APPENDIX A

STANDARD FORMULAS, EXPOSURE DATA, AND RISK CALCULATIONS FOR OCCUPATIONAL AND RESIDENTIAL EXPOSURES TO MEFLUIDIDE

APPENDIX A -1

STANDARD FORMULAS USED FOR CALCULATING OCCUPATIONAL AND RESIDENTIAL EXPOSURES TO MEFLUIDIDE

A. Introduction

This document is a summary of the formulas used to calculate occupational and residential exposures to mefluidide. These formulas and a basic description of how they are used were taken from References A through E. These references also contain more detailed information on the rationale behind these formulas.

B. Occupational Handler/Applicator Exposures

The basic rationale for these formulas is that the daily exposure is the product of the amount of active ingredient (a.i.) handled per day times a unit exposure value. The amount of ai handled per day is the product of the application rate times the area treated. For example, if 1.0 lb/acre of MEFLUIDIDE were applied to 80 acres in one day, the amount of mefluidide handled that day would be 80 lbs. The unit exposure value is the amount of exposure that results from handling a given amount of active ingredient by a certain method while using certain PPE. For example, the inhalation unit exposure value for open mixing and loading of liquids is 1.0 ug per pound of ai handled. In this example, the daily exposure would be 80 lbs ai handled times 1.0 ug unit exposure per pound of ai handled which equals 80 ug per day. The daily absorbed dose (mg/kg BW) is calculated from the exposure by converting the exposure from ug into mg, multiplying the exposures times an absorption factor (usually 1.0 for inhalation) and dividing the result by the body weight (70 kg). In this example the daily dose is (80 ug/day * 0.001 mg/ug *1.0)/70 kg which equals 0.0011 mg/kg/day.

Daily inhalation exposure is calculated**:**

Daily inhalation exposure = Unit exposure x Application rate x Area Treated x Conversion Factor (1.0E-3)
(mg/kg/day)

Where:

Unit exposure = (ug/lb ai handled) derived from PHED or ORETF Study Data
Application rate = lb ai per acre or gallon of spray solution; and
Daily treatment = acres or gallons applied per day).

Absorbed Daily Dose is calculated**:**

Absorbed daily inhalation dose = (Daily inhalation exposure x absorption factor) / body weight
(mg/kg/day) (mg/day) (unitless) (kg)

[Note: an absorption factor of 1.0 was used for inhalation exposures.]

Once the absorbed daily doses are calculated, the Margins of Exposure (MOEs) can be calculated as shown below:

Margin of Exposure is calculated**:**

MOE (unitless) = NOAEL (mg/kg/day) / Dose (mg/kg/day)

The target MOE is 100 for occupational handlers. Scenarios with MOEs greater than the target MOEs do not exceed the Agency's level of concern.

C. Residential Handler Exposures

Residential handler exposures are calculated in the same manner as described above for occupational handlers, however, there are a few differences in the assumptions used. These differences are described in References B and C and include the following:

*PPE such as respirators are not worn.
*The areas treated are much smaller.

D. Residential Post Application Exposure on Treated Turf

The *SOPs For Residential Exposure Assessment (Reference B)* define three incidental oral pathways that apply to post application toddler exposure on treated turf. The SOPs and the associated pathways are presented below:

- ***Dose from hand-to-mouth activity from treated turf calculated using SOP 2.3.2:***
  Residues ingested from a child touching turf and then putting their hands in their mouth.

- ***Dose from object-to-mouth activity from treated turf calculated using SOP 2.3.3:***
  Residues ingested from a child mouthing a handful of treated turf); and

- ***Dose from soil ingestion activity from treated turf calculated using SOP 2.3.4:***
  Residues from a child touching treated soil and then putting their hands in their mouth.

The algorithms used for each type of dose calculation are presented on the following pages.

Exposures from Hand to Mouth Behavior on Treated Turf**:**

The following formula is used to calculate the incidental oral ingestion exposures from to hand-to-mouth behavior on treated turf (SOP 2.3.2).

$$PDR = TTR * (SE/100) * SA * Freq * Hours * (1\ mg/1000\ ug)$$

where:

PDR	=	potential dose rate from hand-to-mouth activity (mg/day);
TTR	=	Turf Transferable Residue ($\mu g/cm^2$);
SE	=	saliva extraction factor (50%);
SA	=	surface area of the hands (20 cm^2);
Freq	=	frequency of hand-to-mouth events (20 events/hour); and
Hours	=	exposure duration (2 hours).

When used for hand to mouth exposures, the TTR value is based upon the default assumption of 5 percent of the application rate and not the TTR study .

