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Standard Operating Procedures (SOPs) for Residential Exposure Assessments

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Prepared by:

The Residential Exposure Assessment Work Group

Includes:

Office of Pesticide Programs, Health Effects Division
Versar, Inc.

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1.0 INTRODUCTION

These Residential Exposure Assessment Standard Operating Procedures (SOPs) are designed for those who assess exposure to pesticides in a residential setting. The objective of these SOPs is to provide standard default methods for developing residential exposure assessments for both handler and postapplication exposures when chemical- and/or site-specific field data are limited (U.S. EPA, 1987, 1995). These methods may be used in the absence of, or as a supplement to, chemical- and/or site-specific data.

Handler and postapplication SOPs for developing assessments of dermal, inhalation, and/or incidental ingestion doses are provided in the following major residential exposure scenarios:

- residential lawns,
- garden plants,
- trees (e.g., fruit, ornamental),
- swimming pools,
- painting and wood preservative treatments,
- fogging,
- crack and crevice and broadcast treatments,
- pet treatments,
- detergent/hand soap,
- impregnated materials,
- termiticides,
- inhalation of residues from indoor treatments, and
- rodenticides.

Each SOP includes:

- a description of the exposure scenario,
- the recommended methods (i.e., algorithms and default parameters) for quantifying doses,
- example calculations,
- limitations and uncertainties associated with the use of the SOP, and
- applicable references.

This document also provides information on the general principles of exposure assessment (Section 1.1), background information on the development and use of these residential SOPs (Section 1.2), guidance for amortizing daily doses to obtain lifetime doses, and guidance on using labeling information to determine whether a pesticide is registered for use at residential sites, and to determine formulation type, application methods, use-rates, and use frequency (Section 1.4). General labeling considerations are provided in Section 1.4, and scenario-specific labeling information is provided at the beginning of each chapter. Section 1.5 provides information on many of the conversion factors used in the SOPs, and Section 1.6 provides definitions for many of the common terms used. Appendix A summarizes the data inputs for the various scenarios.

The SOPs were prepared by EPA's Office of Pesticide Programs, Health Effects Division and Antimicrobial Division with input from EPA=s Office of Pollution Prevention and Toxics, and Office

of Research and Development. The Workgroup was also provided with technical support from Versar, Inc.

1.1 General Principles of Exposure Assessment

Exposure assessment is the process by which: (1) potentially exposed populations are identified; (2) potential pathways of exposure are identified; and (3) chemical intakes/potential doses are quantified. The populations considered in these SOPs are those individuals who are potentially exposed to pesticides used in residential settings. Exposures to pesticides may occur from handling or postapplication via contact by oral, inhalation, or dermal absorption routes. ***Exposure*** is commonly defined as contact of visible external physical boundaries (i.e., external boundaries such as the mouth, nostrils, and skin) with a chemical agent (U.S. EPA, 1992). As described in the *Guidelines for Exposure Assessment* (U.S. EPA, 1992), exposure is dependent upon the intensity, frequency, and duration of contact. The intensity of contact is typically expressed in terms of the concentration of contaminant per unit mass or volume (i.e., μg/g, μg/L, mg/m^3, ppm, etc.) in the medium to which humans are exposed (U.S. EPA, 1992).

Dose refers to the amount of chemical to which individuals are exposed that crosses the external boundary. Dose is dependent upon contaminant concentration and the rate of intake (i.e., inhalation or ingestion) or uptake (i.e., dermal absorption) and may be normalized to body weight as a function of time (i.e., mg/kg/day). ***Potential dose*** is the amount of chemical that could be ingested or deposited upon the skin. The ***absorbed dose*** is the amount of chemical absorbed into the body through the gastrointestinal tract, lung, or skin. The toxicologic basis for risk assessment is typically either the potential dose from animal feeding studies or the absorbed dose from pharmacokinetic studies followed by intraperitoneal or other injected delivery into the test animal. Potential dose may be calculated as follows:

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click here to view equation.

where:

PDR = potential dose rate (mg/day);
C = contaminant concentration in the media of interest (mg/cm^2; mg/m^3, mg/g); and
CR = contact rate with that media (cm^2/day; m^3/day; day).

Absorbed doses may be calculated by including an absorption factor in the equation above.

The contaminant concentration is the amount of pesticide in the media to which humans are exposed. The contaminant concentration may be affected by dissipation of chemical over time by evaporation, degradation, or other fate processes. Contact rate may be defined as the rate of ingestion, inhalation, or dermal absorption or as the transfer coefficient (U.S. EPA, 1989).

Average, high-end, and/or bounding estimates may be made using this algorithm. These exposure descriptors account for individual and population variability and represent points on the distribution of exposures. Average potential dose rates represent the mean and may be estimated using central tendency values for all the parameters in the dose algorithm. The high-end potential

dose rate (90th or 95th percentile) is a reasonable approximation of dose for individuals at the upper end of the distribution of exposures (U.S. EPA, 1992). High-end values are estimated by setting some, but not all, input parameters to the upper-end values. Finally, bounding potential dose rates are exposures that are estimated to be greater than the highest individual exposure in the population of interest. Bounding estimates use all upper-percentile inputs and are often used in screening-level assessments.

Inputs for the standard exposure calculations should be representative of the population/scenarios being evaluated. Contaminant concentration values may be generated based on residue and dissipation assumptions for the media of interest. Factors such as frequency and duration of use can be derived from actual data on the activities/uses associated with site/scenario-specific uses of a chemical, or from general population survey data on activity patterns and product usage. Other inputs to the exposure calculations such as contact rate (ingestion rate, inhalation rate, skin surface area), body weight, and lifetime may be based on standard exposure factors. Mean and upper-percentile exposure factors based on distributions of data collected from the scientific literature are reported in EPA's *Exposure Factors Handbook* (1996) and EPA's *Risk Assessment Guidance for Superfund* (1989).

Uncertainty may be introduced into the dose calculations at various stages of the exposure assessment process. Uncertainty may occur as a result of: (1) the techniques used to estimate chemical residues, (2) chemical dissipation assumptions, and (3) the selection of exposure scenarios and exposure factors. Variability can occur as a result of variations in individual day-to-day or event-to-event exposure factors or variations among the exposed population. Variability can be addressed by estimating exposure for the various descriptors of exposure [i.e., central tendency (mean or median), high-end (90th or 95th percentile), or bounding (100th percentile)] to represent points on the distribution of exposures.

1.2 Residential SOPs

These SOPs are for residential exposure assessments and rely on high-end scenarios. The residential lawn scenario, for example, is assumed to represent the upper end of the distribution of exposures that could occur from lawns, parks, playgrounds, recreational areas, athletic fields, and other turf areas. Also, these scenarios normally rely on one or more upper-percentile assumptions such as 90th percentile exposure duration values and/or 90th percentile skin surface area values. They are intended to represent Tier 1 assessments. If a Tier 1 assessment indicates a potential concern, a more detailed exposure assessment is warranted, possibly including chemical-specific or site-specific data (U.S. EPA, 1987, 1995).

The estimated doses resulting from using these SOPs are appropriate for use in developing estimates of human risks associated with residential exposures to pesticides. (The actual calculations of human health risks are not within the scope of this document.) Each SOP provides calculations for daily dose. The daily potential dose rate calculations are based on the amount of chemical to which an individual is exposed in a day and are expressed as milligrams per day. The daily potential dose rate, normalized to body weight, is a calculation of the amount of chemical to which an individual is exposed on a per-unit-body-weight basis and is expressed in units of milligrams per kilogram per day. The potential dose rate definition used here is consistent with EPA=s Exposure Assessment Guidelines (U.S. EPA, 1992), which states that dose is defined as "the amount of a

chemical contained in material ingested, air breathed, or bulk material applied to the skin." The dermal and inhalation dose values determined by these SOPs represent potential doses and do not, in general, include an adjustment for the amount of chemical likely to pass through the skin or lungs and be absorbed into the human system. Assessors will need to apply chemical-specific dermal and inhalation absorption rates, if available, to determine absorbed dose. (See Section 1.6 for definitions of the terms used in exposure assessment.)

Each SOP provides methods for estimating short-term or acute daily doses for a single route of exposure (e.g., dermal, inhalation, ingestion). These represent estimates of exposure that may need to be combined with estimates from other routes of exposure and other use sites to estimate aggregate exposures. Techniques for determining aggregate doses are not within the scope of this document. The assumptions in the SOPs do not include the distributions of inputs that would be necessary for a probability analysis (e.g., Monte Carlo).

For calculating exposures for many cancer assessments, the daily dose values estimated in the individual SOPs may have to be amortized to obtain lifetime average daily potential dose. Section 1.3 provides guidance for amortizing daily doses. In general, the daily doses estimated by these SOPs represent acute doses and use maximum application rates as input. Cancer assessments should use typical application rates.

The assumptions in these SOPs will be periodically updated as new data become available. In addition, these SOPs are designed to allow the assessor to substitute alternate inputs for the default assumptions when more specific data are available or when professional judgement indicates that alternative values are more appropriate. Currently, the SOPs do not include adjustments for exposure-reduction techniques, such as coatings on granules that reduce exposures to dusts, or specialized packaging that reduces exposure. Also, these SOPs do not attempt to discuss toxicity or selection of endpoints for use in calculating risk. The exposure assessor would need to consult with the toxicologist especially if dermal or inhalation endpoints have not been previously selected.

Most SOPs include body weights for adults and for children within specific age groups. When exposure assessments are conducted for age groups other than those specified in the SOP, standard body weights in EPA's Exposure Factors Handbook (1996) may be used to ensure consistency among the assessments prepared by OPP. The body weight for specific age groups are summarized in Table 1-1.

Table 1-1. Body Weight Values for Specified Age Groups

Age (Years)	Body Weight (kg)	Comments
Infants (0.5 to 1.5)	10	Mean of median values for males and females in the 6-11 month and 1 year age groups
Toddlers (3)	15	Mean of median values for male and female 3 year olds
Children (6)	22	Mean of median values for male and female 6 year olds
Youth (10 to 12)	39.1	Mean of median values for males and females age 10, 11, and 12 years
Adult Reproductive Females	60	Mean for females age 13 to 54 years
Adults	71.8	Mean for males and females 18 years and older

Source: U.S. EPA (1996)

Many postapplication exposure scenarios make assumptions regarding the amount of dislodgeable pesticide residues. Dislodgeable residues are those residues that may be transferred to the skin as a result of contact and are available for dermal absorption or ingestion. Assumptions regarding transfer of dislodgeable residues are generally based on the experience and professional judgement of OPP staff from the review of monitoring studies. Many of the handler SOPs use unit exposure values from the Pesticide Handlers Exposure Database (PHED) as inputs into the exposure assessment algorithms. PHED is a data base containing surrogate handler data collected from field exposure studies. Assessors should refer to Appendix B for these unit exposure values. (See Appendix B.) Appendix B provides surrogate exposure information for various handler exposure scenarios as well as the confidence/grades associated with the data.

1.3 Amortizing Dose

Generally, the SOPs provided in this document provide methods for calculating the potential daily dose rates for pesticides to which individuals are exposed. These daily dose rate estimates are appropriate for assessing risk to human health from short-term exposure. However, further calculation may be required to obtain amortized doses that represent average doses over a lifetime. The lifetime average daily dose (LADD) is used for many assessments involving cancer effects. The LADD is calculated as follows:

$$LADD = (D * EF * ED) / (AT * CF)$$

where:

D	=	dose (mg/kg-day)
EF	=	exposure frequency (i.e., frequency of product use) (days/year)
ED	=	exposure duration (years)
AT	=	averaging time (i.e., lifetime) (years)
CF	=	conversion factor (365 days/year)

For handler scenarios, estimated doses on the day of application may be amortized using this LADD algorithm and assumptions regarding the exposure frequency, exposure duration, and averaging time (i.e., lifetime). It should be noted that OPP/HED is currently in the process of developing information on exposure frequency on the scenarios provided in this document. These frequency data will be available in an update of these SOPs. For postapplication scenarios, exposures on the day of application and on subsequent days while residues are dissipating must first be summed and averaged within the scenario prior to amortizing the postapplication dose.

1.4 Labeling Considerations

Prior to conducting an exposure assessment using the SOPs in this document, several labeling issues should be considered, as follows.

Obtain End-Use Product Labels: Attempt to obtain copies of all end-use product labels (or at least representative labels for broad spectrum chemicals).

Determine Whether Registered for Use at Residential Sites: *Assume that a product may be used at residential sites unless labeling statements indicate otherwise.* (See site-specific labeling for more information.) Restricted-Use classification, statements such as "For use by commercial or professional applicators only," or liquid-concentrate formulations marketed only in large containers (e.g., 40 gallons) indicate that the product cannot be bought or applied by homeowners. No residential handler exposure/risk assessment is required for these products. However, it may be applied by commercial applicators to residential sites; therefore, a post-application exposure/risk assessment may be required. Sometimes the Reference Files System (REFs) data base will indicate whether the product is used at residential sites.

Determine Formulation Type: Often the label front panel will list the type of formulation as part of, or associated with, the brand name. For example, Pesto 3G indicates the product is a granular; whereas, Pesto WP is a wettable powder, and Pesto EC is an emulsifiable concentrate. Sometimes the formulation type is not listed on the front panel. For all liquid formulations, a statement listing the number of pounds of active ingredient contained in a gallon of the liquid formulated product is found immediately before or after the active ingredient statement. The label use-directions also may provide an indication of the formulation type. Look at the mixing/loading instructions, application-equipment types, and dose-rates (in general, dry products are measured in ounces or pounds and liquid products are measured in pints, quarts, or gallons).

Determine Possible Methods of Application: The label use-directions often specify the methods of application for a product either by prohibiting specific application techniques (e.g., "do not apply in any type of irrigation equipment" or "spot treatment only") or by listing the application equipment to be used. Unless certain equipment or application techniques are specifically prohibited on the labeling or are obviously incompatible with the formulation or use-directions, assume any equipment or technique can be used.

Determine Use-Rates: **Maximum Use-Rates**: Determine the maximum label-permitted use-rate by comparing the use-directions for each use listed on the label. Often there are multiple use-directions with widely varying use-rates due to factors such as indoor/outdoor use, pests to be controlled, timing of application, and type of surface (e.g., plant, soil, carpet, hard-surface) being treated. Maximum use-rates may vary by formulation-type, so the maximum rate for each formulation must be determined. **Typical Use-Rates:** Determine the typical use-rates (needed only for cancer risk assessments) by studying the label use-directions and choosing the use-rate that would most commonly be used; do not select the rate for heavy infestations, severe conditions, etc. However, when a range of application rates is given for a routine pest or situation, choose the highest use-rate. Typical use-rates may vary by formulation-type, so the typical rate for each formulation must be determined.

Determine Use Frequency: For cancer risk assessments, it may be necessary to estimate the number of handler and postapplication exposures per year. The pesticide label will often indicate how frequently the product may be applied. Look in the Directions-For-Use section for instructions about frequency. Examples of typical statements include "apply at 7-day intervals while pests are present," "apply in early spring before first mowing," or "apply a second spray in 3 to 5 days."

1.5 Conversion Factors

Many SOPs require the use of weight, area, or volume unit conversion factors. These conversion factors are used to convert common units of measure to those needed to calculate dose. Table 1-2 provides a list of conversion factors that are frequently used in these SOPs.

Table 1-2. Conversion Factors

To Convert	Multiply by	To Obtain
acres	43,560	square feet (ft^2)
acres	4.047E3	square meters (m^2)
cubic centimeters (cm^3)	1E-3	liter (L)
gallons (gal)	3.785	liter (L)
grams (g)	1,000	milligrams (mg)
grams (g)	2.2E-3	pound (lb)
liters (L)	1,000	cubic centimeter (cm^3)
liters (L)	2.64E-1	U.S. gallon (gal)
micrograms (μg)	1E-3	milligram (mg)
milligrams (mg)	1,000	micrograms (μg)
milligrams (mg)	1E-3	gram (g)
pounds (lb)	454	grams (g)
square meters (m^2)	1E4	square centimeter (cm^2)
square feet (ft^2)	2.29E-5	acre
square meters (m^2)	2.47E-4	acre
square centimeters (cm^2)	1E-4	square meter (m^2)
square centimeters (cm^2)	2.47E-8	acre
square centimeters (cm^2)	1.08E-3	square feet (ft^2)

1.6 Definitions

This section provides definitions for many of the key terms used in these SOPs. Most of these definitions are taken directly from EPA=s Guidelines for Exposure Assessment (U.S. EPA, 1992) or EPA=s Draft Series 875 - Occupational and Residential Exposure Test Guidelines, Group B - Postapplication Exposure Monitoring Test Guidelines (U.S. EPA, 1997).

Absorbed Dose - The amount of a substance penetrating across the absorption barriers (the exchange boundaries) of an organism, via either physical or biological processes. This is synonymous with internal dose.

Active Ingredient (ai) - The chemical component of a pesticide formulation or end-use product that is intended to act as a pest deterent; the active chemical agent in a pesticide product.

Bounding Dose Estimate - An estimate of dose that is higher than that incurred by the person in the population with the highest dose. Bounding estimates are useful in developing statements that doses are "not greater than" the estimated value.

Central Tendency Dose Estimate - An estimate of dose for individuals within the central portion (average or median) of a dose distribution.

Dislodgeable Residues - The portion of pesticide residues that are available for transfer to humans.

Dose Rate - Dose per unit time, for example in mg/day, sometimes also called dosage. Dose rates are often expressed on a per-unit-body-weight basis yielding such units as mg/kg/day. They are also often expressed as averages over some time period (e.g., a lifetime).

Exposure Assessment - The determination of the magnitude, frequency, duration, and route of exposure.

Exposure Concentration - The concentration of a chemical in its transport or carrier medium at the point of contact.

Exposure Pathway - The physical course a chemical or pollutant takes from the source to the organism exposed.

Exposure Route - The way a chemical or pollutant enters an organism after contact (e.g., by ingestion, inhalation, or dermal absorption).

Exposure Scenario - A set of facts, assumptions, and inferences about how exposure takes place that aids the exposure assessor in evaluating, estimating, or quantifying exposure.

Geometric Mean - The n^{th} root of the product of n values.

High-end Dose Estimates - A plausible estimate of individual dose for those persons at the upper end of a dose distribution, conceptually above the 95th percentile, but not higher than the individual in the population who has the highest dose.

Mean Value - The arithmetic average of a set of numbers.

Median Value - The value in a measurement data set such that half the measured values are greater and half are less.

Potential Dose - The amount of a chemical contained in material ingested, air breathed, or bulk material applied to the skin.

Surrogate Data - Substitute data or measurements on one substance (or population) used to estimate analogous or corresponding values for another substance (or population).

Unit Exposure - The amount of residue to which individuals are exposed (based on monitoring data), normalized to the amount of active ingredient used.

Upper-Percentile Value - The value in a measurement data set that is at the upper end of the distribution of values (i.e., 90th to 95th percentile).

1.7 References

U.S. Environmental Protection Agency. (1987) Pesticide Assessment Guidelines. Subdivision U. Applicator Exposure Monitoring. Office of Pesticide Programs, Washington, DC. EPA/540/9-87-127. National Technical Information Service; PB87-133286.

U.S. Environmental Protection Agency. (1989) Risk Assessment Guidance for Superfund. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

U.S. Environmental Protection Agency. (1992) Guidelines for Exposure Assessment. Federal Register Notice. Vol. 57. No. 104, pp. 22888-22938.

U.S. Environmental Protection Agency. (1995) Series 875: Occupational and Residential Exposure Test Guidelines, Group B - Post-Application Exposure Monitoring Test Guidelines (Working Draft, Version 5.1). Office of Prevention, Pesticides, and Toxic Substances. Washington, DC.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook, External Review Draft. Office of Health and Environmental Assessment, Washington, DC. EPA/600/P-95/002B.

U.S. Environmental Protection Agency. (1997) Series 875 - Occupational and Residential Exposure Test Guidelines, Group B - Postapplication Exposure Monitoring Test Guidelines. Draft Document (Version 5.2). Office of Prevention, Pesticides, and Toxic Substances, Washington, DC.

2.0 RESIDENTIAL LAWNS

Prior to the development of an exposure assessment for a turf scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for residential lawns are as follows:

Registered for Use on Turfgrass: Determine whether the labeling contains directions for use on "turfgrass," "lawns," or "ornamental turf," or on specific species of turfgrasses, such as "bluegrass," "zoysia," "bentgrass," etc. Be sure that the product is intended to be applied at turfgrass sites and is not an herbicide intended to kill turfgrass species growing at other sites, such as gardens, landscape plants, and industrial sites.

Limitation and Descriptive Statements: Look for statements describing or limiting the use on turfgrass. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that a product registered for use on turfgrass is used on home lawns, unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners (no residential handler exposure/risk assessment required), but it may be applied by commercial applicators to residential sites; therefore, a postapplication exposure/risk assessment may be required. Statements such as "Golf course use only," "For use only on commercial sod farms," or "For use in commercial plantings only," and the more specific "Not for use on home lawns" indicate that the product cannot be used on residential turf, and no residential handler or postapplication exposure/risk assessment is required.

2.1 Handler Inhalation and Dermal Potential Dose from Pesticides Applied to Turf

Introduction

This SOP provides a standard method to be used for estimating potential doses that homeowners may receive during turf applications from inhalation and dermal contact when chemical specific data are unavailable. This scenario assumes that pesticides are available to be inhaled or have the potential to come in contact with the skin of adults and youth during the mixing/loading and application of lawn chemicals. The method to determine handler inhalation and dermal exposure to pesticides from turf applications relies on using surrogate PHED data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 2.0.) The data required for estimating handler exposures to pesticides when treating turfgrass are the application method specific data (i.e., use scenario, formulation types, and unit exposures), application rates, and usage data (e.g., acreage or gallons). The maximum application rate specified on the label should be used, except in cancer assessments when the typical application rates should be used. However, it should be noted that the typical residential use rate is often the maximum residential use rate. The following assumptions are also needed for estimating daily inhalation and dermal mixer/loader/applicator doses.

- Application methods for granulars will include drop-type spreaders, whirly-bird spreaders, shaker cans, and dispersed by hand (spot treatment). Application methods for liquid formulations will include hose-end sprayers, typical garden sprinkler/watering can (spot treatment), low-pressure handwands (spot treatment), and backpacks (spot treatment). Dermal and inhalation unit exposures and data confidence descriptions are available for all of these application methods in Appendix B, except for shaker cans (refer to Section 9.1.1) and for the sprinkler/watering can scenario (use hose-end sprayers as a high-end estimate for this scenario). The current version of PHED uses measures of central tendency to estimate the best-fit unit exposure.

- The amount handled is based on 20,000 ft^2 (i.e., approximately 1/2 acre) lawns for full treatments and 1,000 ft^2 or 5 gallons of diluted spray for spot treatments. The mean lawn size is estimated to be 0.3 acre (Vinlove and Torla, 1995). Thus, 1/2 acre is assumed to be within the mean to upper-percentile range of the distribution of lawn size. The amounts typically used to represent an upper-percentile value by OPP/HED in risk assessments are 1,000 ft^2 or 5 gallons because this represents two 2-1/2-gallon low-pressure handwand containers.

