# ULV Public Health Adulticides:
# Standard Operating Procedures

Table of Contents

## 1.0 Introduction

A variety of pesticides are available for control of flying insects over large areas, typically as a public health vector control measure (*i.e.*, mosquitos, biting midges, black flies). While using similar equipment as conventional pesticide applications, such as aircraft and ground vehicle sprays, these differ from conventional applications in that they are deployed over large geographic areas rather than specific targets (*e.g.*, farms) and they utilize specialized, ultra-low volume (ULV), spray equipment to achieve their efficacy.

Adulticides are chemicals that target the adult stage of flying insects via applications over large geographic areas using equipment settings that are different from conventional applications. Communities seeking to control the adult stages of flying insects will apply adulticides over specified large swaths of land using aircraft or ground vehicle sprayers. To achieve efficacy, they are applied as ULV sprays (*i.e.*, small quantities of a pesticidal active ingredient in relation to the size of the area treated)[1] with specifications for smaller droplet sizes (between 5 to 30 µm)[2], higher release heights, and larger swath widths that are different from conventional applications. These application parameters are intended to ensure the spray stays aloft for a period of time, killing flying insects upon contact. This SOP provides procedural guidance to assess bystander exposure following adulticide application via ground (truck-mounted sprayer) and aircraft. Procedural guidance to assess occupational handler and occupational post-application exposure is covered by separate guidance and policy documents.[3]

Larvicides are chemical or biological pesticides typically formulated as liquids, tablets, pellets, granules, and briquettes, applied directly to aquatic breeding areas to target flying insect larvae. While applied over large areas, application equipment settings such as droplet sizes and spray release height are similar to conventional pesticide applications; therefore, potential bystander exposures following these applications are captured by the standard spray drift assessment.[4] Similar to adulticides, occupational handler and occupational post-application exposures from larvicides are covered by separate guidance and policy documents.

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[1] https://www.epa.gov/mosquitocontrol/controlling-adult-mosquitoes

[2] It is generally accepted by the mosquito control industry that optimum droplet size for mosquito control is in the range of 5-25 µm in diameter where 8 – 15 µm droplets are most effective. Insecticidal efficacy decreases rapidly for droplet sizes smaller than 5 and larger than 25 µm. Further information can be found at https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg13.pdf

[3] 2012 Standard Operating Procedures for Residential Pesticide Exposure Assessment: https://www.epa.gov/sites/default/files/2015-08/documents/usepa-opp-hed_residential_sops_oct2012.pdf; Occupational Pesticide Handler Exposure Data: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data

[4] The Agency has also prepared a draft document on how to appropriately consider spray drift as a potential source of exposure in risk assessments for pesticides. The approach is outlined in the revised 2013 *Residential Exposure Assessment Standard Operating Procedures Addenda 1: Consideration of Spray Drift*, which can be found at https://www.regulations.gov in docket identification number EPA-HQ-OPP-2013-0676

## 2.0 Ground-Based ULV Post-Application Assessment

For ground-based ULV adulticide application via a truck mounted sprayer, the fraction of the amount applied that deposits on the ground after an application (*Dep*) is based on an EPA analysis of studies measuring deposition following ground-based ULV applications. An appropriate mechanistic model is not currently available for evaluating ground adulticide applications. Air concentrations in the breathing zone of potential bystanders are calculated using the standard well-mixed box (WMB) model. Section 2.1 describes the standard methods used to assess non-occupational post-application exposures from dermal and non-dietary ingestion contact with ground-deposited residues following ground-based ULV applications. Section 2.2 describes the methods used to assess non-occupational post-application inhalation exposures following ground-based ULV applications.

### 2.1 Post-Application Dermal and Non-Dietary Ingestion Exposure Assessment

Post-application exposures are expected to occur from activities on turf following ground-based ULV adulticide applications in residential areas. Dermal and non-dietary ingestion (hand-to-mouth) exposure pathways are expected to result from contact with residues deposited on turf. The standard methods used for estimating potential dermal and hand-to-mouth doses among adults and children 1 to <2 years old are as described in the 2012 Residential SOPs: Treated Turf SOP as follow.[5]

<u>Post-application Dermal Exposure Algorithm – Physical Activities on Turf</u>
Exposure resulting from contacting previously treated turf while performing physical activities is calculated as shown below. Residential post-application exposure assessment must include calculation of exposure on the day of application. Therefore, though an assessment can present exposures for any day “t” following the application, it must include “day 0” exposure.

$$E = TTR_t * CF1 * TC * ET$$

where:

E = exposure (mg/day);
$TTR_t$ = turf transferable residue on day t (µg/cm$^2$);
CF1 = weight unit conversion factor (0.001 mg/µg);
TC = transfer coefficient (cm$^2$/hr); and
ET = exposure time (hr/day).

If chemical-specific TTR data are available, then surface residues from the day of application should be used (assume that individuals could be exposed to residues immediately after application). However, if data are not available, then $TTR_t$ can be calculated using the following formula:

$$TTR_t = (AR * F * (1-FD)_t * CF2 * CF3) * Dep$$

[5] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

where:

$TTR_t$ = turf transferable residue on day t (µg/cm$^2$);
AR = application rate (lbs ai/ft$^2$ or lb ai/acre);
F = fraction of ai as transferable residue following application (unitless);
FD = fraction of residue that dissipates daily (unitless);
t = post-application day on which exposure is being assessed;
CF2 = weight unit conversion factor (4.54 x 10$^8$ µg/lb);
CF3 = area unit conversion factor (1.08 x 10$^{-3}$ ft$^2$/ cm$^2$ or 2.47 x 10$^{-8}$ acre/cm$^2$); and
Dep = deposition fraction (0.052).

Dermal absorbed doses are calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (dermal); and
BW = body weight (kg).

| **Table 2.1.1: Turf (Physical Activities) -- Inputs for Residential Post-application Dermal Exposure Following Ground-Based ULV Adulticide Applications** | | | |
|---|---|---|---|
| **Algorithm Notation** | **Exposure Factor (units)** | | **Point Estimate(s)** |
| AR | Application rate (mass active ingredient per unit area) | | **[input]** |
| Dep | Deposition Fraction (fraction of active ingredient applied deposited on residential turf) | | 0.052 |
| F | Fraction of AR (liquid formulation) as TTR following application (if chemical-specific data is unavailable) | | 0.01 |
| $F_D$ | Daily residue dissipation (if chemical-specific data is unavailable) (fraction) | | 0.1 |
| TC | Transfer Coefficient (Liquid Residue) (cm$^2$/hr) | Adults | 180,000 |
| | | Children 1 < 2 years old | 49,000 |
| ET | Exposure Time (hours per day) | Adults | 1.5 |
| | | Children 1 < 2 years old | 1.5 |
| BW | Body Weight (kg) | Adults | 80 |
| | | Children 1 < 2 years old | 11 |
| L/WP/WDG = Liquids/Wettable Powders/Water-dispersible Granules | | | |

Post-application Hand-to-Mouth Exposure Algorithm– Physical Activities on Turf

Exposure from hand-to-mouth activity is calculated as follows (based on the algorithm utilized in the SHEDS-Multimedia model):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N\text{-}Replen)})]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm$^2$);
$F_M$ = fraction hand surface area mouthed / event (fraction/event);
$SA_H$ = typical surface area of one hand (cm$^2$);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (*i.e.*, mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:

HR = hand residue loading (mg/cm$^2$);
$Fai_{hands}$ = fraction ai on hands compared to total surface residue from dermal transfer coefficient study (unitless);
DE = dermal exposure (mg); and
$SA_H$ = typical surface area of one hand (cm$^2$).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

| Table 2.1.2: Turf (Physical Activities) – Inputs for Residential Post-application Hand-to-Mouth Exposure Following Ground-Based ULV Adulticide Applications | | |
|---|---|---|
| **Algorithm Notation** | **Exposure Factor (units)** | **Point Estimate(s)** |
| $Fai_{hands}$ | Fraction of ai on hands from dermal transfer coefficient study (unitless) | 0.06 |
| DE | Dermal exposure (mg) | Calculated |
| $SA_H$ | Typical surface area of one hand (cm$^2$), children 1 < 2 years old | 150 |

| Table 2.1.2: Turf (Physical Activities) – Inputs for Residential Post-application Hand-to-Mouth Exposure Following Ground-Based ULV Adulticide Applications | | | |
|---|---|---|---|
| **Algorithm Notation** | **Exposure Factor (units)** | | **Point Estimate(s)** |
| HR | Residue available on the hands ($mg/cm^2$) | | Calculated via (DE * $Fai_{hands}$)/$SA_H$ |
| $F_M$ | Fraction hand surface area mouthed (fraction/event) | | 0.127 |
| N_Replen | Replenishment intervals per hour (intervals/hr) | | 4 |
| ET | Exposure time (hrs/day) | | 1.5 |
| SE | Saliva extraction factor (unitless) | | 0.48 |
| Freq_HtM | Hand-to-mouth events per hour (events/hr) | | 13.9 |
| BW | Body Weight (kg) | Children 1 < 2 years old | 11 |

All algorithm inputs referenced in Tables 2.1.1 and 2.1.2 are defined in the 2012 SOPs: Treated Turf SOP (Section 3.2), except for the ground-based residue deposition fraction (*Dep*) input, described as follows.

