**Field volatility of [test compound]**

|  |  |
| --- | --- |
| **Report:** | [Provide full citation. Provide the MRID (first) if the review is unilateral.] |
| **Document No.:** | [MRID xxxxxxxx] |
| **Guideline:** | OCSPP 835.8100  [If the study was conducted under a different guideline than it is being reviewed under, state ‘Conducted by’ and provide the most relevant guideline(s) the study was conducted under. Then state ‘Reviewed by OCSPP 835.8100.’ If in multilateral review, also provide the guideline numbers under which participating agencies are reviewing the study.] |
| **Statements:** | [Indicate whether the study was conducted in compliance with FIFRA GLP standards and whether signed and dated Data Confidentiality, GLP Compliance, Quality Assurance, and Authenticity Certification statements were provided. If the study was not conducted in compliance with FIFRA GLP standards, indicate why or how it deviated.] |
| **Classification:** | This study is [provide classification and very concise statement of any deficiencies that impacted the classification]. [If multiple classification terminologies are needed for multilateral reviews, list or tabulate them.] |
| **PC Code:** | [xxxxxx] |
| **Reviewer:** | [Provide final reviewer(s)’s name **Signature:**  and title.] **Date:** [Type date of signature.] |

**Executive Summary [Modify the Executive Summary if required, incorporating the following critical elements and level of detail.]**

Field volatilization of [test material] was examined from [bare plots or cropped plots] at [number] of plots(s)/site(s) in [location(s), state(s), province(s)]. The site(s) where the studies were conducted were at [locations]. The experiment(s) in [site(s)] was/were conducted for [number] days. The nominal application rate[s] in [plots(s)/site(s)] were [value] lbs. a.i./A. The treated plots were [value] m apart, and the control plot was [value] m away from the treated plot. [Provide details on differences with application methods between plot(s)/site(s).]

Under field conditions at Site 1/Plot 1, [test material] a peak volatile flux rate of \_\_ g/m2·s of the applied was measured accounting for \_\_\_ % of the applied observed \_\_\_ to \_\_\_ hours post-application. By the end of the study, a total of \_\_\_ % of [test material] volatilized and was lost from the field. Other secondary peak volatile flux rates of \_\_ g/m2·s, \_\_ g/m2·s,….,and \_\_\_ g/m2·s, occurred at \_\_\_ to \_\_\_, \_\_\_ to \_\_\_, …, and \_\_\_ to \_\_\_ hours post-application, respectively. [State hypotheses for reasons of specific off-gasing events. Repeat information for additional sites, plots, or applications].

**[Include a time series plot of flux rates from the spreadsheets in Attachment 2.]**

1. **Materials and Methods**

Provide (a) small image(s) of the active ingredient(s) in the right margin.

1. **Materials**
2. **Test Material** Product Name:

Formulation Type (*e.g.*, liquid or granular):

CAS #:

Storage stability: [Indicate the time period that the test material was stable as well as any degradation rate information.]

1. **Storage Conditions**

[Indicate if the test material was frozen, refrigerated, and/or maintained in the dark for [#] days.]

1. **Study Design**
2. **Site Description**

[Indicate geographic location (nearby city), number of treated fields, and corresponding field sizes and crop cover. Indicate field type (*e.g.*, bare soil or cropped), field dimensions, soil type (*e.g.*, textural and taxonomic classification), and information on past land and pesticide use on plot(s). Indicate distance of separation between plots. Indicate the terrain characteristics (*e.g.*, rolling or flat terrain characterized by mixed trees and open fields, mixed small vegetative cover and open fields, or complete coverage by agricultural land).]

1. **Application Details**

Application rate(s): [Describe the target application rate and actual measured application rate including the method used to verify the actual application rate for all of the fields and plots.]

Irrigation and Water Seal(s): [If irrigation water was used, describe the amount of water applied in inches and method used to apply water to the field before and throughout the study.]

Tarp Applications: [If tarps were used, describe the tarp material used (e.g., HDPE, LDPE, etc. and brand), the type of application (broadcast or bedded strip), the percentage of field covered, the dimensions/number of areas covered, and the time duration of the covering]

Application Equipment: [Describe all equipment used in the application of the test substance.]

