UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

June 13, 2005

SUBJECT: Metam Sodium: Revised HED Human Health Risk Assessment For Phase 3: DP Barcode: D318051, Metam Sodium PC Code: 039003, MITC PC Code: 068103

FROM: Sherrie Kinard, Residue Chemist/Risk Assessor
Bill Smith, Environmental Scientist/Risk Assessor
Health Effects Division/Reregistration Branch 2 (7509C)

THRU: Alan Nielsen, Branch Senior Scientist
Health Effects Division/Reregistration Branch 2 (7509C)

TO: Mark Seaton, Chemical Review Manager
Special Review & Reregistration Division (7508C)

Attached is the Health Effects Division's (HED) risk assessment of the soil fumigant, metam sodium and its main degradate MITC. HED evaluated the hazard and exposure data and conducted exposure assessments, as needed, to estimate the human health risks from the uses of metam sodium. This assessment also incorporates error correction comments received from the Metam Sodium Alliance (April 4, 2005) and responded to by HED (D318052/June 13, 2005). This risk assessment addresses both exposures in general population and for those occupationally exposed. The key concern for this assessment were exposures in the general population which occur primarily via inhalation for those in proximity to treated fields and facilities (i.e., bystanders). The potential for dietary exposure, drinking water exposure and occupational exposures via inhalation were also addressed.

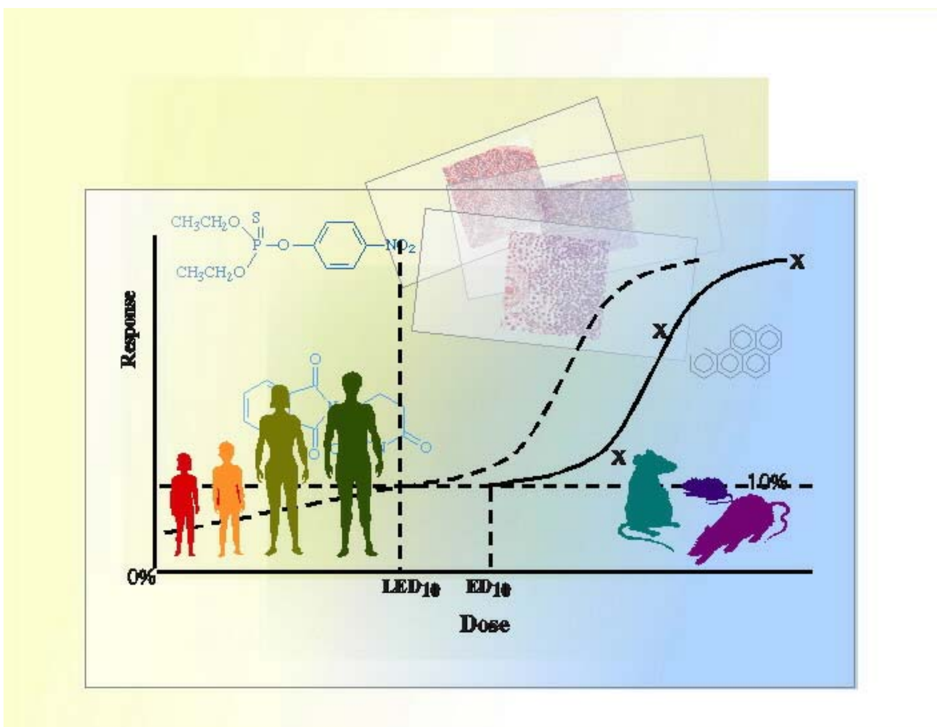
The development of the bystander assessment has been an iterative process that reflects the evolution of HED's methodologies for calculating the potential risks associated with fumigant uses. There are a number of volatility studies which quantified MITC emissions from metam sodium application sites such as treated fields and facilities. However, these data are limited in their utility because they provide results only for the specific conditions under which the experiments were conducted. Therefore, to provide flexibility, HED also used ISCST3 or the Industrial Source Complex: Short-Term Model to develop risk estimates for bystanders associated with metam sodium uses (http://www.epa.gov/scram001/). In addition, in response to HED's methodologies for assessing risks for pre-plant soil fumigants, three separate air models based on ISCST3 that incorporate weather and emissions variability over time and that provide results only for pre-plant soil fumigations (PERFUM, FEMS, SOFEA) were submitted for review by the FIFRA SAP (see Aug. & Sept. - http://www.epa.gov/scipoly/sap/2004/index.htm). The SAP concluded that each of the three models could provide scientifically defensible results for risks associated with soil fumigation practices and also suggested modifications and additional data that could further refine risk estimates. For a number of reasons detailed below, PERFUM was used to evaluate bystander risks in this assessment (http://www.epa.gov/opphed01/models/fumigant/). HED would also evaluate submissions based on the other models if detailed training and documentation accompanied any such submission.

EPA has undertaken an effort to evaluate each of the soil fumigant pesticides. Because of the difficult, complicated issues surrounding the evaluation of the chemicals, HED has developed similar regulatory schedules for these chemicals. These schedules are consistent with the six phase process followed by EPA's Office of Pesticide Programs for the development of risk assessments and solicitation of public comment and public participation. The current risk assessment for metam sodium is considered the 'Phase 3' risk assessment. Unlike the other soil fumigants currently being evaluated by the EPA, a risk assessment for metam sodium was previously released to the public in June 2004 for public comment followed by a revised risk assessment in August, 2004. The risk assessments and supporting technical documentation (e.g., disciplinary chapters for hazard and exposure assessment) from 2004 were developed as part of the consent decree with the National Resources Defense Council. Since that time, EPA has worked collaboratively with California's Department of Pesticide Regulation (CDPR), EPA's Office of Research and Development, and the stakeholders to develop new methodologies and to refine the use of existing methods. Because of these efforts, some aspects of the current metam sodium risk assessment are significantly changed from the revised risk assessment from August, 2004. For example, since that time, EPA has presented three exposure models (PERFUM, FEMS, SOPHIA) to the FIFRA Scientific Advisory Panel (August/September of 2004). In the current assessment, in conjunction with the actual monitoring data, and ISC, EPA has utilized PERFUM to evaluate bystander exposure. Furthermore, additional flux studies more representative of current use patterns of metam sodium have been recently provided to EPA. Due to the substantial changes in the methodologies used in the exposure assessment, the previous Occupational Residential Exposure (dated August 19, 2004) is no longer applicable. HED's Phase 3 Human Health Risk Assessment for Metam Sodium supercedes any and all previously released ORE chapters and risk assessment documents. However, not all components of the August, 2004 metam sodium risk assessment have been changed. The toxicology disciplinary chapter and residue chemistry chapter and supporting documentation have not been revised.

<u>All technical documentation supporting the risk estimates provided here including the toxicology chapter, occupational and bystander exposure assessment, and residue chemistry chapter are provided in this document or in the Appendices.</u>

HUMAN HEALTH RISK ASSESSMENT

Metam Sodium



U.S. Environmental Protection Agency
Office of Pesticide Programs
Health Effects Division (7509C)
Sherrie Kinard, Residue Chemist/Risk Assessor
Bill Smith, Environmental Scientist/Risk Assessor
Date: June 13,2005

HUMAN HEALTH RISK ASSESSMENT

Metam Sodium Risk Assessment Team

Risk Assessor:	Sherrie Kinard Bill Smith
Product and Residue Chemistry:	Ken Dockter Sherrie Kinard
Occupational and Residential Exposure:	Bill Smith
Epidemiology:	Jerome Blondell, MPH, Ph.D.
Toxicology:	Anna Lowit, Ph.D. Judy Facey, Ph.D.
Drinking Water Estimates:	Faruque Khan, Ph.D.

Table of Contents

Appendix List

1.0 Executive Summary

Metam sodium (sodium N-methyldithiocarbamate) and metam potassium (potassium N-methyldithiocarbamate) are non-selective pre-plant soil fumigants with fungicidal, herbicidal, insecticidal, and nematicidal properties. Metam sodium is one of the most widely used agricultural pesticides in the U.S. with an estimated total of 51 million pounds applied annually. Lesser amounts of metam potassium are used in the U.S. (estimated 1-2 million pounds annually). Unless further qualified or specified, use of the term 'metam sodium' should be assumed to also include 'metam potassium.' EPA has commenced a significant effort to systematically evaluate the risks and benefits of six soil fumigants; metam sodium is included as one of these six.

Metam sodium's volatility in the environment and results of metabolism studies in plants assure that there is no reasonable expectation of finite residues to be incurred in/on any raw agricultural commodity when these products are applied according to label directions. Therefore, this fumigant does not require food tolerances and is not subject to the amendments to the FFDCA promulgated under the Food Quality Protection Act of 1996; therefore, an aggregate risk assessment is not required.

The scope of this assessment addresses only the major uses of metam sodium being supported by the registrants. These uses include an agricultural fumigant, a root control agent for use in sewers and drains, and a vegetation control agent for shorelines and drained bodies of water. There are also other uses of metam sodium, potassium, and MITC which have been assessed by OPP's Antimicrobial Division and as such are not included in this assessment. Metam sodium and potassium soil fumigant end-use products are registered for all crops. The primary degradate for both metam sodium and metam potassium is MITC.

