).

APPLICATION REGIMEN:

Total release indoor fogger application per label instructions (see Ross et al. 1990 review or details).

PPE:

Clothing scenario included tights, long-sleeved shirt, socks and gloves.

SAMPLING & ANALYTICAL METHODS:

SAMPLE TYPE

CDFA Indoor Roller:

The CDFA indoor carpet roller device was used to transfer deposited residues from carpet to a percale sheet (50% cotton / 50% Kodel polyester, 180 thread count, 1840 cm^2 ± 90 cm^2. The roller was rolled over a plastic/percale sheet/carpet "sandwich" ten times. One push forward plus one backward constituted one roll. Roller samples were collected at 0, 6, and 12.5 hrs post-application. Analytical chemistry analyses were performed by the CDFA Chemistry Laboratory Services. Analyses were done for chlorpyrifos, its oxon and d-trans-allethrin (analytical method was not specified but is presumed to be that described in Ross et al. 1990).

DETECTION LIMIT(S):

Minimum detectable value was 0.0005 and 0.0027 µg/cm^2 for chlorpyrifos and d-trans-allethrin, respectively.

RESULTS AND CONCLUSIONS:

Transferable residues of chlorpyrifos and d-trans-allethrin from facility carpet material to percale using CDFA roller device are presented in the Table below. The carpet roller method transfers approximately 1 to 3% of the deposited floor residue, when comparing mean gauze pad residues to amount of material transferred to the roller sheet. Chlorpyrifos mean % transfer was approximately 1%; whereas d-trans-allethrin mean % transfer was approximately 3%. The transferability of both chlorpyrifos and d-trans-allethrin declined with half-lives of 10 and 12 hours, respectively, over the 12 hour test period.

TABLE 1. Transferred residue values (µg/cm^2) from facility carpet material to percale using the CDFA carpet roller device. Mean gauze dosimeter (MGD) values also presented (roman numerals identify replicate rooms).

	Chlorpyrifos	d-trans-Allethrin
0 hrs Post-Application		
Right quadrant I	0.048	0.0055
Right quadrant II	0.106	0.0124
Left quadrant I	0.040	0.0048
Left quadrant II	0.027	0.0028
MEAN	0.055 ± 0.035	0.0064 ± 0.0042
MGD	2.36	0.2175
6 hrs Post-Application		
Right quadrant I	0.058	0.0104
Right quadrant II	0.022	0.0045
Left quadrant I	0.015	0.0031
Left quadrant II	0.026	0.0061
MEAN	0.030 ± 0.019	0.0060 ± 0.0032
MGD	2.311	0.2350[b]
12.5 hrs Post-Application		
Right quadrant I	0.048	0.0087
Right quadrant II	0.016	0.0033
Left quadrant I	0.013	MDL
Left quadrant II	0.014	MDL
MEAN	0.023 ± 0.017	0.0044 ± 0.0029[c]
MGD	2.019	0.2450

a. MDL = Minimum Detectable Value (chlorpyrifos - 0.0005, d-trans - 0.0027

b. Derived from different room series (physicochemical vs. Jazzercise exposure room) gauze data since no gauze d-trans allethrin samples were taken in the appropriate room.

c. Includes MDL values from left quadrant.

III OTHER CONSIDERATIONS (TIER II)

QUALITY ASSURANCE DATA:

Unexposed control rooms had no detectable levels of d-trans-allethrin and two samples of four were 2X above the minimum detectable level for chlorpyrifos. Non-GLP study.

ANALYTICAL RECOVERIES:

Not specified.

RECOVERY EFFICIENCY CORRECTION:

Not specified.

FIELD FORTIFICATION SAMPLES:

Not specified.

NUMBER OF REPLICATES:

At each time interval (0, 6 and 12.5 hrs post-application), duplicate roller samples were collected, one from each of two quadrants.

ATTACHMENT B

REx Deterministic Input Values

INPUTS

Variable	Unit	EPA Def	Single	Param 1	Param 2	Param 3	Type
Inputs - General							
Clothing Penetration Fraction (uncovered)	*unitless*		1				Single
Clothing Penetration Fraction (covered)	*unitless*		1				Single
HtoM Fraction transferred (total) (child)	*unitless*		0.1				Single
Reference duration (child/adult)	*day*		1				Single
Fraction absorbed (dermal)	*unitless*		0.03				Single
Fraction absorbed (ingestion)	*unitless*		1				Single
Fraction absorbed (inhalation)	*unitless*		1				Single
NOEL (dermal) (applied dose)	*mg/kg/day*		60				Single
NOEL (ingestion) (applied dose)	*mg/kg/day*		60				Single
NOEL (inhalation) (applied dose)	*mg/kg/day*		60				Single
NOEL (absorbed dose) (systemic)	*mg/kg/day*		60				Single
Area (hands) (uncovered) (adult)	*cm2*		793				Single
Area (hands) (covered) (adult)	*cm2*		0				Single
Area (upper body) (uncovered) (adult)	*cm2*		2190				Single
Area (upper body) (covered) (adult)	*cm2*		3705				Single
Area (lower body) (uncovered) (adult)	*cm2*		3972				Single
Area (lower body) (covered) (adult)	*cm2*		2845				Single
Area (feet) (uncovered) (adult)	*cm2*		1048				Single
Area (feet) (covered) (adult)	*cm2*		0				Single
Area (hands) (uncovered) (child)	*cm2*		452				Single
Area (hands) (covered) (child)	*cm2*		0				Single
Area (upper body) (uncovered) (child)	*cm2*		1085				Single
Area (upper body) (covered) (child)	*cm2*		1615				Single
Area (lower body) (uncovered) (child)	*cm2*		1650				Single
Area (lower body) (covered) (child)	*cm2*		1220				Single
Area (feet) (uncovered) (child)	*cm2*		553				Single
Area (feet) (covered) (child)	*cm2*		0				Single
Body weight (adult)	*kg*		71.8				Single
Body weight (child)	*kg*		18.9				Single
Inputs - Scenario Specific: Lawn Care							
Application of AI (Area treated)	*lb ai/acre*		4				Single
Area treated	*acre*		0.92				Single
Transferable Residue (surface) (env/pet)	*mg/cm2*		0.00224				Single
Unit exposure (dermal) (during application)	*mg/lb ai*		0.075				Single
Unit exposure (inhalation) (during app)	*mg/lb ai*		0.000004				Single
Transfer Factor - hands (uncovered)	*unitless*		11.8				Single
Transfer Factor - hands (covered)	*unitless*		0.118				Single
Transfer Factor - upper body (uncovered)	*unitless*		3.1				Single
Transfer Factor - upper body (covered)	*unitless*		0.31				Single
Transfer Factor - lower body (uncovered)	*unitless*		3.2				Single
Transfer Factor - lower body (covered)	*unitless*		0.32				Single
Transfer Factor - feet (uncovered)	*unitless*		15.4				Single
Transfer Factor - feet (covered)	*unitless*		0.154				Single