*Ground-Based Residue Deposition Fraction (Dep)*

The potential for contact with settled residues following ground-based ULV applications is primarily determined based on the ground-based residue deposition fraction. Previously, the ground-based deposition fraction was informed by a 2013[6] analysis conducted by the Environmental Fate and Effects Division (EFED). The analysis reviewed eight published studies on ground-based ULV applications in which deposition was measured. The studies varied in collection media (*i.e.*, grass clippings and coupons), distance from application or spray head (ranging from 8 to 500 meters), and chemical measured (*i.e.*, fenthion, malathion, naled, and permethrin). Since the 2013 analysis, an additional ground-based deposition study was submitted and has been evaluated by EFED.[7] The resulting malathion study deposition fraction data were incorporated with the data from the other eight deposition studies to result in an off-target deposition rate of 5.2 percent of the application rate (Deposition Fraction = 0.052). This deposition value is recommended to evaluate ground-based ULV applications (*i.e.*, 5.2 percent of the target application rate deposits on turf). The 5.2% ground fraction is used in conjunction with the methods and inputs described in the 2012 Residential SOPs: Treated Turf SOP, for estimation of post-application exposures (dermal and incidental oral) which may occur from indirect deposition on the ground/turf following ground-based ULV adulticide application targeting adult flying insects. The deposition input is used to determine what fraction of the total ground-based ULV adulticide application rate is expected to deposit and be available on turf for transfer to the exposed individual. The nine ground-based deposition studies evaluated measured deposition at a variety of distances; therefore, the recommended deposition fraction has no relationship to distance from application site. Further, this value does <u>not</u> represent the fraction of the deposited residues which may transfer from the turf (as TTR) to the treated individual following

[6] C. Peck, D407817, 3/28/2013; Environmental Fate and Effects Division (EFED) Memo

[7] C. Peck. Malathion Deposition Study: Ground ULV Application. MRID 51048301: Anderson, L. and Bonds, J. 2020. Malathion Deposition Study: From Operational Ground ULV Applications. 3/19/2021.

application ($F$). The value, $F$, is the same as is recommended as an SOP default for liquid formulations, 0.01 (1%) as shown in Table 2.1.1 above. If chemical-specific TTR data are available, these should be considered for use in place of the default Treated Turf SOP, F value.

## 2.2 Post-Application Inhalation Exposure Assessment

Post-application inhalation exposures are expected to occur while conducting outdoor activities following applications of ground-based ULV applications in residential areas. The potential for non-occupational post-application exposures following a ground-based ULV adulticide application is determined by following the principles of the WMB model for determination of potential inhalation exposure[8]. The WMB model is used to model pesticide air concentrations within an enclosed, fixed volume (*i.e.*, a box) over time. It incorporates several simplifying assumptions: fresh air (having no pesticide concentration) enters the box at a constant airflow rate; a turbulent internal airflow thoroughly mixes the fresh air with the pesticide-laden air resulting in a uniform pesticide air concentration within the box; and the perfectly mixed air exits the box at the same constant airflow rate (*i.e.*, the inflow rate equals the outflow rate). Thus, the outdoor area where the adulticide is present is assumed to be in an enclosed box. Using the WMB model is conservative for estimation of exposures for a yard where dissipation in outdoor air is expected to be greater than the enclosed space that the WMB model depicts. The following describes the SOP standard WMB model methods used for estimating inhalation exposures following ground-based ULV adulticide applications:

<u>Post-application Inhalation Exposure Algorithm</u>

The following algorithm is used to determine post-application inhalation exposure to outdoor aerosol space sprays:

$$E = \frac{IR * AR}{Q}$$

where:

E = inhalation exposure (mg/day);
IR = inhalation rate ($m^3$/hour);
AR = application rate (mg ai/day); and
Q = airflow through the treated area ($m^3$/hour).

The airflow through the treated space can be calculated as follows:

$$Q = AV * CF1 * CF2 * A_{cross\text{-}section}$$

where:

Q = airflow through treated space ($m^3$/hr);
AV = air velocity (m/s);
CF1 = time unit conversion factor (60 seconds/1 minute);

[8] 2012 Standard operating Procedures for Residential Pesticide Exposure Assessment – Section 5: Outdoor Fogging/ Misting Systems: https://www.epa.gov/sites/default/files/2015-08/documents/usepa-opp-hed_residential_sops_oct2012.pdf

CF2 = time unit conversion factor (60 minutes / hour); and
$A_{cross\text{-}section}$ = cross-section of outdoor space treated ($m^2$).

Application rate can be calculated as follows:

$$AR = AR_{product} * CF1 * CF2 * CF3 * A_{cross\text{-}section}$$

where:

AR = application rate (mg ai/ day);
$AR_{product}$ = application rate ULV adulticide (lbs ai/acre);
CF1 = weight conversion factor (454 g/lb);
CF2 = area conversion factor (1 acre/43560 $ft^2$);
CF3 = weight conversion factor (1000 mg/g); and
$A_{cross\text{-}section}$ = cross-section of outdoor space treated (400 $ft^2$)[9]

Absorbed inhalation dose normalized to body weight is calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (inhalation); and
BW = body weight (kg).

**Table 2.2.: Ground-Based ULV Adulticide Application –Inputs for Residential Post-application Inhalation Exposure**

| **Algorithm Notation** | **Exposure Factor (units)** | | **Point Estimate(s)** |
|---|---|---|---|
| AR | Application rate (mg ai/ day) | | **[input]** |
| Q | Airflow through treated area ($m^3$/hr) | | 5,400 |
| V | Volume of treated space ($m^3$) | | 90 |
| ET | Exposure time (hrs/day) | | 1.5 |
| IR | Inhalation rate ($m^3$/hour) | Adult | 0.64 |
| | | Children (1 < 2 years old) | 0.33 |
| BW | Body Weight (kg) | Adult | 80 |
| | | Children (1 < 2 years old) | 11 |

[9] Per the 2012 Standard Operating Procedures for Residential Pesticide Exposure Assessment – Section 5: Outdoor Fogging/ Misting Systems: An outdoor living space with dimensions of 20 ft. x 20 ft. x 8 ft. (*i.e.*, 400 $ft^2$ ) is assumed when calculating airborne concentration levels and turf deposition. Across-section represents the cross-sectional area of the volume of treated space for this exposure scenario, with units $m^2$.

## 2.3 Inhalation Risk Quantification

Non-occupational bystander inhalation risks from ground-based ULV applications can be estimated with these WMB-modeled adult and child air concentrations and the human equivalent concentrations (HECs) estimated by the toxicologist specific to the exposure scenario being assessed. The anticipated time spent outdoors on turf by adults and children is 1.5 hours on the day of application only (Section 3; Treated Turf SOP) – there is no expectation that bystanders will be repeatedly exposed to airborne concentrations of adulticides over a period of many days or weeks. Ideally, the selected HEC should reflect this anticipated acute bystander inhalation exposure.[10] Since appropriate acute toxicological inhalation data are rarely available and/or subchronic inhalation studies may not be available, it may be necessary to use an oral point of departure, which may require additional conversion of modeled air concentrations for comparison to oral points of departure. The risk assessor should work with their toxicologist to determine appropriate endpoints based on the toxicological profile of the active ingredient.

Quantification of post-application inhalation margin of exposure (MOE) with use of an HEC is conducted by use of the following formula:

*MOE = Human Equivalent Concentration (mg/m$^3$)/ Time Weighted Average Concentration (mg/m$^3$)*

When an inhalation study is not available for the calculation of an HEC, non-occupational bystander inhalation risks from ground-based ULV applications can also be estimated with these WMB-modeled adult and child air concentrations and a point of departure (POD) selected from an oral study. Quantification of post-application inhalation MOE with use of an oral POD is conducted by use of the following formula:

*MOE = Oral POD (mg/kg/day)/ Absorbed Dose (mg/kg/day)*

## 3.0 Aerial ULV Post-Application Exposure Assessment: Using the AGDISP™ Model

The potential non-occupational exposure following an aerial ULV adulticide application is determined using the AGDISP™ model. The AGDISP™ model was developed by the United States Department of Agriculture (USDA) Forest Service. It is a "first-principles" science-based model that predicts spray drift from application sites. AGDISP™ was designed to optimize agricultural spraying operations and has detailed algorithms for characterizing the release, dispersion, and deposition over and downwind of

[10] An acute inhalation study appropriate for this duration of exposure is rarely conducted. The active ingredient, naled, is an example where a “special” acute inhalation study was designed similar to a subchronic study and included more detailed evaluations of potential systemic and portal of entry (POE) effects following acute exposures. This “special” study was conducted for the express purpose of estimating acute inhalation risks on a single day for an anticipated duration of 2 hours. For most active ingredients, an acute inhalation study of this type will not be available. Further, the acute inhalation 6-pack guideline study is unlikely to be appropriate for assessing bystander exposures since the measured endpoint is lethality and rarely include evaluations of the respiratory tract. Therefore, the HECs selected for non-occupational bystander inhalation risk following aerial ULV mosquito adulticide applications are typically selected from a subchronic inhalation study. Since subchronic inhalation studies are repeat dose studies that are typically conducted for 28 or 90 days with daily exposures of 6 hours for 5 days per week, the use of these studies to establish the bystander inhalation POD is conservative.

the application area. This model was originally created to be used in estimating downwind deposition of spray drift from aerial and ground boom applications. In this case, it is used to estimate deposition from ULV adulticide applications by selecting parameters in the system intended to simulate such applications. The inputs used in AGDISP™ are either pesticide label-specific or defaults based on best professional assumptions or general practice (as described in the stepwise guidance provided below). The critical outputs from the AGDISP™ model for use in the exposure assessment of an adulticide pesticide application include (1) the deposition fraction, or the fraction of the application rate expected to deposit on the ground downwind as a result of an aerial ULV application targeting adult flying insects, and (2) the highest air concentration of the active ingredient at the breathing zone corresponds to the highest deposition following an aerial ULV application.