Following application of metam sodium and potassium, MITC can volatilize into the atmosphere and be transported off-site. This can lead to exposures to MITC in the general public and to workers following application of metam sodium and potassium. [Note: Dazomet is another fumigant which produces MITC upon application. This document does not quantify exposure to dazomet or MITC coming from dazomet applications or use of MITC itself.]

In acute toxicity testing, MITC is Acute Toxicity Category II for the oral and inhalation routes and Category I for the dermal route. MITC also causes skin and eye irritation (Acute Toxicity Category I) and is a sensitizer in guinea pigs. Eye irritation and odor threshold for MITC has been evaluated in humans. Metam sodium is relatively less acutely toxic compared to MITC. Metam sodium is of low toxicity (Acute Toxicity Category III) in acute toxicity studies by the oral, dermal, and inhalation routes. Metam sodium is not a skin and eye irritant (Category III and IV, respectively) and is positive for skin sensitization in guinea pigs.

Following inhalation exposures to MITC, consistent effects are observed in rats and humans. In rat studies, clinical signs and pathological changes of the respiratory tract consistent with an irritant have been observed. Incident data for MITC are consistent with these findings as symptoms of some individuals include itchy and burning eyes, rash and burning skin, nausea, scratchy throat, salivation, coughing, and shortness of breath. At the present time, the data base of acceptable inhalation toxicology studies is limited to a 28-day study in rat, an eye irritation and odor threshold in human subjects, and an acute lethality study in rat. There are no studies with laboratory animals available which better quantify the dose-response relationship and the continuum of potential *acute, single-day* respiratory effects (i.e., progression to more serious clinical outcomes) from exposure to MITC. There is, however, an eye irritation study in human subjects. This irritation study evaluated both the impact of duration of exposure and dose on human eye irritation. For acute exposures of 1 to 8 hours in duration, a NOAEL was selected from the human eye irritation study based on effects observed at the LOAEL. Typically EPA uses a 10x factor to account for variability within species and another 10x factor to account for interspecies variability. In this case a MOE of 10 defines HED's level of concern (LOC) for acute inhalation risk to MITC because an endpoint was selected for risk assessment from the human eye irritation study. Due to the limitations in the existing inhalation toxicology database for MITC, the degree to which eye irritation predicts more serious outcomes is unclear. However, in the absence of more robust dose-response data from acute exposures, eye irritation can be considered as an appropriate biomarker and surrogate for potential respiratory effects.

For durations other than acute, the 28-day rat inhalation study provides critical effects for estimating short-term (ST), intermediate-term (IT), and long-term (LT) inhalation risk for exposure to MITC. Clinical signs consistent with irritation in both sexes and increased neutrophilic polymorphonuclear granulocytes (indicative of an inflammatory response) in the blood of males were noted at the mid dose in the 28-day study. However, the local effects noted in the nasal passages (metaplasia of the respiratory epithelium and atrophy of the olfactory epithelium) at the highest dose provided the lowest human equivalent concentrations (HECs) and have been selected for developing margins of exposure (MOE). Using the equations provided in the EPA's reference concentration (RfC) methodology (1994), systemic and local effects in different regions of the respiratory tract are evaluated separately. As shown for MITC, the HECs for local effects can be more protective than HECs calculated for systemic effects, even if the overall NOAEL identified for the study provides a lower value. The HECs differ between non-occupational and occupational scenarios because the residential HEC is based on 24-hour exposures occurring 7 days per week, whereas the occupational HEC is based on 8-hour exposures occurring 5 days per week. Because EPA's RfC methodology incorporates some pharmacokinetic differences between rats and humans, the interspecies factor is generally 3x. Typically EPA uses a 10x factor to account for intraspecies variability. Therefore, a MOE of 30 defines HED's LOC for ST and IT inhalation risk to MITC. Where there are no chronic toxicity studies available for MITC, HED typically applies a 10x factor to account for the uncertainties when extrapolating from subchronic to chronic duration. Therefore, a MOE of 300 defines HED's LOC for chronic inhalation risk to MITC.

Metam sodium is currently classified as a probable human carcinogen, based on statistically significant increases in malignant angiosarcoma in both sexes of the mouse. Carcinogenicity studies for MITC *per se* are insufficient to characterize cancer risk, therefore, the carcinogenic potential of MITC cannot be determined at this time. However, due to the potential for chronic exposures and also the observation of metaplasia of the respiratory epithelium following 28-days of inhalation exposure, EPA is requiring inhalation carcinogenicity studies with MITC in rats and mice.

Systemic effects following dermal exposure to metam sodium are not known at this time; the existing dermal study does not take adequate precautions for the volatilization of MITC. Therefore, HED has elected to use oral studies and route to route extrapolation using a dermal absorption factor (2.5%) for risk assessment. The ST dermal endpoint is based on reduced body weight gain and decreased food efficiency in maternal rats seen in a developmental toxicity study with metam sodium. The IT dermal endpoint is an oral NOAEL based on microscopic changes in the liver in females seen in a chronic oral toxicity study in the dog. A NOAEL for inhalation exposure to metam sodium is used to assess ST and IT inhalation exposure. The dose selected is based upon histopathological changes in the nasal passages and changes in clinical chemistry seen at the LOAEL in females following inhalation exposure. The RfC methods were not used to calculate HECs for the metam sodium inhalation study. Typically EPA uses a 10x factor to account for intraspecies and interspecies variability (combined UF of 100). Therefore, a MOE of 100 defines HED's LOC for ST and IT dermal and inhalation risk to metam sodium.

Releases of fumigants such as MITC from metam sodium applications, can be categorized in two distinct manners that include addressing bystander exposures from single known application sites such as area (i.e., treated farm fields) sources and also by evaluating available ambient air monitoring data where residues could result from many applications within a region. Risks from known single sources were evaluated using monitoring data and modeling techniques. Risks from ambient air were evaluated solely on the basis of monitoring data from California.

When considering the potential risks of bystanders for single application sites that encompass single known sources (e.g., area sources such as farmfields) it is also important to understand that this has been an iterative process that reflects the evolution of HED's methodologies for calculating the potential risks associated with fumigant use. There are a number of volatility studies which quantified MITC emissions from metam sodium treated fields and facilities. However, these data are limited in their utility because they provide results only for the specific conditions under which the experiment was conducted. Therefore, to provide more flexibility, ISCST3 or the Industrial Source Complex: Short-Term Model was also used to develop risk estimates for bystanders associated with metam sodium uses (http://www.epa.gov/scram001/). In addition, in response to HED's ISCST3 methodologies for assessing pre-plant soil fumigants, three separate air models based on ISCST3 that incorporate weather and emissions variability over time (PERFUM, FEMS, SOFEA) were reviewed by the FIFRA SAP (http://www.epa.gov/scipoly/sap/2004/index.htm - see Aug. & Sept.). The SAP concluded that each of the three models could provide scientifically defensible results for risks associated with soil fumigation practices and also suggested modifications and additional data that could further refine risk estimates. For a number of reasons, PERFUM was used to evaluate bystander risks (http://www.epa.gov/opphed01/models/fumigant/). HED also believes the use of PERFUM (or FEMS and SOFEA as well) as opposed to ISCST3 the way it has been used in this case provides more appropriate information for risk managers and, as such, recommends that PERFUM results be the basis for risk management decisions related to the pre-plant field uses of metam sodium. HED would also evaluate submissions based on the other aforementioned models (i.e., FEMS or SOFEA) if detailed training accompanied any such submission. ISCST3 results are recommended for evaluating risks associated with all other use sectors as ISCST3 provides the ability to consider many types of field conditions and inputs as opposed to the only other possible approach based on monitoring data.

For known area or point sources (e.g., treated farm fields), the available volatility data related to several key metam sodium use sectors (pre-field fumigation) indicate that there are risks of concern. These data, however, are limited both temporally and spatially which limits their utility when considering risk management options under varied conditions. As a next step, HED used data to develop flux inputs for modeling based on the Office of Air's ISCST3 to further assess exposures in each use sector. HED believes that the exposures calculated in this risk assessment using ISCST3 are high-end estimates and do not underestimate the risk based on the manner in which it has been used. Although the Agency's Office of Air routinely uses ISCST3 for regulatory purposes, HED has not routinely used the model to estimate air concentrations for pesticides, but is confident that ISCST3 is an appropriate model for this analysis. This is also supported by discussions at the recent 2004 Science Advisory Panel meetings on fumigant issues. Additionally, the CDPR has been using the ISCST3 model since the early 1990's to estimate bystander exposure to fumigants including metam sodium with excellent agreement between monitoring data and model results. The conclusions based on the ISCST3 analyses show that for all use sectors of interest, the required distances to fall below HED's level of concern are generally on the order of hundreds to thousands of feet depending upon the meteorological conditions, the size of the source (e.g., field size), and the rate of emissions from the treated area.