- Adults are assumed to weigh 71.8 kilograms (kg) (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, 18 years and older) and is the value recommended in EPA=s Exposure Factors Handbook (U.S. EPA, 1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old

youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years.

Inhalation and/or dermal potential dose rates are calculated as follows:

$$PDR = UE * AR * A$$

where:

PDR	=	potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai)
AR	=	maximum application rate (lb ai/acre or lb ai/gal)
A	=	maximum area treated (acres/day) or (gal/day)

Inhalation and/or dermal potential doses normalized to body weight are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (for example, exposure to male or female adults).

Example Calculations

The following is an example calculation to determine the dermal dose to an adult homeowner loading/applying a granular lawn chemical. A complete assessment would include inhalation and dermal dose for all registered application methods that might include whirly-bird spreaders, shaker cans, and dispersed by hand (spot treatment). For the purpose of this example, the application rate is assumed to be 1 lb ai/acre.

The estimated dermal potential dose rate using a push-type granular spreader would be as follows:

$$PDR = UE * AR * A$$

$$PDR = 3.0 \text{ mg/lb ai} * 1 \text{ lb ai/acre} * 0.5 \text{ acre/day}$$

$$PDR = 1.5 \text{ mg/day}$$

Finally, the estimated potential dermal dose rate, normalized to body weight for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (1.5 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 0.02 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on central tendency estimates of the unit exposure, area treated, and body weight, and a central to upper-percentile assumption for the application rate and are considered to be representative of central tendency exposures. The uncertainties associated with this assessment stem from the use of surrogate exposure data (e.g., differences in the use scenarios and data confidence - see Surrogate Exposure Table) and assumptions regarding amount of chemical handled. These estimated doses are believed to be reasonable central tendency to high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

Vinlove, F.K.; Torla, R. (1995) Comprehensive Estimation of U.S. Home Lawn Area. Journal of Turfgrass Management 1(1):83-97.

2.2 Postapplication Dermal Potential Dose from Pesticide Residues on Turf

Introduction

This SOP provides a standard method for estimating potential doses among adults and/or toddlers from dermal contact with turf that has previously been treated with pesticides. Inhalation exposure is considered minimal due to the air exchange in the outdoor scenarios. This scenario assumes that pesticide residues are transferred to the skin of adults/toddlers who enter treated yards for recreation, yardwork, or other homeowner activities. The method for estimating postapplication dermal exposure to pesticide residues on turf is based on assumptions applicable when adequate chemical specific field data are unavailable. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 2.0.) The only datum required for estimating postapplication doses to pesticide residues on turfgrass is the application rate (e.g., lb ai/acre). The maximum application rate specified on the label should be used as the residential lawn application rate. One exception is for cancer assessments, when the typical application rates should be used. It should be noted that the typical residential use rate is often the maximum residential use rate. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- On the day of application, it may be assumed that 20 percent of the application rate are available from the turfgrass as dislodgeable residue. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data, and is assumed to represent an upper-percentile input value.

- Postapplication must be assessed on the same day the pesticide is applied because it is assumed that the homeowner could be exposed to turfgrass immediately after application. Therefore, postapplication exposures are based on day 0. For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- The upper percentile dermal transfer coefficient is assumed to be 43,000 cm^2/hr for adults and 8,700 cm^2/hr for toddlers. (Cal EPA, 1996 reported a transfer coefficient of 43,000 for adults and 8,700 for children on carpet. The children=s value was corrected from the adult transfer coefficient using the ratio of an adult body surface area to a child=s surface area.) The Cal EPA (1996) value of 43,000 cm^2/hr is a calculated mean, based on the Jazzercize method, which is believed to result in an upper percentile estimate of the transfer coefficient for this scenario.

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Toddlers (3 years

old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female children (U.S. EPA, 1996).

- **$** The duration of exposure for toddlers and adults is assumed to be 2 hours per day. The 95th percentile value for playing on grass is 121 minutes per day for both age groups 1-4 years and 18-64 years (U.S. EPA, 1996).

Dermal potential dose rates are calculated as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

where:

PDR_t	=	potential dose rate on day "t" (mg/day)
DFR_t	=	dislodgeable foliar residue on day "t" ($\mu g/cm^2$)
CF1	=	weight unit conversion factor to convert μg units in the DFR value to mg for the daily dose (0.001 mg/μg)
Tc	=	transfer coefficient (cm^2/hr)
ET	=	exposure time (hr/day)

and

$$DFR_t = AR * F * (1-D)^t * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/ft^2 or lb ai/acre)
F	=	fraction of ai retained on foliage (unitless)
D	=	fraction of residue that dissipates daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	weight unit conversion factor to convert the lbs ai in the application rate to μg for the DFR value (4.54E8 μg/lb)
CF3	=	area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the DFR value (1.08E-3 ft^2/cm^2 or 24.7E-9 acre/cm^2 if the application rate is per acre)

Dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$	=	potential dose rate on day "t," normalized to body weight
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the dose based on an assumed DFR over time. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb ai/acre). Thus, the dislodgeable foliar residue on day 0 is as follows:

$$DFR_t = AR * F * (1\text{-}D)^t * CF2 * CF3$$

$$DFR_0 = 2.2E\text{-}5 \text{ lb ai/ft}^2 * 0.2 * (1\text{-}D)^0 * 4.54E8 \ \mu g/lb * 1.08E\text{-}3 \text{ ft}^2/cm^2$$

$$DFR_0 = 2.16 \ \mu g/cm^2$$

The estimated potential dose rate for the day of application would be as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

$$PDR_0 = 2.16 \ \mu g/cm^2 * 0.001 \text{ mg/}\mu g * 8{,}700 \text{ cm}^2/hr * 2 \text{ hours/day}$$

$$PDR_0 = 37.6 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a child with a body weight of 15 kg would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (37.6 \text{ mg/day}) / (15 \text{ kg})$$

$$PDR_{0\text{-}norm} = 2.51 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., body weight and transfer coefficient) and some upper-percentile assumptions (i.e., duration of exposure, and maximum application rate for acute assessments) and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on turf, and assumptions regarding dissipation and transfer of chemical residues. The dose estimates are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

California Environmental Protection Agency. (1996) Memorandum from T. Formoli (California EPA, Department of Pesticide Regulation, Worker Health and Safety Branch) to M. Mason (California EPA, Department of Pesticide Regulation, Pesticide Regulation Branch), October 17, 1996.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

2.3 Postapplication - Incidental Nondietary Ingestion

2.3.1 Postapplication Potential Dose Among Toddlers from the Ingestion of Pesticide Pellets or Granules from Treated Areas

Introduction

This SOP provides a standard method for estimating postapplication doses among toddlers from incidental ingestion of pesticide pellets and granules that have been applied to lawns and gardens when adequate site-or chemical-specific field data are unavailable. This scenario assumes that dry pesticide materials are ingested by toddlers who play in treated areas (i.e., yards, gardens, playgrounds). The doses estimated using this method may be combined with toxicity data to estimate the risks associated with incidental ingestion exposure from pesticide granules or pellets used to treat outdoor residential areas.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 2.0.) The datum required for estimating postapplication doses from dry pesticide pellets and granules is the percent ai content of the dry formulation. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- The assumed ingestion rate for dry pesticide formulations (i.e., pellets and granules) is 0.3 gram/day for children (age 3 years). This is based on the assumption that if 150 pounds of product were applied to a 1/2-acre lawn, the amount of product per square foot would be approximately 3 g/ft^2, and a child would consume one-tenth of the product available in a square foot. This is believed to be an upper-percentile assumption, based on the experience and professional judgement of OPP/HED staff.

- Toddlers (age 3 years), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is a mean of the median values for male and female children (U.S. EPA, 1996).

Potential dose rates from ingestion are calculated as follows:

$$PDR = IgR^* F * CF1$$

where:

PDR	=	potential dose rate (mg/day)
IgR	=	ingestion rate of dry pesticide formulation (g/day)
F	=	fraction of ai in dry formulation (unitless)
CF1	=	weight unit conversion factor to convert g units in the ingestion rate value to mg for the daily exposure (1,000 mg/g)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / Bw$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the potential dose rate based on an assumed quantity of active ingredient per dry weight of pesticide pellets or granules. For the purpose of this example, the percent ai in the dry pesticide formulation is 0.5 percent (0.005). Thus, the estimated potential dose rate among toddlers from dry pesticide materials would be as follows:

$$PDR = IgR * F * CF1$$

$$PDR = 0.3 \text{ g/day} * 0.005 * 1{,}000 \text{ mg/g}$$

$$PDR = 1.5 \text{ mg/day}$$

Finally, the estimated potential dose rate normalized to body weight for a toddler with a body weight of 15 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (1.5 \text{ mg/day}) / (15 \text{ kg})$$

$$PDR_{norm} = 0.1 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., body weight) and some upper-percentile assumptions (i.e., ingestion rate of dry pesticide formulation, and maximum application rate for acute assessments) and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed ingestion rate of dry pesticide formulation. The dose estimates are considered to be reasonable high-end estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

2.3.2 Postapplication Potential Dose among Toddlers from Incidental Nondietary Ingestion of Pesticide Residues on Residential Lawns from Hand-to-mouth Transfer

Introduction

This SOP provides a standard method for estimating potential dose among toddlers from incidental ingestion of pesticide residues from previously treated turf. This scenario assumes that pesticide residues are transferred to the skin of toddlers playing on treated yards and are subsequently ingested as a result of hand-to-mouth transfer. It does not include residues ingested as a result of soil ingestion. (See Section 2.3.4.) The method for estimating postapplication incidental ingestion dose from pesticide residues on turf is based on assumptions when adequate chemical specific field data are unavailable.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 2.0.) The only datum required for estimating postapplication doses to pesticide residues on turfgrass is the application rate (e.g., lb ai/acre). The maximum application rate specified on the label should be used, except in cancer assessments when the typical application rates should be used. It should be noted, however, that the typical residential use rate is often the same as the maximum rate. The following assumptions are also needed for estimating pesticide postapplication doses.

- **$** On the day of application, it may be assumed that 20 percent (i.e., 0.20) of the application rate are available on the turfgrass as dislodgeable residue. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data and is believed to be an upper-percentile value.

- **$** Postapplication activities must be assessed on the same day that the pesticide is applied because it is assumed that toddlers could play on the lawn immediately after application. For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- **$** The median surface area of both hands is 350 cm^2 for a toddler (age 3 years). This value represents the mean of the 50th percentile total surface area values for males and females in the 2<3 year and 3<4 year age groups, multiplied by the mean percentage of the total body represented by hands for males and females. (U.S. EPA, 1996a). The 3 year old age group was selected for use in this scenario because this is the youngest age group for which data on hand-to-mouth activity data were available.

- Replenishment of the hands with pesticide residues is assumed to be an implicit factor in this assessment.

- It is assumed that there is a one-to-one relationship between the dislodgeable residues on the turf and on the surface area of the skin after contact (i.e., if the dislodgeable residue on the turf is 1 mg/cm^2, then the residue on the human skin is also 1 mg/cm^2 after contacting the turf).

- **$** The mean rate of hand-to-mouth activity is 0.026 events/minute (i.e., 1.56 events/hr) for toddlers (3 to 5 year olds) (U.S. EPA, 1996b).

- The duration of exposure for toddlers is assumed to be 2 hours per day. This is based on the 95th percentile value (i.e., 121 minutes/day) for playing on grass for ages 1-4 years (U.S. EPA, 1996a).

- **$** Toddlers (age 3 years), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female children (U.S. EPA, 1996a).

Potential dose rates from ingestion are calculated as follows:

$$PDR_t = DFR_t * SA * FQ * ET * CF1$$

where:

PDR_t	=	potential dose rate on day "t" (mg/day)
DFR_t	=	dislodgeable foliar residue on day "t" (μg/cm^2 turf)
SA	=	surface area of the hands (cm^2/event)
FQ	=	frequency of hand-to-mouth activity (events/hr)
ET	=	exposure time (hr/day)
CF1	=	weight unit conversion factor to convert μg units in the DFR value to mg for the daily exposure (0.001 mg/μg)

and

$$DFR_t = AR * F * (1-D)^t * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/ft^2 or lb ai/acre)
F	=	fraction of ai available on turf (unitless)
D	=	fraction of residue that dissipates daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	weight unit conversion factor to convert the lbs ai in the application rate to μg for the DFR value (4.54E8 μg/lb)
CF3	=	area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the DFR value (1.08E-3 ft^2/cm^2 or 2.47E-8 acre/cm^2, if the application rate is per acre)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$	=	potential dose rate normalized to body weight on day "t" (mg/kg/day)
BW	=	body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed dislodgeable foliar residue. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb/acre). Thus, the dislodgeable foliar residue on day 0 (i.e., the day of application) is as follows:

$$DFR_t = AR * F * (1\text{-}D)^t * CF2 * CF3$$

$$DFR_0 = 2.2E\text{-}5 \text{ lb ai/ft}^2 * 0.2 * (1\text{-}D)^0 * 4.54E8 \ \mu g/lb * 1.08E\text{-}3 \text{ ft}^2/cm^2$$

$$DFR_0 = 2.16 \ \mu g/cm^2$$

The estimated incidental ingestion dose for a toddler on the day of application would be as follows:

$$PDR_t = DFR_t * SA * FQ * ET * CF1$$

$$PDR_0 = 2.16 \text{ ug/cm}^2 * 350 \text{ cm}^2\text{/event} * 1.56 \text{ events/hr} * 2 \text{ hr/day} * 0.001 \text{ mg/}\mu g$$

$$PDR_0 = 2.36 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized by body weight, for a toddler with a body weight of 15 kg would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (2.36 \text{ mg/day}) / (15 \text{ kg})$$

$$PDR_{0\text{-}norm} = 0.16 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some upper-percentile (i.e., available residues, duration of exposure) and some central tendency (i.e., surface area, hand-to-mouth activity, and body weight) assumptions and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide available from turf, and assumptions regarding dissipation and hand-to-mouth activity. The estimated doses are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996a) Exposure Factors Handbook. [Draft]. National Center for Environmental Assessment, Washington, DC. EPA/600/P-95/002Ba.

U.S. Environmental Protection Agency. (1996b) Time location activity pattern methodology: the creation of Bayesian distributions for the field investigations of exposure of infants and children to toxic substances. EPA-007-2. (To be included in an EPA Project Report entitled "Protocol for dermal exposure assessment in residential and non-occupational environments" which is currently in preparation and subject to EPA/ORD peer review).

2.3.3 Postapplication Potential Dose among Toddlers from the Ingestion of Pesticide-Treated Turfgrass

Introduction

This SOP provides a standard method for estimating doses among toddlers from incidental ingestion of residential turfgrass that has been previously treated with pesticides. This scenario assumes that turf is ingested by toddlers who play on treated areas (i.e., yards, playgrounds). The method for estimating postapplication ingestion dose from pesticide residues on grass is based on assumptions when adequate site-or chemical-specific field data are unavailable. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 2.0.) The only datum required for estimating postapplication doses from pesticide residues on grass is the application rate for the treatment areas (e.g., lb ai/acre). The maximum application rate specified on the label should be used, except in cancer assessments, when the typical application rates should be used. It should be noted that the typical residential use rate is often also the maximum residential use rate. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- **$** On the day of application, it may be assumed that 20 percent of the application rate are available to be ingested. Based on the experience and professional judgement of the OPP/HED staff, this is assumed to represent an upper-percentile input.

- **$** Postapplication must be assessed on the same day the pesticide is applied because it is assumed that toddlers could play on the lawn immediately after application. For subsequent days after application, an assumed pesticide dissipation should be used, based on chemical-specific data.

- **$** The assumed ingestion rate for grass for toddlers (age 3 years) is 25 cm^2/day (i.e., 2 x 2 inches or 4 in^2). This value is intended to represent the approximate area from which a child may grasp a handful of grass. Based on the experience and professional judgement of the OPP/HED staff, this is assumed to represent an upper-percentile input.

- **$** Toddlers (age 3 years), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female children (U.S. EPA, 1996).

Potential dose rates from ingestion are calculated as follows:

$$PDR_t = GR_t * IgR * CF1$$

where:

PDR_t = potential dose rate on day "t" (mg/day)
GR_t = grass (and plant matter) residue on day "t" ($\mu g/cm^2$)

IgR = ingestion rate of grass (cm^2/day)
CF1 = weight unit conversion factor to convert the μ of residues on the grass to mg to provide units of mg/day (1E-3 mg/μ)

and

$$GR_t = AR * F * (1-D)^t * CF2 * CF3$$

where:

AR = application rate (lbs ai/ft^2 or lb ai/acre)
F = fraction of ai available on the grass (unitless)
D = fraction of residue that dissipates daily (unitless)
t = postapplication day on which exposure is being assessed
CF2 = weight unit conversion factor to convert the lbs ai in the application rate to μ for the grass residue value (4.54E8 μ/lb)
CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the grass residue value (1.08E-3 ft^2/cm^2 or 2.47E-8 acre/cm^2 if the application rate is per acre)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$ = potential dose rate, normalized to body weight, on day "t" (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed residue on the grass. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb ai/acre). Thus, the turf residue on day 0 (i.e., the day of application) is as follows:

$$GR_t = AR * F * (1-D)^t * CF2 * CF3$$

$$GR_0=(2.2E\text{-}5 \text{ lb ai}/ft^2) * (0.2) * (1-D)^0 * (4.54E8\ \mu/\text{lb}) * (1.08E\text{-}3\ ft^2/cm^2)$$

$$GR_0 = 2.16\ \mu g/cm^2$$

The estimated dose to toddlers from grass ingestion for the day of application would be as follows:

$$PDR_t = GR_t * IgR * CF1$$

$$PDR_0 = 2.16\ \mu g/cm^2 * 25\ cm^2/\text{day} * 1E\text{-}3\ mg/\mu g$$

$$PDR_0 = 0.054 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a toddler with a body weight of 15 kg would be:

$$PDR_{t\text{-}norm} = E_t / BW$$

$$DPR_{0\text{-}norm} = (0.054 \text{ mg/day}) / (15 \text{ kg})$$

$$PDR_{0\text{-}norm} = 0.0036 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions (except body weight which is an average value) and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide on the turf, assumptions regarding dissipation of chemical residues on the grass, and the ingestion rate. The estimated doses are believed to be reasonable high-end estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

2.3.4 Postapplication Potential Dose Among Toddlers from Incidental Ingestion of Soil from Pesticide-Treated Residential Areas

Introduction

This SOP provides a standard method for estimating dose among toddlers from incidental ingestion of soil containing pesticide residues. This scenario assumes that pesticide residues in soil are ingested by toddlers who play on treated areas (i.e., yards, gardens, playgrounds) as a result of normal mouthing activities (i.e., these estimates do not represent exposure among toddlers who exhibit pica, an abnormal ingestion behavior). The method for estimating postapplication ingestion exposure to pesticide residues in soil is based on assumptions when adequate site-or chemical-specific field data are unavailable. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 2.0.) The only datum required for estimating postapplication exposures to pesticide residues in soil is the application rate for the treatment areas (e.g., lb ai/acre). The maximum application rate specified on the label should be used, except in cancer assessments when the typical application rates should be used. However, it should be noted that the typical residential use rate is often the maximum residential use rate. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- On the day of application, it is assumed that 100 percent of the application rate are located within the soil's uppermost 1 cm. Based on the experience and professional judgement of the OPP/HED staff, this is assumed to be an upper-percentile assumption.

- Postapplication must be assessed on the same day the pesticide is applied because it is assumed that toddlers could play on the lawn or other outdoor treated areas immediately after application. For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- The assumed soil ingestion rate for children (ages 1-6 years) is 100 mg/day. This is the mean soil ingestion rate value recommended by EPA for use in exposure/risk assessments. (U.S. EPA, 1996).

- Toddlers (age 3 years), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female children. (U.S. EPA, 1996).

Potential dose rates from ingestion are calculated as follows:

$$PDR_t = SR_t * IgR * CF1$$

where:

PDR_t = potential dose rate on day "t" (mg/day)
SR_t = soil residue on day "t" (μg/g)
IgR = ingestion rate of soil (mg/day)
CF1 = weight unit conversion factor to convert the μg of residues on the soil to grams to provide units of mg/day (1E-6 g/μg)

and

$$SR_t = AR * F * (1\text{-}D)^t * CF2 * CF3 * CF4$$

where:

AR = application rate (lbs ai/ft^2 or lb ai/acre)
F = fraction of ai available in uppermost cm of soil (fraction/cm)
D = fraction of residue that dissipates daily (unitless)
t = postapplication day on which exposure is being assessed
CF2 = weight unit conversion factor to convert the lbs ai in the application rate to μg for the soil residue value (4.54E8 μg/lb)
CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the SR value (1.08E-3 ft^2/cm^2 or 2.47E-8 acre/cm^2 if the application rate is per acre)
CF4 = volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (U.S. EPA, 1992) (0.67 cm^3/g soil)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$ = potential dose rate, normalized to body weight, on day "t" (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed soil residue concentration. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb ai/acre). Thus, the soil residue on day 0 (i.e., the day of application) is as follows:

$$SR_t = AR * F * (1\text{-}D)^t * CF2 * CF3 * CF4$$

$$SR_0 = 2.2E\text{-}5 \text{ lb ai/ft}^2 * 1.0/\text{cm} * (1\text{-}D)^0 * 4.54E8 \ \mu\text{g/lb} * 1.08E\text{-}3 \text{ ft}^2/\text{cm}^2 * 0.67 \text{ cm}^3/\text{g soil}$$

$$SR_0 = 7.2 \ \mu\text{g/g}$$

The estimated incidental soil ingestion dose among toddlers for the day of application would be as follows:

$$PDR_t = SR_t * IgR * CF1$$

$$PDR_0 = 7.2\ \mu g/g * 100\ mg/day * 1E\text{-}6\ g/\mu g$$

$$PDR_0 = 0.0007\ mg/day$$

Finally, the estimated potential dose rate, normalized to body weight, for a toddler with a body weight of 15 kg would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (0.0007\ mg/day) / (15\ kg)$$

$$PDR_{0\text{-}norm} = 4.8E\text{-}5\ mg/kg/day$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central (i.e., soil ingestion rate and body weight) tendency and some upper-percentile (i.e., availability of residues) assumptions and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide available in the uppermost 1 cm of soil, and assumptions regarding dissipation of chemical residues in the soil and soil ingestion. The estimated doses are believed to be reasonable high-end estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

U.S. Environmental Protection Agency. (1992) Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment. EPA/600/8-9/011F.