Equipment Calibration

Procedures: [Describe the methods used to calibrate the equipment to apply the targeted test material.]

Application Regime: The application rates and methods used in the study are summarized in **Table 1**.

**Table 1. Summary of application methods and rates for [test substance]**

| **Field** | **Application Method** | **Time of Application (Date and Start Time)** | **Amount [Test Substance] Applied**  **(lbs)** | **Area Treated**  **(acres)** | **Calculated Application Rate**  **(lb ai/acre)** | **Reported Application Rate**  **(gal ai/acre)** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | [#] | [#] | [#] | [#] | [#] | [#] |
| 2 | [#] | [#] | [#] | [#] | [#] | [#] |
| 3 | [#] | [#] | [#] | [#] | [#] | [#] |
| n | [#] | [#] | [#] | [#] | [#] | [#] |

Application Scheduling: Critical events of the study in relation to the application period are provided in **Table 2**.

**Table 2. Summary of [test substance] application and monitoring schedule**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Field/Plot** | **Treated Acres** | **Application Period** | **Initial Air/Flux Monitoring Period** | **Water Sealing Period** | **Tarp Covering Period** |
| Field 1 | [#] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY  [##:##] –  MM/DD/YY  [##:##] |
| Field 2 | [#] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY  [##:##] –  MM/DD/YY  [##:##] |
| Field 3 | [#] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY  [##:##] –  MM/DD/YY  [##:##] |
| Field n | [#] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY between  [##:##] – [##:##] | MM/DD/YY  [##:##] –  MM/DD/YY  [##:##] |

[If application methods other than water sealing or tarp coverings are included, please include this in **Table 2** as well.]

1. **Soil Properties**

Soil properties measured before the study are provided in **Table 3**.

**Table 3. Summary of soil properties for fields/plots**

| **Field** | **Sampling Depth** | **USDA Soil Textural Classification** | **USGS Soil Series** | **WRB Soil Taxonomic Classification** | **Bulk Density (g/cm3)** | **Soil Composition** |
| --- | --- | --- | --- | --- | --- | --- |
| [#] | [#] – [#] | [#] | [#] | [#] | [#] | % Organic Carbon = [#]%  % Sand = [#]%  %Silt = [#]%  %Clay = [#]% |
| [#] | [#] – [#] | [#] | [#] | [#] | [#] | % Organic Carbon = [#]%  % Sand = [#]%  %Silt = [#]%  %Clay = [#]% |
| [#] | [#] – [#] | [#] | [#] | [#] | [#] | % Organic Carbon = [#]%  % Sand = [#]%  %Silt = [#]%  %Clay = [#]% |
| [#] | [#] – [#] | [#] | [#] | [#] | [#] | % Organic Carbon = [#]%  % Sand = [#]%  %Silt = [#]%  %Clay = [#]% |

[Also include plots of soil temperature (°C) and soil moisture (% of field capacity) measured throughout the study.]

1. **Meteorological Sampling**

[Describe the meteorological instrumentation and vertical profile of measurements taken, if applicable. Details of the sensor heights and the meteorological parameters for which data were collected are illustrated in **Table 4**. The location of the meteorological equipment for each field is shown in **Attachment 3**.]

**Table 4. Summary of meteorological parameters measured in the field**

| **Field** | **Minimum Fetch\***  **(m)** | **Parameter** | **Monitoring heights**  **(m)** | **Averaging Period** |
| --- | --- | --- | --- | --- |
| 1 | [#] | Wind speed/Wind direction | Height [z1], ….Height [zn] | 1 minute |
| Ambient air temperature | Height [z1], ….Height [zn] | 1 minute |
| 2 | [#] | Wind speed/Wind direction | Height [z1], ….Height [zn] | 1 minute |
| Ambient air temperature | Height [z1], ….Height [zn] | 1 minute |
| Solar radiation | Height [zi] | 15 minutes |
| Precipitation | Height [zi] | 15 minutes |
| 3 | [#] | Wind speed/Wind direction | Height [z1], ….Height [zn] | 1 minute |
| n | [#] | Ambient air temperature | Height [z1], ….Height [zn] | 1 minute |
| Ambient air temperature | Height [z1], ….Height [zn] | 1 minute |

\*Only include for on-field flux air sampling. Values calculated in spreadsheets provided in Attachment 2.