HED recommends using PERFUM to evaluate risks from pre-plant soil applications in agricultural fields because PERFUM provides the most refined estimates of risks for pre-plant soil fumigation scenarios as it incorporates actual weather data and flux distributions. It is also capable of providing distributional outputs for varying receptor locations and using varied statistical approaches. At the upper percentiles of the exposure distributions generated with PERFUM, the results are markedly similar to those calculated with ISCST3. The power of using a system such as PERFUM, however, is inherent in the capability of providing outputs that can be used to examine the range of exposures one would expect based on the distributions it calculates. It is also clear that many different factors can impact the air concentrations (and hence, risks) in proximity to agricultural fields that have been treated with metam sodium; these include many of the factors which have been investigated in this assessment. It is also important to acknowledge this issue so that stakeholders understand that the results of this analysis can be interpreted in many ways depending upon the factors which are considered. Many conclusions can be drawn but the key ones include: (1) at the edge of the treated fields that NOAEL HECs generally are not exceeded given proper use of metam sodium (i.e., with no uncertainty factors applied such as for inter-species variation from rats to humans and intra-species variability within humans) but conversely the distance predicted for MOEs between 5 and 10 at the upper percentiles of exposure are at 1440 meters for many scenarios where the appropriate uncertainty factors have been applied; (2) the methods used to evaluate MITC exposure (from metam sodium applications) in this assessment generally agree and they are based on techniques that have been routinely used for regulatory purposes, they have also undergone a significant level of review; (3) the sensitivity of results to changes in key factors such as flux and meteorological conditions is generally well within an order of magnitude for the factors which have been evaluated; (4) PERFUM is an empirically based approach so the generation of additional flux and meteorological data would allow a broader analysis that could be applied more specifically to other regions of the country and application techniques; and (5) the identification of a result, *per se*, for any sort of regulatory action would depend upon careful consideration of the variability and uncertainty associated with each as well as any particular merits of the inputs associated with each.

Available ambient data provide results for MITC, but the specific source of MITC cannot be determined (i.e., from metam sodium, metam potassium, or dazomet). With regard to potential multiple sources of exposures from ambient air, the acute risks to targeted ambient air concentrations for all of the monitoring stations considered do not exceed HED's level of concern.

Acute risks to occupational handlers for the majority of tasks associated with pre-plant field fumigation, applications to ornamentals, food, and feed crops, tobacco plant beds, and turf indicate that risks exceed HED's level of concern (MOE < 10). Short- and intermediate-term risks to handlers also exceed HED's level of concern (MOE < 30) for most of the tasks assessed.

Acute risks to occupational handlers for fumigation of sewers indicate that risks exceed HED's level of concern (MOE < 10). Short- and intermediate-term risks to occupational handlers for fumigation of sewers indicate that risks exceed HED's level of concern (MOE < 30).

There are a number of data gaps in both the occupational handler and the occupational and non-occupational (residential bystander) postapplication exposure and risk assessments. Notably, to refine the occupational handler risk assessment, data on actual use patterns including rates, timing, and area treated would better characterize metam sodium and MITC risks. Exposure studies for many equipment types that lack data or that are not well represented in HED's PHED (e.g., because of low replicate numbers or data quality) should also be considered based on the data gaps identified in this assessment and based on a review of the quality of the data used in this assessment. Postapplication data gaps include lack of information on the effect of soil seal removal several days after initial application; knowledge of the influence of factors such as wind speed, direction and application rate on the air concentration of MITC after a metam sodium application; effect of an individuals' exposure to multiple metam sodium treated fields; and, the postapplication effect of the use of metam sodium in greenhouses.

2.0 Ingredient Profile

2.1 Summary of Registered Uses

Metam sodium and metam potassium are non-selective soil fumigants with fungicidal, herbicidal, insecticidal, and nematicidal properties. The mode of action is inactivation of sulfhydryl groups in amino acids.

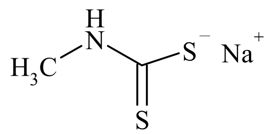
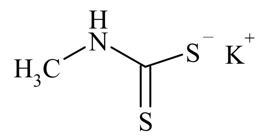
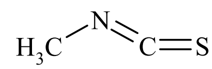
Metam sodium and potassium are active against all living matter in the soil. Metam sodium and potassium end-use products are registered for a variety of crops. Typical applications are made prior to planting. Metam sodium may be applied to plant beds as a soil drench treatment, e.g., tobacco plant beds. It may also be applied to field or row crops during pre-plant stages via chemigation, soil broadcast treatment, soil band treatment, soil-incorporated treatment, and soil-injection treatment. Chemigation is the most common method of application. Metam sodium is the third most widely used agricultural pesticide in the U.S. There are a total of 51 active end-use products currently registered. (*Metam Sodium. Residue Chemistry Chapter for the Metam Sodium Reregistration Eligibility Decision (RED) Document. Sherrie Kinard, September 30, 2003.*)

The range of percent of active ingredient in the end-use products is 18-42.5% for metam sodium and 5-54% for metam potassium for uses on food, fiber and ornamental crops. The maximum application rate is 320 lbs. a.i./A for food and fiber crops; agricultural crops such as tobacco have higher rates. Application equipment that is used to apply metam sodium and metam potassium includes drencher, drip irrigation, gravity irrigation, soil incorporation equipment, soil injector equipment, and sprinkler irrigation. The current entry prohibition period is 48 hours.

Available information from EPA's Biological and Economic Analysis Division (BEAD) using different EPA databases indicates usage for the year 2002 is in the range of 51-55 million pounds per year for metam sodium and 1-2 million pounds per year for metam potassium. (Alsadek, J. *Internal Communication*). Most of the acreage is treated with 190 pounds or less of a.i. per application, the highest use rate is 412 lb a.i./A. Metam sodium's largest markets in terms of total pounds of active ingredient is allocated to potatoes (52.2%) followed by tomatoes (11.5%) and carrots (11.5%). The remaining usage is applied over all agricultural sectors but usage in terms of pounds active ingredient used per crop site ranges from less than 1 % to 5% (Quantitative Usage Analysis. July 13, 2004).

2.2 Structure and Nomenclature

Table 1 provides the structures and relevant nomenclature for metam sodium, metam potassium, and methyl isothiocyanate (MITC).

Table 1: Test Compound Nomenclature			
Properties	**Metam Sodium**	**Metam Potassium**	**MITC**
Chemical Structure			
Chemical Group	dithiocarbamate	dithiocarbamate	isothiocyanate
Common Name	metam sodium	metam potassium	methyl isothiocyanate
Molecular formula	$C_2H_4NS_2Na$	$C_2H_4NS_2K$	C_2H_3NS
Molecular Weight	129.18	145.289	73.12
CAS No.	137-42-8	137-41-7	556-61-6
PC Code	039003	039002	068103

2.3 Physical and Chemical Properties

A listing of the physical and chemical properties of metam sodium, metam potassium, and MITC included in this assessment is provided in Table 2.

Table 2: Physical and Chemical Properties of Metam Sodium, Metam Potassium, and MITC			
Parameter	**Metam Sodium**	**Metam Potassium**	**MITC**
Mode of Pesticidal Action	generates MITC	generates MITC	The mode of toxic action for MITC is not known at this time; reactivity with biological nucleophiles such as sulfhydryl groups of glutathione or proteins has been proposed.[1]
Appearance	yellow to light yellow-green in solution	yellow to light yellow-green (aqueous formulation (54%)[2])	colorless crystalline solid
Melting Point	N/A	N/A	35-36° C
Vapor Pressure	4.31×10^{-4} mm of Hg	24 mm of Hg at 25° C (aqueous formulation (54%)[1])	20 mm of Hg at 25° C
Partition Coefficient	(Log P) ≤-2.91	N/A	1.05 at 20° C
Solubility in Water	578.29 g/L at 20° C	yes, insoluble in mineral oil	8.94 g/L at 20° C
Toxic Impurities	none[3]	none[3]	none[3]

1 Valentine, et al., 1995

2 Data for the aqueous formulations MPs/EPs have been accepted because of the difficulties encountered in producing and maintaining aqueous solutions containing higher concentrations of active ingredient.

3 There are no major toxic impurities; however, there are several toxic degradate compounds.

3.0 Metabolism

Metam sodium and metam potassium quickly and predominantly degrade to MITC when placed in soil and water generating 60 to 83% of MITC under prevalent environmental conditions. Environmental fate data suggest that metam sodium photolyzes in surface water with a half-life of 28 minutes and metabolizes aerobically in soil with a half-life of 23 minutes. Metam sodium and metam potassium are also efficiently converted to MITC *in vivo*; therefore, MITC is considered to be the primary degradate for both metam sodium and metam potassium.

3.1 Description of Primary Crop Metabolism

In an acceptable turnip metabolism study, the results show that the ultimate breakdown products consist of natural plant biochemicals. Neither metam sodium, MITC, nor any related thioureas or methylated ureas were detected in the extractable radioactivity or the post-extraction solids. The observed radioactivity was shown to be distributed over a variety of natural products indicating complete incorporation of metam sodium into the carbon pool. These data are supported by the strawberry and tomato studies conducted with another MITC generator, dazomet. Based upon the results of the metabolism studies, residues of metam sodium and MITC are not expected to occur in plants. MITC's volatility in the environment, phytotoxity to crops, and metabolism in plants assure that there is no reasonable expectation of finite residues to be incurred in/on any raw agricultural commodity when these products are applied according to label directions. Therefore the use of metam sodium/potassium as a soil fumigant is considered to be a non-food use and tolerances are not needed.