3.0 GARDEN PLANTS

Prior to the development of an exposure assessment for a garden scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for garden plants are as follows:

Registered for Use on Ornamentals, Fruits, or Vegetables: Determine whether the labeling contains directions for use on "ornamentals," "flowers," "shrubs," "house plants," "fruits" (non-tree), "vegetables," or on specific species of ornamentals, fruits, or vegetables such as "African violets," "strawberries," "sweet corn," etc.

Limitation and Descriptive Statements: Look for statements describing or limiting the use on ornamentals, fruits, or vegetables. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. *Assume that a product registered for use on ornamentals, fruit, or vegetables is used at residential sites unless a specific labeling statement indicates otherwise.* Field crops, such as corn (other than sweet corn), soybeans, alfalfa, or cotton are assumed to not be grown at residential sites. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners. Therefore, no residential handler exposure/risk assessment is required. Because commercial applicators do not usually apply pesticides to residential gardens, no postapplication exposure/risk assessment is required for these restricted use products. Statements such as "Commercial or research greenhouse use only," "For nursery-grown ornamentals," or "For use in commercial plantings only," and the more specific "Not for use on residential site," "Not for use in home gardens," or "Not for use in and around homes or dwellings" indicate that the product cannot be used on residential gardens, and no residential handler or postapplication exposure/risk assessment is required.

3.1 Handler Inhalation and Dermal Potential Dose from Pesticides Applied to the Garden

Introduction

This SOP provides a standard method to be used for estimating potential doses that homeowners may receive during applications of pesticides to the garden when chemical specific data are unavailable. Garden applications include insect and weed treatments around walkways, driveways, foundations, vegetables, and ornamentals. Garden applications are also made to control plant diseases. This scenario assumes that pesticides are available for inhalation or have the potential to come in contact with the skin of adults and youth during the mixing/loading and application of pesticides used around the garden. The method to determine handler inhalation and dermal exposure to pesticides from garden applications relies on surrogate PHED data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 3.0.) The data required for estimating handler exposures to pesticide when treating the yard and garden are the application method specific data (i.e., use scenario, formulation types, and unit exposures), application rates, and usage data (e.g., acreage or gallons). The maximum application rate specified on the label should be used, except in cancer assessments, when the typical application rate should be used. However, it should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily inhalation and dermal mixer/loader/applicator doses.

- Application methods for granulars will include whirly-bird spreaders, shaker cans, and dispersed by hand (spot treatment). Application methods for liquid formulations will include hose-end sprayers, sprinkler/watering can, low-pressure handwands, and backpack. Application methods for ready-to-use products will include trigger pump applications. Dermal and inhalation unit exposures and data confidence descriptions are available for all of these application methods in Appendix B, except for shaker cans (refer to Section 9.1.1), sprinkler/watering can, and the trigger pump scenarios. The unit exposures from the hose-end sprayers should be used as an upper-percentile estimate for the sprinkler/watering can scenario. The current version of PHED uses measures of central tendency to estimate the best-fit unit exposures.

- The amount handled is based on 10,000 ft^2 (i.e., 1/4 acre; large garden in a farm-type setting) for treatments based on area, and 5 gallons of spray diluent (i.e., two 2 1/2-gallon handwand treatments) for treatments based on concentrations. These are believed to be upper-percentile assumptions based on the experience and professional judgement of OPP/HED staff.

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The mean body weight for a 10 to 12 year old youth is 39.1 kg. This

represents the mean of the median values for males and females at ages 10, 11, and 12 years.

- **$** The density of an organic spray solution contained in a single use pressurized can may be assumed to be 0.80 g/mL unless a product-specific value is available. This is based on an informal survey of various organic solvents described in CRC (1981). A value of 0.80 g/mL represents an mean of various organic solvents from this source.

Inhalation and dermal potential dose rates are calculated as follows:

$$PDR = UE * AR * A$$

where:

PDR	=	daily potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai)
AR	=	maximum application rate (lb ai/acre, or lbs ai/gal)
A	=	maximum area treated (acres/day), amount handled (gal/day)

Inhalation and dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (for example, exposure to male or female adults).

Example Calculations

The following is an example calculation to determine the inhalation dose to an adult homeowner applying a product to the garden using a liquid formulation in a low-pressure handwand at a rate of 1 lb ai/acre. For the purpose of this example, the estimated inhalation dose assuming an application rate of 1 lb ai/acre and using a unit exposure of 0.03 mg/lb ai would be as follows:

$$PDR = UE * AR * A$$

$$PDR = 0.03 \text{ mg/lb ai} * 1 \text{ lb ai/acre} * 0.25 \text{ acre/day}$$

$$PDR = 0.0075 \text{ mg/day}$$

Finally, the estimated potential inhalation dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (0.0075 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 0.00010 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on a central tendency estimate of unit exposure and an upper-percentile assumption for the application rate, and are assumed to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of surrogate exposure data (e.g., differences in use scenario and data confidence) and assumptions regarding the amount of chemical handled. The estimated doses are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington, D.C. EPA/600/P-95/002Ba.

3.2 Postapplication Dermal Potential Doses from Pesticide Residues on Gardens

Introduction

This SOP provides a standard method for estimating doses among adults and/or toddlers from dermal contact with gardens that have previously been treated with pesticides. Inhalation dose is considered minimal due to the air exchange that occurs in outdoor scenarios. This scenario assumes that pesticide residues are transferred to the skin of adults and youth who enter treated gardens for gardening or other homeowner activities. The method for estimating postapplication dermal dose from pesticides on gardens is based on assumptions when adequate chemical specific field data are unavailable. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 3.0.) The only datum required for estimating postapplication doses from pesticide residues on gardens is the application rate. The maximum application rate specified on the label should be used as the residential garden rate. One exception is for cancer assessments, when the typical application rates should be used. It should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

- On the day of application, it may be assumed that 20 percent of the application rate are available on the foliage as dislodgeable residue. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data, and is assumed to represent an upper-percentile value.

- Postapplication exposure must be assessed on the same day the pesticide is applied because it is assumed that homeowners could enter the garden immediately after application. For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- The assumed mean dermal transfer coefficient is 10,000 cm^2/hr for adults and 5,000 cm^2/hr for youth (age 10-12 years) (e.g., tomato harvesting). These values are based on the professional judgement and experience of the OPP/HED staff from the reviewed company-submitted data.

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the average of the median values for males and females at ages 10, 11, and 12 years.

- **$** The duration of exposure is assumed to be 0.25 hours per day for youths (age 10-12 years) and 0.67 hours per day for adults (age 18-64 years), based on the 95th percentile values for time spent working in a garden or other circumstances working with soil (U.S. EPA, 1996).

Dermal potential dose rates are calculated as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

where:

PDR_t	=	potential dose rate on day "t" (mg/day)
DFR_t	=	dislodgeable foliar residue on day "t" ($\mu g/cm^2$)
CF1	=	weight unit conversion factor to convert μg units in the DFR value to mg for the daily exposure (0.001 mg/μg)
Tc	=	transfer coefficient (cm^2/hr)
ET	=	exposure time (hr/day)

and

$$DFR_t = (AR * F) * (1-D)^t * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/ft^2 or lbs ai/acre)
F	=	fraction of ai retained on foliage (unitless)
D	=	fraction of residue that dissipates daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	conversion factor to convert the lbs ai in the application rate to μg for the DFR value (4.54E8 μg/lb)
CF3	=	conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the DFR value (1.08E-3 ft^2/cm^2 or 2.47E-8 acre/cm^2 if the application rate is per acre)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$	=	potential dose rate, normalized to body weight, on day "t" (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (for example, exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the dose based on an assumed DFR over time. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb ai/acre). Thus, the dislodgeable foliar residue on day 0 is as follows:

$$DFR_t = (AR * F) * (1\text{-}D)^t * CF2 * CF3$$

$$DFR_0 = (2.2E\text{-}5 \text{ lb ai}/ft^2 * 0.2) * (1\text{-}D)^0 * (4.54E8 \ \mu g/lb) * (1.08E\text{-}3 \ ft^2/cm^2)$$

$$DFR_0 = 2.16 \ \mu g/cm^2$$

The estimated potential dose rate for the day of application would be as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

$$PDR_0 = 2.16 \ \mu g/cm^2 * 0.001 \text{ mg}/\mu g * 10{,}000 \ cm^2/hr * 0.67 \text{ hours/day}$$

$$PDR_0 = 14.5 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (14.5 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{0\text{-}norm} = 0.20 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions for transfer coefficients and duration, and central tendency estimates for body weights. They are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on gardens, and assumptions regarding dissipation and transfer of chemical residues. The dose estimates are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

3.3 Postapplication - Incidental Nondietary Ingestion

3.3.1 Eating Pellets or Granules (refer to 2.3.1)

3.3.2 Hand-to-Mouth Transfer (refer to 2.3.2)

3.3.3 Eating Plant Material (no SOP - exposure via this route is considered negligible)

3.3.4 Soil Ingestion (refer to 2.3.4)

4.0 TREES (NUT, FRUIT, ORNAMENTAL)

Prior to the development of an exposure assessment for a tree scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for trees are as follows:

Registered for Use on Trees (Ornamentals, Fruits, or Nuts): Determine whether the labeling contains directions for use on "fruit trees," "nut trees," or "ornamental trees," or on specific species of trees, such as "citrus," "pecans," "maples," etc.

Limitation and Descriptive Statements: Look for statements describing or limiting the use on trees. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that a product registered for use on trees is used at residential sites unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners; therefore, no residential handler exposure/risk assessment is required. Because commercial applicators do not usually apply pesticides to residential trees, no postapplication exposure/risk assessment is required for these restricted-use products. Statements such as "For use in commercial or research forests only," "For nursery-grown trees only,"or "For use on commercial plantings only," and the more specific "Not for use on residential sites," or "Not for use in and around homes or dwellings" indicate that the product cannot be used on residential trees, and no residential handler or postapplication exposure/risk assessment is required. Assume no residential uses if the directions for use are solely for Christmas tree farms and/or wide-area (i.e., aerial) uses in forestry settings.

4.1 Handler Inhalation and Dermal Potential Doses from Pesticides Applied to Trees

Introduction

This SOP provides a standard method for estimating potential doses that homeowners may receive during application of pesticides to "backyard" trees (e.g., fruit and nut trees) when chemical specific data are unavailable. This scenario assumes that pesticide are available to be inhaled or have the potential to come in contact with the skin of adults and youth during the mixing/loading and application of pesticides used to treat "backyard" trees. The method to determine handler inhalation and dermal exposure to pesticides during the treatment of trees relies on using PHED surrogate data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 4.0.) The data required for estimating handler doses from pesticide when treating trees are the application method specific data (i.e., use scenario and unit exposures), application rates, and usage data (e.g., gallons). The maximum application rate specified on the label should be used as the residential application rate. One exception is for cancer assessments, when the typical application rate should be used. It should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily inhalation and dermal mixer/loader/applicator doses.

- **$** Application methods will include hose-end sprayers, low-pressure handwands, backpack sprayers, and potentially brush-type applications. The PHED V1.1 data for "back yard" trees are not representative. Most of the available data are based on applications below the waist, which may underestimate exposure for this scenario. Dermal and inhalation unit exposures and data confidence descriptions are available in Appendix B. The current version of PHED uses measures of central tendency to estimate the best-fit unit exposure.

- **$** The amount handled will be based on 5 gallons for runoff treatments (i.e., one 5-gallon backpack sprayer) and 1 gallon for brush-on treatments (i.e., this is believed to be the maximum amount an individual would brush on; at a higher rate, an individual would be likely to use a different application method).

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years.

Inhalation and dermal potential dose rates are calculated as follows:

$$PDR = UE * AR * A$$

where:

PDR	=	daily potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai)
AR	=	maximum application rate (lb ai/gal)
A	=	maximum amount handled (gal/day)

Inhalation and/or dermal potential dose rate, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to male or female adults).

Example Calculations

The following is an example calculation to determine the dermal dose based on a homeowner mixing/loading/applying a liquid application using a hose-end sprayer. A complete assessment would also include inhalation and dermal exposure for low pressure handwands, backpack sprayers, and potentially brush-on applications. For the purpose of this example, the application rate is assumed to be 0.5 lb ai/gallon of diluted spray.

The estimated dermal potential dose rate using a hose-end sprayer would be as follows, using a unit exposure value of 30 mg/lb ai:

$$PDR = UE * AR * A$$

$$PDR = 30 \text{ mg/lb ai} * 0.5 \text{ lb ai/gal} * 5 \text{ gal/day}$$

$$PDR = 75 \text{ mg/day}$$

Finally, the estimated dermal potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (75 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 1.0 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on a central tendency to high-end estimate of the unit exposure and an upper-percentile assumption for the application rate, and are assumed to be representative of high-end exposures. The uncertainties associated with this assessment stem from the representativeness of the available surrogate exposure data (e.g., surrogate data available in PHED V1.1 are mostly based on applications below the waist), data confidence, and assumptions regarding the amount of chemical handled. These assumptions are believed to be reasonable central tendency to high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

4.2 Postapplication Dermal Potential Doses from Pesticide Residues While Harvesting Fruit from Trees

Introduction

This SOP provides a standard method for estimating dose to adults and/or children from dermal contact while harvesting fruit from fruit trees that have previously been treated with pesticides. Inhalation dose is considered minimal due to the air exchange rate that occurs in outdoor scenarios. This scenario assumes that pesticide residues are transferred to the skin of adults and youth who come in contact with treated fruit trees while harvesting fruit or during other homeowner activities. The method for estimating postapplication dermal dose from pesticides while harvesting fruit from trees is based on assumptions when adequate site-specific field data are unavailable. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 4.0.) The only datum required for estimating postapplication exposures to pesticide residues while harvesting fruit from fruit trees is the application rate. The maximum application rate specified on the label should be used as the residential fruit tree application rate. One exception is for cancer assessments, when the typical application rates should be used. It should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

- **$** On the day of application it may be assumed that 20 percent of the application rate are available on the foliage as dislodgeable residue. This value is based on the experience and professional judgement of the OPP/HED staff from the review of company-submitted data and is assumed to be an upper-percentile value.

- **$** Postapplication exposure must be assessed on the same day the pesticide is applied because it is assumed that homeowners may harvest fruits immediately after application. For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- **$** The assumed mean dermal transfer coefficient is 10,000 cm^2/hr for adults and 5,000 cm^2/hr for youth (age 10-12 years). This value is based on the experience and professional judgement of the OPP/HED staff from the review of company-submitted data.

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This

represents the mean of the median values for males and females at ages 10, 11, and 12 years.

- **$** The duration of exposure is assumed to be 0.25 hours per day for youth (age 10-12 years) and 0.67 hours per day for adults (age 18-64 years), based on the 95th percentile values for time spent working in a garden or other circumstances working with soil (U.S. EPA, 1996).

Dermal potential dose rates are calculated as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

where:

PDR_t	=	potential dose rate on day "t" (mg/day)
DFR_t	=	dislodgeable foliar residue on day "t" ($\mu g/cm^2$)
CF1	=	weight unit conversion factor to convert μg units in the DFR value to mg for the daily exposure (0.001 mg/μg)
Tc	=	transfer coefficient (cm^2/hr)
ET	=	exposure time (hr/day)

and

$$DFR_t = AR * F * (1-D)^t * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/ft^2 or lbs ai/acre)
F	=	fraction of ai retained on foliage (unitless)
D	=	fraction of residue that dissipates daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	conversion factor to convert the lbs ai in the application rate to μg for the DFR value (4.54E8 μg/lb)
CF3	=	conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the DFR value (1.08E-3 ft^2/cm^2 or 2.47E-8 acre/cm^2 if the application rate is per acre)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$	=	potential dose rate, normalized to body weight, on day "t" (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the doses from liquid formulations based on an assumed DFR over time. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb ai/acre). Thus, the dislodgeable foliar residue on day 0 is as follows:

$$DFR_t = AR * F * (1\text{-}D)^t * CF2 * CF3$$

$$DFR_0 = 2.2E\text{-}5 \text{ lb ai/ft}^2 * 0.2 * (1\text{-}D)^0 * 4.54E8 \ \mu\text{g/lb} * 1.08E\text{-}3 \text{ ft}^2/\text{cm}^2$$

$$DFR_0 = 2.16 \ \mu\text{g/cm}^2$$

The estimated potential dose rate for the day of application would be as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

$$PDR_0 = 2.16 \ \mu\text{g/cm}^2 * 0.001 \text{ mg/}\mu\text{g} * 10{,}000 \text{ cm}^2\text{/hr} * 0.67 \text{ hours/day}$$

$$PDR_0 = 14.5 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (14.5 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{0\text{-}norm} = 0.20 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions for duration of exposure, transfer coefficient, and application rate, and a central tendency estimate of body weight, and are assumed to be representative of high-end exposure. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained in the fruit trees, and assumptions regarding dissipation and transfer of chemical residues. The estimated doses are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

5.0 SWIMMING POOLS

Prior to the development of an exposure assessment for a swimming pool scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for swimming pools are as follows:

Registered for Use in Swimming Pool Water: Determine whether the labeling contains directions for use in swimming pool water.

Limitation and Descriptive Statements: Look for statements describing or limiting the use in swimming pools. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that a product registered for use in swimming pools is used at residential sites unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners; therefore, no residential handler exposure/risk assessment is required. Because commercial applicators do not usually apply pesticides to residential swimming pools, these restricted-use pesticides would be unlikely to be in residential pools; thus no postapplication exposure/risk assessment would be required for these types of pesticides.

5.1 Handler Inhalation and Dermal Potential Doses from Pesticides Applied to Swimming Pools

Introduction

This SOP provides a standard method to be used for estimating potential doses that homeowners may receive during pesticide applications to swimming pools from inhalation and dermal contact when chemical specific data are unavailable. This scenario assumes that pesticides are available to be inhaled or have the potential to come in contact with the skin of adults and youth during the loading and application of pesticides. The method to determine handler inhalation and dermal exposure to pesticide applications relies on surrogate PHED data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 5.0.) The data required for estimating handler exposures to biocides for swimming pools are the application method specific data (i.e., open pour liquids, place solid, etc. and unit exposures), application rates (e.g., amount of ai per 1,000 gallons of pool water), and usage data (e.g., typical pool size in gallons). The maximum application rate specified on the label should be used. One exception is for cancer assessments, when the typical application rate should be used. It should be noted that the typical residential use rate is often the maximum residential use rate. The following assumptions are also needed for estimating daily inhalation and dermal applicator doses.

- **$** Application methods for ready-to-use dry formulations will include pour solid, place solid, and water soluble packets; ready-to-use liquid formulations will include open pour liquid and water soluble gel packets. (Note: pump or gravity feed will not be included as a potential scenario for homeowners.) Dermal and inhalation unit exposures and data confidence descriptions (e.g., PHED grades and number of replicates) are available in Appendix B. The current version of PHED uses measures of central tendency to estimate the best-fit exposures.

- **$** The average pool size for homeowners is assumed to be 20,000 gallons (Kirk-Othmer, 1984).

- **$** Adults are assumed to weigh kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years.

Inhalation and/or dermal potential dose rates are calculated as follows:

$$PDR = UE * AR * V$$

where:

PDR	=	potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai)
AR	=	maximum application rate (lb ai/gal)
V	=	maximum volume treated (gals/day)

Inhalation and/or dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to male or female adults).

Example Calculations

The following is an example calculation to determine the dermal dose for a homeowner pouring a ready-to-use liquid formulation into a swimming pool. For the purpose of this example, the application rate is assumed to be 1 lb ai/20,000 gallons of pool water or 5E-5 lb ai/gallon.

The estimated dermal dose for a homeowner pouring a ready-to-use liquid formulation into a swimming pool assuming a unit exposure of 2.9 mg/lb ai would be as follows:

$$PDR = UE * AR * V$$

$$PDR = 2.9 \text{ mg/lb ai} * 5E\text{-}5 \text{ lb ai/gallon} * 20{,}000 \text{ gallons/day}$$

$$PDR = 2.9 \text{ mg/day}$$

Finally, the estimated dermal potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = 2.9 \text{ mg/day} / 71.8 \text{ kg}$$

$$PDR_{norm} = 0.04 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on a central tendency assumption for unit exposure and pool size treated, and an upper-percentile application rate, and are assumed to be representative of central tendency exposures. The uncertainties associated with this assessment stem from the use of surrogate exposure data (e.g., differences in the use scenarios and data confidence) and assumptions regarding amount of chemical handled. The estimated doses are believed to be reasonable central tendency estimates based on professional judgement.

References

Kirk-Othmer. (1984) Encyclopedia of Chemical Technology, 3rd Edition. Vol. 24, p. 427.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

5.2 Postapplication

5.2.1 Postapplication Potential Doses from Incidental Nondietary Ingestion of Pesticide Residues While Swimming

Introduction

This SOP provides a standard method to be used for estimating postapplication incidental ingestion dose from pesticides in previously treated residential swimming pools when chemical specific data are unavailable. This scenario assumes that swimmers ingest pool water that enters their mouth during swimming or playing in the pool. This method should be used in the absence of actual field data. Methods for estimating doses from pesticides in swimming pool water via other routes of exposure (i.e., buccal/sublingual, orbital/nasal, aural, and sexual organs) are described by Dang (1996).

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 5.0.) The only datum required for estimating postapplication doses from pesticides in swimming pools is the use rate. The maximum use rate specified on the label should be used, except in cancer assessments, when the typical application rates should be used. It should be noted, however, that the typical residential use rate is often the same as the maximum rate. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- It may be assumed that 100 percent of the application concentration are available in the pool water for ingestion. This is believed to be a reasonable assumption because biocides are typically maintained in pool water at specified levels.

- For subsequent days after application, it may be assumed that the pesticide will not dissipate because it is usually desirable to maintain a specified level of biocide in the water.

- The assumed mean ingestion rate for adult and children swimmers is 0.05 L/hour (U.S. EPA, 1989; Dang, 1996).

- The duration of exposure is assumed to be 5 hours per day for both children (age 6 years) and adults (18-64 years). This is the 90^{th} percentile value for the time spent at home in a pool or spa (U.S. EPA, 1996).

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Children (age 6) are assumed to weigh 22 kg. This is the mean of the median values for male and female children (age 6 years) (U.S. EPA, 1996).