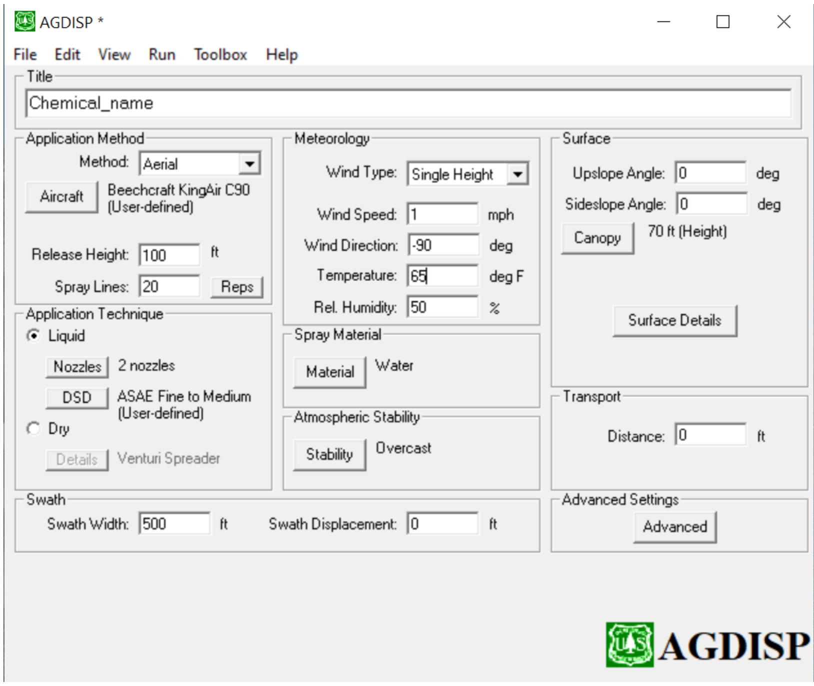
The AGDISP™ model[11] provides an estimation for off-target deposition and air concentrations that can be expected following an application which is the basis for estimating post-application exposures following aerial adulticide applications. These values are based on application parameters from the adulticide product label including application rate, minimum height of release, minimum wind speed, and droplet size needed for efficacy. Table 3.1 presents the inputs and parameters used to define the post-application exposure scenario within AGDISP™ as well as where the information can be found. The model inputs and parameters described in Section 3.1 were derived in consultation with the American Mosquito Control Association (AMCA) and the pesticide industry.

### 3.1 Model Inputs and Parameters

The model and inputs and parameters that are described below are based on the Agency approved version of AGDISP™ Version 8.26. Figure 1 provides a visual illustration of the model and example input parameters. Table 3.1 provides guidance for the specific parameters considered when using the AGDISP™ model to evaluate the potential for exposures from aerial ULV applications. Table 3.1 also identifies the application parameter and whether the input information needed is found on the adulticide product label, a generic application default value (*i.e.*, a generic value used to represent the adulticide application not dependent on product label information), or a model default value (*i.e.*, a default value provided within AGDISP™ that reflects the aerial application method but not specific to adulticide applications).

[11] Model details and availability can be found at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment

**Figure 1. AGDISP™ Version 8.26 User Interface**



| Table 3.1. AGDISP™ Inputs (v8.26): [Chemical] ULV Adulticide Application | | | |
|---|---|---|---|
| **Parameter** | **Input Selection** | **Notes/Comments**[1] | **Risk Assessment Considerations** |
| Application Method | Aerial | Model default | None |
| Aircraft | Beechcraft KingAir C90[4] | Default Input.<br><br>The fixed wing aircraft type must be manually inputted per user defined aircraft properties. If necessary, the helicopter type (Bell 206B JetRanger III) is selected from the model library. | See "Beechcraft KingAir C90 Inputs" section 3.2 below for user defined aircraft properties<br><br>See "Helicopter Assessment" section 3.3 below for whether to evaluate risks from this aircraft type. |
| Release Height | 100 feet minimum release[4] | This information is sometimes provided on the product label. | Typically, the minimum release height ranges from 100 to 300 feet. If the label provides a minimum release height, this should be used for the Tier I evaluation of risk. However, if the label does not specify a minimum release height, a Tier 1 default release height of 100 feet is used. As a Tier II evaluation, release heights of 200 or 300 feet can be considered based on the product labeling or additional information provided by the product registrant specific to the adulticide used.<br><br>If the assessor would like to further refine the risk assessment it is suggested to contact the pesticide re-evaluation division (PRD) to confirm the registrant's intended minimum release height. |
| Spray Lines | 20 Passes | Spray lines varies based on drop size distribution (DSD) and target area. | |
| Application Technique | Liquid | Model default | |
| Application Technique: *Nozzles* | 2 Nozzles; Extent 60 % or Spacing 29.4 ft[4] | Default input | If the product label recommends more than 2 nozzles for aerial applications, the nozzle |

| Table 3.1. AGDISP™ Inputs (v8.26): [Chemical] ULV Adulticide Application | | | |
|---|---|---|---|
| **Parameter** | **Input Selection** | **Notes/Comments[1]** | **Risk Assessment Considerations** |
| | | | configuration can be determined by first entering the number of nozzles. Then the user can estimate the extent or spacing (only one needs to be entered). For example, if 3 nozzles are required, the extent would = 76.3% and spacing = 18.7 feet. |
| Application Technique: *Drop Size Distribution (DSD)* | 1) Select DSD<br><br>2) Select User-defined<br><br>3) Select Parametric<br><br>4) Input label recommended $D_{V0.5}$: X µm<br><br>5) Follow directions provided in Section 3.4 to estimate the relative span input<br><br>6) Uncheck Convert PMS to Malvern<br><br>7) Select Drop Size Distribution (instead of the default Drop Size Classification)<br><br>8) Select no conversion to Malvern Drop Size Distribution | The $D_{v0.5}$ value is provided on the product label.<br><br>The user must estimate the relative span using the directions provided in this SOP and the lower bound ($D_{v0.5}$) and upper bound (e.g., $D_{v0.9}$) droplet size range as provided on product labeling (see Section 3.4). | None |

| Table 3.1. AGDISP™ Inputs (v8.26): [Chemical] ULV Adulticide Application | | | |
|---|---|---|---|
| **Parameter** | **Input Selection** | **Notes/Comments[1]** | **Risk Assessment Considerations** |
| Swath Width | 500 feet[4] | Default input | None |
| Swath Displacement | 0 feet | The model defaults to 0 feet. However, if the spray deposition shows the peak deposition to be at a distance other than 0 feet (*i.e.*, the edge of the application area), the swath displacement should be changed to the horizontal distance from the y-axis where the peak deposition occurs before selecting the air concentration value.<br>[See Section 4.1.1, Swath Displacement Adjustment for Peak Deposition, for an example in the “output” section.] | None |
| Meteorology | Wind type: single height<br>Wind direction: -90 deg | Model default | These inputs ensure that the wind is blowing perpendicular to the application spray line, providing a worst case estimate. |
| | Wind speed: 1 mph | Default input | Minimum wind speed may be found on labels and should be used in place of the default (1 mph) if required. If, in consultation with product registrants, it is determined that there are a range of acceptable wind speeds, these wind speeds can be modeled as a Tier 2 evaluation of risk. |
| | Temperature: 65 F° | Default input based on typical adulticide environmental conditions at dusk/dawn. | None |
| | Relative humidity: 50% | Model default | None |
| Spray Material | 1) Select Material<br><br>2) Enter Name as the product active ingredient | | None |

| Table 3.1. AGDISP™ Inputs (v8.26): [Chemical] ULV Adulticide Application | | | |
|---|---|---|---|
| **Parameter** | **Input Selection** | **Notes/Comments[1]** | **Risk Assessment Considerations** |
| | 3) Check or uncheck Spray Material Evaporates based on whether it is oil (uncheck) or water (check)<br><br>4) Enter the spray volume rate: X (gal/A)<br><br>5) Enter the Active Fraction: X<br>Nonvol Fraction: \ | Uncheck the box for "spray material evaporates" if it is applied neat or mixed with an oil; check the box if it is mixed with water.<br><br>The spray volume rate (gal/A); active fraction; non-vol value are based on the product label.<br><br>[See Section 3.5, Spray Material, on how to calculate each input.] | |
| Atmospheric Stability | Overcast | Model default | None |
| Surface | Upslope angle: 0 deg<br>Sideslope angle: 0 deg | Model default | None |
| | Canopy: None | Default input | While the potential exists for obstructions (e.g., trees, vegetation, and houses) to be present during ULV aircraft applications, HED recommends no canopy. A "no canopy" input ensures that the assessment of post-application exposures is reflective of and protective for applications settling on a grass lawn free from obstructions that may reduce exposure potential. |
| Transport | Distance: 0 feet | Model default | None |

| Table 3.1. AGDISP™ Inputs (v8.26): [Chemical] ULV Adulticide Application | | | |
|---|---|---|---|
| **Parameter** | **Input Selection** | **Notes/Comments[1]** | **Risk Assessment Considerations** |
| Advanced Settings[2] | 1) Select Advanced<br><br>2) Select Default Swath offset, 0 Swath<br><br>3) Calculate Specific Gravity carrier: Oil, Water, or undiluted specific gravity value<br>Specific Gravity active and additive = X<br><br>Evaporation Rate: 84.76 µm²/C°/sec | Default inputs<br><br>See Section 3.6, Specific Gravity, on how to calculate each. | None |

1. Model default – Assumptions as recommended/programmed for use of the AGDISP™ model.
2. Default input - Assumptions that are recommended specific to modeling the application of ULV adulticides. Deviation from "model defaults" are justifiable as required for ULV adulticide applications or if there are specific instructions on the product label.
3. Additional parameters are listed in the Advanced Settings; however, this SOP only recommends adjusting the values described under input selection if need be. The remaining inputs are considered default for the purposes of this assessment.
4. Default value derived through discussions with the American Mosquito Control Association (AMCA).

### 3.2 Beechcraft KingAir C90 Inputs

In consultation with the AMCA and leaders in the mosquitocide industry, HED has determined that the AGDISP™ model default fixed wing aircraft type, Air Tractor AT-401, is not the predominant aircraft model for ULV adulticide applications. The Beechcraft KingAir C90 was recommended by the AMCA and the mosquitocide industry as the default since the majority of these applications are now made with this aircraft type and the aircraft type results in more protective modeling outputs. However, the Beechcraft KingAir C90 is not included in the AGDISP™ library, therefore its properties must be inputted for modeling purposes. The aircraft properties presented in Table 3.2 should be used to model deposition and air concentrations following ULV adulticide applications with the Beechcraft KingAir C90.