ATTACHMENT C

Stochastic Case Study – Lawn Care
(Liquid Formulation; Hose-End Sprayer)

Stochastic Case Study – Lawn Care Product

INPUTS						
Variable	**Unit**	**Single**	**Param 1**	**Param 2**	**Param 3**	**Type**
Inputs - General						
Clothing Penetration Fraction (uncovered)	*unitless*	1				Single
Clothing Penetration Fraction (covered)	*unitless*	1				Single
HtoM Transfer efficiency (child)	*unitless*		0.01	0.1	0.4	Triangular
Reference duration (child/adult)	*day*	1				Single
Fraction absorbed (dermal)	*unitless*		0.025	0.035		Uniform
Fraction absorbed (ingestion)	*unitless*		0.6	0.8	1	Triangular
Fraction absorbed (inhalation)	*unitless*		0.5	0.9	1	Triangular
NOEL (dermal) (applied dose)	*mg/kg/day*	6				Single
NOEL (ingestion) (applied dose)	*mg/kg/day*	0.6				Single
NOEL (inhalation) (applied dose)	*mg/kg/day*	0.2				Single
NOEL (absorbed dose) (systemic)	*mg/kg/day*	0.6				Single
Area (hands) (uncovered) (adult)	*cm2*	793				Single
Area (hands) (covered) (adult)	*cm2*	0				Single
Area (upper body) (uncovered) (adult)	*cm2*	2190				Single
Area (upper body) (covered) (adult)	*cm2*	3705				Single
Area (lower body) (uncovered) (adult)	*cm2*	3972				Single
Area (lower body) (covered) (adult)	*cm2*	2845				Single
Area (feet) (uncovered) (adult)	*cm2*	1048				Single
Area (feet) (covered) (adult)	*cm2*	0				Single
Area (hands) (uncovered) (child)	*cm2*	452				Single
Area (hands) (covered) (child)	*cm2*	0				Single
Area (upper body) (uncovered) (child)	*cm2*	1085				Single
Area (upper body) (covered) (child)	*cm2*	1615				Single
Area (lower body) (uncovered) (child)	*cm2*	1650				Single
Area (lower body) (covered) (child)	*cm2*	1220				Single
Area (feet) (uncovered) (child)	*cm2*	553				Single
Area (feet) (covered) (child)	*cm2*	0				Single
HtoM Contact frequency (child)	*events/hr*	0.25				Single
Inhalation rate (adult)	*m3/hr*		0.3	1.74		Uniform
Inhalation rate (child)	*m3/hr*		0.23	0.96		Uniform
Body weight (adult)	*kg*		70.6	1.22		Lognormal
Body weight (child)	*kg*		16.15	1.22		Lognormal
Inputs - Scenario Specific: Lawn Care						
Application of AI (Area treated)	*lb ai/acre*	4				Single
Area treated	*acre*	0.92				Single
Air concentration of AI	*mg/m3*		15.2	1.42		Lognormal
Transferable Residue (surface) (env/pet)	*mg/cm2*		0.00224	1.3		Lognormal
Unit exposure (dermal) (during application)	*mg/lb ai*		0.075	2.49		Lognormal
Unit exposure (inhalation) (during app)	*mg/lb ai*		0.000004	1.749		Lognormal
Transfer Factor - hands (uncovered)	*unitless*		9.82	1.83		Lognormal
Transfer Factor - hands (covered)	*unitless*	0				Single
Transfer Factor - upper body (uncovered)	*unitless*		2.66	1.7		Lognormal

Transfer Factor - upper body (covered)	*unitless*	0.266				Single
Transfer Factor - lower body (uncovered)	*unitless*		3.02	1.64		Lognormal
Transfer Factor - lower body (covered)	*unitless*	0.302				Single
Transfer Factor - feet (uncovered)	*unitless*		15.15	1.6		Lognormal
Transfer Factor - feet (covered)	*unitless*	0				Single
Exposure duration (adult)	*hr/day*	4				Single
Exposure duration (child: 1 < age < 6)	*hr/day*	4				Single
Exposure duration (HtoM) (child: 1 < age < 6)	*hr*	4				Single