1. **Air Sampling**

[Describe the air monitoring sampling network (*e.g.*, sampling mast for on-field monitoring and levels above ground for sampling or distribution of samplers around the treated field stations and distances from the edge of the field). Also describe the pre-application monitoring (*e.g.*, placement of air samplers, total monitoring duration, and averaging periods for sampling).]

1. **Sample Handling and Storage Stability**

[Provide a brief description of the storage conditions of samples after collection and the longest duration of storage for each media analyzed. Indicate the stability of the analytes based on the submitted storage stability study(ies) for each media (provide MRID(s)) and whether the storage stability study duration(s) was/were sufficient to evaluate the longest field study storage duration(s). State whether corrections were made to account for any instability. Details of the storage stability study(ies) can be discussed in a separate study review(s).]

1. **Analytical Methodology**

[Describe the following attributes of the air sampling analysis:

* Sampling Procedure and Trapping Material:

[Include apparatus, air pump flow rates, and sorbent material used to capture air samples.]

* Extraction method:

[Include information regarding the retrievals of air samples.]

* Method validation (Including LOD and LOQ):

[Include information and study report title of any independent laboratory validations. Also, describe the establishment of the limits of detection and limits of quantification for air samples.]

* Instrument performance:

[Include information on calibration standards for the detection method.]

1. **Quality Control for Air Sampling**

Lab Recovery: [Most/All] laboratory spike recoveries are within the acceptable range with overall recoveries between [x and y percent]. The exceptions include laboratory spikes extracted concurrent with [sampling period] with an average percent recovery of [x percent + y percent] at the fortification level of [<c1 g, c1 g – c2 g, or c2 g>]. [Repeat for additional unacceptable laboratory spike extractions (less than 90 percent or greater than 110 percent).]

Field blanks: [Describe any background levels of test substance measured before application(s) in the study.]

Field Recovery: [Most/All] field spike recoveries are within the acceptable range with overall recoveries between [x and y percent]. The exceptions include field spikes extracted during [sampling period] with an average percent recovery of [x percent + y percent] at the fortification level of [<c1 g, c1 g – c2 g, or c2 g>]. [Repeat for additional unacceptable field spike extractions (less than 90 percent or greater than 110 percent).]

Travel Recovery: [Describe the number of travel spikes prepared along with the fortification levels included. Describe the range of recoveries measured from the spiked samples.]

Breakthrough: [Describe any analysis or instances of test substance breakthrough in air sampling tubes, if applicable.]

1. **Application Verification**

Briefly describe the application verification methods used, *e.g.*, petri dish, saturation pads, spray tank analysis, *etc.*

Recoveries achieved on extraction and analysis of application monitors were in the range [xx to xy %]. Recovery achieved on analysis of field spiked samples was [xx %].

1. **Results and Discussion**
2. **Empirical Flux Determination Method Description and Applicability**

[Describe the empirical approach the registrant used to determine the flux rates as well as their appropriateness to the study design. Consider the below excerpts for various methods that have been developed for past reviews:]

<Indirect Method>

*The indirect method, commonly referred to as the “back calculation” method, was the technique employed for estimating flux rates from fields treated for this field study given the available data. In the indirect method, air samples are collected at various locations outside the boundaries of a treated field. Meteorological conditions, including air temperature, wind speed, and wind direction, are also collected for the duration of the sampling event. The dimensions and orientation of the treated field, the location of the samplers, and the meteorological information are used in combination with the ISCST3 dispersion model (Version 02035) and a unit flux rate of 0.001 g/m2·s to estimate concentrations at the sampler locations. Since there is a linear relationship between flux and the concentration at a given location, the results from the ISC model runs are compared to those concentrations actually measured, and a regression is performed, using the modeled values along the x-axis and the measured values along the y-axis. If the linear regression does not result in a statistically significant relationship, the regression may be rerun forcing the intercept through the origin, or the ratio of averages between the monitored to modeled concentrations may be computed, removing the spatial relationship of the concentrations. The indirect method flux back calculation procedure is described in detail in Johnson et al., 1999.*