**Table 3.2. Beechcraft KingAir C90 Aircraft Property Inputs**

| Property | Input |
|---|---|
| Type | User Defined |
| Semispan* (ft) | 25.1 |
| Weight (lbs) | 9,000 |
| Typ. Speed (mph) | 170 |
| Propeller RPM | 2,000 |
| Prop Radius (ft) | 3.9 |
| Biplane Sep* (ft) | 0 |
| Planform Area* ($ft^2$) | 294 |
| Engines | 2 |
| Engine Vert.* (ft) | 1 |
| Engine Forward* (ft) | 15/ 6.4 |
| Engine Horizontal* (ft) | 0 |
| Wing Vert* (ft) | 1.51 |
| Boom Vert* (ft) | -1 |
| Boom Fwd* (ft) | -0.8333 |

Acronyms/Abbreviations - RPM = Revolution Per Minute, Prop = Propeller, Sep = Separation, Vert = Vertical, Fwd = Forward
* Definitions can be found in the Glossary of this SOP.

### 3.3 Helicopter Application Assessment

Aerial applications of ULV adulticides are most commonly applied by fixed wing aircraft (*i.e.*, airplanes) but depending on the product label, may also be applied with helicopters. Helicopters are commonly used for areas which are more difficult to treat such as barrier islands. If the product label allows for both fixed-wing aircraft or helicopter applications, a helicopter assessment may not always need to be conducted. HED has conducted sensitivity analyses to evaluate the differences in deposition and 1-hour average air concentrations between fixed-wing aircraft and helicopters. The results of the sensitivity analyses indicate that fixed-wing aircraft result in the potential for higher exposures to adulticide applications. Therefore, if the modeling of deposition and 1-hour average air concentration for fixed-wing aircraft does not result in risks of concern, then the modeling results for fixed-wing aircrafts are protective for helicopter applications and modeling of the helicopter application is not required. If the fixed-wing aircraft modeling results in risks of concern, the modeling of the helicopter application is necessary. Table 3.3 presents the parameters used to define the helicopter scenario within AGDISP™. Modeling input parameters for spray lines, application technique, swath width, swatch displacement, meteorology, spray material, atmospheric stability, surface, transport, and advanced settings are the same as those for fixed-wing aircraft.

| Table 3.3. AGDISP™ Inputs (v8.26): [Chemical] ULV Adulticide Application (Helicopter) | | | |
|---|---|---|---|
| **Parameter** | **Input Selection** | **Notes/Comments[1]** | **Risk Assessment Considerations** |
| Aircraft | Bell 206B JetRanger III[2] (choose user-defined to alter aircraft inputs) | User-defined inputs:<br><br>Type: Helicopter<br>Rotor radius: 16.7 ft<br>Weight: 2880 lbs<br>Typ. Speed: 105 mph<br>Rotor RPM: 384<br>Boom vert: -9 ft<br>Boom fwd: 0 ft | AGDISP™ includes a default Bell 206B JetRanger III in the Aircraft Type library. The default parameters will result in lower deposition and 1-hour average air concentrations, compared to the User-Defined inputs provided by the mosquito control industry. |
| Release Height | 80 feet minimum release[2] | This information is sometimes provided on the product label. | Helicopters are capable of much lower release heights. The default height of 80 ft is typically used for treating small areas (barrier islands).[2] Unless the label specifies a higher release height, the use of 80 ft will be a conservative assumption. |

1: All other AGDISP™ inputs for helicopter are the same as those for fixed-wing aircraft (spray lines, application technique, SW, SD, meteorology, spray material, atmospheric stability, surface, transport, advanced settings).
2: Default value derived through discussions with the American Mosquito Control Association (AMCA).

### 3.4 Droplet Size Distribution/Relative Span

For adulticide control operators to maximize insecticidal efficacy, the ULV adulticide product label will provide details on the required droplet size distribution (*i.e.*, the range of diameters of spray particles) for aerial applications. For example, a product label for Chemical X may instruct users to calibrate their spray nozzles and outputs such that the diameter of 50% of the spray droplets is less than 60 microns and the diameter of 90% of the spray droplets is less than 115 microns. This is described on the product labeling as DV0.5 < 60 µm and DV0.9 < 115 µm. To represent this droplet size distribution in AGDISP™, the relative span (a parameter representing the breadth of the drop size distribution), may be calculated using the equation $Dv_{0.9}$-$Dv_{0.1}$/$Dv_{0.5}$ or by adjusting relative span in AGDISP™ until the required droplet size distribution is represented in the model.

If the DV0.1 value is not provided on the product label, then the relative span must be determined. Using the Parametric Drop Size Distribution model (see Figure 2), the relative span must be adjusted to match label droplet distribution criteria. For the example given, the user would input the labeled DV0.5 of 60 µm, and then repeatedly enter and adjust the relative span until the DV0.9 of the droplet size distribution diameter matches the labeled value, 115 µm. In the example provided in the paragraph above, a relative span input of 1.5 results in a droplet size distribution of DV0.5 ≈ 60 um and DV0.9 ≈ 115 um, which matches label requirements. This will be represented in the Average Diameter and Cumulative Volume Fraction columns (see Figure 3). If volume median diameter (DV values) are not provided for the relative span calculation, the user can start with a relative span of 1.5 and adjust either up or down until the DV 0.9 and DV 0.5 range are within product label recommendations.

**Figure 2. Adjustment of Relative Span to Match Label Droplet Size Distribution**

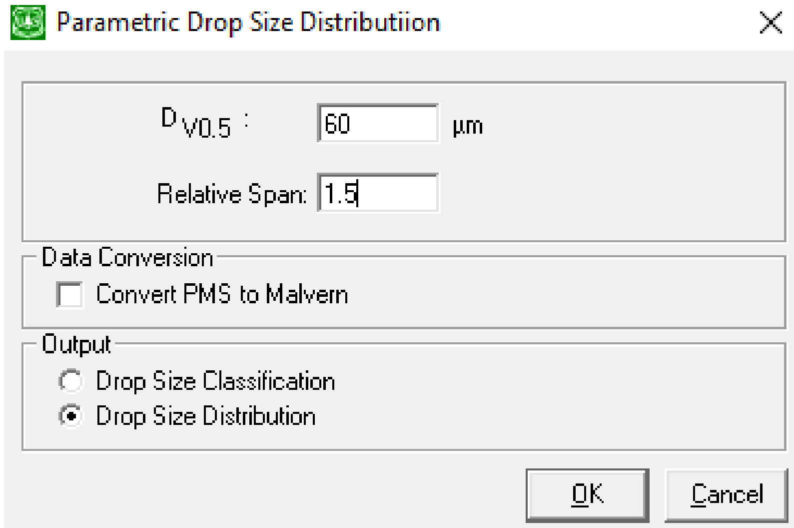
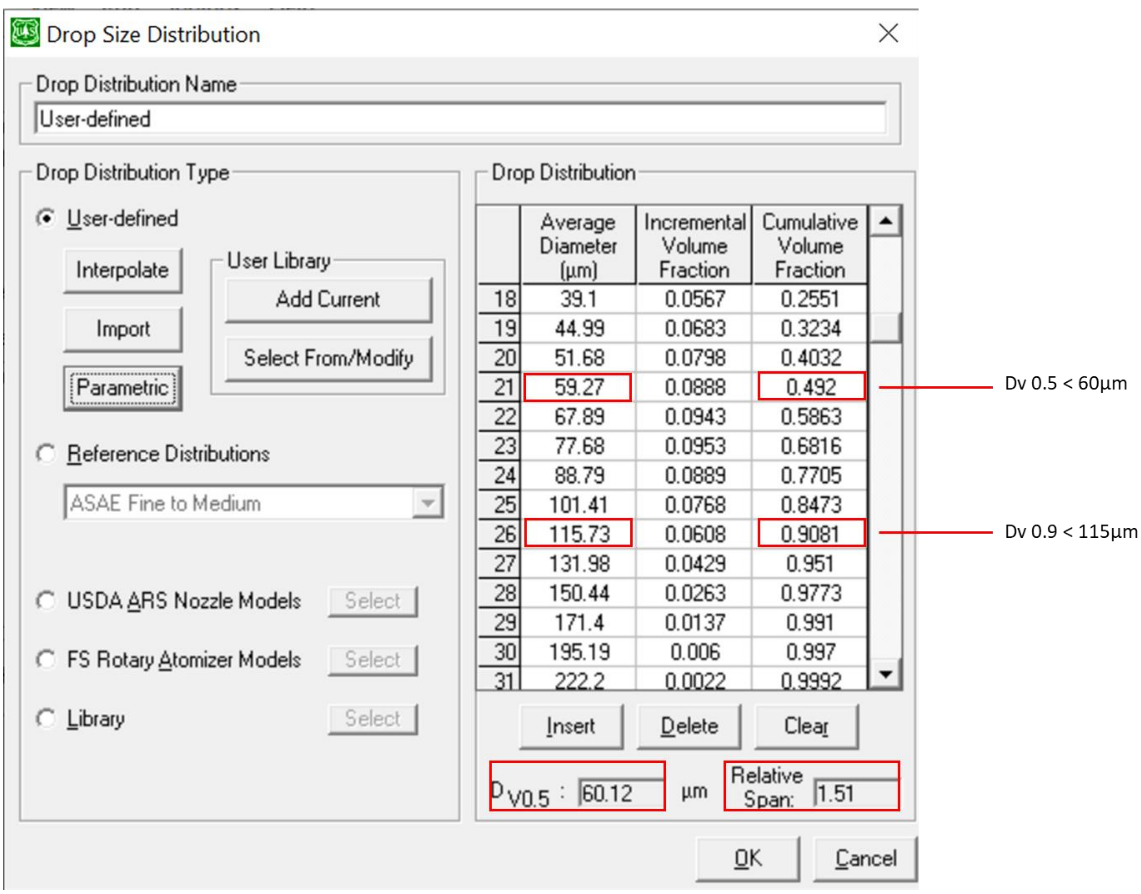
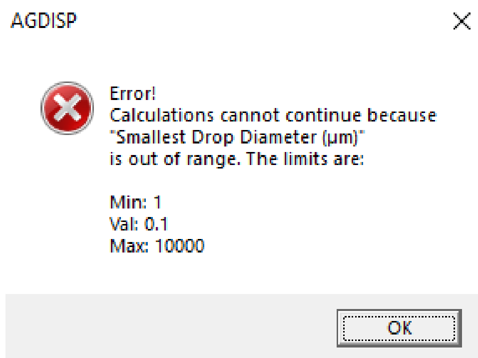



**Figure 3. AGDISP™ Version 8.26 Drop Size Distribution Interface**




Note: To prevent the AGDISP™ model from producing an error message when runs are conducted (see Figure 4), check to ensure that the droplet size distribution (see Figure 3), contains values only within the model's allowable range. In order for the model to run the calculations, the smallest DSD must have a minimum value of 1.00 and a maximum value of 10,000. To alleviate the error prior to running the model, right click and delete any row(s) in the drop distribution menu < 1.00 and > 10,000. This correction should then allow the model to run without error.