Potential dose rates from ingestion are calculated as follows:

$$PDR = C_W * IgR * ET$$

where:

PDR	=	potential dose rate (mg/day)
C_W	=	concentration of ai in pool water (mg/L)
IgR	=	ingestion rate of pool water (L/hour)
ET	=	exposure time (hours/day)

and

$$C_W = AR * CF1 * CF2$$

where:

AR	=	application rate (lbs ai/gal)
CF1	=	weight unit conversion factor (4.54E5 mg/lb)
CF2	=	volume unit conversion factor (2.64E-1 gal/L)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on ingestion of pool water. For the purpose of this example, the application rate is assumed to be 5E-5 lbs ai/ gal (approximately 1 lb ai/20,000 gal or 5E-5 lb ai/gal). Thus, the concentration of ai in the pool water is as follows:

$$C_W = AR * CF1 * CF2$$

$$C_W = (5E\text{-}5 \text{ lb ai/gal}) * (4.54E5 \text{ mg/lb}) * (2.64E\text{-}1 \text{ gal/L})$$

$$C_w = 6.0 \text{ mg/L}$$

The estimated incidental ingestion potential dose rate among children would be as follows:

$$PDR = C_w * IgR * ET$$

$$PDR = 6.0 \text{ mg/L} * 0.05 \text{ L/hr} * 5 \text{ hr/day}$$

$$PDR = 1.5 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a child with a body weight of 22 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (1.5 \text{ mg/day}) / (22 \text{ kg})$$

$$PDR_{norm} = 0.07 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The exposure dose generated using this method is based on some central tendency (i.e., ingestion rate, body weight) and some upper-percentile assumptions (i.e., exposure, duration, application rate for acute assessments), and is assumed to be representative of high-end exposures. The uncertainties associated with this assessment stem from the assumptions regarding dissipation of chemical residues in the water. The dose estimates are considered to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

Dang, W. (1996) The swimmer exposure assessment model (SWIMODEL) and its use in estimating risks of chemical use in swimming pools. EPA internal guidance document.

U.S. Environmental Protection Agency. (1989) Risk Assessment Guidance for Superfund. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

5.2.2 Postapplication Dermally Absorbed Dose from Swimming in Pesticide-Treated Residential Swimming Pools

Introduction

This SOP provides a standard method to be used for estimating postapplication dermally absorbed dose from pesticides in previously treated residential swimming pools when chemical specific data are unavailable. This scenario assumes that swimmers are exposed to pesticides in pool water as a result of dermal contact with the water and subsequent absorption of the chemical through the skin while swimming or playing in the pool. This method should be used in the absence of actual field data, or as a supplement to estimates based on field data. Methods for estimating dose from pesticides in swimming pool water via other routes of exposure (i.e., buccal/sublingual, orbital/nasal, aural, and sexual organs) are described by Dang (1996).

Methods for Estimating Absorbed Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 5.0.) The data required for estimating postapplication dermally absorbed dose from pesticides in swimming pools are the use rate and the skin permeability of the pesticide. The maximum use rate specified on the label should be used, except in cancer assessments, when the typical application rates should be used. It should be noted, however, that the typical residential use rate is often the same as the maximum rate. The following assumptions are also needed for estimating daily pesticide postapplication dermally absorbed doses.

- **$** It may be assumed that 100 percent of the application concentration are available in the pool water for dermal contact. This is believed to be a reasonable assumption because biocides are typically maintained in pool water at specified levels.

- **$** For subsequent days after application, it may be assumed that the pesticide will not dissipate because it is usually desirable to maintain a specified level of biocide in the water.

- **$** The assumed surface area is 20,900 cm^2 for adults and 9,000 cm^2 for children (age 6 years) (U.S. EPA, 1996). These are the means of the 90^{th} percentile values for females and males in these age groups (U.S. EPA, 1996).

- **$** The duration of exposure is assumed to be 5 hours a day for both children (age 6 years) and adults (18-64 years). This is the 90^{th} percentile value for the time spent at home in a pool or spa (U.S. EPA, 1996).

- **$** The permeability coefficient (Kp) is a chemical specific value (cm/hr). (U.S. EPA, 1992, provides measured or predicted Kp values for various chemicals and equations for estimating Kp from octanol-water partition coefficient (Kow) values and molecular weight.)

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg

represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Children (age 6) are assumed to weigh 22 kg. This is the mean of the median value for male and female children (age 6 years) (U.S. EPA, 1996).

Dermally absorbed dose rates are calculated as follows:

$$ADR = C_W * SA * ET * K_p * CF1$$

where:

ADR	=	absorbed dose rate (mg/day)
C_W	=	concentration of ai in pool water (mg/L)
SA	=	surface area exposed (cm^2)
ET	=	exposure time (hours/day)
K_p	=	permeability coefficient (cm/hr)
CF1	=	volume unit conversion factor (L/1,000 cm^3)

and

$$C_W = AR * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/gal)
CF2	=	weight unit conversion factor (4.54E5 mg/lb)
CF3	=	volume unit conversion factor (2.64E-1 gal/L)

Dermally absorbed dose rate, normalized to body weight, is calculated as:

$$ADR_{norm} = ADR / BW$$

where:

ADR_{norm}	=	absorbed dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

Example Calculations

The following is an example calculation to determine the dermally absorbed dose of a pesticide used in swimming pool water. For the purpose of this example, the application rate is assumed to be 5E-5 lbs ai/gal (approximately 1 lb ai/20,000 gal). The assumed permeability coefficient is 0.001 cm/hr. Thus, the concentration of ai in the pool water is as follows:

$$C_W = AR * CF2 * CF3$$

$$C_W = (5E\text{-}5 \text{ lb ai/gal}) * (4.54E5 \text{ mg/lb}) * (2.64E\text{-}1 \text{ gal/L})$$

$$C_W = 6.0 \text{ mg/L}$$

The estimated dermally absorbed dose among 6 year old children would be as follows:

$$ADR = C_W * SA * ET * K_p * CF1$$

$$ADR = 6.0 \text{ mg/L} * 9{,}000 \text{ cm}^2 * 5 \text{ hr/day} * 0.001 \text{ cm/hr} * \text{L}/1{,}000 \text{ cm}^3$$

$$ADR = 0.27 \text{ mg/day}$$

Finally, the estimated dermally absorbed dose, normalized to body weight, for a child with a body weight of 22 kg would be:

$$ADR_{norm} = ADR / BW$$

$$ADR_{norm} = (0.27 \text{ mg/day}) / (22 \text{ kg})$$

$$ADR_{norm} = 0.012 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The exposure dose generated using this method is based on some central tendency (i.e., body weight) and some upper-percentile assumptions (i.e., surface area, exposure duration, application rate), and is assumed to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed permeability coefficient, and assumptions regarding dissipation of chemical residues in the water. The estimated dose is considered to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

Dang, W. (1996) The swimmer exposure assessment model (SWIMODEL) and its use in estimating risks of chemical use in swimming pools. EPA internal guidance document.

U.S. Environmental Protection Agency. (1992) Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-90/011F.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

5.2.3 Postapplication Potential Dose from Inhalation of Pesticide Residues in Swimming Pools

Introduction

This SOP provides a standard method to be used for estimating postapplication inhalation dose from pesticides in previously treated residential swimming pools when chemical specific data are unavailable. This scenario assumes that swimmers inhale pesticides that offgas from the pool water. This method should be used in the absence of actual field data, or as a supplement to estimates based on field data. Methods for estimating exposure to pesticides in swimming pool water via other routes of exposure (i.e., buccal/sublingual, orbital/nasal, aural, sexual organs) are described by Dang (1996).

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 5.0.) The data required for estimating postapplication doses from pesticides in swimming pools are the application rate (i.e., the target concentration of the pesticide active ingredient in the pool water) and the pesticide=s vapor pressure. The maximum application rate specified on the label should be used, except in cancer assessments, when the typical application rates should be used. It should be noted, however, that the typical residential use rate is often the same as the maximum rate. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- **$** It may be assumed that 100 percent of the application rate are available in the pool water for inhalation. This is believed to be a reasonable assumption because biocides are typically maintained in pool water at specified levels.

- **$** For subsequent days after application, it may be assumed that the pesticide will not dissipate because it is usually desirable to maintain a specified level of biocide in the water.

- **$** The assumed mean inhalation rate is 1.7 m^3/hour for adults (i.e., over 18 years) and 1.2 m^3/hour for children (i.e., under 18 years), based on a moderate activity level (U.S. EPA, 1996).

- **$** The duration of exposure is assumed to be 5 hours a day for both children (age 6 years) and adults (18-64 years). These are 90^{th} percentile values for the time spent at home in a pool or spa (U.S. EPA, 1996).

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Children (age 6) are assumed to weigh 22 kg. This is the mean of the median values for male and female children (age 6 years). (U.S. EPA, 1996).

- **$** Gas phase concentrations are based on an ideal gas model and Raoult=s Law (Dang, 1996).

Inhalation potential dose rates are calculated as follows:

$$PDR = C_{vp} * IR * ET$$

where:

PDR	=	potential dose rate (mg/day)
C_{vp}	=	vapor concentration of ai in air (mg/m^3)
IR	=	inhalation rate (m^3/hour)
ET	=	exposure time (hours/day)

C_{vp} is calculated as follows (Dang, 1996):

$$C_{vp} = (C_w * VP * 273\ K * MW * 1{,}000\ L/m^3 * L/1{,}000\ g) / (760\ mm\ Hg * T * 22.4\ L/mole)$$

where:

C_w	=	concentration of ai in water (mg/L)
VP	=	vapor pressure (mm Hg or Torr) at the pool water temperature
T	=	Kelvin temperature (K)
MW	=	molecular weight of water (18 g/mole)

and

$$C_w = AR * CF1 * CF2$$

where:

AR	=	application rate (lbs ai/gal)
CF1	=	weight unit conversion factor (4.54E5 mg/lb)
CF2	=	volume unit conversion factor (2.64E-1 gal/L)

Inhalation potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed pool water vapor inhalation rate. For the purpose of this example, the application rate is assumed to be 5E-5 lbs ai/gal (approximately 1 lb ai/20,000 gal). Thus, the concentration of ai in the pool water is as follows:

$$C_w = AR * CF1 * CF2$$

$$C_w = (5E\text{-}5 \text{ lb ai/gal}) * (4.54E5 \text{ mg/lb}) * (2.64E\text{-}1 \text{ gal/L})$$

$$C_w = 6.0 \text{ mg/L}$$

The vapor concentration (C_{vp}) for a chemical with a vapor pressure of 200 mm Hg at 298 K would be:

$$C_{vp} = (C_w * VP * 273 \text{ K} * MW * 1{,}000 \text{ L/m}^3 * \text{L/1,000 g}) / (760 \text{ mm Hg} * T * 22.4 \text{ L/mole})$$

$$C_{vp} = (6.0 \text{ mg/L} * 200 \text{ mm Hg} * 273 \text{ K} * 18 \text{ g/mole} * 1{,}000 \text{ L/m}^3 * \text{L/1,000 g}) / (760 \text{ mm Hg} * 298 \text{ K} * 22.4 \text{ L/mole})$$

$$C_{vp} = 1.16 \text{ mg/m}^3$$

The estimated inhalation potential dose rate among children would be as follows:

$$PDR = C_{vp} * IR * ET$$

$$PDR = 1.16 \text{ mg/m}^3 * 1.2 \text{ m}^3\text{/hr} * 5 \text{ hr/day}$$

$$PDR = 6.96 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a child with a body weight of 22 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (6.96 \text{ mg/day}) / (22 \text{ kg})$$

$$PDR_{norm} = 0.32 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., inhalation rate, body weight) and some upper-percentile (i.e., exposure, duration, and application rate for acute assessments) assumptions and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of assumptions regarding dissipation of chemical residues in pool water. The estimated doses are considered to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

Dang, W. (1996) The swimmer exposure assessment model (SWIMODEL) and its use in estimating risks of chemical use in swimming pools. EPA internal guidance document.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook, [Draft]. National Center for Environmental Assessment, Washington, DC. EPA/600/P-95/002Ba.

6.0 PAINTING AND WOOD PRESERVATIVE TREATMENTS

Prior to the development of an exposure assessment for painting scenario, the assessor should consult the pesticide label to determine if the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for painting and wood preservative treatments are as follows:

Registered for Use in Paints or Wood Preservatives: Some paints, stains, and wood preservatives that contain pesticides do not have a pesticide label on their container, and their labels do not make claims about pest control. The pesticide in these products is present as a biocide to preserve the product itself. Persons using these paint products are considered "secondary handlers," because they are not handling the pesticide itself -- they are handling products that contain pesticide as a general preservative. The SOP for exposure/risk assessments for such secondary handlers (and secondary postapplication exposures) is in the biocide SOP under secondary exposures to general preservative uses. In order to determine the amount of pesticide in these products, the pesticide label for the biocide product must be obtained, and the use-rate per gallon of paint product must be calculated.

Other paints, stains, and wood preservatives that contain pesticides have a pesticide label on their container. The labels of such products make claims about pest control, such as "kills mildew," "prevents wood rot," or "kills algae." These labels will contain an active ingredient statement indicating the amount of active ingredient in the container.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of the paints, stains, or wood preservatives. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that such products are used at residential sites unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners. Therefore, no residential handler exposure/risk assessment is required. Because commercial applicators may apply pesticides to residential sites, a postapplication exposure/risk assessment is required. Statements such as "For use in or on commercial buildings only," and the more specific "Not for use at residential sites," or "Not for use in and around homes or dwellings" indicate that the product cannot be used at residential sites, and no residential handler or postapplication exposure/risk assessment is required.

6.1 Handler - Dermal and Inhalation

6.1.1 Inhalation and Dermal Potential Doses from Painting/Staining in Residential Settings

Introduction

This SOP provides a standard method for completing dermal and inhalation exposure assessments for homeowners while painting with paint containing a pesticide. This scenario assumes that paint aerosols containing pesticides are available to be inhaled or dermal contact occurs while spraying, brushing, and rolling. Spray paint aerosols are assumed to be similar to that of an insecticide pressurized spray can application. All brush and roller paints and stains are assumed to be similar regardless of the paint type (e.g., alkyd or latex paints and stains). The method for completing exposure assessments for this scenario relies on using surrogate PHED data. Thus, this method should be used only in the absence of adequate data or as a supplement to existing data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 6.0.) The data required include the application rate, the concentration of the pesticide active ingredient in the paint, the specific gravity of the paint product, the volume of the end-use product in the container, and the clothing scenario required by the label during painting. In the absence of actual data, the following assumptions are also used to calculate doses from painting:

$ Daily dose is based on the amount of active ingredient handled per day and not the exposure duration (i.e., a single painting event per day).

- For aerosol spray paints, the upper-percentile assumption for the amount handled is 3 cans (12 ounces each) used per event (the 90th percentile amount of spray paint used per event is 36.11 oz/use, U.S. EPA, 1996).

- For paints used with a brush, the amount of paint used per event is 2 gallons (two 1-gallon cans) of paint. This is based on a 90th percentile value of 8 gallons of latex paint used per year divided by the mean frequency of 4 painting events per year (U.S. EPA, 1996).

- For roller painting, it is assumed that a homeowner will use 2 gallons of paint. This is based on a 90th percentile value of 8 gallons of latex paint used per year divided by the mean frequency of 4 painting events per year (U.S. EPA, 1996).

- For painting/staining with a low-pressure sprayer, it is assumed that homeowners may use up to 5 gallons product or of finished spray prepared from a concentrated product and water. This is based on the experience and professional judgement of the OPP/HED staff by assuming that more product would be used with a low-pressure sprayer than with a roller or brush, but less than that used with a high-pressure sprayer.

- For painting/staining with an airless sprayer, a homeowner is assumed to use three 5-gallon cans of ready-to-use product or of finished spray prepared from a concentrated product and water. This is based on a coverage rate of 200 ft^2/gallon and a house size of 40x30x20 ft (surface area of 2,800 ft^2). This is based on the experience and professional judgement of the OPP/HED staff and is assumed to be an upper-percentile input.

$ The unit exposure values and comments regarding data confidence can be found in the Appendix B. The current version of PHED uses measures of central tendency to estimate the best-fit unit exposure.

- Unit exposure values for the application of a typical pesticide product from an aerosol can are assumed to be similar to that of an aerosol paint product.

- For rolling scenarios, unit exposure values are based on a single paint roller application study to be entered into PHED V2.0. In the event that the study is not available in PHED V2.0, the PHED value for the paint brush unit exposure is to be used. This is based on the experience and professional judgement of the OPP/HED staff and is assumed to be a central tendency value.

- Unit exposure values for a mixer/loader/applicator during the use of typical pesticide products using a low-pressure handwand are assumed to be similar to that of a paint/stain being applied with a low-pressure handwand.

- Unit exposure values for a mixer/loader/applicator during the application of a house stain using an airless sprayer are assumed to be similar for all paint/stain applications with these types of equipment. All airless sprayers are treated as similar equipment even though homeowners may use different devices.

$ All paint categories are considered similar for exposure assessment purposes (e.g., an exterior alkyd paint would be considered the same as a latex).

$ The density of spray paint is 1.24 g/mL. This is based on the mean density for latex paint. (U.S. EPA, 1986).

$ Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The mean body weight for a 10 to 12 year old youth is 39.1 kg. This represents the average of the median values for males and females at ages 10, 11, and 12 years.

The pounds of active ingredient applied per can(s) of paint (AR) can be calculated as follows:

$$AR = V * \tilde{n} * (P/100) * (CF1)$$

where:

AR	=	amount of active ingredient applied for each can of paint (lb ai/can)
V	=	volume of paint contained in each can (mL/can)
ñ	=	specific gravity of paint solution contained in can (g/mL)
P	=	percent by weight of ai in the paint
CF1	=	weight conversion factor (2.2E-3 lbs/g)

Inhalation and potential dose rates are calculated as follows:

$$PDR = UE * AR * N$$

where:

PDR	=	potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai applied)
N	=	number of cans paint used per exposure day (cans/day)

Inhalation and dermal potential dose rates, normalized to body weight, are then calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	daily potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to male or female adults).

Example Calculations

The following example is for aerosol spray painting. The pounds of active ingredient applied for each can of spray paint applied (AR) can be calculated as follows assuming that the paint in this example comes in aerosol cans of 12 ounces or 350 mL and has an ai content of 0.5 percent:

$$AR = V * \tilde{n} * (P/100) * CF1$$

$$AR = 350 \text{ mL/can} * 1.24 \text{ g/mL} * (0.5\%/100) * 2.2E\text{-}3 \text{ lbs/g}$$

$$AR = 4.8E\text{-}3 \text{ lb ai/can}$$

The following is an example calculation to determine the dermal dose based on a single aerosol spray painting event, assuming a unit exposure value of 220 mg/lb ai.

$$PDR = UE * AR * N$$

$$PDR = 220 \text{ mg/lb ai} * 4.8E\text{-}3 \text{ lb ai/can} * 3 \text{ cans/day}$$

$$PDR = 3.2 \text{ mg/day}$$

The estimated dermal potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (3.2 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 0.04 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., unit exposure values, density, body weight) and some upper-percentile (i.e., amount used per event) assumptions and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of a generic paint density and assumptions regarding the applicability of the selected unit exposure value (e.g., aerosols generated from a typical pesticide spray solution "behave" in similar fashion to a paint aerosol and associated data confidence for PHED generated value) . These assumptions are believed to be reasonable to calculate high-end doses based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1986) Standard Scenarios for Estimating Exposure to Chemical Substances During Use of Consumer Products -- Volume 1, Prepared for U.S. EPA, Office of Toxic Substances, Exposure Evaluation Division, by Versar, Inc. EPA Contract # 68-02-3968.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

6.2 Postapplication - Dermal (Refer to 11.2) and Inhalation (Refer to 13.2) (Indoor and Outdoor)

6.3 Postapplication Potential Dose among Children from the Ingestion of Paint Chips Containing Pesticide Residues

Introduction

This SOP provides a standard method for estimating postapplication dose among children from ingestion of paint chips containing pesticide residues when adequate chemical-specific field data are unavailable. This scenario assumes that pesticide containing paint chips are ingested by children. This method should be used in the absence of actual field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 6.0.) The only datum required for estimating postapplication doses from paint chips containing pesticide residues is the percent ai content in the paint. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

- The assumed ingestion rate for paint chips containing pesticides is 0.04 gram/day for children (age 6 months to 1-1/2 year). This assumes that a child ingests a paint chip with an overall size of 1 in^2 (6.25 cm^2) and an average weight of 6.5 mg/cm^2 for a paint chip that is one layer thick (U.S. EPA, 1994). This is believed to be an upper-percentile value.

- Infants (age 6 months to 1-1/2 year)are assumed to weigh 10 kg. This is the mean of the median values for male and female children in the 6-11 month and 1 year age groups. (U.S. EPA, 1996).

- Assume that 20 percent of the active ingredient is remaining in paint and is available for ingestion via paint chips. This is believed to be an upper-percentile assumption, based on the experience and professional judgement of the OPP/HED staff.

Potential dose rates from ingestion are calculated as follows:

$$PDR = IgR * (P/100) * F * CF1$$

where:

PDR	=	potential dose rate (mg/day)
IgR	=	ingestion rate of paint chips containing pesticide residues (g/day)
P	=	percent of ai in paint
F	=	fraction of ai available for ingestion (unitless)
CF1	=	weight unit conversion factor (1,000 mg/g)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed quantity of 1 percent active ingredient in the paint chips containing pesticide residues. The estimated dose among children from ingestion of paint chips containing pesticide residues would be as follows:

$$PDR = IgR * (P/100) * F * CF1$$

$$PDR = 0.04 \text{ g/day} * 0.01 * 0.20 * 1{,}000 \text{ mg/g}$$

$$PDR = 0.08 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a child with a body weight of 10 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (0.08 \text{ mg/day}) / (10 \text{ kg})$$

$$PDR_{norm} = 0.008 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions for the paint chip ingestion rate and amount of ai available for ingestion, and a central tendency estimate for body weight and are considered to be representative of high-end to bounding exposures. The uncertainties associated with this assessment stem from the use of an assumed ingestion rate of paint chips and an assumed amount of ai available in the paint chips. The estimated doses are believed to be reasonable high-end to bounding estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1994) Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Prepared by the Technical Review Workgroup for Lead for EPA:s Office of Emergency and Remedial Response. EPA 540-R-93-081.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

7.0 FOGGING

Prior to the development of an exposure assessment for a fogging scenario, the assessor should consult the pesticide label to determine if the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for fogging are as follows:

Registered for Use as a Fog: Determine whether the labeling contains directions for use as a fog.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of the fog. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that a product registered for use as a fog is used at residential sites unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners. Therefore, no residential handler exposure/risk assessment is required. Because commercial applicators may apply pesticides to residential sites, particularly indoors, a postapplication exposure/risk assessment is required. Statements such as "For use in commercial livestock premises only," and the more specific "Not for use at residential sites," or "Not for use in and around homes or dwellings" indicate that the product cannot be used at residential sites, and no residential handler or postapplication exposure/risk assessment is required. Also, assume no residential uses if the directions for use are solely for application with a thermal fogger or other expensive fogging equipment.

7.1 Inhalation Doses among Adults and Children after Pesticide Applications (e.g., Foggers) Outside of a Residence for the Purposes of Short-term Pest Control

Introduction

This SOP provides a standard method for completing postapplication inhalation exposure assessments for adults and children after a pesticide treatment outside their residence for the purposes of short-term pest control. The basis for this exposure scenario is that nonhandler inhalation exposure occurs while treated outdoor living spaces are occupied, typically for social gatherings, shortly after application of products intended for short-term pest control (e.g., fogging a yard or deck area prior to a party). This SOP addresses the use of several types of products including typical single use homeowner aerosol foggers, multi-use insecticide candles and torches, and other single use, slow-release type products (e.g., impregnated solids that slowly burn over a given duration and emit pesticide containing fumes). The method for completing exposure assessments for all outdoor residential inhalation exposure scenarios, when the application is intended for short-term pest control is based on assumptions.