3.2 Description of Livestock Metabolism

The requirement for a livestock metabolism study is waived for metam sodium and metam potassium because there are no metam sodium residues of concern detected in plants.

3.3 Description of Rat Metabolism

In a rat metabolism study, dazomet, metam sodium, and MITC were tested at two dose levels. All three were excreted mainly in urine with small amounts excreted in feces. Three different compounds (MITC, carbon dioxide [CO_2], carbon oxide sulfide [COS]/carbon disulfide [CS_2]) were found to be excreted in the lungs over a 73 hour collection period. There were no differences between males and females in amounts excreted *via* the three excretion routes; however, tissue and plasma levels, and plasma area under the curves (AUCs) were consistently higher in females than in males. It should be noted that these differences were approximately 2-fold or less. All three compounds were rapidly absorbed from the GI tract. High uptake was seen in the liver, kidneys, and lung, with the lowest level in testes, brain and eyes. Metabolic profiles detected in urine, liver, and kidneys were basically similar for the three compounds but there were some differences, mainly quantitative in nature. No inhalation pharmacokinetic studies are available at this time.

4.0 Hazard Assessment and Characterization

4.1 Hazard Characterization

The text and tables below were summarized or extracted from the following documents prepared for EPA's revised risk assessment for metam sodium.

- 3rd Revised Toxicology Disciplinary Chapter for: Metam Sodium (PC Code 039003) and Methyl isothiocyanate (MITC, PC Code 068103) August 19, 2004. TXRNo.: 0050771

- Toxicity endpoint selection and inhalation dosimetry calculations for metam sodium, dazomet, and MITC. August 19, 2004. TXR No: 0051475

- Human eye and nasal irritation resulting from air exposure to MITC. August 19, 2004. TXR No: 0051475

- Addendum to Memo from May 13, 2004 (TXR No.0052547): Quantification of carcinogenic potential for MITC with metam sodium cancer slope factor and cancer classification of metam sodium. August 19, 2004 TXR No. 0052776

- METAM SODIUM/METAM POTASSIUM: The HED Chapter of the Reregistration Eligibility Decision Document (RED). PC Codes 039003 and 039002. Case 2390. DP Barcode: D293329. August 19, 2004

4.1.1 Database Summary

Studies available and acceptable (animal, human, general literature)
Although the toxicological database for metam sodium and dazomet are complete for risk assessment purposes, the toxicological database for MITC is not complete. Many toxicological studies via the oral route with MITC do not meet the guideline requirements, primarily due to problems surrounding the volatility of MITC and inadequate characterization of exposure concentrations or doses. Some of the oral data gaps are being filled through bridging with the toxicology databases of metam sodium and dazomet. Relating to the inhalation toxicity with these pesticides, two subchronic inhalation studies in MITC, one subchronic inhalation study in metam sodium, and no inhalation studies in dazomet are available at this time. An eye irritation and odor threshold study in human subjects with MITC is also available.

Metabolism, toxicokinetic, mode of action data
No inhalation pharmacokinetic or metabolism studies are available at this time for MITC, metam sodium, or dazomet. Metam sodium, metam potassium, and dazomet are efficiently converted to MITC *in vivo*. Oral pharmacokinetic and metabolism studies in rats for dazomet, metam sodium, and MITC were submitted. All three were excreted mainly in urine with small amounts excreted in feces. Three different compounds (MITC, carbon dioxide [CO_2], carbon oxide sulfide [COS]/carbon disulfide [CS_2]) were found to be excreted in the lungs over a 73 hour collection period. Tissue and plasma levels at all time periods, and plasma AUCs were consistently higher in females than in males; however these differences were approximately 2-fold or less. Although, the tissue with the highest uptake for all three compounds was the thyroid gland is notable that tissue retention of radioactive material was low in both sexes and at all doses. High uptake were also seen by the liver, kidneys, and lung, with the lowest level in testes, brain and eyes. Metabolic profiles detected in urine, liver, and kidneys were basically similar for the three compounds but there were some differences, mainly quantitative in nature.

The mode of toxic action for MITC is not known at this time; reactivity with biological nucleophiles such as sulfhydryl groups of glutathione or proteins has been proposed (Valentine, et al., 1995).

Sufficiency of studies/data
An acute inhalation neurotoxicity study in MITC with additional measurements to characterize the effects on the complete respiratory tract is required at this time. There are no studies available for evaluating the effects of MITC following inhalation exposure in the young, therefore an inhalation reproductive toxicity study is also required at this time. Because of the potential for chronic exposures and the finding of focal squamous cell metaplasia in the respiratory epithelium following 28-days of inhalation exposure to MITC in rats, at this time, EPA is requiring carcinogenicity studies in mice and rats via the inhalation route.

4.1.2 Endpoints

Following air exposures to MITC, consistent effects are observed in rats and humans. For example, clinical signs and pathological changes of the respiratory tract consistent with an irritant have been observed in laboratory studies in rat. Humans exposed to MITC complain of symptoms such as itchy and burning eyes, rash and burning skin, nausea, scratchy throat, salivation, coughing, and shortness of breath. Histological changes consistent with a highly irritating compound in the nasal passages and lungs were observed in the 28-day study with MITC and also the 90-day study with metam sodium. In the 90-day inhalation study with MITC, negative histopathological findings are questionable because of several reasons including lack of nasal pathology and poor analytical data.

There is remarkable similarity in the oral doses causing similar toxic effects for metam sodium, dazomet, and MITC, particularly at low to moderate doses. Specifically, reduced body weight gain and food consumption in addition to changes in hematological parameters were observed at low doses in oral toxicity studies with rats, mice, rabbits, and dogs. Effects on the liver have been noted in dogs at doses with similar molar levels. Reduced motor activity has been noted at all dose levels in oral acute neurotoxicity testing in studies with metam sodium and dazomet. In oral developmental toxicity studies with MITC, dazomet, and metam sodium, effects such as fetal weight decrements, reduced ossification of various skeletal structures, and increased incidence of resorptions have been noted at similar molar dose levels. There is no quantitative susceptibility observed in the oral developmental and reproductive toxicity studies with metam sodium, MITC, or dazomet. All of the developmental NOAELs are equal to or larger than the NOAELs for maternal toxicity. There is, however, qualitative susceptibility in two rabbit developmental studies with dazomet and two rat developmental toxicity studies with metam sodium. In these studies, increased incidence of resorptions were noted at a dose that resulted in maternal body weight gain decreases. At higher doses levels of metam sodium, the neurotoxic effects from the *in vivo* production of CS_2 begin to manifest. Specifically, incidence of meningocele has been noted following oral administration of metam sodium in two developmental studies in rat and one developmental study in rabbits. There were no neuropathological changes noted in the oral acute and subchronic neurotoxicity studies with metam sodium and dazomet, however, the doses used in the metam sodium subchronic toxicity study may not be sufficiently high to detect these effects. There is some evidence that MITC may cause immunotoxicity at high oral and dermal doses (Pruett et al., 1992, Padgett, et al., 1992; Kiel et al., 1996).

There is no evidence of endocrine disruption in the database of toxicology studies. The systemic effects following dermal exposure to metam sodium at this time are not known; the existing dermal study does not take adequate precautions for the volatilization of MITC.

4.1.3 Dose-response

Based on the currently registered use pattern of metam sodium, dietary exposure is not expected. Acute and chronic reference doses are not necessary at this time.

Historically, for typical agricultural pesticide chemicals, the Health Effects Division (HED) has not developed quantitative risk assessments based on eye or respiratory irritation. For occupational pesticide workers, EPA assumes that the personal protective equipment (PPE) worn by workers adequately protects against irritation-type effects which could result from exposure to pesticide chemicals. The level of PPE required for workers is based on the results of quantitative risk assessments, acute dermal and inhalation toxicity testing in animals along with eye and skin irritation and skin sensitization studies. For the general population, EPA assumes that respiratory and eye irritation effects are not of concern, in general, since most agricultural pesticides are not volatile and are unlikely to move offsite after application is complete. However, the general public can be exposed to fumigants in air following application because of their volatility. Specifically, fumigants can off-gas into ambient air and can be transported off-site by wind to non-agricultural areas. For example, the California Pesticide Illness Surveillance Program (CPISP) reports that from 1990 to 1998, 278 of 390 reported cases regarding metam sodium/MITC involved non-occupational exposure from drift. The types of symptoms reported by the CPISP are consistent with exposure to an irritant and include: eye effects-- watery, burning, and itchy eyes, blurred vision; skin effects - rash, burns, redness, swelling; systemic effects- nausea, chest pain, scratchy throat, diarrhea, weakness, dizziness, headache, malaise, salivation, vomiting; and respiratory effects- cough, shortness of breath. Hazard effects induced by MITC and metam sodium have been evaluated by HED's Hazard Identification and Assessment Review Committee (HIARC) several times between 2000-2004, most recently on March 16, 2004 (TXR no 0052467). On May 24, 2004, HED's Science Policy Council (HED-SPC) met to discuss issues related to the merit of utilizing eye and/or respiratory irritation for estimating acute inhalation risk and at that meeting recommended that the eye irritation study with MITC be selected as the acute inhalation endpoint. The toxicological endpoints discussed below reflect the combined conclusions of the HIARC and HED-SPC in addition to relevant calculations using EPA's reference concentration methodology.