**Figure 4. AGDISP™ Version 8.26 Drop Size Distribution Error Correction**

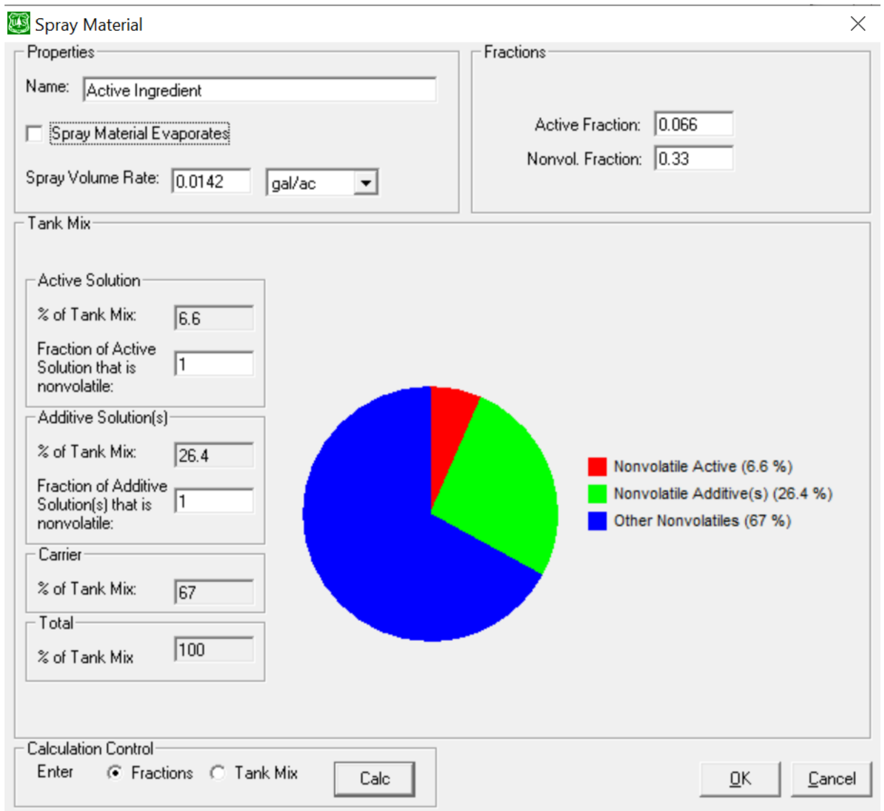



### 3.5. Spray Material

The spray material inputs for AGDISP™ are specific to the adulticide product under consideration. The Spray Volume and Active and Nonvol Fractions are determined and calculated based on whether the product is diluted or undiluted prior to application and based on the product label instructions for number of gallons of spray to be applied over an acre. Figure 5 provides a visual illustration of the Spray Material parameters screen within AGDISP™ and example input parameters as derived from the product application rate and calculated using the methods described in Table 3.1. Tables 3.5.1 and 3.5.2 provide examples of these calculations. The Spray Volume Rate and Nonvol Fractions can also be determined with use of these same calculations.

For Figure 5, the example adulticide product is assumed to be applied neat (applied undiluted) and does not evaporate. Typically, ULV adulticide products are formulated in a manner which inhibits spray material evaporation and increases the stability of active ingredient. Ideally, the applied droplets are small enough to remain aloft but do not evaporate such that they reduce in size and inhibit the ability of the droplet to impact targeted flying insects. Therefore, if the product is oil-based, it is recommended that the "Spray Material Evaporates" box be unchecked. However, not all adulticide products are oil-based; some adulticide products are water-based and will evaporate. In the case that an adulticide is water-based, the "Spray Material Evaporates" box should be checked before running the model.

**Figure 5. AGDISP™ Version 8.26 Spray Material User Interface**




| **Table 3.5.1. AGDISP™ Inputs (v8.26): Spray Material Inputs and Calculations** | | |
|---|---|---|
| **% ai**[1] | Determined by the product label | |
| **lbs ai/ gallon product**[1] | Determined by the product label | |
| **lb ai/acre**[1] | Application rate determined by the product label | |
| **Diluted or undiluted**[1] | Determined by the product label | |
| **Dilution Factor**[1] | Determined by the product label (1:x) | $= (1\ part\ product + X\ parts\ water\ or\ oil)$ (*i.e.*, 1:1 dilution = 2 dilution factor) |
| **Spray volume (gal finished spray/A)**[2] | Calculated based on the application rate (lbs ai/acre) and lbs ai/gallon of product, adjusted by the dilution factor | $= \frac{(\frac{lbs\ ai}{acre})}{(\frac{lbs\ ai}{gallon\ product})} \times dilution\ factor$ |
| **Nonvol Fraction**[2] | Determined based on the dilution fraction | $= \frac{1}{Dilution\ factor}$ |
| **Active Fraction**[2] | Calculated based on the %ai and nonvol fraction | $= \left(\frac{\%ai}{100}\right) \times nonvol\ fraction$ |

1. These values and label information help with calculating the inputs for the spray material parameters.
2. These calculations are direct inputs for the information used to complete the spray material parameters (See Figure 3.1 above).

| Table 3.5.2. AGDISP™ Inputs (v8.26): Example Spray Material Inputs and Calculations | | | | |
|---|---|---|---|---|
| **% ai** | 20 | 20 | 20 | 20 |
| **lbs ai/ gallon product** | 1.48 | 1.48 | 1.48 | 1.48 |
| **lb ai/acre (application rate)** | 0.0070 | 0.0070 | 0.0070 | 0.0070 |
| **Diluted or undiluted** | undiluted | diluted 1:1 | diluted 1:2 | diluted 1:4.5 |
| **Spray volume (gal finished spray/A)** | $= \frac{0.0070}{1.48} \times 1$ <br> $= 0.0047$ | $= \frac{0.0070}{1.48} \times 2$ <br> $= 0.0095$ | $= \frac{0.0070}{1.48} \times 3$ <br> $= 0.014$ | $= \frac{0.0070}{1.48} \times 5.5$ <br> $= 0.026$ |
| **Nonvol Fraction[1]** | $1 = \frac{1}{1}$ | $0.5 = \frac{1}{2}$ | $0.33 = \frac{1}{3}$ | $0.18 = \frac{1}{5.5}$ |
| **Active Fraction** | $= \left(\frac{20}{100}\right) \times 1$ <br> $= 0.20$ | $= \left(\frac{20}{100}\right) \times 0.5$ <br> $= 0.1$ | $= \left(\frac{20}{100}\right) \times 0.33$ <br> $= 0.067$ | $= \left(\frac{20}{100}\right) \times 0.18$ <br> $= 0.036$ |

1. The model will not allow a Nonvol Fraction of “1”. If the user receives an error, replace “1” with “0.99”

### 3.6 Specific Gravity

The Specific Gravity input for the product is located under the Advanced Settings segment of the AGDISP™ model. Specific gravity of a substance is the ratio of the density of the substance to the density of water. The “Specific Gravity (Carrier)” input reflects the specific gravity of the solvent or diluent. In most cases for ULV adulticides, this is an oil-based formulation. In the case of an application spray being undiluted, the specific gravity is reflective of the specific gravity of the product (Active and Additive). The specific gravity can be located on the chemical product’s confidential statement of formulation (CSF) found in the Office of Pesticide Programs Information Network (OPPIN) or by searching online for the product’s most recent safety data sheet (SDS) using the product name and/or EPA Registration Number. The specific gravity is typically located in the physical and chemical properties section of the SDS. If specific gravity is not provided in the SDS or cannot be located in OPPIN, the user can determine this using specific gravity calculations below.

“Specific Gravity (Active and Additive)” is calculated based on the density of the product (lbs ai/ gallons of product) divided by the active fraction of the product (%ai/100) then further divided by the density of water (8.34 lb/gal). [Note: Although the example above in Table 3.5.2 shows that the active fraction changes as the product is further diluted for spray application, the “Specific Gravity (Active and Additive)” is based solely on the undiluted product].

| Table 3.6. AGDISP™ Inputs (v8.26): Specific Gravity Calculations | |
|---|---|
| Specific Gravity (Carrier = Water) | 1 |
| Specific Gravity (Carrier = Oil) | 0.8 |
| Specific Gravity (No Carrier/Undiluted) and/or <br> Specific Gravity (Active and Additive) | $= (\frac{lbs\ ai}{gallon\ of\ product}) \div (\%ai) \div (8.34\ lb/gal)$ |

| Table 3.6. AGDISP™ Inputs (v8.26): Specific Gravity Calculations |
| --- |
| Using the example in Table 3.5.2 above for Chemical X with a water carrier the equation would look as follows: |
| 0.89= $\left(\frac{1.48\ lbs\ ai}{gallon\ of\ product}\right) \div (0.2) \div (8.34\ lb/gal)$ |

## 4.0 Aerial ULV Post-Application Exposure Assessment: Running the AGDISP™ Model

### 4.1 Modeling Peak Deposition

Once all the inputs for AGDISP™ have been determined or calculated, and inserted, the model can be run.