Methods For Estimating Dose

If outdoor residential application is a potential scenario, information contained in the label of the product must be extracted for use as data inputs for the exposure assessment. (See Section 6.0.) The data required include the application rate, the concentration of the pesticide active ingredient in the product, the specific gravity of the product, the volume of the end-use product in the container, and any requirements for respiratory protection during handling activities. The following assumptions are also used to calculate bystander and postapplication inhalation doses from a pesticide product intended for short-term pest control:

- An outdoor living space with dimensions of 20 ft long x 20 ft wide x 8 ft high (i.e. 3,200 ft^3 or 90.62 m^3) will be assumed to calculate airborne concentration levels. This is assumed to represent a central tendency value for the area of a yard that may be treated (this may also represent the size of a deck or patio), based on the experience and professional judgement of the OPP/HED staff.

- The emission is to be treated as an "instant release" scenario. All active ingredient is assumed to be "thrown up" in the air immediately. This is an assumption made in lieu of product-specific data. Although "instant release" is more applicable to the use of foggers than the use of candles or torches, this method is used as a simplified technique for assessing exposure and is assumed to represent a conservative (i.e., upper-percentile) approach. Further, the chemical is assumed to be diluted in outdoor air at a ratio of 1 to 100 [i.e., 1 percent (0.01) of the product released is available for exposure], and the pesticide is assumed to remain in the air at this concentration of the entire duration of exposure.

- The outdoor living space will be assumed to be treated with two single use, ready-to-use products such as a fogger. This is assumed to be an upper-percentile value based on the experience and professional judgement of the OPP/HED staff.

- **$** All products are considered similar for exposure assessment purposes (e.g., emissions from a candle would be considered similar to a fogger).

- **$** Most end use products included in this category are petroleum based. A specific gravity of 0.80 g/mL is assumed in all calculations unless a product specific value is available. This is based on an informal survey of various organic solvents described in CRC (1981). A value of 0.80 g/mL represents a mean of various organic solvents from this source.

- **$** The adult inhalation rate is assumed to be 13.3 m^3/day or 0.55 m^3/hour for calculating daily exposures. This is the mean inhalation rate for males and females (U.S. EPA, 1996). A mean inhalation rate of 8.7 m^3/day or 0.36 m^3/hour is assumed for toddlers (i.e., age 3 years) (U.S. EPA, 1996).

- **$** Occupancy of the treated outdoor living space is assumed to be 5 hours/day for adults (age 18-64 years) and 3 hours/day for toddlers (age 1-4 years). These values represent the 95th percentile values for time spent outdoors at a restaurant/picnic area for these age groups (U.S. EPA, 1996).

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Toddlers (3 years old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female toddlers. (U.S. EPA, 1996).

The grams of active ingredient applied using a container of product (AR) can be calculated as follows:

$$AR = V * \tilde{n} * (P/100)$$

where:

AR	=	amount of active ingredient applied for each container of end use product (grams ai/container)
V	=	volume of product solution contained in each container (mL/container)
$\tilde{n}$	=	specific gravity of product in container (g/mL)
P	=	percent by weight of ai in the end use product solution

The concentration of the active ingredient available for inhalation exposure in the treated outdoor living space can be calculated as follow:

$$C_a = (N * AR * F * CF1) / (V)$$

where:

C_a = outdoor air concentration in outside living space available for inhalation exposure adjusted for dilution (mg/m^3)
N = number of containers of end use product applied per use event (i.e., N = 2 for all assessments completed using this SOP)
V = volume (m^3) of outside living space (i.e., volume of 90.62 m^3 will be used to calculate airborne concentration levels outdoors in all cases)
F = fraction of chemical available in outdoor air for exposure used to adjust amount of chemical released for "infinite dilution" attributable to being outdoors (i.e., a value of 1 percent (0.01) of the active ingredient released will be used for all calculations)
CF1 = weight unit conversion factor (1,000 mg/g)

Inhalation potential dose rates are calculated as follows:

$$PDR = C_a * IR * ET$$

where:

PDR = potential dose rate (mg/day)
IR = inhalation rate (m^3/hour)
ET = exposure time in treated outside living space (hr/day)

Inhalation potential dose rates, normalized to body weight, are then calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

The body weight and inhalation rate can be adjusted to fit any specific scenario (e.g., use of 60 kg for women when developmental endpoints are available).

Example Calculations

The following is an example calculation to determine the postapplication inhalation dose for an adult, based on a single treatment event using an aerosol fogger (i.e., 2 cans with an ai content of 1.5 percent). The grams of active ingredient applied for each can of fogger are calculated as follows:

$$AR = V * \tilde{n} * (P/100)$$

$$AR = (500 \text{ mL/container}) * (0.80 \text{ g/mL}) * (1.5\%/100)$$

$$AR = 6.0 \text{ grams ai/container}$$

The concentration of the active ingredient available for inhalation exposure in the defined outdoor living space is calculated as follows:

$$C_a = (N * AR * F * CF1) / (V)$$

$$C_a = (2 \text{ containers} * 6.0 \text{ g ai/container} * 0.01 * 1{,}000 \text{ mg/g}) / (90.62 \text{ m}^3)$$

$$C_a = 1.32 \text{ mg/m}^3$$

Potential dose rates are calculated as follows:

$$PDR = C_a * IR * ET$$

$$PDR = 1.32 \text{ mg/m}^3 * 0.55 \text{ m}^3\text{/hr} * 5 \text{ hr/day}$$

$$PDR = 3.6 \text{ mg/day}$$

Potential dose rates, normalized to body weight, for an adult with a weight of 71.8 kg, are then calculated as:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (3.6 \text{ mg/day}) / 71.8 \text{ (kg)}$$

$$PDR_{norm} = 0.051 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions. The uncertainties associated with this assessment stem from the use of assumptions regarding the dilution of pesticides in outdoor air, and the amount and density of the product used. These assumptions are believed to be reasonable to calculate high-end estimates based on observations from similar field studies.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

CRC. (1981) CRC Handbook of Chemistry and Physics, 61st Edition. Boca Raton, Florida: CRC Press Inc.

8.0 CRACK AND CREVICE AND BROADCAST TREATMENT

Prior to the development of an exposure assessment for a crack and crevice and broadcast treatment scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for crack and crevice and broadcast treatment are as follows:

Registered for Use as a Pesticide to be Applied as a Crack and Crevice Treatment. Determine whether the pesticide label contains directions for use as a crack and crevice treatment.

Registered for Use as a Pesticide to be Applied to Carpets or Hard Surfaces Determine whether the pesticide label contains directions for use on carpets or hard surfaces, such as walls, counter-tops, hard floors, or cabinets.

Household Cleaning/Maintenance Product with Pesticidal Claims. Some household cleaning or maintenance products that contain pesticides have a pesticide label on their container. The labels of such products make claims about pest control, such as "kills mildew," "disinfects," or "kills germs on contact." These labels will contain an active ingredient statement indicating the amount of active ingredient in the container.

Household Cleaning/Maintenance Product with No Pesticidal Claims. Some household cleaning or maintenance products that contain pesticides do not have a pesticide label on their container and their labels do not make claims about pest control. The pesticide in these products is present as a biocide to preserve the product itself. Persons using these household products are considered "secondary handlers," because they are not handling the pesticide itself -- they are handling products that contain pesticide as a general preservative. The SOP for exposure/risk assessments for such secondary handlers (and secondary postapplication exposures) is in the biocide SOP under secondary exposures to general preservative uses. In order to determine the amount of pesticide in these products, the pesticide label for the biocide product must be obtained, and the use-rate per quart/gallon of household product must be calculated.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of these products. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that such products are used at residential sites unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by commercial or professional applicators only" indicate that the product cannot be bought or applied by homeowners; therefore, no residential handler exposure/risk assessment is required. Because commercial applicators may apply pesticides to residential sites, a postapplication exposure/risk assessment is required. Statements such as "For use in or on commercial buildings only," and the more specific "Not for use at residential sites," or "Not for use in and around homes or dwellings" indicate that the product cannot be used at residential sites, and no residential handler or postapplication exposure/risk assessment is required.

8.1 Handler Surrogate Inhalation and Dermal Potential Dose from Pesticides Applied Indoors as Crack & Crevice and Broadcast Treatments

Introduction

This SOP provides a standard method for estimating potential doses that homeowners may receive from inhalation and dermal contact during pesticide crack and crevice and broadcast treatments indoors. This scenario assumes that pesticides are available to be inhaled or have the potential to come in contact with the skin of adults during the mixing/loading and application of pesticides used indoors. The method for estimating handler inhalation doses from pesticides during indoor treatments relies on using PHED surrogate data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 8.0.) The data required for estimating handler doses from pesticides used indoors are the application method specific data (i.e., use scenario and unit exposures), application rates, and usage data (e.g., gallons). The maximum application rate specified on the label should be used. It is also assumed that the typical rate a homeowner would use is the maximum labeled rate. In the absence of actual data, the following assumptions are also needed for estimating daily inhalation mixer/loader/applicator doses.

- Application methods for indoor treatments will include crack and crevice (e.g., baseboard applications) or broadcast treatments (e.g., carpet or walls) using low-pressure handwands, aerosol cans, and shaker cans (dust). Dermal and inhalation unit exposures and data confidence descriptions are available in Appendix B except for shaker cans. (Refer to Section 9.1.1 for exposure assessments based on shaker cans.) The current version of PHED uses measured central tendency to estimate the best-fit unit exposure.

- The amount handled to treat baseboards or carpets will be based on two aerosol cans and/or 2 gallons of diluted spray for low-pressure handwands. These are based on the experience and professional judgement of OPP/HED staff and are believed to be upper-percentile values..

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the average body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years.

Inhalation potential dose rates are calculated as follows:

$$PDR = UE * AR * N$$

where:

PDR	=	potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai)
AR	=	maximum amount of active ingredient applied per can or per gallon of diluted solution (lb ai/can or lb ai/gal)
N	=	number of cans spray paint used per exposure day or number of gallons of diluted solution used per exposure day (cans/day) or (gal/day)

Inhalation and dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to male or female adults).

Example Calculations

The following is an example calculation to determine the inhalation dose based on a homeowner mixing/loading/applying a liquid broadcast application using a low-pressure handwand. For the purpose of this example, the application rate is assumed to be 0.05 lb ai/gallon diluted spray solution and the inhalation unit exposure value is 0.03 mg/lb ai.

The estimated inhalation dose using a low-pressure handwand would be as follows:

$$PDR = UE * AR * N$$

$$PDR = 0.03 \text{ mg/lb ai} * 0.05 \text{ lb ai/gal} * 2 \text{ gal/day}$$

$$PDR = 0.003 \text{ mg/day}$$

Finally, the estimated inhalation potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (0.003 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 4.2E\text{-}5 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk. Dermal doses would be calculated in the same manner, using dermal unit exposure values.

Limitations and Uncertainty

The dose estimates generated using this method are based on central to high-end tendency assumptions (i.e., unit exposures, application rate, body weight). The uncertainties associated with this assessment stem from the use of surrogate exposure data (e.g., differences in use scenario and data confidence) and assumptions regarding amount of chemical handled. The dose estimates are considered to be reasonable central tendency to high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

8.2 Postapplication - Dermal

8.2.1 Postapplication Dermal Dose from Pesticide Residues on Carpets

Introduction

This SOP provides a standard method for estimating dose among adults and/or toddlers from dermal contact with carpets that have previously been treated with pesticides. This scenario assumes that pesticide residues are transferred to the skin of adults, toddlers, and infants who come in contact with treated carpets for recreation, housework, or other occupant activities. The method for estimating postapplication dermal exposure to pesticides on carpets is based on assumptions when adequate chemical specific field data are unavailable. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 8.0.) The only datum required for estimating postapplication doses from pesticide residues on carpet is the application rate. The maximum application rate specified on the label should be used as the residential carpet rate. One exception is for cancer assessments, when the typical application rates should be used. It should be noted that the typical residential rate is often the maximum residential application use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

Solid and Liquid Formulation:

- It is assumed that an average of 50 percent of the application rate (from broadcast or crack and crevice treatments) are available on the carpet as dislodgeable residue (U.S. EPA, 1993). Postapplication exposure must be assessed on the same day the pesticide was applied because it is assumed that homeowners could contact the treated carpet immediately after application.

- For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- The assumed dermal transfer coefficient is 43,000 cm^2/hr for adults, 8,700 cm^2/hr for toddlers (Cal EPA, 1996), and 6,000 cm^2/hr for infants (age 6 months to 1-1/2 years). The Cal EPA (1996) value of 43,000 cm^2/hr is a calculated mean, based on the Jazzercize method, which is believed to result in an upper percentile estimate of the transfer coefficient for this scenario. The infant value is a mean value based on monitoring an adult crawling across treated carpet (U.S. EPA, 1996a).

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S.

EPA, 1996b). Toddlers (3 years old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is based on the mean of the median body weights for male and female toddlers. (U.S. EPA, 1996b). Infants (age 6 months to 1-1/2 year) are assumed to weigh 10 kg. This is the mean of the median values for male and female children in the 6-11 month and 1 year age groups. (U.S. EPA, 1996).

- The duration of exposure is assumed to be 8 hours per day. The assumption of 8 hours per day of indoor exposure is based on the mean of the 50th percentile values for time spent inside a residence for adults (age 18-64 years) and toddlers (age 1-4 years) and infants, not including the 50th percentile amount of time that these individuals would spend sleeping (U.S. EPA, 1996b). For example, for adults, the 50th percentile indoor value is 900 minutes (15 hours) and the 50th percentile value for time spent sleeping is 480 minutes (8 hours). Thus, the total amount of time spent awake indoors is 7 hours. For toddlers, age 1-4 years, the amount of time indoors is 1,260 minutes (21 hours), the amount of time sleeping is 720 minutes (12 hours), and the amount of time awake indoors is 9 hours. Thus, the mean for these age groups is 8 hours. The toddler data are also used to represent infants (age 6 months to 1-2 years) because no data are available specifically for this age group.

Dermal potential dose rates are calculated as follows:

$$PDR_t = ISR_t * CF1 * Tc * ET$$

where:

- PDR_t = potential dose rate on day "t" (mg/day)
- ISR_t = indoor surface residue on day "t" ($\mu g/cm^2$)
- CF1 = conversion factor to convert μg units in the carpet residue value to mg for the daily exposure (0.001 mg/μg)
- Tc = transfer coefficient (cm^2/hr)
- ET = exposure time (hr/day)

and

$$ISR_t = AR * F * (1-D)^t * CF2 * CF3$$

where:

- AR = application rate (lbs ai/ft^2)
- F = fraction of ai retained on carpet (unitless)
- D = fraction of residue dissipating daily (unitless)
- t = postapplication day on which exposure is being assessed
- CF2 = weight unit conversion factor to convert the lbs ai in the application rate to μg for the carpet residue value (4.54E8 μg/lb)
- CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the carpet value (1.08E-03 ft^2/cm^2)

Dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$ = potential dose rate, normalized to body weight, on day "t" (mg/kg/day)
BW = body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the dose based on an assumed ISR over time. For the purpose of this example, the application rate is assumed to be 1.0E-5 lbs ai/ft^2. Thus, the dislodgeable carpet residue on day 0 is as follows:

$$ISR_t = AR * F * (1\text{-}D)^t * CF2 * CF3$$

$$ISR_0 = 1.0E\text{-}5 \text{ lb ai/ft}^2 * 0.5 * (1\text{-}D)^0 * 4.54E8 \ \mu\text{g/lb} * 1.08E\text{-}03 \text{ ft}^2/\text{cm}^2$$

$$ISR_0 = 2.45 \ \mu\text{g/cm}^2$$

The estimated potential dose rate for the day of application would be as follows:

$$PDR_t = ISR_t * CF1 * Tc * ET$$

$$PDR_0 = 2.45 \ \mu\text{g/cm}^2 * 0.001 \text{ mg/}\mu\text{g} * 43{,}000 \text{ cm}^2\text{/hr} * 8 \text{ hours/day}$$

$$PDR_0 = 842.8 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (842.8 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{0\text{-}norm} = 11.7 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on central tendency assumptions and are considered to be representative of central tendency exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on carpet, and assumptions regarding dissipation and transfer of chemical residues. The dose estimates are believed to be reasonable central tendency estimates based on observations from chemical-specific field studies and professional judgement.

References

California Environmental Protection Agency. (1996) Memorandum from T. Formoli (California EPA, Department of Pesticide Regulation, Worker Health and Safety Branch) to M. Mason (California EPA, Department of Pesticide Regulation, Pesticide Regulation Branch), October 17, 1996.

U.S. Environmental Protection Agency. (1993) Protocol for Dermal Exposure Assessment: A Technical Report. Environmental Monitoring Systems Laboratory. EPA/600/X-93/005.

U.S. Environmental Protection Agency. (1996a) Assessment of Peak Performance System as a Tool for the Acquisition of Biomechanics Data Which May be Useful in the Calculation of Risks to Sensitive Populations. Prepared for the Office of Research and Development, National Exposure Research Laboratory by Versar, Inc. Under Contract No. 68-D3-0013.

U.S. Environmental Protection Agency. (1996b) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

8.2.2 Postapplication Dermal Dose from Pesticide Residues on Hard Surfaces

Introduction

This SOP provides a standard method for estimating dose among adults and/or toddlers from dermal contact with counter tops that have previously been treated with pesticides. This scenario assumes that pesticide residues are transferred to the skin of an adult/toddler who comes in contact with treated areas such as floors and counter tops for recreation, housework, or other occupant activities. The method for estimating postapplication dermal doses from pesticides on hard surfaces is based on assumptions. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 8.0.) The only datum required for estimating postapplication doses from pesticide residues on counter tops is the application rate. The maximum application rate specified on the label should be used as the residential counter top application rate. One exception is for cancer assessment, when the typical application rates should be used. It should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

Solid and Liquid Formulation:

- It is assumed that an average of 50 percent of the application rate (from broadcast or crack and crevice treatments) are available on the hard surfaces as dislodgeable residue (U.S. EPA, 1993). Postapplication exposure must be assessed on the same day the pesticide was applied because it is assumed that homeowners could contact the treated hard surfaces immediately after application.

- For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- The assumed dermal transfer coefficient is 43,000 cm^2/hr for adults, 8,700 cm^2/hr for toddlers (Cal EPA, 1996), and is 6,000 cm^2/hr for infants (age 6 months to 1-1/2 years). The Cal EPA (1996) value of 43,000 cm^2/hr is a calculated mean, based on the Jazzercize method, which is believed to result in an upper percentile estimate of the transfer coefficient for this scenario. The infant value is a mean value based on monitoring an adult crawling across treated carpet (U.S. EPA, 1996a).

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996b). Toddlers (3 years old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female children. (U.S. EPA, 1996b). Infants (age 6 months to 1-1/2 year) are

assumed to weigh 10 kg. This is the mean of the median values for male and female children in the 6-11 month and 1 year age groups. (U.S. EPA, 1996).

- **$** The duration of exposure is assumed to be 4 hours per day. This value represents the mean of the 90th percentile values for time spent in the kitchen and bathroom for adults (age 18-64 years) and toddlers (1-4 years) (U.S. EPA, 1996b). The toddler data are also used to represent infants (age 6 months to 1-**2** years) because no data are available specifically for this age group.

Dermal potential dose rates are calculated as follows:

$$PDR_t = ISR_t * CF1 * Tc * ET$$

where:

PDR_t	=	potential dose rate on day "t" (mg/day)
ISR_t	=	indoor surface residue on day "t" ($\mu g/cm^2$)
CF1	=	weight unit conversion factor to convert μg units in the residue value to mg for the daily exposure (0.001 mg/μg)
Tc	=	transfer coefficient (cm^2/hr)
ET	=	exposure time (hr/day)

and

$$ISR_t = (AR * F) * (1-D)^t * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/ft^2)
F	=	fraction of ai retained on hard surfaces (unitless)
D	=	fraction of residue dissipating daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	weight conversion factor to convert the lbs ai in the application rate to μg for the carpet residue value (4.54E8 μg/lb)
CF3	=	area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the counter top value (1.08E-3 ft^2/cm^2)

Dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$	=	potential dose rate, normalized to body weight on day At@ (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the dose based on an assumed ISR over time. For the purpose of this example, the application rate is assumed to be 1.0E-5 lbs ai/ft^2. Thus, the dislodgeable counter top residue on day 0 is as follows:

$$ISR_t = AR * F * (1\text{-}D)^t * CF2 * CF3$$

$$ISR_0 = 1.0E\text{-}5 \text{ lb ai/ft}^2 * 0.5 * (1\text{-}D)^0 * 4.54E8 \text{ mg/lb} * 1.08E\text{-}3 \text{ ft}^2/\text{cm}^2$$

$$ISR_0 = 2.45 \ \mu\text{g/cm}^2$$

The estimated potential dose rate for the day of application would be as follows:

$$PDR_t = ISR_t * CF1 * Tc * ET$$

$$PDR_0 = 2.45 \text{ g/cm}^2 * 0.001 \text{ mg/}\mu\text{g} * 43{,}000 \text{ cm}^2\text{/hr} * 4 \text{ hours/day}$$

$$PDR_0 = 421.4 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (421.4 \text{ mg/day}) / (71.8 \text{ kg})$$

$$DPR_{0\text{-}norm} = 5.87 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., transfer coefficients, body weights) and some upper-percentile (i.e., exposure duration) assumptions. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on counter tops, and assumptions regarding dissipation and transfer of chemical residues. The dose estimates are believed to be reasonable central to high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

California Environmental Protection Agency. (1996) Memorandum from T. Formoli (California EPA, Department of Pesticide Regulation, Worker Health and Safety Branch) to M. Mason (California EPA, Department of Pesticide Regulation, Pesticide Regulation Branch), October 17, 1996.

U.S. Environmental Protection Agency. (1993) Protocol for Dermal Exposure Assessment: A Technical Report. Environmental Monitoring Systems Laboratory. EPA/600/X-93/005.

U.S. Environmental Protection Agency. . (1996a) Assessment of Peak Performance System as a Tool for the Acquisition of Biomechanics Data Which May be Useful in the Calculation of Risks to Sensitive Populations. Prepared for the Office of Research and Development, National Exposure Research Laboratory by Versar, Inc. under Contract No. 68-D3-0013.