Based on air monitoring studies, MITC exposures can be acute (less than 24 hours), short-term (1-30 days), intermediate-term (1 month-6 months), and/or long-term (> 6 months) in duration. Occupational exposure to metam sodium and dazomet can occur from the dermal and inhalation pathways. These fumigants do not require food tolerances, are considered to be a 'non-food use.' Thus, acute and chronic reference doses are not needed for metam sodium, dazomet, or MITC.

4.1.3.1 Inhalation Exposure

As discussed in the revised risk assessment for metam sodium (Aug, 2004), following communication with EPA's Office of Air and Office of Research and Development (ORD), OPP has determined that, when appropriate, the methods and dosimetry equations described in EPA's reference concentration (RfC) guidance (1994) for calculating human equivalent concentrations (HECs) and for use in margin of exposure (MOE) calculations may be used. For example, in studies with human subjects, like the MITC eye irritatation study, interspecies extrapolation is not necessary, thus the RfC methodology is not appropriate. Compared to the methods previously used by OPP, the dosimetry equations in the RfC guidance more appropriately address different properties of gases and particles, different properties of reactive and non-reactive compounds, and explicitly consider some differences in the structure of the respiratory tract between laboratory animals and humans. As shown below, OPP has used the dosimetry equations from the RfC guidance to develop HECs for effects observed in the MITC 28-day rat study. These HECs have been used to estimate short-, intermediate-, and long-term inhalation risk to that chemical. As discussed in detail below, it is noteworthy that the dosimetry equations from the RfC guidance have not been used to develop HECs from the MITC human eye irritation study or the 90-day metam sodium inhalation study.

At present time, EPA and CDPR use different dosimetry equations for calculating inhalation risk. The two approaches differ in their use of species-specific parameters to derive HECs. Therefore, differences noted in the short-, intermediate-, and long-term risk assessments of each organization are due, in part, to their use of different methodologies and use of different uncertainty factors (UFs). Both OPP and CDPR have selected the human eye irritation study for purposes of estimating acute inhalation risk. OPP and CDPR have selected port of entry effects from the 28-day inhalation study in rats for purposes of estimating short-, intermediate-, and long-term risk. The NOAELs/LOAELs for this study, however, differ between OPP and CDPR. As OPP understands the importance to harmonize, to the extent possible with other regulatory agencies, this risk assessment will present HECs derived using both methodologies. OPP plans to continue its effort to communicate and harmonize with other regulatory organizations. Additional information on the methodologies used in this risk assessment and HEC arrays are available in Appendix B.

Acute Inhalation Exposure

a. Metam Sodium

There are no studies which provide appropriate endpoints for estimating acute inhalation risk to metam sodium. Therefore, acute inhalation risk to metam sodium has not been estimated.

b. MITC

As suggested by results of the human eye irritation with MITC and oral acute neurotoxicity studies with metam sodium and dazomet, single inhalation exposures may potentially result in adverse effects. At the present time, the data base of acceptable inhalation toxicology studies for MITC is limited to a 28-day study in rat (MRID no. 45314802), eye irritation and odor threshold in human subjects (MRID no. 44400401), and acute lethality in rat (MRID no 45919410). There are no studies with laboratory animals available which specifically evaluate the dose-response relationship and the continuum of potential *acute, single-day* respiratory effects (i.e., progression to more serious clinical outcomes) from exposure to MITC. However, the MITC eye irritation and odor threshold study (MRID 44400401) evaluated the dose-response relationship for eye irritation at exposure durations ranging from 4 minutes to 8 hours. The eye irritation study provides an appropriate endpoint for acute risk assessment for MITC.

The types of symptoms reported by the CPISP following human exposures to MITC are consistent with exposure to an irritant and include: eye effects-- watery, burning, and itchy eyes, blurred vision; skin effects - rash, burns, redness, swelling; systemic effects- nausea, chest pain, scratchy throat, diarrhea, weakness, dizziness, headache, malaise, salivation, vomiting; and respiratory effects- cough, shortness of breath. With respect to respiratory impairment, arguably, eye irritation is less severe compared to other possible effects associated with inhalation exposure to MITC, particularly given the expected reversible nature of the eye irritation effects at lower concentrations. Nonetheless, eye (as well as nose and throat) irritation is uncomfortable and could potentially interfere with everyday tasks or activities. Due to the limitations in the existing *inhalation* toxicology database for MITC, the degree to which eye irritation predicts more serious outcomes is unclear. However, in the absence of more robust dose-response data from acute exposures, eye irritation can be considered as a *biomarker* and *surrogate for potential respiratory effects*. It is also notable that EPA's RfC methodology document (1994) includes eye, nasal, and throat irritation in the list of adverse effects-- albeit at the lower end of the hierarchal list which ranks effects from most to less severe.

.

- For a one-minute exposure, the NOAEL for eye irritation is 3.3 ppm due to a lack of response in any parameter tested.

- For exposures 4-14 minutes, the NOAEL for eye irritation is 0.6 ppm based on responses on the Likert subjective scale at 1.9 ppm.

- For exposures of 1-8 hours, based on the statistically significant subjective (Likert scale) responses at 0.8 ppm MITC at 1-4 hours and the statistically significant eyeblink responses at 2 and 3 hours, 0.22 ppm was designated as the NOAEL for this study.

Dose and Endpoint for Risk Assessment: As this study used female and male human subjects, animal to human extrapolation is not necessary. No equations have been used to mathematically adjust the NOAELs provided by the eye irritation study. Typically EPA considers an UF of **10x for intraspecies extrapolation**. This study did not evaluate any persons younger than 18 or older than 67. Children and older people are potentially more sensitive than healthy adults, like those who participated in the study. Therefore, at this time there is not sufficient justification for reducing the 10x factor for intraspecies extrapolation. Consequently, a 10X UF defines HED's level of concern (10x intraspecies variation) in accordance with guidance provided in the RfC methodology (see section 4.2 below)and current HED policy.

c. Dazomet

There are no studies which provide appropriate endpoints for estimating acute inhalation risk to dazomet. Therefore, acute inhalation risk to dazomet has not been estimated.

Short and Intermediate Inhalation Exposure

a. Metam Sodium

The 90-day inhalation toxicity study with metam sodium (MRID no. 00162041) provides the endpoints for short- and intermediate-term exposures. Inhalation exposure to metam sodium, most often as an aerosol, is expected only for occupational activities. In this study, 18 Sprague-Dawley rats/sex/dose group were exposed to aerosolized metam sodium (37% a.i.) in whole-body chambers for 6 hr/day, 5 days/week. The cumulative mean chamber metam sodium concentrations were 0, 6.5, 45 and 160 mg/m^3 (measured values based on the *sodium ion* level corrected for sodium ion levels measured from the control). Reviewers at the CDPR calculated the doses to be 0, 1.11, 7.71, and 27.43 mg/kg/day. Mean MITC measured concentrations were 0, 0.78, 2.2, and 5.7 mg/m^3 (0, 0.12, 0.38, 0.98 mg/kg/day) (measured by intrared adsorption).

Dose and Endpoint for Risk Assessment: The LOAEL in females is 45 mg/m^3 (7.71 mg/kg/day)of metam sodium (based on Na levels; 2.2 mg/m^3 [0.38 mg/kg/day] measured MITC), based on histopathological changes in the nasal passages (ie, mucigenic hyperplasia) and changes in clinical chemistry. The LOAEL in males is 160 mg/m^3 (27.43 mg/kg/day) of metam sodium (based on Na levels; 5.7 mg/m^3 [0.98 mg/kg/day] measured MITC) based on histopathological changes in the lungs and nasal passages.

The NOAEL for females is **6.5 mg/m^3 (1.11 mg/kg/day)**of metam sodium (based on Na levels; 0.7 mg/m^3 [0.12 mg/kg/day] measured MITC). The NOAEL for males is 45 mg/m^3 (7.71 mg/kg/day)of metam sodium (based on Na levels; 2.2 mg/m^3 [0.38 mg/kg/day] measured MITC).

The inhalation dosimetry equations in the RfC methodology have *not* been used in the calculation of occupational inhalation risk to metam sodium. Because of the nature of the available exposure data for metam sodium and the need to use PHED in occupational risk calculations, OPP has not revised the toxicity endpoint for use in MOE calculation. In the coming months, as the fumigant cluster risk assessment develops and is further refined, OPP may determine that is appropriate to calculate HECs for metam sodium based on the 90-day rat inhalation study. This study is of the appropriate duration for these risk assessments. Default 10x factors for intraspecies and interspecies extrapolation are appropriate for establishing HED's LOC for short- and intermediate-term inhalation risk to MITC. Thus, a combined UF of 100X defines HED's level of concern.

b. MITC

In a 28 day inhalation toxicity study (MRID 45314802), Methyl Isothiocyanate [96.9 % a.i.] was administered to 5/sex/dose of SPF Wistar/Chubb:THOM rats by whole body exposure at analytical concentrations of 0, 5.0, 20, or 100 mg/m^3 equivalent to 0, 5.0, 20, or 100 ug/L (measured concentrations 0, 5.1, 19.9 or 100 ug/L) and (equivalent to concentrations of 0, 1.7, 6.8, and 34 ppm) for 6 hours per day, 5 days/week for a total of 28 days.