<Aerodynamic Method>

*The aerodynamic method, also referred to as the “flux-gradient” method, was the technique employed for estimating flux rates from fields treated for this field study given the available data. In the aerodynamic method, a mast is erected in the middle of the treated field and concentration samples are typically collected at four or five different heights, ranging from 0.5 to 10 feet. Likewise, temperature and wind speed data are collected at a variety of heights. A log-linear regression is performed relating the natural logarithm of the sample height to the concentration, temperature, and wind speed. These relationships are then incorporated into an equation to estimate flux. The methods to estimate flux and related equations are presented in Majewski et al., 1990. The equation for estimating flux using the aerodynamic method is Thornthwaite-Holzman Equation, which is shown in the following expression:*

*Equation x1 *

*where P is the flux in units of g/m2·s, k is the von Karman’s constant (dimensionless ~0.4), Δ is the vertical gradient pesticide residue concentration in air in units of g/m3 between heights ztop and zbottom in units of meters, Δū is the vertical gradient wind speed in units of m/s between heights ztop and zbottom, and  and  are the momentum and vapor stability correction terms respectively. Following the conditions expected in the neutrally stable internal boundary layer characterized by an absence of convective (buoyant) mixing but mechanical mixing due to wind shear and frictional drag, a log-linear regression is performed relating the natural logarithm of the sample height to the concentration, temperature, and wind speed. The adjusted values of the concentration, temperature, and wind speed from this regression is incorporated into Equation 2-1 to arrive at Equation 2-2 which is ultimately used to compute the flux.*

*Equation x2 *

*where  and  are internal boundary layer (IBL)stability correction terms determined according to the following conditions based on the calculation of the Richardson number, Ri:*

*Equation x3 *

*where Tztop and Tzbottom are the regressed temperatures at the top and bottom of the vertical profile in units of °C.*

*if Ri >0 (for Stagnant/Stable IBL)*

*and *

*if Ri <0 (for Convective/Unstable IBL)*

*and *

*The minimum fetch requirement that the fetch is 100 times the highest height of the air sampler for this method to be valid [was/was not] satisfied at all times [List the sampling periods and resulting fetches with exceptions]. The aerodynamic method used to estimate flux and related equations are presented in Majewski et al., 1990.*

<Integrated Horizontal Flux Method>

*The integrated horizontal flux method, also referred to as the “mass balance” method, was the technique employed for estimating flux rates from fields treated for this field study given the available data. In the integrated horizontal flux method, a mast is erected in the middle of the treated field and concentration samples are typically collected at four or five different heights, ranging from approximately 0.5 to 5 feet. Likewise, wind speed data are collected at a variety of heights. A log-linear regression is performed relating the natural logarithm of the sample height to the air concentration and wind speed following the log law relationships for the atmospheric boundary layer. These relationships are then incorporated into an equation to estimate flux. The methods to estimate flux and related equations are presented in Majewski et al., 1990. The equation for estimating flux using the integrated horizontal flux method is the following expression:*

*Equation x1 *

*where P is the volatile flux in units of g/m2·s,  is the average pesticide residue concentration in units of g/m3 at height Z in units of meters, is the wind speed in units of m/s at height Z, x is the fetch of the air trajectory blowing across the field in units of meters, Z0 is the aerodynamic surface roughness length in units of meters, Zp is the height of the plume top in units of meters, and dz is the depth of an incremental layer in units of meters. Following trapezoidal integration, equation 3 is simplified as follows in equation 2-5 (Yates, 1996):*

*Equation x2 *

*where A is the slope of the wind speed regression line by ln(z), B is the intercept of the wind speed regression line by ln(z), C is the slope of the concentration regression by ln(z), D is the intercept of the concentration regression by ln(z), z is the height above ground level. Zp can be determined from the following equation:*

*Equation x3 *

*The minimum fetch requirement of 20 meters for this method to be valid [was/was not] satisfied at all times [List the sampling periods and resulting fetches with exceptions]. [Describe the surface characteristics of the field and whether the maximum surface roughness length requirement of 0.1 meters for the method to be valid was satisfied. This condition is satisfied for studies conducted over bare soil or sod grass.]*

1. **Temporal Flux Profile**

The flux determined from the registrant and reviewer for each sampling period after the application is provided in **Table 5**.