U.S. Environmental Protection Agency. (1996b) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

8.3 Postapplication - Inhalation (refer to 13.2)

8.4 Postapplication Doses among Toddlers from Incidental Nondietary Ingestion of Pesticide Residues on Indoor Surfaces from Hand-to-mouth Transfer

Introduction

This SOP provides a standard method for estimating incidental dose among toddlers from ingesting pesticide residues that have been transferred from indoor surfaces (e.g., carpet or hard surfaces) to the skin. This scenario assumes that pesticide residues are transferred to the skin of toddlers during postapplication contact with treated indoor areas and are subsequently ingested as a result of hand-to-mouth transfer. This method for estimating postapplication incidental ingestion doses from pesticide residues on indoor surfaces is based on assumptions and should be used in the absence of field data. The exposures estimated using this method may be combined with toxicity data to estimate the risks to toddlers from postapplication doses from treated indoor residential areas.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 8.0.) The datum required for estimating postapplication doses from pesticide residues on indoor surfaces includes the application rate. The maximum application rate specified on the label should be used, except in cancer assessments, when the typical application rates should be used. It should be noted that the typical residential use rate is often also the maximum residential use rate. The following assumptions are also needed for estimating daily pesticide postapplication doses.

- **$** On the day of application, it may be assumed that 50 percent of the application rate are available on the indoor surfaces (e.g., carpet and hard surfaces) as dislodgeable residue (U.S. EPA, 1996a).

- **$** For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- **$** The assumed mean surface area of both hands is 350 cm^2 for a toddler (age 3 years). This value represents the mean of the 50th percentile total surface area values for males and females in the 2<3 year and 3<4 year age groups, multiplied by the mean percentage of the total body represented by hands for males and females. (U.S. EPA, 1996b). The 3 year old age group was selected for use in this scenario because this is the youngest age group for which data on hand-to-mouth activity data were available.

- Replenishment of the hands with pesticide residues is assumed to be an implicit factor in this assessment.

- It is assumed that there is a one-to-one relationship between the dislodgeable residues on the indoor surface and the surface area of the skin after contact (i.e., if the dislodgeable residue

on the indoor surface is 1 mg/cm^2, then the residue on the human skin is also 1 mg/cm^2 after contacting the surface).

- **$** The mean rate of hand-to-mouth activity is 0.026 events/minute (i.e., 1.56 events/hr) for toddlers (3 to 5 year olds) (U.S. EPA, 1996c).

- **$** The duration of exposure to indoor surfaces is assumed to be 4 hours/day. This value represents the mean of the 90th percentile values for time spent in the kitchen and bathroom for adults (age 18-64 years) and toddlers (age 1-4 years) (U.S. EPA, 1996b).

- **$** Toddlers (age 3 years), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is based on the mean of the median values for male and female toddlers. (U.S. EPA, 1996b).

Potential dose rates from ingestion are calculated as follows:

$$PDR = ISR * SA * FQ * ET$$

where:

PDR = potential dose rate (mg/day)
ISR = indoor surface residue (mg/cm^2)
SA = surface area of the anatomical part of the body (e.g., hands) that contact indoor surfaces and then transfer residues to the mouth in a given event (cm^2/event)
FQ = frequency of hand-to-mouth events (events/hr)
ET = exposure time (hours/day)

and

$$ISR = AR * F * CF1 * CF2$$

where:

AR = application rate (lbs ai/m^2)
F = fraction of ai on indoor surfaces that is available for transfer (unitless)
CF1 = conversion factor to convert the lbs ai in the application rate to mg for the indoor surface residue (4.54E5 mg/lb)
CF2 = area unit conversion factor (1E-4 m^2/cm^2)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed ISR. For the purpose of this example, the application rate is assumed to be 0.0001 lb ai/m^2. Thus, the indoor surface residue is as follows:

$$ISR = AR * F * CF1 * CF2$$

$$ISR = 0.0001 \text{ lb ai}/m^2 * 0.5 * (4.54E5 \text{ mg/lb}) * (1E\text{-}4 \ m^2/cm^2)$$

$$ISR = 2.27E\text{-}3 \text{ mg}/cm^2$$

The estimated incidental ingestion dose among toddlers after application would be as follows:

$$PDR = ISR * SA * FQ * ET$$

$$PDR = 2.27E\text{-}3 \text{ mg}/cm^2 * 350 \ cm^2/\text{event} * 1.56 \text{ events/hr} * 4 \text{ hr/day}$$

$$PDR = 4.96 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a toddler with a body weight of 15 kg, would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (4.96 \text{ mg/day}) / (15 \text{ kg})$$

$$PDR_{norm} = 0.33 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., surface area of the hands, rate of hand-to-mouth activity, and body weight) and some upper-percentile (i.e., exposure duration and application rate for acute assessments) assumptions. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on indoor surfaces with no dissipation from the surfaces. Uncertainties also occur from assumptions regarding the skin surface area entering the mouth and the frequency and duration of exposure. For example, it is assumed that toddlers consume all of the pesticide residues that are transferred to the surface area of both hands and that the hands are placed in the mouth on multiple occasions during a 4-hour exposure period. The dose estimates are believed to be reasonable high-end estimates based on observations from chemical-specific field studies.

References

U.S. Environmental Protection Agency. . (1996a) Assessment of Peak Performance System as a Tool for the Acquisition of Biomechanics Data Which May be Useful in the Calculation of Risks to Sensitive Populations. Prepared for the Office of Research and Development, National Exposure Research Laboratory by Versar, Inc. Under Contract No. 68-D3-0013.

U.S. Environmental Protection Agency. (1996b) Exposure Factors Handbook. [Draft]. National Center for Environmental Assessment, Washington, DC. EPA/600/P-95/002Ba.

U.S. Environmental Protection Agency. (1996c) Time location activity pattern methodology: the creation of Bayesian distributions for the field investigations of exposure of infants and children to toxic substances. EPA-007-2. (To be included in an EPA Project Report entitled "Protocol for dermal exposure assessment in residential and non-occupational environments" which is currently in preparation and subject to EPA/ORD peer review).

9.0 PET TREATMENT

Prior to the development of an exposure assessment for a pet product scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the pesticide formulation and on the usage characteristics of the product. Specific lableing considerations for pet treatment products are as follows:

Registered for Use on Pets: Determine whether the labeling contains directions for use on pets.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of the pet product. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that a product registered for use on a pet is used at residential sites unless a specific labeling statement indicates otherwise. Restricted-Use Pesticide classification and statements such as "For use by veterinarians or veterinary assistants only" indicate that the product cannot be bought or applied by homeowners. Therefore, no residential handler exposure/risk assessment is required. Because the treated pets will return to residential sites, a postapplication exposure/risk assessment is required.

9.1 Handler

9.1.1 Handler Inhalation and Dermal Doses from Treating Pets with Dip, Shampoo, Dusts, and Flea Collar Pesticide Formulations

Introduction

This SOP provides a standard method for estimating potential doses that homeowners may receive during pet treatment from inhalation and dermal contact when chemical specific data are unavailable. This scenario assumes that pesticide exposure occurs while dipping or applying the pesticide to pets. The method to determine handler inhalation and dermal doses from pesticides while treating pets relies on using several assumptions. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 9.0.) The datum required for estimating handler doses from pesticides while treating pets is the application rate. The maximum application rate specified on the label should be used, except in cancer assessments, when the typical application rates should be used. However, it should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide handler doses.

- **$** Daily dose is based on the amount of active ingredient handled per day (i.e., a single pet treatment event per day). The pesticide label should be used to determine the amount of active ingredient used during each treatment.

- **$** Ten percent (0.1) of the active ingredient applied to the pet are assumed to be the amount the homeowner is exposed to during dipping, dusting, and shampooing. This assumption is based on the professional judgement of the OPP/HED staff and assumed to be an upper-percentile value.

- **$** One percent (0.01) of the active ingredient applied to the pet is assumed to be available for dermal and inhalation exposure from handling flea collars. This assumption is based on the professional judgement of the OPP/HED staff and assumed to be an upper-percentile value.

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the average body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years.

Inhalation and dermal potential dose rates are calculated as follows:

$$PDR = AR * F$$

where:

PDR = potential dose rate (mg/day)
AR = application rate (i.e., amount of active ingredient handled during treatment) (mg/day) (assessor needs to determine the amount of ai in the formulated product)
F = fraction of ai available for exposure (unitless)

Inhalation and dermal potential dose rates, normalized to body weight, are calculated as follows:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rates, normalized to body weight (mg/kg/day)
BW = body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to males or females).

Example Calculations

The following is an example calculation to determine the combined dermal and inhalation dose from a homeowner spraying a liquid pet treatment pesticide. For the purpose of this example, the application rate is assumed to be 30 mg ai/day.

$$PDR = AR * F$$

$$PDR = 30 \text{ mg/day} * 0.1$$

$$PDR = 3.0 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (3.0 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 0.042 \text{ mg/kg/day}$$

Limitations and Uncertainty

The uncertainties associated with this assessment stem from assumptions regarding amount of chemical handled and the percentage of which humans are exposed. The estimated doses are believed to be reasonable bounding estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

9.1.2 Handler Inhalation and Dermal Doses from Treating Pets with Ready-to-use Pesticide Spray Formulations

Introduction

This SOP provides a standard method for estimating potential doses that homeowners may receive during pet treatment from inhalation and dermal contact when chemical specific data are unavailable. This scenario assumes that pesticide exposure occurs while applying the pesticide to pets using aerosol spray products. The method to determine handler inhalation and dermal dose from pesticides while treating pets relies on using surrogate PHED data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 9.0.) The only datum required for estimating handler doses from pesticides while treating pets is the application rate. The maximum application rate specified on the label should be used, except in cancer assessments when the typical application rates should be used. However, it should be noted that the typical residential use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide handler doses.

- $ Daily dose is based on the amount of active ingredient handled per day (i.e., a single pet treatment event per day).

- $ The amount handled during each treatment is the maximum application rate on the label, if available, or it is assumed to be one-half can of spray. This is assumed to be an upper percentile value.

- $ Unit exposure values from PHED for the application of a typical pesticide product from an aerosol can are similar to that of a pet spray treatment and will be used for this scenario. Dermal and inhalation unit exposures and data confidence descriptions are available in Appendix B. The current version of PHED uses measures of central tendency to estimate the best-fit unit exposure.

- The density of an organic spray solution contained in a single use pressurized can may be assumed to be 0.80 g/mL unless a product-specific value is available. This is based on a informal survey of various organic solvents described in CRC (1981). A value of 0.80 g/mL represents an mean of various organic solvents from this source.

  - $ Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This

represents the mean of the median values for males and females at ages 10, 11, and 12 years.

The pounds of active ingredient applied for each can of spray can be calculated as follows:

$$AR = V * ñ * (P/100) * CF1$$

where:

AR	=	amount of active ingredient applied for each can of spray (lb ai/can)
V	=	liquid volume of spray contained in each can (mL/can)
ñ	=	specific gravity of spray solution contained in can (g/mL)
P	=	percent by weight of the pesticide active ingredient in the spray
CF1	=	weight unit conversion factor to convert g units to lbs (2.2E-3 lb/g)

Inhalation and dermal potential dose rates are calculated as follows:

$$PDR = UE * AR * N$$

where:

PDR	=	potential dose rate (mg/day)
UE	=	unit exposure (mg/lb ai)
N	=	number of cans spray used per exposure day (cans/day)

Inhalation and dermal potential dose rates, normalized to body weight, may be calculated as follows:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to adults or children).

Example Calculations

The following is an example calculation to determine the dermal dose for a homeowner spraying one-half of a 500 mL can of a 15 percent ai liquid pet treatment pesticide with a specific gravity of 0.8 g/mL, using a unit exposure value of 186.6 mg/lb ai. A complete assessment would include both an inhalation and dermal dose.

The pounds of active ingredient applied for each can of spray can be calculated as follows:

$$AR = V * ñ * (P/100) * CF1$$

AR = 500 mL/can * 0.8 g/mL * 15.0%/100 * 2.2E-3 lb/g
AR = 0.13 lb ai/can

Potential dose rate is calculated as:

PDR = UE * AR * N

PDR = 220 mg/lb ai * 0.13 lb ai/can * 0.5 can/day

PDR = 14.3 mg/day

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$PDR_{norm} = PDR / BW$

$PDR_{norm} = (14.3 \text{ mg/day}) / (71.8 \text{ kg})$

$PDR_{norm} = 0.20 \text{ mg/kg/day}$

The dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions. The uncertainties associated with this assessment stem from the use of surrogate exposure data (e.g., differences in the use scenarios and data confidence) and assumptions regarding the amount of chemical handled. The estimated doses are believed to be reasonable bounding estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

CRC. (1981) CRC Handbook of Chemistry and Physics, 61st Edition. Boca Raton, Florida: CRC Press Inc.

9.2 Postapplication

9.2.1 Postapplication Dermal Dose from Pesticide Residues on Pets

Introduction

This SOP provides a standard method for estimating doses among adults and/or toddlers from dermal contact with pets that have previously been treated with pesticides. This scenario assumes that pesticide residues are transferred to the skin of adults/toddlers who come in contact with treated pets while petting or otherwise touching their pets. The method for estimating postapplication dermal dose from pesticides on pets is based on assumptions. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 9.0.) The data required for estimating postapplication doses from pesticide residues on pets is the application rate. The maximum application rate specified on the label should be used. In absence of actual data, the following assumptions are also needed for estimating daily pesticide postapplication doses.

- On the day of application, it may be assumed that 20 percent (0.20) of the application rate are retained on the pets as dislodgeable residue. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data and is believed to be an upper-percentile assumption.

- Ten percent (0.10) of the available residues are transferred to the homeowner during contact with the treated animals. This assumption is based on the professional judgement of the OPP/HED staff and assumed to be an upper-percentile value.

- Postapplication activities must be assessed on the same day that the pesticide is applied because it is assumed that individuals could handle/touch their pets immediately after application. For subsequent days after application, it may be assumed that residues do not dissipate because it is frequently desirable to maintain a specific level of pesticide on the pet (i.e., flea collars).

- It is assumed that one animal is contacted per day.

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Toddlers (3 years old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female toddlers. (U.S. EPA, 1996).

Dermal potential dose rates for liquids are calculated as follows:

$$PDR = AR * F * T$$

where:

PDR	=	potential dose rate (mg/day)
AR	=	amount of active ingredient applied per day (assessor needs to determine the amount of ai in the formulated product)
F	=	fraction of ai available on pet
T	=	fraction of residue transferred to the skin

Dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the dose. For the purpose of this example, the application rate is assumed to be 30 mg ai/day. Thus, the dose on day 0 is as follows:

$$PDR = AR * F * T$$

$$PDR = 30 \text{ mg/day} * 0.2 * 0.1$$

$$PDR = 0.6 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (0.6 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 8.36E\text{-}3 \text{ mg/kg/day}$$

The dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on pets, and assumptions regarding transfer of chemical residues. The estimated doses are believed to be reasonable high-end estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

9.2.2 Postapplication Potential Dose Among Toddlers from Incidental Nondietary Ingestion of Pesticide Residues on Pets from Hand-to-mouth Transfer

Introduction

This SOP provides a standard method for estimating dose among toddlers from incidental ingestion of pesticide residues from previously treated pets. This scenario assumes that pesticide residues are transferred to the skin of toddlers from the handling/touching of treated pets and are subsequently ingested as a result of hand-to-mouth transfer. The method for estimating postapplication incidental ingestion dose from pesticide residues on pets is based on assumptions when adequate chemical specific field data are unavailable.

Methods for Estimating Potential Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 9.0.) The only datum required for estimating postapplication doses to pesticide residues on pets is the application rate (e.g., mg ai per treatment). The maximum application rate specified on the label should be used, except in cancer assessments when the typical application rates should be used. It should be noted, however, that the typical residential use rate is often the same as the maximum rate. The following assumptions are also needed for estimating pesticide postapplication doses.

- $ On the day of application, it may be assumed that 20 percent (i.e., 0.20) of the application rate are available on the pets as dislodgeable residue. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data and is believed to be an upper-percentile assumption.

- $ Postapplication activities must be assessed on the same day that the pesticide is applied because it is assumed that toddlers could handle/touch pets immediately after application. For subsequent days after application, it may be assumed that the pesticide will not dissipate because it is frequently desirable to maintain a specific level of pesticide on the pet (i.e., flea collars).

- $ The median surface area of both hands is 350 cm^2 for a toddler (age 3 years). This value represents the average of the 50th percentile total surface area values for males and females in the 2<3 year and 3<4 year age groups, multiplied by the average percentage of the total body represented by hands for males and females. (U.S. EPA, 1996a).

- Replenishment of the hands with pesticide residues is assumed to be an implicit factor in this assessment.

- An average pet is assumed to have a body surface area of approximately 6,000 cm^2. This is based on an assumed body weight of a medium size dog of 30 lbs and the following algorithm for estimating surface area for mammals from a known body weight, as presented in EPA=s Wildlife Exposure Factors Handbook (U.S. EPA, 1993): Surface Area (cm^2) = 12.3 Body $Weight^{0.65}$ (g).

- It is assumed that there is a one-to-one relationship between the dislodgeable residue on the surface of the pet and on the surface area of the skin after contact (i.e., if the dislodgeable residue on the pet is 1 mg/cm^2, then the residue on the human skin is also 1 mg/cm^2 after contacting the pet).

$ The mean rate of hand-to-mouth activity is 0.026 events/minute (i.e., 1.56 events/hr) for toddlers (3 to 5 year olds) (U.S. EPA, 1996b).

- The duration of exposure for toddlers is assumed to be 2 hours per day. This is based on the professional judgement and experience of the OPP staff. This timeframe (2 hours) is approximately the same time children play outside per day. This is assumed to be an upper-percentile value

$ Toddlers (age 3 years), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female children (U.S.EPA, 1996a).

Potential dose rates from ingestion are calculated as follows:

$$PDR = DR * SA * FQ * ET$$

where:

PDR	=	potential dose rate (mg/day)
DR	=	dislodgeable residue on pet (mg/cm^2 pet)
SA	=	surface area of the hands (cm^2/event)
FQ	=	frequency of hand-to-mouth activity (events/hr)
ET	=	exposure time (hr/day)

and

$$DR = (AR * F) / SA_{pet}$$

where:

AR	=	application rate (mg ai)
F	=	fraction of ai available on pet (unitless)
SA_{pet}	=	surface area of the pet (cm^2)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight on day "t" (mg/kg/day)
BW	=	body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed dislodgeable residue. For the purpose of this example, the application rate is assumed to be 30 mg/day. Thus, the dislodgeable residue on the pet is as follows:

$$DR = (AR * F) / SA_{pet}$$

$$DR = (30 \text{ mg} * 0.2) / 6{,}000 \text{ cm}^2$$

$$DR = 0.001 \text{ mg/cm}^2$$

The estimated incidental ingestion dose for a toddler on the day of application would be as follows:

$$PDR = DR * SA * FQ * ET$$

$$PDR = 0.001 \text{ mg/cm}^2 * 350 \text{ cm}^2\text{/event} * 1.56 \text{ events/hr} * 2 \text{ hr/day}$$

$$PDR = 1.1 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized by body weight, for a toddler with a body weight of 15 kg, would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (1.1 \text{ mg/day}) / (15 \text{ kg})$$

$$PDR_{norm} = 0.07 \text{ mg/kg/day}$$

Limitations and Uncertainty

The dose estimates generated using this method are based on some upper-percentile and some central tendency assumptions and are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide available from the treated pests, and assumptions regarding dissipation and hand-to-mouth activity. The estimated doses are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1993) Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, DC. EPA/600/R-93/187a.

U.S. Environmental Protection Agency. (1996a) Exposure Factors Handbook. [Draft]. National Center for Environmental Assessment, Washington, DC. EPA/600/P-95/002Ba.

U.S. Environmental Protection Agency. (1996b) Time location activity pattern methodology: the creation of Bayesian distributions for the field investigations of exposure of infants and children to toxic substances. EPA-007-2. (To be included in an EPA Project Report entitled "Protocol for dermal exposure assessment in residential and non-occupational environments" which is currently in preparation and subject to EPA/ORD peer review).

10.0 DETERGENT/HANDSOAP

Prior to the development of an exposure assessment for a detergent/handsoap scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage of characteristics of the product. Specific labeling considerations for detergent/handsoap are as follows:

Detergent or Hand Soap with Pesticidal Claims. Some detergents and hand soaps that contain pesticides have a pesticide label on their container. The labels of such products make claims about pest control, such as "kills mildew," "disinfects," or "kills germs on contact." These labels will contain an active ingredient statement indicating the amount of active ingredient in the container.

Detergent or Hand Soap with No Pesticidal Claims. Some detergents and hand soaps that contain pesticides do not have a pesticide label on their container, and their labels do not make claims about pest control. The pesticide in these products is present as a biocide to preserve the product itself. Persons using these household products are considered "secondary handlers," because they are not handling the pesticide itself -- they are handling products that contain pesticide as a general preservative. The SOP for exposure/risk assessments for such secondary handlers (and secondary postapplication exposures) is in the biocide SOP under secondary exposures to general preservative uses. In order to determine the amount of pesticide in these products, the pesticide label for the biocide product must be obtained, and the use-rate per quart/gallon of household product must be calculated.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of detergents or hand soaps that have pesticide labels on their containers. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that such products are used at residential sites unless a specific labeling statement indicates otherwise. Statements such as "For use by commercial or professional laundries only," "Not for sale or use at residential sites," or "Not for homeowner use" indicate that the product cannot be bought or applied by homeowners; therefore, no residential handler exposure/risk assessment is required. Because the laundry will be returned to a residential site, a postapplication exposure/risk assessment is required.

10.1 Handler and Postapplication Dermal Exposure to Pesticides in Detergent/Bar Soap and Other Consumer Products

Introduction

This SOP provides a standard method for estimating doses to handlers from dermal contact with detergent, bar soap, and other consumer products using the DERMAL model. The DERMAL model also provides a method for estimating postapplication (i.e., passive) exposure to laundry detergent.

The DERMAL model was developed by EPA's Office of Pollution Prevention and Toxics, Economics, Exposure, and Technology Division to support the assessment of Premanufacture Notification chemicals under the Toxic Substance Control Act (TSCA). DERMAL is used primarily in screening-level assessments of dermal exposure to the components of consumer products. The model estimates acute potential dose rates and annual average daily dose rates for handlers for dermal exposure scenarios involving the chemical components of 16 consumer product types. The types of consumer products in the model includes the following:

1. General purpose cleaner.
2. Liquid laundry detergent.
3. Rug and upholstery cleaner.
4. Floor cleaners.
5. Spray paint.
6. Exterior latex paint.
7. Interior latex paint.
8. Oil-based paint.
9. Used motor oil.
10. Lubricating greases.
11. Bar soap.
12. Diesel fuel.
13. Gasoline.
14. News ink.
15. Vinyl upholstery cleaner.
16. Wax strippers.

In addition, the DERMAL model includes a generic product scenario that allows users to input their own scenario. The only postapplication scenario included in the model is for transfer of laundry detergent residues on clothing to the skin.