Dose and Endpoint for Risk Assessment: The RfC methodology recommends the development of array tables which evaluate inhalation dosimetry and animal to human extrapolation for systemic effects in addition to local effects in the extrathoracic, tracheobronchial, and pulmonary regions of the respiratory tract. EPA has developed array tables for the effects from the 28-day MITC inhalation study using the NOAELs and LOAELs shown below. The array tables can be found in "Toxicity endpoint selection and inhalation dosimetry calculations for metam sodium, dazomet, and MITC (August 19, 2004. TXR No:

0051475)".

- The systemic LOAEL is 19.9 mg/m^3,(6.8 ppm), based on clinical signs consistent with irritation in both sexes and increased neutrophilic polymorphonuclear granulocytes in the blood of males. The systemic NOAEL is 5 mg/m^3(1.7 ppm).

- The LOAEL for effects in the extrathoracic (ET) region is 100 mg/m^3,(34ppm), based on observation of pathological changes of the nasal cavity (metaplasia of respiratory epithelium and atrophy of the olfactory epithelium). The ET NOAEL is 19.9 mg/m^3(6.8 ppm).

- The LOAEL for effects in the tracheabronchial (TB) region is 100 mg/m^3(34ppm), based on observation of pathological changes (tracheal epithelial proliferation and single cell necrosis, bronchopneumonia and bronchial and bronchiolar epithelial proliferation). The TB NOAEL is 19.9 mg/m^3(6.8 ppm).

As shown below, the pathological effects noted in the nasal cavity (i.e, extrathoracic region; metaplasia of respiratory epithelium and atrophy of the olfactory epithelium) are the most sensitive for this study and have been used to estimate short-, intermediate-, and long-term inhalation risk to MITC. Because EPA's RfC methodology accounts for some of the pharmacokinetic differences between animals and humans, the interspecies factor is typically reduced to 3x. [This 3x accounts for pharmacodynamic differences between animals and humans]. A 10x factor for intraspecies extrapolation accounts for within species variability. Thus, HED's LOC for short- and intermediate-term inhalation risk to MITC is an MOE of 30. The HECs differ between non-occupational and occupational scenarios because the residential HEC is based on 24-hour exposures occurring 7 days per week, whereas the occupational HEC is based on 8-hour exposures occurring 5 days per week.

c. Dazomet

There are no inhalation studies with dazomet available at this time. Inhalation exposure to dazomet is expected only for occupational activities. See HECs calculated for MITC.

Chronic Inhalation Exposure

a. Metam Sodium

Long-term occupational exposure to metam sodium is not expected.

b. MITC

Ambient air monitoring data indicates that chronic exposure is possible. At present time, there are no chronic inhalation studies with MITC. Thus, the 28-day inhalation study in rats provides the most appropriate endpoints for estimating long-term risk to MITC. There is uncertainty regarding effects from chronic exposures and the degree to which the pathological changes in the respiratory tract, notably metaplasia of respiratory epithelium, could occur at lower exposure concentrations following longer exposure durations. EPA's RfC methodology accounts for some of the pharmacokinetic differences between animals and humans, the interspecies factor is typically reduced to 3x. [This 3x accounts for pharmacodynamic differences between animals and humans]. A 10x factor for intraspecies extrapolation accounts for within species variability. EPA historically applies a 10x factor to account for the uncertainties in extrapolating from subchronic to chronic duration. Thus, HED's LOC for long-term inhalation risk to MITC is an MOE of 300.

c. Dazomet

Long-term occupational exposure to dazomet is not expected.

4.1.3.2 Dietary Exposure

Metam sodium's volatility in the environment and results of metabolism studies in plants assure that there is no reasonable expectation of finite residues to be incurred in/on any raw agricultural commodity when these products are applied according to label directions. Therefore, this fumigant does not require food tolerances; therefore, a dietary risk assessment is not required.

4.1.3.3 Dermal Exposure

4.1.3.3.1 Dermal Absorption

a. Metam Sodium

Dermal Absorption Factor: 2.5%

^{14}C-Metam sodium was applied to male rats in aqueous formulations at the nominal dose levels of 0.1, 1 and 10 mg/rat to an area of 11.6 cm^2 on the back. The application site was protected by a glass saddle which contained an activated charcoal filter to adsorb any volatile radioactivity which evaporated from the skin surface. Within each group, four animals were killed following a 1, 2, 10, and 24 hours exposure and excreta collected over the study period. For 4 additional animals in each treatment group, the treatment area was washed 10 h after administration and excretion monitored over a total of 72 hours. Mean percent absorbed dose at 10 hours was 2.5% (2.355%, 3.683%, 1.514%, respectively).

b. MITC

No dermal absorption studies are available. The HIARC did not select a dermal absorption factor for MITC. Dermal endpoints were not selected; dermal risk assessments for MITC are not required.

c. Dazomet

Dermal Absorption Factor: 4.5%
No dermal absorption studies are available. A percent dermal absorption can be estimated by comparing the results of the oral and dermal toxicity studies. Ideally, LOAEL for the similar effects and in the same species via oral and dermal route may be used in estimating dermal absorption. However, the NOAEL in rabbit 21-day dermal toxicity was greater than 1000 mg/kg/day (HDT). A dermal absorption value for dazomet is estimated to be 4.5% (developmental and maternal LOAEL of 45 mg/kg/day in rabbits divided by NOAEL of 1000 mg/kg/day dermal study times 100).

4.1.3.3.2 Short- Term, Dermal (1-30 days) Exposure

a. Metam Sodium

The metam sodium developmental toxicity study in rats (MRID nos 41577101, 42170101, and 92097012) provides the endpoint for the short-term dermal risk assessment. In this developmental toxicity study, metam sodium (42.2%) was administered at dose levels of 0, 4.22, 16.88, and 50.64 mg/kg/day (0, 2.36, 9.45 and 28.36 mg/kg/day MITC equivalent) by gavage to pregnant Wistar rats from days 6 through 15 of gestation.

Dose and Endpoint for Risk Assessment: The developmental LOAEL is 16.88 mg/kg bw/day (9.45 mg/kg/day MITC equiv.), based on the increased incidence of skeletal observations and the increase in total resorptions and resorptions/dam The developmental NOAEL is 4.22 mg/kg /day. Since an oral NOAEL was selected, the 2.5 % dermal absorption factor should be used for route-to-route extrapolation. Default 10x factors for intraspecies and interspecies extrapolation are appropriate for establishing HED's LOC for short-term dermal risk to metam sodium. Thus, a combined UF of 100X defines HED's level of concern.

b. MITC

A short-term dermal endpoint for MITC was not selected. No dermal hazard via typical dermal contact with MITC is expected. Unprotected skin could be exposed to MITC vapor; however this exposure can not, at this time, be quantified.

c. Dazomet

The acute neurotoxicity study with dazomet (MRID no 43465302) provides the endpoint for the short-term dermal risk assessment. This study, Wistar Chbb: THOM (SPF) rats (10/sex/group) were orally gavaged once with dazomet in 0.5% aqueous carboxymethylcellulose at doses of 0 (vehicle only), 50, 150 and 450 mg/kg body weight (a.i. equivalents: 50, 130, and 450 mg/kg) for males and 0, 15, 50, and 150 mg/kg body weight (a.i. equivalents: 13, 50, and 130 mg/kg) for females.

Dose and Endpoint for Risk Assessment: The LOAELs with dazomet for neurobehavioral effects were established at 50 mg/kg in males (FOB findings and reduced number of rearings) and 15 mg/kg in females (decreased motor activity). Since an oral LOAEL was selected, the 4.5 % dermal absorption factor should be used for route-to-route extrapolation. Default 10x factors for intraspecies and interspecies extrapolation are appropriate for short-term dermal risk to dazomet. A NOAEL was not achieved; an additional 10x uncertainty factor is typically applied for the use of a LOAEL (UF_L). Thus, a combined UF of 1000X defines HED's level of concern for short-term dermal risk to dazomet.

4.1.3.3.3 Intermediate- Term, Dermal (1 -6 months) Exposure

a. Metam Sodium

The chronic toxicity in the dog (MRID no 43275801) provides the endpoint for the intermediate-term dermal risk assessment. Metam sodium (43.148% w/w, Batch Reference: BAS/005/00N 90-2) was administered to 4 beagle dogs/sex/dose in gelatin capsules at doses of 0, 0.05, 0.1, and 1.0 mg/kg/day (0, 0.028, 0.056 and 0.56 mg/kg/day MITC equivalent) for 52 weeks.