The formula for calculating the Day 0 TTR value is given below:

TTR = Application Rate * F * CF1 * CF2 * CF3

Where:

Application Rate	=	lbs ai/acre
F	=	fraction of applied ai that is available for hand to mouth exposure (5 percent)
CF1	=	1.0 lb ai/acre equals 2.3×10^{-5} lbs ai per ft^2
CF2	=	4.54×10^8 ug/lb
CF3	=	0.00108 ft^2/cm^2

Note: CF1 * CF2 * CF3 = 11.23

Exposures from Object to Mouth Behaviors on Treated Turf

The following formula is used to calculate exposures from object-to-mouth behavior on treated turf that is represented by a child mouthing on a handful of turf (SOP 2.3.3):

$$PDR = TTR * IGR * (1mg/1000ug)$$

where:

PDR	=	potential dose rate from mouthing activity (mg/day);
TTR	=	Turf Transferable Residue where dissipation is based on TTR study and the 0-day value is based on the 20% initial transferability factor ($\mu g/cm^2$); and
IgR	=	ingestion rate for mouthing of grass per day (25 cm^2/day).

When used for object to mouth exposures, the TTR value is based upon the default assumption of 20 percent of the application rate .

Exposures from Soil Ingestion on Treated Turf

The following formula is used to calculate exposures from soil ingestion (SOP 2.3.4):

PDR = SR * IgR * (0.000001 gm/ 1 ug)

Where:
PDR = dose from soil ingestion activity (mg/day)
SR = Soil Residue where dissipation is based on TTR study and the 0-day value is based on the application rate, 1 cm depth of surface soil, and the density of soil ($\mu g/cm^3$)
IgR = ingestion rate for daily soil ingestion (mg/day)

Where:
SR = Application rate * F*11.23*CF4

Where
F = Faction of ai available in the uppermost cm of soil (100%/cm)
1.0 lbs/acre = 11.23 $\mu g/cm^2$
CF4 = Volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (0.67 cm^3/g soil)

MOE Calculations for Each Pathway

The MOEs are calculated for each individual pathway using the MOE formula:

MOE = NOAIL (mg/kg/day / Dose (mg/kg/day)

MOEs Calculations for All of the Pathways Combined

The dose from each incidental oral pathway was combined into a total dose as shown below.

Total Dose = (Hand-to Mouth Dose + Object to Mouth Dose + Soil Ingestion Dose)

The total dose is then used to calculate an MOE as shown above. The target MOE is 100.

References

(A) PHED Surrogate Exposure Guide, V1.1. Health Effects Division, Office of Pesticide Program. August, 1998.

(B) Standard Operating Procedures for Residential Exposure Assessments. U.S. EPA. December 18, 1997.

(C) ExpoSAC SOP #12 "Recommended Revisions to the Standard Operating Procedures (SOPs) for Residential Exposure Assessments. February 22, 2001

(D) Series 875 - Occupational and Residential Exposure Test Guidelines, Group B - Post Application Exposure Monitoring Test Guidelines. U.S. EPA. February 10, 1998.

(E) Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessment, Presented to the FIFRA Scientific Advisory Panel on September 1999

Appendix A-2: Occupational Handler Exposure Data and Risk Calculations for Mefluidide

Table A-1. Mefluidide Formulations Used, Application Methods, Application Rates and Daily Amounts Treated				
Application Method	**Use Sites**	**Formulations Used**	**Application Rate[1] (lb ai/acre or lb ai/ga)**	**Daily Amount Treated or Applied[2]**
Mixer/Loader (Turfgun)	Turf	Liquid	1.0 lbs ai/acre	100 acres/day[3]
Mixer/Loader (High pressure handwand)	Ornamental trees	Liquid	0.01 lbs ai/gallon	1000 gallons/day
Mixer/Loader (Groundboom)	Golf course	Liquid	1.0 lbs ai/acre	40 acres/day
Mixer/Loader (ROW spray)	Right of way	Liquid	0.067 lbs ai/gallon	1000 gallons/day
Applicator (Groundboom Spray)	Golf Course Turf	Liquid	1.0 lb ai/acre	40 acres/day
Applicator (Right of Way Spray)	Non-Turf Areas	Liquid	0.067 lbs ai/gallon	1000 gallons/day
Applicator (Turfgun)	PCO Turf Areas	Liquid	1.0 lb ai/acre	5 acres/day
Mix/Load/Apply (Turfgun)	PCO Turf Areas	Liquid	1.0 lb ai/acre	5 acres/day
Mix/Load/Apply (Backpack Sprayer)	Non Turf areas	Liquid	0.067 lbs ai/gallon	40 gallons/day
Load/Apply (Push Cyclone)	PCO Turf	Granular	0.5 lb ai/acre	5 acres/day

Notes

1. Application rates are from Table 1.4.

2. Except as noted, these values are from ExpoSAC Policy 9 “Standard Values for Daily Acres Treated in Agriculture”, Revised 7/5/2000.