The DERMAL model calculates dermal exposure using the weight fraction of the chemical in the product of interest and assuming a certain film thickness of product on the skin and surface area exposed. In addition, default values are used for the frequency of events per year, exposure duration, and body weight. These defaults can be changed by the user if desired. For detailed information on the use of the DERMAL model, refer to the User's Manual (U.S. EPA, 1995).

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessments in DERMAL. (See Section 10.0.) Because the DERMAL model provides default values for many of the standard model scenarios, the only input value that is generally required by the user is the weight fraction of ai in the product of interest. After entering the DERMAL model, the user should select the product scenario of interest. When the data entry menu appears, the user should enter the median and high-end weight fractions for the ai in the products. Although the other model inputs may be changed by the user, it is recommended that users accept all model defaults unless product or chemical-specific data are available for the scenario. After all data input values are entered, the user should select "run the model." When the calculations are complete, the output selection screen will prompt the user to direct the results to the screen, the printer, or to a file. The results include central, high-end, and bounding estimates for acute potential dose rates (APDRs) and chronic exposure (lifetime average daily doses - LADDs). To be consistent with other doses calculated using these SOPs, the user should select the APDRs generated by the DERMAL model.

Limitations and Uncertainties

The DERMAL model provides central, high-end, and bounding estimates for dermal exposure to consumer products. The limitations associated with its use include uncertainties associated with the film thickness approach to dermal exposure assessment and uncertainties associated with the various model inputs. The DERMAL Manual (U.S. EPA, 1995) should be consulted for a discussion of the model inputs.

References

U.S. Environmental Protection Agency. (1995) DERMAL Exposure Model Description and User's Manual, draft report. Prepared for the Office of Pollution Prevention and Toxics by Versar, Inc. under Contract No. 68-D3-0013.

10.2 Handler and Postapplication Inhalation Exposure to Detergents and Other Consumer Products (refer to 13.2)

11.0 IMPREGNATED MATERIALS

Prior to the development of an exposure assessment for an impregnated material scenario, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for impregnated materials are as follows:

Impregnated Materials with Pesticidal Claims. Some impregnated materials (e.g., pet collars, "no-pest strips") that contain pesticides have a pesticide label on their container. The labels of such products make claims about pest control, such as "kills fleas and ticks" or "kills flying insects." These labels will contain an active ingredient statement indicating the amount of active ingredient in the container.

Impregnated Materials with No Pesticidal Claims. Some impregnated materials (e.g., mattress covers, shower curtains, paper, adhesives) that contain pesticides do not have a pesticide label, and their labels do not make claims about pest control. The pesticide in these products is present as a biocide added during the manufacture of the product. Persons using these household products are considered "secondary handlers," because they are not handling the pesticide itself -- they are handling products that contain pesticide. The SOP for exposure/risk assessments for such secondary handlers (and secondary postapplication exposures) is in the biocide SOP under secondary exposures. In order to determine the amount of pesticide in these products, the pesticide label for the biocide product must be obtained, and the use-rate for the household product must be calculated.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of impregnated materials that have pesticide labels on their containers. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that such products are used at residential sites unless a specific labeling statement indicates otherwise. Statements such as "For use on commercial livestock only," "Not for sale or use at residential sites," or "Not for homeowner use" indicate that the product cannot be bought or applied by homeowners; therefore, no residential handler exposure/risk assessment is required.

11.1 Handler - Dermal and Inhalation (no SOP - pesticides added in manufacturing setting)

11.2

11.2 Postapplication Pesticide Residue Dermal and Inhalation Dose from Materials Impregnated with Pesticides

Introduction

This SOP provides a standard method for estimating postapplication dose from dermal contact with materials impregnated with pesticides when adequate chemical-specific field data are unavailable. Inhalation dose is not a concern due to several factors including (1) the pesticide is generally contained within the matrix (i.e., vinyl mattress or shower curtain), (2) pesticides usually have low vapor pressures, and (3) the concentrations used are typically low. This method should be used in the absence of actual field data.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 10.0.). The only datum required for estimating postapplication exposures to materials impregnated with pesticides is the percent ai content of the material in question. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

- Flux rate through impregnated materials can be estimated based on the guidance provided in EPA Document 560/5-85-015 (U.S. EPA, 1992). The "AMEM: Polymer Migration Estimation Model," by Arthur D. Little, can also be used for predictive purposes as it is based on the U.S. EPA guidance. AMEM requires the following chemical/polymer-specific imputs: media selection (air, water, or solid); exposure to external phase (single- or double-sided); polymer thickness; migration period; diffusion coefficient (cm^2/s); polymer type (e.g., PVC, rubber); and molecular weight.

  $ Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive, or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Toddlers (3 years old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female toddlers (U.S. EPA, 1996).

- Dose should be based on a surface area of the body that is relevant to the impregnated material being assessed. For example, 1 m^2 for adults or 0.35 m^2 for toddlers (age 3 years) would be reasonable for vinyl mattresses. These values represent one half the 90^{th} percentile body surface area for adults and children. For products such as vinyl shower curtains, where a smaller percentage (i.e., 10 percent) of the body may come into contact with the product, lower skin surface areas may be reasonable (i.e., 0.2 m^2 for adults and 0.07 m^2 for toddlers).

- **$** Dose should be based on a duration of exposure that is relevant to the impregnated material being assessed. For example, 8 hours per day of contact would be reasonable for vinyl mattresses based on the median value for the amount of time sleeping (U.S. EPA, 1996). Materials, such as shower curtains, would have shorter contact periods (e.g., 0.5 hours).

Dermal potential dose rates are calculated as follows:

$$PDR = FR * SA * ET * CF1$$

where:

PDR = potential dose rate (mg/day)
FR = flux rate for pesticide of concern ($mg/m^2/day$)
SA = body surface area (m^2)
ET = exposure time (hours/day)
CF1 = time unit conversion factor (day/24 hours)

Dermal potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on an assumed flux rate of 15 $mg/m^2/day$ in the impregnated materials. The estimated dose from dermal contact with impregnated materials would be as follows:

$$PDR = FR * SA * ET * CF1$$

$$PDR = 15\ mg/m^2/day * 1\ m^2 * 8\ hours/day * 1\ day/24\ hours$$

$$PDR = 5.0\ mg/day$$

Finally, the estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (5.0\ mg/day) / (71.8\ kg)$$

$$PDR_{norm} = 0.070\ mg/kg/day$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on central tendency assumptions. The uncertainties associated with this assessment stem from the potential use of a model for predicting flux rates from impregnated materials. The dose estimates are considered to be reasonable central tendency estimates based on professional judgement.

References

U.S. Environmental Protection Agency. (1992) Methods for Assessing Exposure to Chemical Substances, Volume 11, Methodology for Estimating the Migration of Additives and Impurities from Polymeric Materials. Office of Pollution Prevention and Toxics, Washington, D.C. EPA/560/5-85-015.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

11.3 Postapplication Doses among Toddlers from Incidental Nondietary Ingestion of Pesticide Residues Contained in Materials Impregnated with Pesticides

Introduction

This SOP provides a standard method for estimating incidental dose among toddlers from ingesting pesticide residues that have been transferred from the surfaces of impregnated materials (e.g., toys). This scenario assumes that pesticide residues are transferred to the mouth from mouthing impregnated materials. This method for estimating nondietary ingestion doses from pesticide residues on impregnated materials is based on assumptions and should be used in the absence of field data. The exposures estimated using this method may be combined with toxicity data to estimate the risks to toddlers from nondietary ingestion of pesticide residues from impregnated materials.

Methods for Estimating Dose

Label information is important for selecting appropriate data inputs for the exposure assessment. (See Section 11.0.) The data required for estimating nondietary ingestion doses from impregnated pesticide residues include the solubility factor (i.e., ppm in the finished impregnated material) and the concentration of the active ingredient in the formulation (i.e., chemical-specific concentration factor). The maximum solubility factor specified on the label should be used, except in cancer assessments, when the typical factors should be used. In the absence of actual data, the following assumptions can be used for estimating daily pesticide nondietary ingestion doses.

- Flux rate through impregnated materials can be estimated based on the guidance provided in EPA Document 560/5-85-015 (U.S. EPA, 1992). The "AMEM: Polymer Migration Estimation Model," by Arthur D. Little, can also be used for predictive purposes as it is based on the U.S. EPA guidance. AMEM requires the following chemicl/polymer-specific imputs: media selection (air, water, or solid); exposure to external phase (single- or double-sided); polymer thickness; migration period; diffusion coefficient (cm^2/s); polymer type (e.g., PVC, rubber); and molecular weight.

  - **$** Toddlers (3 years old), used to represent the 1 to 6 year old age group, are assumed to weigh 15 kg. This is the mean of the median values for male and female toddlers (U.S.EPA, 1996).

  - **$** The total surface area of the impregnated material is assumed to be 500 cm^2 (e.g., the surface area of an impregnated toy) (Dang, 1997).

  - **$** It is assumed that the entire surface of the impregnated material is mouthed once per day. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data.

Potential dose rates from incidental nondietary ingestion are calculated as follows:

$$PDR = FR * SA$$

where:

PDR = potential dose rate (mg/day)
FR = flux rate for the pesticide of concern ($mg/cm^2/day$)
SA = surface area of impregnated material mouthed per day (assumed to be 500 cm^2)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

Example Calculations

The following is an example calculation to determine the dose based on assumed chemical-specific solubility and concentration factors. For the purposes of this example, the chemical-specific flux rate is assumed to be 15 $mg/m^2/day$. Thus, the potential dose rate from incidental nondietary ingestion is calculated as follows:

$$PDR = FR * SA$$

$$PDR = 0.0015\ mg/cm^2/day * 500\ cm^2$$

$$PDR = 0.75\ mg/day$$

Finally, the estimated potential dose rate, normalized to body weight, for a toddler with a body weight of 15 kg would be:

$$PDR_{norm} = PDR/BW$$

$$PDR_{norm} = (0.75\ mg/day)/(15\ kg)$$

$$PDR_{norm} = 0.05\ mg/kg/day$$

Limitations and Uncertainty

The dose estimates generated using this method are considered to be based on some central tendency (e.g., surface area of the impregnated material mouthed and body weight) and some upper-percentile assumptions (e.g., 100 percent of chemical flux transferred and entire surface of an impregnated object mouthed on a daily basis). The uncertainties associated with this assessment stem from the potential use of a model for predicting flux rates from impregnated materials. Uncertainties also occur from assumptions regarding the impregnated material surface area entering the mouth and the frequency and duration of exposure. For example, it is assumed that toddlers consume all of the pesticide residues that are transferred to the surface area of the impregnated material and that the material is placed in the mouth, in its entirety, over the course of a day. The dose estimates are believed to be reasonable high-end estimates based on observations from limited study of chemical flux from impregnated materials.

References

Dang (1997) Risk Analysis for microban Additive "B" (Triclosan or Irgasan DP300) Treated Toys for Infants. Memo From Winston Dang (Antimicrobial Division) to Frank Sanders and William Jordan (Antimicrobial Division), Dated February 24, 1997.

U.S. Environmental Protection Agency. (1992) Methods for Assessing Exposure to Chemical Substances, Volume II, Methodology for Estimating the Migration of Additives and Impurities from Polymeric Materials. Office of Pollution Prevention and Toxics, Washington, D.C. EPA/560/5-85-015.

U.S.EPA (1996) Exposure Factors Handbook. [Draft]. National Center for Environmental Assessment, Washington, DC. EPA/600/P-95/002Ba.

12.0 TERMITICIDES

Prior to the development of an exposure assessment for termiticides, the assessor should consult the pesticide label to determine whether the scenario is appropriate based on the usage characteristics of the product. Specific labeling considerations for termiticides are as follows:

Registered for Use as a Termiticide: Determine whether the labeling contains directions for use as a termiticide.

Limitation and Descriptive Statements: Look for statements describing or limiting the use of the termiticide. These statements may be on the front panel of the label associated with the brand or trade name or in the use-directions section of the labeling. Assume that a product registered for use as a termiticide is used at residential sites unless a specific labeling statement indicates otherwise. Assume that all termiticides are applied by commercial applications; therefore, no residential handler exposure/risk assessment is required. Because termiticides are applied to residences, a postapplication exposure/risk assessment is required. Statements such as "For use on commercial buildings only," and the more specific "Not for use at residential sites," or "Not for use in and around homes or dwellings" indicate that the product cannot be used at residential sites, and no residential handler or postapplication exposure/risk assessment is required.

12.1 Handler - Dermal and Inhalation (no SOP - pesticides are applied by commercial handlers only)

12.2 Postapplication - Dermal and Inhalation (no SOP for dermal because of limited exposure potential; refer to 13.2 for inhalation exposure)

13.0 INHALATION OF RESIDUES FROM INDOOR TREATMENTS

13.1 Handler Surrogate Inhalation Dose from Pesticides Applied Indoors as Crack & Crevice and Broadcast Treatments

Introduction

This SOP provides a standard method for estimating potential inhalation doses that homeowners may receive during crack and crevice (e.g., baseboard treatments) and broadcast treatments (e.g., carpets) indoors. This scenario assumes that pesticides are available to be inhaled by adults during the mixing/loading and application of pesticides used indoors. The method for estimating handler inhalation dose from pesticides during indoor treatments relies on using surrogate PHED data. Thus, this method should be used in the absence of actual field data, or as a supplement to estimates based on field data.

Methods for Estimating Dose

Prior to the development of an exposure assessment for this scenario, the assessor should consult the pesticide label to determine whether this scenario is appropriate based on the usage characteristics of the product. Label information is also important for selecting appropriate data inputs for the exposure assessment. The data required for estimating handler doses from pesticide when using pesticides indoors are the application method specific data (i.e., use scenario and unit exposures), application rates, and usage data (e.g., gallons). The maximum application rate specified on the label should be used. In the absence of actual data, the following assumptions are also needed for estimating daily inhalation mixer/loader/applicator doses.

- **$** Application methods for indoor treatments will include crack and crevice or broadcast treatments using low-pressure handwands, aerosol cans, and shaker cans (dust).

- **$** Mixer/loader/applicator inhalation unit exposure values and data confidence descriptions for the low-pressure handwand and aerosol cans are located in Appendix B; for shaker cans refer to Section 9.1.1. The current version of PHED uses measures of central tendency to estimate the best fit unit exposures.

- **$** The amount handled to treat baseboards or carpets are assumed to be one aerosol can of diluted solution (i.e., homeowner may potentially use the entire contents of the product for a single treatment), 2 gallons for low-pressure handwands, and the entire contents of one shaker can (i.e., homeowner may potentially use the entire contents of the product for a single treatment). Based on the experience and professional judgement of the OPP/HED staff, this is assumed to be an upper-percentile value.

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the mean body weight for females between ages 13 and 54 years (U.S. EPA, 1996). The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years.

Inhalation potential dose rates are calculated as follows:

$$PDR = UE * AR * N$$

where:

PDR	=	potential dose rate (mg/day)
UE	=	unit exposure from Appendix B (mg/lb ai)
AR	=	amount of active ingredient applied per container of product or per gallon of diluted solution (lb ai/can or lb ai/gal)
N	=	maximum number of containers used per exposure day or number of gallons of diluted solution used per exposure day (cans/day) or (gal/day)

Inhalation potential dose rates, normalized to body weight, are calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm}	=	potential dose rate, normalized to body weight (mg/kg/day)
BW	=	body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., exposure to male or female adults).

Example Calculations

The following is an example calculation to determine the inhalation dose based on a homeowner mixing/loading/applying a liquid broadcast application using a low-pressure handwand. For the purpose of this example, the application rate is assumed to be 0.05 lb ai/gallon diluted spray. The estimated inhalation potential dose rate using a low-pressure handwand would be as follows:

$$PDR = UE * AR * N$$

$$PDR = 0.03 \text{ mg/lb ai} * 0.05 \text{ lb ai/gal} * 2 \text{ gal/day}$$

$$PDR = 0.003 \text{ mg/day}$$

Finally, the estimated inhalation potential dose rate, normalized to body weight for an adult with a body weight of 71.8 kg would be:

$$PDR_{norm} = PDR / BW$$

$$PDR_{norm} = (0.003 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR_{norm} = 4.2E\text{-}05 \text{ mg/kg/day}$$

This dose would be used in conjunction with toxicity data to assess risk.

Limitations and Uncertainty

The dose estimates generated using this method are based on central tendency and upper percentile assumptions. The uncertainties associated with this assessment stem from the use of surrogate exposure data (e.g., differences in use scenarios and data confidence) and assumptions regarding amount of chemical handled. The dose estimates are believed to be reasonable central tendency to high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.

13.2 Inhalation Bystanders and Postapplication Dose Among Adults and Children from Pesticide Applications in and Around a Residence

Introduction

This SOP provides a standard method for completing postapplication inhalation exposure assessments for adults and children after a pesticide treatment in their residence. The basis for each scenario is that nonhandler inhalation exposure occurs while occupying living spaces within a residence during and after a pesticide treatment. This SOP addresses all types of pesticide use scenarios including short- and long-term emission sources in a treated residence. The method for completing exposure assessments for indoor residential inhalation exposure scenarios when chemical-specific data are not available is based on modeling. Thus, this method should only be used in the absence of adequate data. Two models, developed by EPA/OPPTS, serve as the basis for this SOP. The *Screening-Level Consumer Inhalation Exposure Software (SCIES)* and the *Multi-Chamber Concentration and Exposure Model (MCCEM)* will be used to calculate concentration values to which individuals will be exposed. Further calculations are required to estimate dose. These calculations are also detailed in this SOP. This SOP provides standard model inputs for using *SCIES* and *MCCEM* in exposure assessments. Assessors should refer to the respective *User's Manual* for details on the operation of *SCIES* and *MCCEM* and for information concerning the underlying assumptions and limitations of each. All specific model inputs and calculations represented in this SOP are based are *SCIES* Version 3.0 and *MCCEM* Version 2.4.

General Methods for Estimating Dose

Methods for calculating exposure concentrations and dose are presented below using outputs from both models.

Methods For Calculating Exposure Concentrations

Screening Consumer Inhalation Exposure Software (SCIES)

SCIES was developed to perform screening-level inhalation exposure assessments for 11 predetermined consumer product use scenarios and an "*input your own*" scenario. For the purposes of this SOP, *SCIES* is to be used only to complete calculations for a scenario similar to one of the predetermined consumer product use scenarios. Assessors are asked not to use the "*input your own scenario*" option for calculation. Any exposure scenarios not addressed by one of the 11 predetermined use scenarios are to be addressed through the use of *MCCEM*. The available consumer product categories included in *SCIES* are presented below:

- all-purpose liquid cleaner,
- machine wash laundry detergent (liquid),
- liquid fabric softener (semivolatile),
- liquid fabric softener (volatile),
- automobile vinyl upholstery cleaner,
- floor wax/polish,
- fabric protector,
- aerosol paints/clear coatings,

- **$** latex paint,
- **$** oil-based paint, and
- **$** solid air freshener.

After a use scenario is selected from the *SCIES* main menu, the following basic chemical-and product-specific parameters must be input for all calculations:

- **$** chemical name (optional)
- **$** vapor pressure
- **$** molecular weight
- **$** weight fraction in product

Each predetermined use scenario in *SCIES* includes default numerical values for the following input parameters. Although *SCIES* is also flexible in that these default input parameters can be modified, assessors are asked to accept the default values for all calculations within the SOP.

- **$** room where the product is used
- **$** the annual frequency of use
- **$** the air exchange rate
- **$** the user inhalation rate
- **$** room volume
- **$** user occupancy patterns
- **$** the mass of the product used per event
- **$** the non-user inhalation rate
- **$** the duration of use
- **$** the volume of the house

SCIES provides average and peak concentration values in the room of use and in the remainder of a house. These values will be used to calculate exposure and dose. *SCIES* also provides annualized dose rates for the product user and those passively exposed, but these will not be used for this SOP. An example *SCIES* report that includes both the input parameters and output (i.e., calculated concentrations) is presented in Figure 13-1.

The use of *SCIES* is straightforward as described in the *User's Manual*. However, an overview of the operation for the purposes of this SOP is provided. Once in the *Main Menu* a user selects the predetermined use scenario appropriate for the pesticide label use pattern. After this selection, the *Defaults Submenu* appropriate for the use scenario will appear. All default values are to be accepted. The user is required to enter chemical/product specific data under the *Input Chemical Properties* selection of the *Defaults Submenu*. Concentration calculations can then be completed. [Note: Room of use and start time menus appear in the *Run the Model* submenu. Assessors are asked to also accept the default options for the purposes of this SOP.]

Multi-Chamber Concentration and Exposure Model (MCCEM)

MCCEM is a model that is capable of calculating indoor air concentrations and the corresponding exposure assessments for both acute and chronic scenarios. The model can also calculate the "percent of cases" where the airborne concentration of a contaminant exceeds a toxicological level of concern. *MCCEM* should be used for residential exposure scenarios for which predetermined consumer product use scenarios are unavailable in *SCIES*. *MCCEM* contains a data base of various default house data that are needed to complete each calculation such as air exchange rates, geographically based inter-room air flows, and house/room volumes. Chemical source emission rates of pollutants are entered into the model either as numbers or as formulas. MCCEM can account for chemical decay and the contribution of outdoor concentrations and is capable of performing

sensitivity analyses and Monte Carlo analyses. However, because this SOP is focused on high-end assessments, only the aspects of *MCCEM* required by the SOP are addressed herein.

The essential aspects of *MCCEM* that must be defined to complete a high-end assessment include the following:

- **$** type of house (selection based on construction type),
- **$** definition of zones for selected house (single or multi-zone up to four indoor zones),
- **$** selection of model (i.e., short or long-term scenarios/up to 1 week or 1 year),
- **$** selection/calculation of appropriate emission rate inputs for chemical/product, and
- **$** selection of a decay rate for the chemical/product.

Table 13-1 includes *MCCEM* inputs that are specific to each exposure scenario that are appropriate for a high-end calculation. *MCCEM* requires further input to operate the model; however, these additional inputs represent administrative functions (e.g., file handling). Example *MCCEM* input and output reports are presented in Figure 13-2.

Step-by-step procedures for completing a high-end assessment using *MCCEM* are presented below (refer to Table 13-1 during each step of process):

Step 1/Source of Input Menu: New users select "Specify New Inputs" option.

Step 2/Type of Residence Menu: Select the "Generic House" option (#4) and the defaults "Bedroom House GN001" and "S" (summer) that are presented by the system (i.e., this provides a conservative air exchange rate of 0.18 xch/hr).

Step 3/Multi or Single Chamber Model: Select multi- or single-chamber model depending upon the default inputs specified for the exposure scenario of interest. Input appropriate number of zones for the scenario (i.e., 1 for single- and 2 for multi-chamber model).

Step 4/Model Type: Select the long-term model option. The long-term model is appropriate for all high-end assessments to be completed, as it is appropriate for durations from 24 hours to 1 year, in 2-hour steps. The duration the calculation encompasses is also input (i.e., 90 days is used, except for termiticides where 365 days is used). Calculations using *MCCEM* can completed in 1-hour or 24-hour steps. For the purposes of this SOP, 1-hour steps should used for an acute endpoint, while a 24-hour step should be used for a chronic endpoint.