Dose and Endpoint for Risk Assessment: The LOAEL is > 1mg/kg/day in males and equal to 1 mg/kg/day for females, based on increased ALT and microscopic changes in the liver. The NOAEL is = 1 mg/kg/day for males and 0.1 mg/kg/day for females. This dose/endpoint is appropriate for the intermediate-term exposure duration since increases in ALT were seen over the course over the study until termination. Since an oral NOAEL was selected, the 2.5 % dermal absorption factor should be used for route-to-route extrapolation. Default 10x factors for intraspecies and interspecies extrapolation are appropriate for establishing HED's LOC for intermediate-term dermal risk to metam sodium. Thus, a combined UF of 100X defines HED's level of concern.

b. MITC

An intermediate-term dermal endpoint for MITC was not selected. No dermal hazard via typical dermal contact with MITC is expected. Unprotected skin could be exposed to MITC vapor; however this exposure can not, at this time, be quantified.

c. Dazomet

The subchronic toxicity in the rat (MRID no 41865502) provides the endpoint for the intermediate-term dermal risk assessment. In this study, dazomet(>97% a.i.) was administered to 10 Wistar Chub-THOM (SPF) rats/sex/dose in the diet for 90 days, at dose levels of 0, 20, 60, 180, or 360 ppm. The achieved doses of dazomet were 1.5, 4.5, 13.7, and 28.0 mg/kg/day in males and 1.7, 5.3, 15.4, and 32 mg/kg/day in females.

Dose and Endpoint for Risk Assessment: The systemic NOAEL is 1.5 mg/kg/day in male rats. The systemic LOAEL is 4.5 mg/kg/day for male rats based on increased liver weight, liver:body weight ratio and pronounced foci of fatty degeneration in the liver. Since an oral NOAEL was selected, the 4.5 % dermal absorption factor should be used for route-to-route extrapolation. Default 10x factors for intraspecies and interspecies extrapolation are appropriate for establishing HED's LOC for intermediate-term dermal risk to dazomet. Thus, a combined UF of 100X defines HED's level of concern.

4.1.3.3.4 Long-Term Dermal (>6 Months) Exposure

a. Metam Sodium

Long-Term exposure via the dermal route is not expected.

b. MITC

A long-term dermal endpoint for MITC was not selected. No dermal hazard via typical dermal contact with MITC is expected. Unprotected skin could be exposed to MITC vapor; however this exposure can not, at this time, be quantified.

c. Dazomet

A long-term dermal endpoint for dazomet was not selected. Long-Term exposure via the dermal route is not expected considering the use pattern and its stability in the environment.

4.1.3.4 Classification of Carcinogenic Potential

a. Metam Sodium

The Health Effects Division Carcinogenicity Peer Review committee (CPRC) met on March 01, 1995 to discuss and evaluate the weight -of-the-evidence on metam sodium with particular reference to its carcinogenic potential. The CPRC concluded that metam sodium should be classified as a Group B2 - probable human carcinogen, based on statistically significant increases in malignant angiosarcomas in both sexes of the CD-1 mouse in male. The CPRC recommended that for the purpose of risk characterization, a low dose extrapolation model be applied to the animal data for the quantification of human risk (Q,*) , based on the total incidence of angiosarcomas in male mice, at all sites combined. The most potent unit risk (Q1*) is $1.98x10^{-1}$ in human equivalents converted from animals to humans by use of the 3/4's scaling factor (HED Doc. No. 012954).

Members of the metam sodium risk assessment team and the Health Effects Division's Science Policy Council met on August 10, 2004 to discuss issues related to characterizing cancer risk to methylisothiocyanate (MITC) and metam sodium and to consider public comments received on EPA's preliminary risk assessment of metam sodium (May, 2004) regarding a reclassification of metam sodium's cancer risk. HED considered the public comments and documents provided by the Metam Sodium Alliance and concluded that re-evaluation by the CARC is not warranted at this time–the Group B2 cancer classification for metam sodium remains (TXR 0052776).

b. MITC

There are insufficient data to characterize the cancer risk of MITC, due to the limitations in the rat and mouse MITC oral carcinogenicity studies, and also the lack of chronic testing via the inhalation route.

c. Dazomet

At the March 10, 1993 and on May 26, 1993, meeting the HED Cancer Peer Review Committee (CPRC) classified dazomet as a "Group D- not classifiable as to human carcinogenicity" based on the lack of tumors in male B6C3F1 mice, equivocal evidence for hepatocellular tumors in females, and carcinogenicity and chronic feeding studies in Wistar rats which appeared to be negative for carcinogenicity.

4.2 Uncertainty Factors

Based on the currently registered use pattern of metam sodium, dietary exposure is not expected. Acute and chronic reference doses are not necessary at this time; the 10x factor provided by the Food Quality Protection Act of 1996 does not apply.

For metam sodium, dazomet, and MITC, the uncertainty factors differ based on duration and route of exposure.

- For acute inhalation exposures to MITC, because a study using human subjects is being used, an interspecies factor is not necessary. A default 10X was assigned for intraspecies variability.

- For short, intermediate, and long-term inhalations exposures to MITC, the RfC methodology was used to estimate HECs from the 28-day inhalation rat study. The RfC methodology takes into consideration some of the PK differences between rats and humans; thus the UF for interspecies extrapolation may be reduced to 3X while the UF for intraspecies variation is retained at 10X. The combined UF for short- and intermediate-term risk assessment is 30X. An additional 10X factor to account for extrapolation from subchronic to chronic exposure is assigned for long-term exposure; the combined UF for long-term risk assessment for MITC is 300X.

- For dermal occupational exposures to metam sodium, default 10x factors for intraspecies and interspecies extrapolation are appropriate. The combined UF for short- and intermediate-term dermal exposures is 100X.

- For short-term dermal occupational exposures to dazomet, default 10x factors for intraspecies and interspecies extrapolation are appropriate. A 10x factor is applied for a LOAEL to NOAEL extrapolation. The combined UF for short- and intermediate-term dermal exposures is 1000X.

- For intermediate-term dermal occupational exposures to dazomet, default 10x factors for intraspecies and interspecies extrapolation are appropriate. The combined UF for short- and intermediate-term dermal exposures is 100X.

- For inhalation occupational exposures to metam sodium, the RfC methodology was not used to calculate HECs. Default 10x factors for intraspecies and interspecies extrapolation are appropriate. The combined UF for short- and intermediate-term inhalation exposures to metam sodium is 100X.

- Based on the currently registered uses (as of August 19, 2004) of metam sodium, metam potassium, dazomet, and/or MITC, dietary exposure is not expected. Acute and chronic reference doses are not necessary at this time; the 10x factor provided by the Food Quality Protection Act of 1996 does not apply.

4.3 Endocrine Disruption

Following recommendations of its Endocrine Disruptor and Testing Advisory Committee (EDSTAC), EPA determined that there was a scientific basis for including, as part of the endocrine disruption screening program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC’s recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

It is notable that based on the available toxicology studies in metam sodium and MITC, there is no indication of endocrine disruption.

4.4 Summary of Toxicological Endpoint Selection

Table 3: Summary of Toxicological Dose and Endpoints for Use in Metam Sodium Oral and Dermal Human Health Risk Assessments			
Exposure Scenario	**Dose Used in Risk Assessment**	**Uncertainty Factors and Level of Concern for Risk Assessment**	**Study and Toxicologial Effects**
Acute Dietary general population including infants and children	Acute dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.		
Chronic Dietary all populations	Chronic dietary endpoints were not selectedsince the use-pattern does not indicate potential for dietary exposure.		
Dermal Short-Term (1 - 30 days) Occupational	Maternal NOAEL[a,d]= 4.22 mg/kg/day Dermal absorption factor = 2.5%	**Occupational** = LOC[c] for MOE = 100	**Developmental toxicity in rat (MRID 41577101)** LOAEL[f] = 16.88 mg/kg/day based on reduced body weight gain and decreased food efficiency in maternal rats
Dermal Intermediate-Term (1 - 6 Months) Occupational	Oral NOAEL[a]= 0.1 mg/kg/day Dermal absorption factor = 2.5%	**Occupational** = LOC for MOE = 100	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on increased ALT and microscopic changes in the liver in females.
Dermal Long-Term (> 6 Months) Occupational	Oral NOAEL[a]= 0.1 mg/kg/day Dermal absorption factor = 2.5%	**Occupational** = LOC for MOE = 100	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on based on increased ALT and microscopic changes in the liver in females.
Cancer	**Classification:** Probable human carcinogen (B2) **Q1* =**1.98×10^{-1} in human equivalents converted from animals		

a Since an oral NOAEL was selected, a dermal absorption factor of 2.5% should be used in route-to-route extrapolation.; b Margin of Exposure (MOE) = 100 [10x for interspecies extrapolation and 10x for intraspecies variations.]; c LOC = level of concern; d NOAEL = no observed adverse effect level; e LOAEL = lowest observed adverse effect level.

Table 4: Summary of Toxicological Dose and Endpoints for Use in MITC Oral and Dermal Human Health Risk Assessments			
Exposure Scenario	**Dose Used in Risk Assessment**	**Uncertainty Factors and Level of Concern for Risk Assessment**	**Study and Toxicologial Effects**
Acute Dietary General population including infants and children	Dietary exposure is not expected for MITC at present time.		
Chronic Dietary (All populations)	Dietary exposure is not expected for MITC at present time.		
Dermal **All durations**	No dermal hazard via typical dermal contact with MITC is expected. Unprotected skin could exposed to MITC vapor; however this exposure can not, at this time, be quantified.		
Cancer	Classification: Insufficient data to characterize cancer risk		

a Margin of Exposure (MOE) or Uncertainty Factors (UF) = 100 [10x for interspecies extrapolation, 10x for intraspecies variations.]; b LOC = level of concern; c NOAEL = no observed adverse effect level; d LOAEL = lowest observed adverse effect level.