- Select File then Save the model run
- Select "Run"→ "Run Calculations"

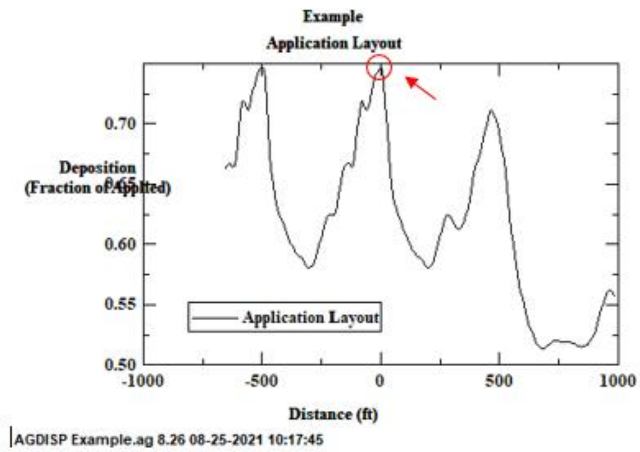
| Note: When the AGDISP™ model is preparing to run the calculations, it often indicates the inputs or parameters defined by the user are outside of the range or capability of the model. This is normal and the user should, after reviewing the warnings, accept them, even if there are multiple, to allow the modeling to proceed. |
| --- |

Once an AGDISP™ model run has been completed, the deposition fraction and air concentration can be determined from the outputs. The user should then determine whether the peak deposition is occurring at the edge of the residential application area (*i.e.*, 0 feet) or at some other distance. It is necessary to model deposition such that the peak occurs at the 0 ft distance so that the model will provide a complementary 1-hour average air concentration output representative of the maximum for the product and aerial application aircraft and inputs modeled (see 4.1.1 Swath Displacement Adjustment for Peak Deposition). The following provides directions for viewing graphical representations of deposition output from the AGDISP™ model.

- Select "View"→ "Application Layout" to see a graphical representation of the deposition pattern

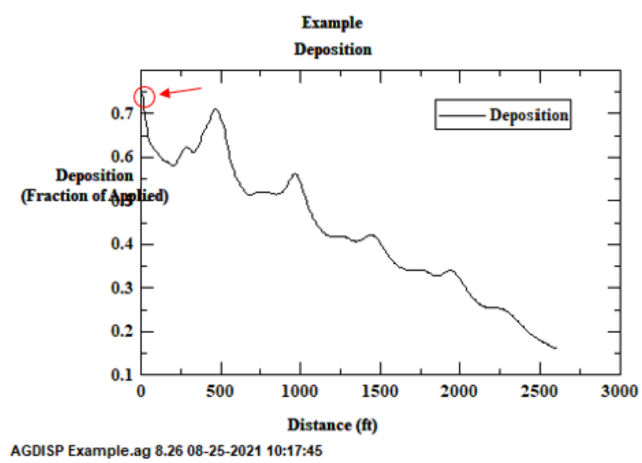
If the peak "Deposition" on the Y-axis occurs at the 0 ft distance on the X-axis, no adjustments need to be made to the above inputs (see Figures 6 and 7). If the graph does not show the peak "Deposition" value occurring at the 0 ft distance on the horizontal X- axis, see Section 4.1.1, Swath Displacement Adjustment for Peak Deposition.

**Figure 6. AGDISP™ Version 8.26 Graphical Representation: Application Layout**




- Select "View"→ "Deposition" to see a graphical representation of the peak deposition fraction.

**Figure 7. AGDISP™ Version 8.26 Graphical Representation: Deposition**




Modeled deposition outputs at different distances can be evaluated in AGDISP™ by viewing the "Application Layout" model export using the following steps:

- For numerical outputs, select "File"→ "Export"→ and check "Application Layout"→ "OK"
- Deposition values are on the right column in the exported .txt file. Peak deposition will be the highest value (shown in bold).

| Distance (ft)<br>X axis | Deposition<br>(unitless fraction)<br>Y axis |
|---|---|
| **0** | **0.746852** |
| 6.5616 | 0.7451532 |
| 13.1232 | 0.7356942 |

| | |
|---|---|
| 19.6848 | 0.7177281 |
| 26.2464 | 0.6959437 |
| 32.808 | 0.6761076 |
| 39.3696 | 0.6607766 |
| 45.9312 | 0.6495197 |

1. The model may output a deposition value greater than 100%. This can occur as applied residues drift and incrementally deposit following multiple fixed-wing aircraft passes within the treatment area.

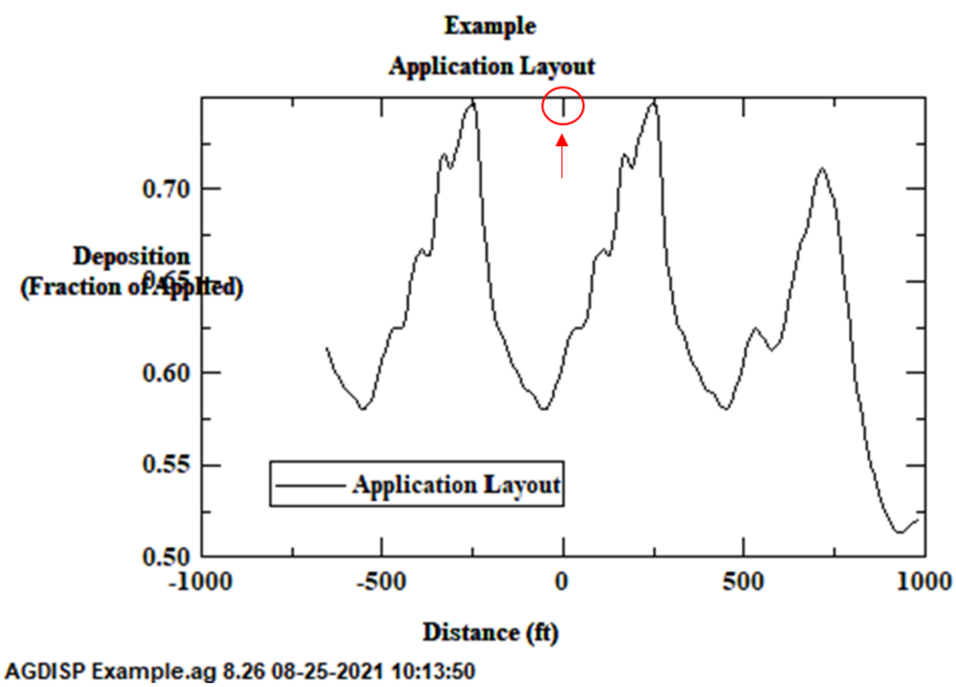
In the example of the table above, peak deposition of 0.746852 (*i.e.*, 75% of the application rate) occurs at 0 feet.

### 4.1.1 Swath Displacement Adjustment for Peak Deposition

The swath displacement input is critical in estimation of both peak deposition and 1-hour average air concentration. If the “Application Layout” graphical view does not show peak deposition occurring at the 0 ft distance mark (see Figure 8, below), it is necessary that the user adjust the “Swath Displacement” input in AGDISP™ to ensure that the maximum air concentration is identified. The example below shows the deposition fraction of 0.746852 occuring at distances other than “0 ft.” Because of this, the distance (X-axis) for the highest deposition fraction must be inputted into the swath displacement. After adjusting the swath displacement and then re-running and re-saving the model run, the peak deposition of 0.746852 will be graphically represented at 0 ft. The user can then rely on the 1-hour average air concentration value to be used for risk assessment.

The following example illustrates how to adjust swath displacement so that the peak deposition occurs at the 0 ft distance mark. In **Figure 8.**, the application layout’s graphical representation is not depicting peak deposition occurring at 0 ft. Because of this, the swatch displacement input must be adjusted. It is important to note that peak deposition can occur at more than one distance (ft) on the X-axis, as shown in **Figure 8**. The user can choose either distance from the highest deposition fraction for adjusting swatch displacement (*i.e.*, -249.3408 ft or 249.3408 ft), and the resulting 1-hour average air concentration values will be identical. Use the following directions to correctly determine the value for swath displacement:

**Figure 8. AGDISP™ Version 8.26 Application Layout Graphical Representation: Before Adjusting for Swath Displacement**




1. For numerical outputs, select "File"→ "Export"→ and check "Application Layout"→ "OK"
2. Scroll until the highest (peak) deposition in the right column (shown below) is identified. The user may have to scroll down in the output text file to find the peak deposition value.
3. Select the distance associated with the peak deposition and input this distance value (left column) into the swath displacement input window in AGDISP™. Note: This distance may be represented as either a positive or negative number. The user should select the distance value corresponding to the highest deposition, whether it be a positive or negative value. However, if the values are equivalent in either direction, it is recommended to use the positive value for simplicity.
4. Once the peak deposition value can be seen occurring at or close to 0 ft, the user can rely on that run for both the deposition fraction and the air concentration.