Step 5/Emission Rate & Exposure Zone Inputs: For the high-end assessment requirement, two emission mechanisms have been selected as options. The first type is to be used to model "Instant Release" scenarios, such as a house fogger (i.e., all chemical is "thrown up" in the air of a residence as an aerosol immediately -- less than 1 hour). Emissions for this scenario are calculated as the amount of product released times the percent of active ingredient (ai) in the product. For example, if a fogger can contains 1 lb (454 g) of pressurized spray at 50 percent ai (w/w), the mass applied (m) is 0.5 lb (227 g) of ai (i.e., 454 * 0.5). The second type of emission is the Chinn-type or long-term emission (e.g., a crack and crevice treatment is completed, and the pesticide offgasses from the treated surfaces for several weeks). The offgassing emission rate is calculated based on an empirical relationship between evaporation

time, vapor pressure, and molecular weight (Chinn, 1981). The equations used to calculate a Chinn-type emission rate and an example calculation are presented in Figure 13-3. Example *MCCEM* emission input tables for both scenarios are presented in Figures 13-4 and 13-5. [Note: For all calculations including two zone scenarios, emissions will occur in Zone 1 (Column D). In Figure 13-5, the source is active for only 545 hours of the 2,160 hours of the run.]

Step 6/Decay Rate Input: "Nonreactive" or a value of 0 should be used for all calculations unless information is available to indicate otherwise.

Step 7/Outdoor Concentrations: No contributions from the outdoors will be assumed for this SOP (i.e., pass through to next screen with no inputs).

Step 8/Monte Carlo & Sensitivity Options: Neither of these options will be used in a high-end assessment (i.e., pass through to next screens by selecting "No").

Step 9/Level of Concern & LADD Inputs: Neither of these options will be used in a high-end assessment (i.e., pass through to next screens by selecting "No").

Step 10/Execute the Model: Run the model and save the output files for review purposes.

Calculating Exposure and Dose

Once a model has been used to calculate an exposure concentration, human inhalation exposure/dose must be calculated. Selection of the proper concentration value to be used in an exposure assessment depends on the inhalation toxicological endpoint (i.e., acute or chronic). If *SCIES* was used to complete the assessment, the " average concentration in the zone of release during the period of use" is selected for an acute scenario. If the endpoint is chronic, the "average concentration to which the non-user is exposed" is selected. (See Figure 13-1 for further information.) If *MCCEM* was used to complete the assessment, the "average concentration in the Zone 1" is selected for an acute endpoint. This value is used even if a multi-chamber model run is completed, because Zone 1 will have slightly higher concentration values as it will always be designated as the release zone. If the endpoint is chronic, the "TWA or Time-Weighted-Average" value is selected for Zone 1.

In order to complete the calculation, current and/or proposed labeling should be consulted to define any remaining required information. The following assumptions are also used to calculate post application inhalation exposures in a residence after the use of pesticide containing products in and around the residence:

- Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study) A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the average body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Toddlers (3 years old), used to represent the 1 to 6 year old age

group, are assumed to weigh 15 kg. This is the average of the median values for male and female toddlers (U.S. EPA, 1996).

- **$** A mean inhalation rate of 13.3 m^3/day for adults will be used to calculate daily exposures (U.S. EPA, 1996). A mean inhalation rate of 8.7 m^3/day for toddlers will be used to calculate daily exposures (U.S. EPA, 1996).

- **$** Five percent of termiticides applied by foundation/soil injection techniques penetrate the foundation of a house to become a source for offgassing in a Chinn-type emission. This is based on the experience and professional judgement of the OPP staff based on the review of company-submitted data. All termiticides applied indoors are assumed to 100 percent available for emission.

- **$** Table 13-1 includes various assumptions required for the use of *MCCEM* not addressed in this list. The default values in *SCIES* are not assumptions; they are based on actual data.

Inhalation potential dose rates for acute scenarios are calculated as follows:

$$PDR = C_a * IR$$

where:

PDR = potential dose rate (mg/day)
C_a = modeled airborne concentration of pesticide in air (mg/m^3)
IR = inhalation rate (m^3/day)

Inhalation potential dose rates, normalized to body weight, are then calculated as:

$$PDR_{norm} = PDR / BW$$

where:

PDR_{norm} = potential dose rate, normalized to body weight (mg/kg/day)
BW = body weight (kg)

The body weight used can be adjusted to fit any specific scenario (e.g., use of 60 kg for women when developmental endpoints are available).

Example Calculations

The following is an example calculation to determine the potential dose rates based on a single latex painting event using *SCIES* for an adult. Refer to Figure 13-1 for C_a value, which is the "average concentration in zone of release during period of use."

$$PDR = C_a * IR$$

$$PDR = 0.947 \text{ mg/m}^3 * 13.3 \text{ m}^3\text{/day}$$

$$PDR = 12.6 \text{ mg/day}$$

The estimated potential dose rate, normalized to body weight, for an adult with a body weight of 71.8 kg, would be:

$$PDR_{norm} = PDR / BW$$

$$PDR = (12.6 \text{ mg/day}) / (71.8 \text{ kg})$$

$$PDR = 0.18 \text{ mg/kg/day}$$

Limitations and Uncertainty

The dose estimates generated using this method are based on some central tendency (i.e., inhalation rate and body weight) and some upper-percentile (i.e., model inputs and exposure concentrations) assumptions. The uncertainties associated with this assessment stem from the generic applicability for exposure scenarios, and assumptions regarding the model inputs. MCCEM may calculate concentrations that exceed the theoretical saturation value. A saturation concentration must be calculated using the ideal gas law for comparison to MCCEM results. If MCCEM calculated values exceed the saturation concentration, the saturation value must be used in the exposure assessment process. This is not an issue for SCIES. Other limitations of the SCIES model are that it is intended for use as a screening-level tool and is designed to use very limited data to generate high-end to bounding exposure estimates. Also, the Chinn relationship is based on the evaporation of pure substances under artificial conditions and may overestimate the emissions expected from substances in mixtures. These assumptions are believed to be reasonable to calculate high-end estimates based on observations from similar field studies.

References

Chinn, K.S.K. (1981) A simple method for predicting chemical agent evaporation. September 1981. Dugway, UT: U.S. Army Proving Ground. DPG Document No. DPG-TR-401.

U.S. Environmental Protection Agency. (1995) Multi-Chamber Concentration and Exposure Model (MCCEM): User's Guide, Version 2.4. Office of Pollution Prevention and Toxics, Economics, Exposure and Technology Division, Exposure Assessment Branch, Washington D.C.

U.S. Environmental Protection Agency. (1994) Screening-Level Consumer Inhalation Exposure Software (SCIES): Description and Users Manual, Version 3.0. Office of Pollution Prevention and Toxics, Exposure Assessment Branch, Washington D.C.

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P95/002B.

TABLE 13-1: SCENARIOS AND INPUT PARAMETERS FOR *MCCEM*[a]

Use Scenario	House Type & Season	Air Exchange Rate (xch/hr)	Chamber Type (Number Zones)	Model Type	Calculation Duration[b] (days)	Emission Type[c]	Emission Rate[c]	Product Use Scenario[a]	Room of Use	*MCCEM* Decay Rate
Single Use Pressurized Fumigant Can	Generic/Summer	0.18	Single (1)	Long-Term	90	Instant Release	Total/hr	2 Cans	Bedroom	0
Crack and Crevice	Generic/Summer	0.18	Single (1)	Long-Term	90	Chinn Evaporation	Chinn Rate	All Rooms	Bedroom	0
Carpet Broadcast	Generic/Summer	0.18	Multi (2)	Long-Term	90	Chinn Evaporation	Chinn Rate	1 Room	Bedroom	0
Termiticides	Generic/Summer	0.18	Single (1)	Long-Term	365	Chinn Evaporation	Chinn Rate	Entire House and 5 % Penetration Inside	Bedroom	0
Pressurized or RTU Sprays	Generic/Summer	0.18	Multi (2)	Long-Term	90	Instant Release	Total/hr	1 Can	Bedroom	0
Carpet Dusting	Generic/Summer	0.18	Multi (2)	Long-Term	90	Chinn Evaporation	Chinn Rate	1 Room	Bedroom	0
Pet Treatments	Generic/Summer	0.18	Single (1)	Long-Term	90	Chinn Evaporation	Chinn Rate	2 Pets	Bedroom	0

a Use scenario provides basis for calculating the amount of chemical used in each type of use scenario and, for termiticides, the amount of applied chemical that penetrates a residence through the foundation in order to characterize the source.

b Calculation duration refers to the length of time that the chemical concentration is modeled. It is recommended that if a highly toxic compound is being modeled that the model outputs be saved and imported into a spreadsheet in order to review the data to ensure that the model was run for a sufficient period of time.

c See Figure 6 for details concerning the calculation of these emission rates.

```
 Latex Paint

      Annual Frequency of Use  :       6     Events/Year
      Mass of Product          :  9.070E+03 grams
      Duration of Use          :     4.900 hours
      Zone 1 Volume            :    35.000 cubic meters
      Whole House Volume       :   408.000 cubic meters
      House Air Exchange Rate  :     0.200 air exchanges/hr
      User Inhalation Rate     :     1.300 cubic meter/hr (during use)
      Non-User Inhalation Rate :     1.100 cubic meter/hr (& user after use)
      Molecular Weight         :   450.000 g/mole
      Vapor Pressure           :  4.000E-05 torr
      Weight Fraction          :     0.040
      Starting Time            :      9:00 AM

       OUTPUT SUMMARY
  Evaporation Time                    :  6.708E+03  hours
  Release Time                        :  6.708E+03  hours (Evaporation Time)
  Duration Following Each Use         :  1.311E+04  hours
  Interval Between Uses               :  1.460E+03  hours

  User Potential Dose Rate From Inhalation      :  4.62435E+03 mg/yr
  Non-User Potential Dose Rate From Inhalation  :  4.61155E+03 mg/yr
-------------------------------------------------------------------------------
                                       Average (mg/m3   Peak (mg/m3)
  Concentration in zone of release
     During period of use                      0.947         0.969
     During period after use                   0.893         0.969
  Concentration in Zone 2
     During period of use                      0.220         0.302
     During period after use                   0.287         0.311

  Concentration to which User and Non-User are exposed
     Person Using Product (user)               0.479         0.969
     Person Not Using Product (non-user)       0.479         0.969

                             HOURLY ACTIVITY PATTERN


 User          : 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1 1 1 1 1 1 4 1 1
 Non-User      : 1 1 1 1 1 1 1 3 4 5 4 2 4 6 7 4 2 2 7 4 4 4 1 1
 Hour          :     03    06    ^     12    15    18    21    24
                                 |
                             START HOUR

Room of Use : Bedroom
```

FIGURE 13-1: EXAMPLE SCIES INPUT/OUTPUT REPORT

SUMMARY OF INPUTS FOR MODEL RUN

1. TYPE OF STRUCTURE: Generic House
2. GEOGRAPHIC AREA: (N/A)
3. HOUSE CODE: GN001 SEASON: Summer
4. NUMBER OF ZONES: 1 (Single-chamber)
5. SHORT/LONG TERM: Long-term
   LENGTH OF RUN: 90 day(s) TIME STEP: 1 hour(s)
6. MAXIMUM INDOOR EMISSION RATE (g/hr): 227
   Z1 = 227
7. DECAY RATE: 0:0
8. MAXIMUM OUTDOOR CONCENTRATION (mg/m^3: 0
9. MONTE CARLO OPTION: No
10. SENSITIVITY OPTION: No
11. CALCULATE % CASES >= 0 mg/m^3
12. LIFETIME AVG. DAILY DOSE OPTION: No

Specify screen to be updated (1-12): [0]

SINGLE RUN SUMMARY STATISTICS

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	EXPOSURE
	Whole House (Single-chamber)				
TWA, mg/m^3	1.43E+00				0.00E+00
STD. DEVIATION	1.99E+01				0.00E+00
MAXIMUM, mg/m^3	5.09E+02				0.00E+00
PERCENT OF CASES >= 0 mg/m^3					100.0
PERCENT OF TIME IN RESIDENCE					0.0
LIFETIME AVG. DAILY DOSE, mg/kg-day					(N/A)

FIGURE 13-2: EXAMPLE MCCEM INPUT/OUTPUT REPORT

Equations:

Calculate the mass of active ingredient applied (m) in grams during a single application event as described above and using the assumptions provided in Table 13-1. Next calculate the Chinn Evaporation time using the following formula (Chinn, 1981):

$$d = 145/((mw * vp)^{0.9546})$$

where:

d = Chinn evaporation time (hr)
mw = molecular weight of pesticide active ingredient (unitless)
vp = vapor pressure (torr)

Finally, calculate the emission rate (g/hr) using the following formula

$$er = m/d$$

Example:

3 gallons of solution containing 500 grams of ai with a vapor pressure of $5x10^{-4}$ torr and a molecular weight of 500 are applied in a typical crack-and-crevice scenario, then:

$$d = 145/((500 * (5x10^{-4}))^{0.9546})$$
$$= 545 \text{ hours}$$

and

$$er = 500/545$$
$$= 0.917 \text{ grams/hour}$$

FIGURE 13-3: CALCULATION OF CHINN RELEASE EMISSION RATES

File:GNS1L002 * Total of 2160 Time Steps *

Whole House (Single-chamber)

Step	Day	Hour	Emission Rate [g/hr]				Exposure
(A)	(B)	(C)	Zone1(D)	Zone2(E)	Zone3(F)	Zone4(G)	Zone(H)
1	1	1	[227]	[ ]	[ ]	[ ]	[0]
2	1	2	[0]	[ ]	[ ]	[ ]	[0]
3	1	3	[0]	[ ]	[ ]	[ ]	[0]
4	1	4	[0]	[ ]	[ ]	[ ]	[0]
5	1	5	[0]	[ ]	[ ]	[ ]	[0]
6	1	6	[0]	[ ]	[ ]	[ ]	[0]
7	1	7	[0]	[ ]	[ ]	[ ]	[0]
8	1	8	[0]	[ ]	[ ]	[ ]	[0]
9	1	9	[0]	[ ]	[ ]	[ ]	[0]
10	1	10	[0]	[ ]	[ ]	[ ]	[0]
11	1	11	[0]	[ ]	[ ]	[ ]	[0]
12	1	12	[0]	[ ]	[ ]	[ ]	[0]
13	1	13	[0]	[ ]	[ ]	[ ]	[0]
14	1	14	[0]	[ ]	[ ]	[ ]	[0]
15	1	15	[0]	[ ]	[ ]	[ ]	[0]
16	1	16	[0]	[ ]	[ ]	[ ]	[0]

F1-Help F2-Edit/Formula F3-Import F5-Goto F6-Copy F7-Done F10-Exit

[(Ctrl+) Arrows, Home/End, PgUp/PgDn]-Move Cursor Esc-Cancel

FIGURE 13-4: EXAMPLE MCCEM INSTANT RELEASE EMISSION TABLE

File:GNS1L002 * Total of 2160 Time Steps * Day: 1

Whole House (Single-chamber)

Step	Day	Hour	Emission Rate [g/hr]				Exposure
(A)	(B)	(C)	Zone1(D)	Zone2(E)	Zone3(F)	Zone4(G)	Zone(H)
1	1	1	[.917]	[ ]	[ ]	[ ]	[0]
2	1	2	[.917]	[ ]	[ ]	[ ]	[0]
3	1	3	[.917]	[ ]	[ ]	[ ]	[0]
4	1	4	[.917]	[ ]	[ ]	[ ]	[0]
5	1	5	[.917]	[ ]	[ ]	[ ]	[0]
6	1	6	[.917]	[ ]	[ ]	[ ]	[0]
7	1	7	[.917]	[ ]	[ ]	[ ]	[0]
8	1	8	[.917]	[ ]	[ ]	[ ]	[0]
9	1	9	[.917]	[ ]	[ ]	[ ]	[0]
10	1	10	[.917]	[ ]	[ ]	[ ]	[0]
11	1	11	[.917]	[ ]	[ ]	[ ]	[0]
12	1	12	[.917]	[ ]	[ ]	[ ]	[0]
13	1	13	[.917]	[ ]	[ ]	[ ]	[0]
14	1	14	[.917]	[ ]	[ ]	[ ]	[0]
15	1	15	[.917]	[ ]	[ ]	[ ]	[0]
16	1	16	[.917]	[ ]	[ ]	[ ]	[0]

F1-Help F2-Edit/Formula F3-Import F5-Goto F6-Copy F7-Done F10-Exit

[(Ctrl+) Arrows, Home/End, PgUp/PgDn]-Move Cursor Esc-Cancel

FIGURE 13-5: EXAMPLE MCCEM CHINN RELEASE EMISSION TABLE

14.0 RODENTICIDES (REFER TO 2.3.1)

15.0 PICK YOUR OWN

15.1 Postapplication Dermal Potential Doses from Pesticide Residues on Pick Your Own Strawberries

Introduction

This SOP provides a standard method for estimating doses among adults and/or toddlers from dermal contact with strawberries that have previously been treated with pesticides. Inhalation dose is considered minimal due to the air exchange that occurs in outdoor scenarios. This scenario assumes that pesticide residues are transferred to the skin of adults/youth who enter treated strawberry fields during "pick your own" fruit harvesting. For the purposes of this SOP, "pick your own" facilities are considered commercial farming operations that allow public access for harvesting strawberries in large-scale fields treated with commercially labeled pesticides. The method for estimating postapplication dermal dose from pesticides on strawberries is based on assumptions when adequate chemical specific field data are unavailable. Thus, this method should be used in the absence of actual field data.

Methods for Estimating Potential Dose

Prior to the development of an exposure assessment for this scenario, the assessor should consult the pesticide label to determine whether this scenario is appropriate based on the usage characteristics of the product. Label information is also important for selecting appropriate data inputs for the exposure assessment. The only datum required for estimating postapplication doses from pesticide residues on "pick your own" strawberries is the application rate. The maximum application rate specified on the label should be used as the application rate. One exception is for cancer assessments, when the typical application rates should be used. It should be noted that pesticide products not labelled for the residential/home garden market must be considered for this scenario as label stipulations do not typically preclude "pick your own." It should also be noted that the typical use rate is often the maximum residential use rate. In the absence of actual data, the following assumptions can be used for estimating daily pesticide postapplication doses.

- On the day of application, it may be assumed that 20 percent of the application rate are available on the foliage as dislodgeable residue. This value is based on the professional judgement and experience of the OPP/HED staff from the review of company-submitted data.

- Postapplication exposure must be assessed on the same day the pesticide is applied because it is assumed that individuals could enter a "pick your own@ site immediately after application. For subsequent days after application, an assumed pesticide dissipation rate should be used, based on chemical-specific data.

- **$** The duration of exposure is assumed to be 2.0 hours per day for youth (age 10-12 years) and 4.0 hours per day for adults (age 18-64 years), based on the 50th percentile values for time spent outdoors at a farm (U.S. EPA, 1996).

- **$** The assumed dermal transfer coefficient is 10,000 cm^2/hr for adults and 5,000 cm^2/hr for youth (age 10-12 years). This value is based on the professional judgement and experience of the OPP/HED staff from the reviewed company-submitted data.

- **$** Adults are assumed to weigh 71.8 kg (use 60 kg for females when the selected endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 years and older) and is the value recommended in U.S. EPA (1996). A body weight of 60 kg represents the average body weight for females between ages 13 and 54 years (U.S. EPA, 1996). Youth (10-12 years) are assumed to weigh 39.1 kg. This is the mean of the median values for male and female children. (U.S.EPA, 1996).

Dermal potential dose rates are calculated as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

where:

PDR_t	=	potential dose rate on day "t" (mg/day)
DFR_t	=	dislodgeable foliar residue on day "t" (μg/cm^2)
CF1	=	weight unit conversion factor to convert μg units in the DFR value to mg for the daily exposure (0.001 mg/μg)
Tc	=	transfer coefficient (cm^2/hr)
ET	=	exposure time (hr/day)

and

$$DFR_t = (AR * F) * (1-D)^t * CF2 * CF3$$

where:

AR	=	application rate (lbs ai/ft^2 or lbs ai/acre)
F	=	fraction of ai retained on foliage (unitless)
D	=	fraction of residue dissipating daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	conversion factor to convert the lbs ai in the application rate to μg for the DFR value (4.54E8 μg/lb)
CF3	=	conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the DFR value (1.08E-3 ft^2/cm^2 or 2.47E-8 acre/cm^2 if the application rate is per acre)

Potential dose rates, normalized to body weight, are calculated as:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

where:

$PDR_{t\text{-}norm}$ = potential dose rate on day "t", normalized to body weight (mg/kg/day)
BW = body weight (kg)

The body weight used can be adjusted to fit any specific scenario (for example, exposure to adults or toddlers).

Example Calculations

The following is an example calculation to determine the dose based on an assumed DFR over time. For the purpose of this example, the application rate is assumed to be 2.2E-5 lbs ai/ft^2 (approximately 1 lb ai/acre). Thus, the dislodgeable foliar residue on day 0 is as follows:

$$DFR_t = (AR * F) * (1\text{-}D)^t * CF2 * CF3$$

$$DFR_0 = (2.2E\text{-}5 \text{ lb ai/ft}^2 * 0.2) * (1\text{-}D)^0 * (4.54E8 \ \mu g/lb) * (1.08E\text{-}3 \text{ ft}^2/\text{cm}^2)$$

$$DFR_0 = 2.16 \ \mu g/cm^2$$

The estimated dose for the day of application would be as follows:

$$PDR_t = DFR_t * CF1 * Tc * ET$$

$$PDR_0 = 2.16 \ \mu g/cm^2 * 0.001 \text{ mg}/\mu g * 5{,}000 \text{ cm}^2/\text{hr} * 2 \text{ hours/day}$$

$$PDR_0 = 21.6 \text{ mg/day}$$

Finally, the estimated potential dose rate, normalized to body weight, for a youth with a body weight of 39.1 kg would be:

$$PDR_{t\text{-}norm} = PDR_t / BW$$

$$PDR_{0\text{-}norm} = (21.6 \text{ mg/day}) / (39.1 \text{ kg})$$

$$PDR_{0\text{-}norm} = 0.55 \text{ mg/kg/day}$$

Limitations and Uncertainty

The dose estimates generated using this method are based on upper-percentile assumptions for transfer coefficients and duration, and central tendency estimates for body weights. They are considered to be representative of high-end exposures. The uncertainties associated with this assessment stem from the use of an assumed amount of pesticide retained on strawberries, and assumptions regarding dissipation and transfer of chemical residues. The dose estimates are believed to be reasonable high-end estimates based on observations from chemical-specific field studies and professional judgement.

References

U.S. Environmental Protection Agency. (1996) Exposure Factors Handbook [Draft]. National Center for Environmental Assessment, Washington D.C. EPA/600/P-95/002Ba.