3. Based upon a mixer loader at a central location supporting a PCO crew of 20 applicators.

Table A-2. Exposure Data Used for Mefluidide Occupational Handler/Applicator Risk Assessment								
Exposure Scenarios (See notes for PPE Descriptions)	**Baseline Dermal (mg/lb ai)**	**Baseline Inhalation (ug/lb ai)**	**Single Layer Dermal (mg/lb ai)**	**Double Layer Dermal (mg/lb ai)**	**PF5 Respirator Inhalation (ug/lb ai)**	**PF10 Respirator Inhalation (ug/lb ai)**	**Engineering Control Dermal (mg/lb ai)**	**Engineering Control Inhalation (ug/lb ai)**
Mixer Loader Unit Exposure Values								
Mix/Load Liquid Formulations	2.9	1.2	0.023	0.017	0.24	0.12	0.0086	0.083
Applicator Unit Exposure Values								
Groundboom Application	0.014	0.74	0.014	0.011	0.15	0.074	0.005	0.043
Right of Way (ROW) Application	1.3	3.9	6.1	ND	10.8	5.4	NA	NA
Turf Gun Application	No Data	1.0	0.73	0.40	0.20	0.10	NA	NA
Mixer/Loader/Applicator Unit Exposure Values								
Mix/Load/Apply Liquid Flowables with a Turfgun	No Data	1.9	0.5	0.27	0.38	0.19	N/Feasible	Not Feasible
Mix/Load/Apply Liquids with Backpack Sprayer	No Data	30	2.5	1.6	6.0	3.0	N/Feasible	Not Feasible
Load/Apply Granules with a Push Cyclone Spreader	0.35	7.5	0.22	0.11	1.5	0.75	N/Feasible	Not Feasible

Notes - PPE Descriptions
Badeline dermal and inhalation unit exposure values are from PHED.
Baseline Dermal - includes long sleeve shirts, long pants, shoes and socks.
Single Layer Dermal - includes water resistant gloves over Baseline PPE
Double Layer Dermal - includes Tyvek or cotton coveralls over Single Layer PPE
PF5 Respirator Inhalation - filtering facepiece disposable respirator (i.e. dustmask) with a protection factor of 5
PF10 Respirator Inhalation - half face cartridge respirator with a protection factor of 10

Table A-3. Sources of Exposure Data Used for Mefluidide Occupational Handler Exposure and Risk Calculations

Exposure Scenario	Data Source	Comments[2, 3]
Mixer/Loader		
Mix/Load Liquid Formulations	PHED [1]	**Baseline:** Hands, dermal, and inhalation = acceptable grades. Hands = 53 replicates; Dermal = 72 to 122 replicates; and Inhalation = 85 replicates. High confidence in hand, dermal, and inhalation data. No protection factor was needed to define the unit exposures. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = acceptable grades. Hands = 59 replicates. High confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls:** Hands, dermal, and inhalation = acceptable grades. Hands = 31 replicates; Dermal = 16 to 22 replicates; and Inhalation = 27 replicates. High confidence in hand, dermal, and inhalation data.
Applicator		
Groundboom Application	PHED[1]	**Baseline**: Hand, dermal, and inhalation = acceptable grades. Hands =29 replicates, dermal = 23 to 42 replicates, and inhalation = 22 replicates. High confidence in hand, dermal, and inhalation data. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Hands = ABC grades. Hands = 21 replicates. Medium confidence in hand data. A respirator protection factor of 5 is applied to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls**: Hand and dermal = ABC grade. Inhalation = acceptable grades. Hands = 16 replicates; dermal = 20 to 31 replicates; and inhalation = 16 replicates. Medium confidence in the hand and dermal data. High confidence in inhalation data. No protection factor needed to define the unit exposure value. Protective gloves not used.
Right of Way Sprayer Application	PHED Right of Way Sprayer Data	**Baseline:** Hands = 16 replicates with ABC grade data, dermal = 4 to 20 replicates with ABC grade data, and inhalation = 16 replicates with AB grade data. Low confidence due to lack of dermal replicates. No protection factor was needed to define the unit exposure value. **PPE:** Hands = 4 replicates with AB grade data, dermal = 4 to 20 replicates with ABC grade data. The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. Low confidence due to low number of dermal and hand replicates. A respirator protection factor of 5 is applied to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls:** No data is available.
Turfgun Application	ORETF OMA002	**Baseline:** No ungloved data **PPE**: Dermal and hands = B grade; Inhalation = B grade; Dermal = 10 replicates; hands = 10 replicates; and inhalation = 10 replicates. Medium confidence in inhalation, dermal, and hand data due to low number of replicates. A 50% protection factor to account for an additional layer of clothing. A respirator protection factor of 5 is applied to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls:** Not considered feasible for this exposure scenario.