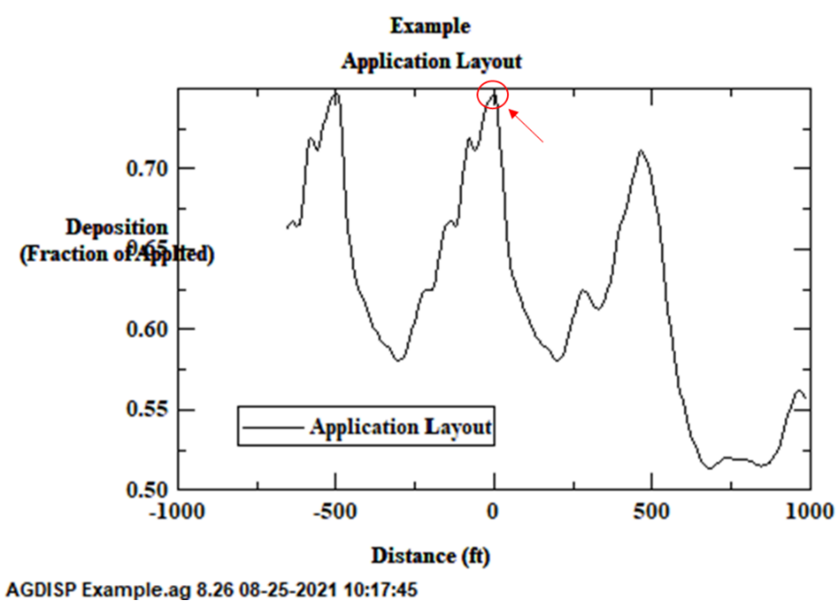
| Distance (ft) X axis | Deposition Y axis |
|---|---|
| 229.656 | 0.740643 |
| 236.2176 | 0.7429743 |
| 242.7792 | 0.745122 |
| **249.3408** | **0.746852** |
| 255.9024 | 0.7451532 |
| 262.464 | 0.7356942 |
| 269.0256 | 0.7177281 |
| 275.5872 | 0.6959437 |
| 282.1488 | 0.6761076 |

In this example output above, the peak deposition (0.747852) occurs at approximately 249.3 ft. For the peak deposition mark to occur at 0 ft, the “Swath Displacement” value should be adjusted from 0 to an input of 249.3 (add 249.3 into the input box for “Swath Displacement” in AGDISP$^{TM}$). After re-running and re-saving the model run, the peak deposition of 0.746852 will be graphically represented at 0 ft.

Once the peak deposition value occurs at or close to 0 ft, the user can rely on that run for estimates of both the deposition fraction and the 1-hour average air concentration. Figure 9 presents the graphical representation of the application layout output results after adjusting the swath width to achieve peak deposition at 0 ft.

| Distance (ft) X axis | Deposition Y axis |
|---|---|
| **0** | **0.746852** |
| 6.5616 | 0.7451532 |
| 13.1232 | 0.7356942 |
| 19.6848 | 0.7177281 |
| 26.2464 | 0.6959437 |
| 32.808 | 0.6761076 |
| 39.3696 | 0.6607766 |
| 45.9312 | 0.6495197 |

**Figure 9. AGDISP™ Version 8.26 Application Layout Graphical Representation: After Adjusting for Swath Displacement**



### 4.1.2 Post-Application Dermal and Non-Dietary Ingestion Exposure Assessment

Post-application exposures are expected to occur from activities on turf following aerial ULV adulticide applications in residential areas. Dermal and non-dietary ingestion (hand-to-mouth) exposure pathways are expected to result from contact with residues deposited on turf.

Once the highest estimated deposition fraction from AGDISP™ is determined, it is used in conjunction with the standard methods used for estimating potential dermal and hand-to-mouth doses among adults and children 1 to <2 years old as described in the 2012 Residential SOPs: Treated Turf SOP and presented below.[12] Indirect deposition on the ground/turf can occur following an aerial ULV adulticide application targeting adult flying insects. The deposition output (Dep) is used to determine what fraction of the total aerial ULV adulticide application rate is expected to deposit and be available on turf for transfer to the exposed individual. This value does <u>not</u> represent the fraction of residues which may transfer from the turf to the treated individual. This value, F, the fraction of deposited residue that is transferable residue following application, is the same as is recommended as an SOP default for liquid formulations, 0.01 (1%). If chemical-specific TTR data are available, these should be considered for usage in place of the default SOP "F" value.

The following presents the standard methods used to estimate dermal and hand-to-mouth doses following aerial ULV applications:

<u>Post-application Dermal Exposure Algorithm – Physical Activities on Turf</u>
Exposure resulting from contacting previously treated turf while performing physical activities is calculated as shown below. Residential post-application exposure assessment must include calculation of exposure on the day of application. Therefore, though an assessment can present exposures for any day "t" following the application, it must include "day 0" exposure.

$$E = TTR_t * CF1 * TC * ET$$

where:

E = exposure (mg/day);
$TTR_t$ = turf transferable residue on day t (µg/cm$^2$);
CF1 = weight unit conversion factor (0.001 mg/µg);
TC = transfer coefficient (cm$^2$/hr); and
ET = exposure time (hr/day).

If chemical-specific TTR data are available, then surface residues from the day of application should be used (assume that individuals could be exposed to residues immediately after application). However, if data are not available, then $TTR_t$ can be calculated using the following formula:

$$TTR_t = (AR * F * (1-FD)_t * CF2 * CF3) * Dep$$

[12] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

where:

$TTR_t$ = turf transferable residue on day t (µg/cm$^2$);
AR = application rate (lbs ai/ft$^2$ or lb ai/acre);
F = fraction of ai as transferable residue following application (unitless);
FD = fraction of residue that dissipates daily (unitless);
t = post-application day on which exposure is being assessed;
CF2 = weight unit conversion factor (4.54 x 10$^8$ µg/lb);
CF3 = area unit conversion factor (1.08 x 10$^{-3}$ ft$^2$/ cm$^2$ or 2.47 x 10$^{-8}$ acre/cm$^2$);
Dep = deposition fraction (unitless).

Dermal absorbed doses are calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (dermal); and
BW = body weight (kg).

| Table 4.1.2.1: Turf (Physical Activities) -- Inputs for Residential Post-application Dermal Exposure Following Aerial ULV Adulticide Applications | | | |
|---|---|---|---|
| **Algorithm Notation** | **Exposure Factor (units)** | | **Point Estimate(s)** |
| AR | Application rate (mass active ingredient per unit area) | | **[input]** |
| Dep | AGDISP™ Modeled Deposition Fraction (fraction of active ingredient applied deposited on residential turf) | | **X** |
| F | Fraction of AR (liquid formulation) as TTR following application (if chemical-specific data is unavailable) | | 0.01 |
| $F_D$ | Daily residue dissipation (if chemical-specific data is unavailable) (fraction) | | 0.1 |
| TC | Transfer Coefficient (Liquid Residue) (cm$^2$/hr) | Adults | 180,000 |
| | | Children 1 < 2 years old | 49,000 |
| ET | Exposure Time (hours per day) | Adults | 1.5 |
| | | Children 1 < 2 years old | 1.5 |
| BW | Body Weight (kg) | Adults | 80 |
| | | Children 1 < 2 years old | 11 |
| L/WP/WDG = Liquids/Wettable Powders/Water-dispersible Granules | | | |

Post-application Hand-to-Mouth Exposure Algorithm– Physical Activities on Turf

Exposure from hand-to-mouth activity is calculated as follows (based on the algorithm utilized in the SHEDS-Multimedia model):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N\text{-}Replen)})]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm$^2$);
FM = fraction hand surface area mouthed / event (fraction/event);
SAH = typical surface area of one hand (cm$^2$);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (*i.e.*, mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:

HR = hand residue loading (mg/cm$^2$);
$Fai_{hands}$ = fraction ai on hands compared to total surface residue from dermal transfer coefficient study (unitless);
DE = dermal exposure (mg); and
$SA_H$ = typical surface area of one hand (cm$^2$).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:
D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

| **Table 4.1.2.2: Turf (Physical Activities) – Inputs for Residential Post-application Hand-to-Mouth Exposure Following Aerial ULV Adulticide Applications** | | |
|---|---|---|
| **Algorithm Notation** | **Exposure Factor (units)** | **Point Estimate(s)** |
| $Fai_{hands}$ | Fraction of ai on hands from dermal transfer coefficient study (unitless) | 0.06 |
| DE | Dermal exposure (mg) | Calculated |
| $SA_H$ | Typical surface area of one hand (cm$^2$), children 1 < 2 years old | 150 |

| Table 4.1.2.2: Turf (Physical Activities) – Inputs for Residential Post-application Hand-to-Mouth Exposure Following Aerial ULV Adulticide Applications | | | |
|---|---|---|---|
| **Algorithm Notation** | **Exposure Factor (units)** | | **Point Estimate(s)** |
| HR | Residue available on the hands ($mg/cm^2$) | | Calculated via (DE * $Fai_{hands}$)/$SA_H$ |
| $F_M$ | Fraction hand surface area mouthed (fraction/event) | | 0.127 |
| N_Replen | Replenishment intervals per hour (intervals/hr) | | 4 |
| ET | Exposure time (hrs/day) | | 1.5 |
| SE | Saliva extraction factor (unitless) | | 0.48 |
| Freq_HtM | Hand-to-mouth events per hour (events/hr) | | 13.9 |
| BW | Body Weight (kg) | Children 1 < 2 years old | 11 |

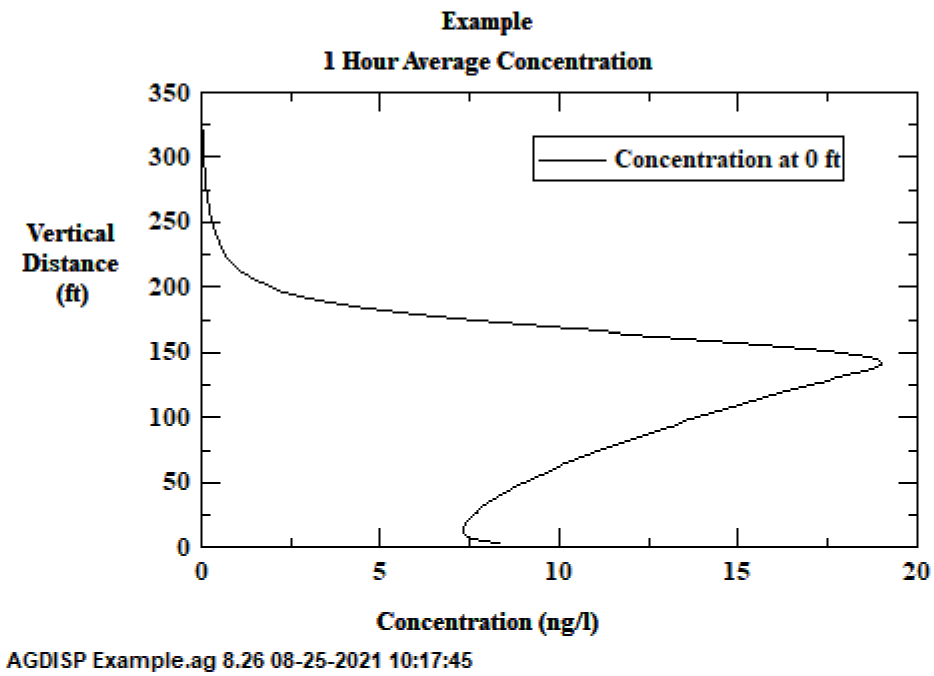
All algorithm inputs referenced in Tables 4.1.2.1 and 4.1.2.2 are defined in the 2012 SOPs: Treated Turf SOP (Section 3.2) except for the aerial ULV residue deposition fraction (*Dep*) input as estimated using AGDISP$^{TM}$.