**Table 5. Field volatilization flux rates of [test substance or analyte] obtained in study [Field or Plot, Application]**

| **Sampling Period** | **Date/**  **Time** | **Sampling Duration**  **(hours)** | **Flux Estimate** | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Reviewer** | **Registrant** | **Empirical Flux Determination Method** | **Notes** |
| 1 | MM/DD/YY  [##:##] – [##:##] | [#] | [#] | [#] | [ID, AD, IHF, *etc*.] | [Include notes on missing data, or selection of reasoning used for Indirect Method.] |
| 2 | MM/DD/YY  [##:##] – [##:##] | [#] | [#] | [#] | [ID, AD, IHF, *etc*.] | [Include notes on missing data, or selection of reasoning used for Indirect Method.] |
| 3 | MM/DD/YY  [##:##] – [##:##] | [#] | [#] | [#] | [ID, AD, IHF, *etc*.] | [Include notes on missing data, or selection of reasoning used for Indirect Method.] |
| 4 | MM/DD/YY  [##:##] – [##:##] | [#] | [#] | [#] | [ID, AD, IHF, *etc*.] | [Include notes on missing data, or selection of reasoning used for Indirect Method.] |
| 5 | MM/DD/YY  [##:##] – [##:##] | [#] | [#] | [#] | [ID, AD, IHF, *etc*.] | [Include notes on missing data, or selection of reasoning used for Indirect Method.] |
| n | MM/DD/YY  [##:##] – [##:##] | [#] | [#] | [#] | [ID, AD, IHF, *etc*.] | [Include notes on missing data, or selection of reasoning used for Indirect Method.] |

**\***Methods legend: ID = Indirect method, AD = Aerodynamic Method, IHF = Integrated Horizontal Flux.

[Add on to tables as necessary for different locations, plots, or applications.]

[List specific maxima in volatile flux rates and possible factors contributing to these off-gasing events].

[Describe any abnormalities leading to potential uncertainties in the flux determinations such as missing data, low statistical significance between modeling and air sampling data in the indirect method, or low r-squared values in log-linear vertical profiles of temperature, wind speed, and concentration in any of the on-field methods (*e.g.*, aerodynamic or integrated horizontal flux methods).]

1. **Study Deficiencies and Reviewer’s Comments**

[List any deficiencies with the study and any additional salient information. Specifically mention any aspects of the study that lead to uncertainties in the determination of flux rates.]

1. **References** [List any references cited in the review.]

Johnson, B., Barry, T., and Wofford P. 1999. Workbook for Gaussian Modeling Analysis of Air Concentrations Measurements. State of California Environmental Protection Agency, Department of Pesticide Regulation. Sacramento, CA.

Majewski, M.S., Glotfelty, D.E., Kyaw Tha Paw U., Seiber, JN. 1990. A field comparison of several methods for measuring pesticide evaporation rates from soil. Environmental Science and Technology, 24:1490-1497.

Wilson, J.D., and Shum. W.K.N. 1992. A re-examination of the integrated horizontal flux method for estimating volatilisation from circular plots. Agriculture Forest Meteor. Vol 57:281-295.

Yates, S.R., F.F. Ernst, J. Gan, F. Gao, and Yates, M.V. 1996. Methyl Bromide Emissions from a Covered Field: II. Volatilization,” Journal of Environmental Quality, 25: 192-202.