Table A-3. Sources of Exposure Data Used for Mefluidide Occupational Handler Exposure and Risk Calculations		
Exposure Scenario	**Data Source**	**Comments[2, 3]**
Mixer/Loader/Applicator (M/L/A)		
M/L/A Liquids with a Turfgun	ORETF OMA002	**Baseline:** No ungloved data **PPE**: Dermal and hands = B grade with 15 replicates; Inhalation = B grade with 15 replicates. High confidence in inhalation, dermal, and hand data. A 50% protection factor to account for an additional layer of clothing. A respirator protection factor of 5 is applied to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls:** Not considered feasible for this exposure scenario.
M/L/A Liquids with a Backpack Sprayer	PHED[1]	**Baseline:** No Data **PPE:** Hands = C grades. Hands = 11 replicates. Low confidence in hand data. The same dermal data are used as for baseline coupled with a 50% protection factor to account for an additional layer of clothing. A respirator protection factor of 5 is applied to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls:** Not considered feasible for this exposure scenario.
Load/Apply Granules with a Push Cyclone Spreader	ORETF OMA001	**Baseline:** Dermal and ungloved hands = AB grade with 20 replicates; Inhalation = AB grade with 40 replicates. High confidence in inhalation, dermal, and hand data. **PPE**: Dermal and gloved hands = AB grade with 20 replicates; High confidence in dermal, and hand data. A 50% protection factor to account for an additional layer of clothing. A respirator protection factor of 5 is applied to baseline inhalation data to estimate the use of a dust mask. A respirator protection factor of 10 is applied to estimate the use of a half-face respirator. **Engineering Controls:** Not considered feasible for this exposure scenario.

Notes

1. PHED refers to the Pesticide Handler Exposure Database Version 1.1 PHED Surrogate Exposure Guide of August 1998

2. The data grade and confidence categories are assigned as follows:

   Grade A data = Lab recovery is 90 to 110 percent with a CV $\leq$15. Field recovery is 70 to 120 percent. Storage stability data are optional.
   Grade B data = Lab recovery is 80 to 110 percent with a CV $\leq$25. Field recovery is 50 to 120 percent. Storage stability data are optional.
   Grade C data = Lab recovery is 70 to 120 percent with a CV $\leq$33. Field recovery is 30 to 120 percent or is missing. Storage stability data is 50 to 120 percent
   Grade D data = Lab recovery is 60 to 120 percent with a CV $\leq$33. Field recovery and storage stability data are optional.
   Grade E data = Does not meet above criteria.

High Confidence = grade A and B data and 15 or more replicates per body part
Medium Confidence = grade A, B, and C data and 15 or more replicates per body part
Low Confidence = grade A, B, C, D and E data or any combination of grades with less than 15 replicates.

- **PHED grading criteria only affect one aspect of the exposure assessment. The other exposure factors should also be considered in the risk management decision.**

Table A-4. Exposure Factors and Formulas Used for Mefluidide	
Exposure Factors	**Formulas**
Inhalation Absorption = 100 percent	Daily Exposure = Application Rate * Area treated or amount applied* Unit Exposure Value
NOAIL for Short/Intermediate/Long Term Inhalation Exposures = 35 mg/kg/day (based upon the same study used for dermal exposures)	Daily Dose = (Daily Exposure * Absorption factor)/Body Weight
Body Weight = 70 kg	MOE = NOAEL/Daily Dose

Appendix A-3: Residential Handler Exposure Data and Risk Calculations for Mefluidide

Table A-5. Unit Exposure Data for Mefluidide Residential Exposure Assessment			
Scenario	Data Source	Unit Exposure Values (Per lb AI Handled)	Data Confidence
1 - Belly Grinder Application	PHED	Inhalation = 62 ug	N = 40 Inhalation replicates, AB grades, High Confidence.
2. Load/Apply Granules with a Broadcast Spreader	ORETF[1]	Inhalation = 0.91 ug	Grade AB Data. N = 30 replicates. High Confidence despite large variability in results.
3. Mix/Load/Apply with a Hose-end Sprayer (Mix your own)	ORETF[1]	Inhalation = 16 ug	Grade A Data. N = 30 replicates. High Confidence.
4. Mix/Load/Apply with Hand Held Pump Sprayer	MRID[2] 444598-01	Inhalation = 9 ug	A total of 40 replicates per application method were monitored in this study. Half of the people wore gloves and the other half did not. The clothing scenario represents short-sleeved shirt, short pants, and no gloves. The data are considered high quality by the Agency.

Notes for Table 3

[1] This study involved the application of granular and liquid formulations of Dacthal to residential lawns. It was reviewed by Health Canada and Gary Bangs in Document #D261948.

[2] This study involved the application of liquid carbaryl to home garden vegetables. It was reviewed by Jeff Dawson in Document #D287251.