### 4.2 Determining 1-Hour Average Air Concentration

Once the highest estimated deposition fraction from AGDISP$^{TM}$ is determined, the 1-hour average air concentration can be viewed. This output allows for estimating potential inhalation exposures to both adults and children following ULV adulticide applications. The following step is used to view a graphical representation of the estimated 1-hour average air concentration. Figure 10 presents the graphical representation of 1-hour average air concentration from AGDISP$^{TM}$ modeling.

- Select "View"→ "1-Hour Average Concentration" to see a graphical representation of the air concentration.

**Figure 10. AGDISP™ Version 8.26 Graphical Representation: 1-Hour Average Air Concentration**




In the example shown in Figure 10, the 1-hour average air concentration can be seen to fluctuate as residues settle to the ground. The 1-hour average air concentrations of concern for risk quantitation range from 3 to 6 feet. These concentrations can be difficult to estimate with use of the graphical output alone and can be viewed as an exported ".txt" file for determination of the modeled air concentration values. The following should be used to view the 1-hour average concentration export file.

- For numerical outputs, select "File"→ "Export"→ and check "1-hour Average Concentration"→ "OK"
- Save exported file to view

| Concentration (ng/l) X-axis | Vertical distance (ft) Y-axis | |
|---|---|---|
| 2.080899 | 2.224989 | |
| 2.034909 | 3.337484 | ← Child breathing height (3 ft) |
| 2.0401 | 4.449979 | |
| 2.067568 | 5.562473 | |
| 2.106068 | 6.674968 | ← Adult breathing height (6 ft) |
| 2.150297 | 7.787463 | |
| 2.197544 | 8.899958 | |
| 2.246435 | 10.01245 | |

For the assessment of inhalation risks following aerial ULV adulticide applications, adult breathing height is considered 6 feet and child breathing height is 3 feet (see adult and child breathing heights and corresponding concentrations as shown in the image above). Select the air concentration, which is the closest to either the 3-, or 6-foot height for child and adult breathing height, respectively. Keep in mind the air concentration values calculated within AGDISP™ are provided in units, ng/L, and, therefore, the output units must be converted.

### 4.2.1 Use the Estimated 1-Hour Average Air Concentration to Quantify Inhalation Risks

Non-occupational bystander inhalation risks can be estimated with use of the modeled adult and child 1-hour average air concentrations and the human equivalent concentrations (HECs) estimated by the toxicologist specific to the exposure scenario being assessed. The anticipated time spent outdoors on turf by adults and children is 1.5 hours on the day of application only (Section 3; Treated Turf SOP) – there is no expectation that bystanders will be repeatedly exposed to airborne concentrations of adulticides over a period of many days or weeks. Ideally, the HEC should be calculated in a manner such that the anticipated acute bystander inhalation exposure duration would match the duration of the study used as the basis for the toxicological endpoint. Since appropriate acute toxicological inhalation data are rarely available and/or subchronic inhalation studies may not be available, it may be necessary to use an oral point of departure, which may require additional conversion of modeled air concentrations for comparison to oral points of departure. The risk assessor should work with their toxicologist to determine appropriate endpoints based on the toxicological profile of the active ingredient.

Quantification of post-application inhalation margins of exposure (MOEs) following aerial ULV adulticide applications is conducted by use of the following formula:

*MOE = Human Equivalent Concentration (mg/m³)/ AGDISP™ 1-Hour Average Concentration (mg/m³)*

## 5.0 Glossary

**Active Rate**: The mass of the active ingredient applied over a given area mixed into a finished spray.

**Aircraft type**: In AGDISP™, one of two aircraft types may be selected: either fixed-wing aircraft or helicopter. Both models contain databases generated by the Spray Drift Task Force and the Foresty Service containing properties for a number of different aircraft used in pesticide applications.

**Biplane Separation:** Vertical distance separating two wings in a biplane.

**Boom Forward**: horizontal distance ahead of the trailing edge of the wing to the spray boom, measured positive forward from the wing and thus typically a negative number.

**Boom Vertical**: vertical distance above the trailing edge of the wing to the spray boom, measured positive upward from the wing and thus typically a negative number.

**Canopy**: A description of the canopy, available in regular mode in AGDISP™. Inputs include Canopy Name, Canopy Type (None, Basic, Story, and Optical), Canopy Properties, Properties, and Preview. Under Canopy Type, None removes the canopy type. Basic type enters only Canopy Height. For Story and Optical canopy types the user enters the Canopy Element Size, Temperature, and Relative Humidity. For Story type the user enters Stand Density and describes the canopy by Tree Height (in feet or meters), Tree Diameter (in feet or meters), and Probability of Penetration (0 to 1). For Optical type the user may select from an Optical Tree Library, then modify Tree Height and LAI, or describe the canopy by Tree Height (in feet or meters) and Cumulative LAI.

**Carrier type**: The material used to dilute a formulated product to a finished spray material.

**Drop size distribution**: The range of diameters of spray particles, as defined by the American Society of Agricultural Engineers (ASAE), which can be altered through variable nozzles and spray pressure. The ASAE recently changed its name to American Society of Agricultural and Biological Engineers (ASABE).
**$D_{v0.5}$**: The drop diameter (in microns) at which 50 percent of the spray volume is in drops smaller than this value, and 50 percent is in drops larger than this value.

**Engine Forward**: horizontal location of the aircraft engine propeller relative to the trailing edge of the wing, measured positive forward and thus typically a positive distance.

**Engine Horizontal**: horizontal location of the aircraft engine centerline, relative to the centerline of the aircraft, measured positive to the right of the pilot and thus zero or a positive distance.

**Engine Vertical**: vertical location of the aircraft engine centerline relative to the trailing edge of the wing, measured positive upward.

**Fraction of Applied**: The amount of deposition divided by the application rate.

**Malvern:** A type of laser diffraction particle size analyzer used to measure droplet distributions. It was used by the Spray Drift Task Force to measure the drop size distributions used in their trials. The system uses spatial, or number-density weighted, sampling.

**Nonvolatile rate**: The volume (AGDISP$^{TM}$) of formulated product applied over a given area.

**Number of flight lines**: The effective upwind dimension (or width) of the spray area is computed by multiplying the Number of Flight Lines by the Swath Width of the aircraft.

**Planform Area**: The surface area of the wing calculated from a top down view.

**Relative humidity**: Ratio of the actual vapor pressure of the air to the saturation vapor pressure (in percent). Its value is normally between 5 and 100 percent.

**Relative Span**: A parameter representing the breadth of the drop size distribution, ($Dv_{0.9}$-$Dv_{0.1}$/$Dv_{0.5}$).

**Release height**: Height of release of pesticide product (similar to boom height).

**Semispan**: Half of the calculated wingspan.

**Specific gravity**: Density (*i.e.* the ratio) of the mass of a material to the mass of an equal volume of water at a specific temperature, such as 20 °C. Thus, the specific gravity of water is 1.0, while the specific gravity of oil is 0.8. Its value for carriers and nonvolatiles is normally between 0.78 and 1.35.

**Spray block:** The designated area being treated via aerial application, also referred to as treatment block.

**Spray volume rate**: The volume of finished spray applied over a given area.

**Swath width**: The width of field that receives pesticide application from a single pass of a spray boom. For agricultural crops, this is typically a factor of the aircraft type, the span of the nozzles along the wing, the droplet size, and the height of release. This along with the number of flight lines and the length of the spray line determines how big of an area is treated. For agricultural crops this is typically 40-75 ft. For adulticide applications, this is typically 500-1500 ft. Part of this is because the height of release for agricultural crops is about 10 ft above the crop, while adulticide applications are usually 75-300 ft above the ground.

**Swath displacement**: The horizontal distance along the ground from the farthest downwind flight line to the edge of the application area, used to make sure the application does not extend beyond the edge of the field.

**Swath offset:** The distance a pilot offsets application from the downwind edge of the application area to account for the wind speed.

**Temperature**: The ambient temperature (in degrees Fahrenheit or degrees Centigrade).

**Wind Direction**: The direction from which the wind is blowing, measured relative to the flight direction of the aircraft. The default model value is -90 deg, implying the wind is blowing perpendicular to the direction of flight.

**Wind Speed**: The wind speed (in miles per hour or meters per second) 2 meters off the ground. Its value is normally between 1 and 20 mph. Most adulticide applications are limited to wind speeds of 1 to 10 mph.

**Wing Vertical**: the vertical distance between the wing tip and the wing root at the centerline of the aircraft, positive upward.