**Attachment 1: Chemical Names and Structures**

**[**Attach a table (*i.e.*, structure table) of the chemical names, SMILES strings, CAS numbers, and structures of the analytes or refer to this table if it exists in a separate, associated document. Do not include in the table multiple versions of chemical names, structures, or SMILES strings. Sources of data need not be included. However, formatting the structure table in conformance with the guidance for tabulating transformation product data for EFED ROCKS memoranda is recommended. This formatting includes table columns for MRIDs and associated study data such as maximum and final concentrations of transformation products and their intervals. At a minimum, repeat the table below for the analytes.

For multilateral reviews, chemical names, SMILES strings, structures, and CAS numbers are captured elsewhere in the Monograph. Therefore these data are not attached to each study review within the Monograph. When the Monograph is split into individual reviews in EFED’s files, however, either reference the Monograph’s structure table as a separate, associated document or attach it to each individual review.]

[Sample structure table with the minimum information needed.]

|  |  |
| --- | --- |
| **[Common name [list other common names] [if the same common name is used in different studies for different compounds, provide in parentheses the MRID associated with the common name for this compound.]]** | |
|  |  |
| **IUPAC Name:** | [Provide one IUPAC name.] |
| **CAS Name:** | [Provide one CAS name.] |
| **CAS Number:** | [Provide if available.] |
| **SMILES String:** | [Provide one SMILES string.] |
|  | |
| [Paste structure here.] | |
|  | |
|  | |

[Sample EFED ROCKS memorandum format for structure tables.]



**Attachment 2: Statistics Spreadsheets and Graphs**

[Insert supporting electronic spreadsheet files here (electronic attachment files are electronically finalized as separate files as well). Name electronic attachments the same file name as the Microsoft Word study review file with the addition of “Calc” for Excel workbooks and WinZip files, the addition of “Data” for Adobe Acrobat and Document Imaging files, and the addition of brief descriptors as appropriate for SigmaPlot Notebooks. Compress electronic attachment files into a WinZip file when three or more are prepared for a study review.]

[Print hard copies of the study review and any attachment sheets from separate electronic files to produce one hard copy file for finalization.]

[Example Excel files and spreadsheets follow below.]

1. Validation spreadsheet for studies following the Indirect Method:



1. Validation spreadsheet for studies following the Aerodynamic Method:



1. Validation spreadsheet for studies following the Integrated Horizontal Flux Method:



**Attachment 3: Field Volatility Study Design and Plot Maps**

[Insert map of study plot(s) from study report here.]

**Attachment 4: Calculations and Index of Variables Used in Flux Determination Methods**

*Aerodynamic Method*

Equation x1 

Flux (g/m2s): volatile flux of pesticide from release source surface

cztop (g/m3): concentration at the top sampler adjusted according to the regression of concentration vs. ln (height)

czbottom (g/m3): concentration at the bottom sampler adjusted according to the regression of concentration vs. ln (height)

uztop (m/s): wind speed at the top sampler adjust according to the regression of wind speed vs. ln (height)

uzbottom (m/s): wind speed at the top sampler adjust according to the regression of wind speed vs. ln (height)

 and  (dimensionless): Internal Boundary Layer (IBL) stability correction terms determined according to the following conditions based on the calculation of the Richardson number, Ri:

Equation x2 

where:

Tztop: Temperature at the top sampler adjusted according to the regression of temperature vs. ln (height)

Tzbottom: Temperature at the bottom sampler adjusted according to the regression of temperature vs. ln (height)

Ri (dimensionless): Richardson Number

if Ri >0 (for Stagnant/Stable IBL)

and 

if Ri <0 (for Convective/Unstable IBL)

and 

*Integrated Horizontal Flux Method*

*Equation x3 *

P (g/m2s): volatile flux of pesticide from release source surface

z (m): height above ground level

A (s-1): slope of the wind speed regression line by ln(z)

B (m/s): intercept of the wind speed regression line by ln(z)

C (g/m4): slope of the concentration regression by ln(z)

D (g/m3): intercept of the concentration regression by ln(z)

Z0 (m): aerodynamic surface roughness length of release source surface

Zp (m): volatile plume top height; calculated from the following equation:

*Equation x4 *