Table 5: Summary of Toxicological Dose and Endpoints for Use in Dazomet Oral and Dermal Human Health Risk Assessments			
Exposure Scenario	**Dose Used in Risk Assessment**	**Uncertainty Factors and Level of Concern for Risk Assessment**	**Study and Toxicologial Effects**
Acute Dietary (General population including infants and children)	Acute dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.		
Chronic Dietary (All populations)	Chronic dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.		
Dermal Short-Term (1 - 30 days) Occupational	Oral LOAEL[a]= 15 mg/kg/day	**Occupational** LOC for MOE = 1000[d]	**Acute neurotoxicity study (MRID 43465302)** LOAEL[f] = 15 mg/kg in females (6.75 mg/kg MITC equivalents; decreased motor activity) based on neurobehavioral effects FOB findings and reduced number of rearings**.**
Dermal Intermediate-Term (1 - 6 months) Occupational	Oral NOAEL[a,e]= 1.5	**Occupational** LOC for MOE = 100[g]	**Subchronic toxicity- feeding rats (MRID 41865502)** LOAEL = 4.5 mg/kg/day based on increased liver weight, liver:body weight ratio and pronounced foci of fatty degeneration in the liver
Dermal Long-Term (> 6 Months) Occupational	Long-Term exposure via the dermal route is not expected considering the use pattern and its stability in the environment.		
Cancer	**Classification: Not classifiable as human carcinogen.**		

a Use 4.5% dermal absorption to convert oral dose to dermal equivalent; c Level of Concern = LOC; d Margin of Exposure (MOE) = 1000 [10x for interspecies extrapolation, 10x for intraspecies variations, 10x NOAEL to LOAEL factor]; e NOAEL = no observed adverse effect level; f LOAEL = lowest observed adverse effect level; g 100 [10x for interspecies extrapolation, 10x for intraspecies variations.]

Table 6: Summary of Toxicological Dose and Endpoints for Use in Metam Sodium Human Health Inhalation Risk Assessment						
Risk Assessment		**Study**	**NOAEL/LOAEL**	**Endpoints**	**HED HECs**	**CDPR HECs**
Acute	Occupational	No appropriate studies are available.				Same
Short- and Intermediate-Term Inhalation (1 day to 6 months)	Occupational	**90-day inhalation study (MRID00162041)**	NOAEL= 6.5 mg/m^3 (1.11 mg/kg/day) LOAEL =45 mg/m^3 (7.71 mg/kg/day) in females	histopathological changes in the naval passages (ie, mucigenic hyperplasia) and changes in clinical chemistry.	HEC: 6.5 mg/m^3 (1.11 mg/kg/day) UF = 300	None selected; Note: OPP and DPR agree on NOAELs and LOAELs
Cancer		**Classification:** Probable human carcinogen (B2) **Q1* =**$1.98x10^{-1}$ in human equivalents converted from animals				Q1* =$1.85x10^{-1}$ in human equivalents converted from animals

a Uncertainty Factors = UF [10x for interspecies extrapolation, 10x for intraspecies variations,10 x for subchronic to chronic.]; b NOAEL = no observed adverse effect level; c HEC = Human equivalent concentration; d HC = Human concentration.; e HECs differ between non-occupational and occupational scenarios because the residential HEC is based on 24-hour exposures occurring 7 days per week, whereas the occupational HEC is based on 8-hour exposures occurring 5 days per week; f LOAEL = low observed adverse effect level.

Table 7: Summary of Toxicological Dose and Endpoints for Use in MITC Human Health Inhalation Risk Assessment						
Risk Assessment		**Study**	**NOAEL/LOAEL**	**Endpoints**	**HED HECs**	**CPDR[g] HECs**
Acute	Non-occupational and Occupational	Eye irritation study (MRID 44400401)	One minute NOAEL[b] = 3.3 ppm 4-14 minutes NOAEL = 0.6 ppm 1-8 hours NOAEL = 0.22 ppm	Subjective responses to the Likert scale and eyeblink responses	One minute HC = 3.3 ppm UF = 10 4-14 minutes HC = 0.6 ppm UF = 10 1-8 hours HC = 0.22 ppm UF = 10	Same
Short- and Intermediate-Term Inhalation (1 day to 6 months)	Non-occupational	28-day inhalation study in rat (MRID 43514802)	NOAEL = 6.8 ppm LOAEL[f] = 34 ppm	Metaplasia of respiratory epithelium and atrophy of the olfactory epithelium	0.16 ppm UF = 30	0.30 ppm UF = 300
	Occupational	Same as non-occupational			0.68 ppm UF = 30[e]	0.30 ppm UF = 300
Long-Term Inhalation (>6 months)	Non-occupational	28-day inhalation study in rat (MRID 43514802)	NOAEL = 6.8 ppm LOAEL[f] = 34 ppm	Metaplasia of respiratory epithelium and atrophy of the olfactory epithelium	HEC: 0.16 ppm UF = 300	0.30 ppm UF = 3000
	Occupational	Same as non-occupational			HEC: 0.68 ppm UF = 300[e]	0.30 ppm UF = 3000
Cancer		Classification: Insufficient data to characterize cancer risk				

a Uncertainty Factors = UF [10x for interspecies extrapolation, 10x for intraspecies variations,10 x for subchronic to chronic.]; b NOAEL = no observed adverse effect level; c HEC = Human equivalent concentration; d HC = Human concentration.; e HECs differ between non-occupational and occupational scenarios because the residential HEC is based on 24-hour exposures occurring 7 days per week, whereas the occupational HEC is based on 8-hour exposures occurring 5 days per week; f LOAEL = low observed adverse effect level; g Differences between OPP and CDPR reflect different methodologies, Ufs, and NOAELs; h CDPR did not use this NOAEL to calculate risks.

5.0 Public Health Data

The effects of drifting MITC are usually minor to moderate leading primarily to irritant effects to eyes, throat, and skin, headache, nausea and shortness of breath. A serious threat to bystander health reported in the literature is the development and exacerbation of asthma seen in adults exposed to the fumes from an accidental spill in the Sacramento River in California. This incident is described in detail, below. The potential for MITC to drift and cause health effects at distances above one-quarter mile and many hours after application is well documented. Direct contact of metam sodium to skin surfaces is well documented to cause irritative dermatitis. The potential for health effects to large numbers of persons in communities and schools adjacent to metam sodium applications, either by a sprinkler system or poorly sealed soil fumigation is also well documented.

There are a number of different datasets with which HED compiled a human exposure incident report for metam sodium and its toxic degradate MITC. The OPP Incident Data System includes reports of incidents submitted to OPP since 1992. These reports are from various sources, including registrants, other federal and state health and environmental agencies, and private individuals, and are anecdotal unless otherwise noted. The many incidents reported in OPP IDS include incidents related to the sewer use of metam sodium, a 1997 incident involving the use of metam sodium in a greenhouse, and incidents related to the agricultural use of metam sodium. The review by Blondell and Hawkin includes a summary of all metam sodium-related incidents reported to OPP IDS through 2002.

Another OPP source of incident information is Poison Control Center (PCC) data from 1993-1998 that are obtained from about 65-70 centers at hospitals and universities. Dermal symptoms were most commonly reported among Poison Control Center cases, including skin irritation or pain. Other symptoms included erythema, rash, severe burn, eye irritation, nausea, and difficulty breathing.

Detailed descriptions of 902 cases submitted to the CPISP from 1982 to 1994 were also reviewed by Blondell and Hawkin. In 889 of these cases, metam sodium was used alone or was judged to be responsible for the health effects reported. Excluding the 435 cases resulting from the derailment into the Sacramento River of a six-car train carrying metam sodium in 1991, metam sodium still ranked in the top 40 pesticides responsible for systemic poisoning in California from 1982 to 1994. According to these data, changes in wind direction and temperature inversions can readily contribute to significant illness. Metam sodium accounted for nine percent of the nearly 1,000 drift-related (*i.e.*, bystander) cases reported in California from 1994 through 1997 and 22% of the incidents involving clusters of 10 or more people during the same time period.

The state of California summarized 2002 pesticide incident data at www.cdpr.ca.gov/doc/whs/2002pisp/. Between 2001 and 2002, the number of potential cases of pesticide illness in California more than doubled, 979 cases in 2001 and 1,859 cases in 2002. The state attributes this increase to two factors: increased surveillance, and a significant number of reported cases from two metam sodium incidents involving drift from agricultural fields, one involving vineyard workers in Bakersfield on June 6, 2002, and one involving residents of Arvin on July 8 2002.

Another source of incident data reviewed by Blondell and Hawkin is the National Institute of Occupational Safety and Health (NIOSH) Sentinel Event Notification System for Occupational

Risks (SENSOR). In addition to metam sodium incidents from California, NIOSH compiled data on metam sodium incidents from Arizona (2 incidents) and Oregon (3 incidents) for the period from 1998 to 2002. Under special arrangement with NIOSH, Washington State prepared a summary of 11 metam sodium incidents reported between 1994 and 2001. Washington State identified the following factors as contributing to metam sodium incidents and health effects: non-compliance with personal protective equipment (PPE) requirements, a lack of worker and supervisor understanding of product hazards, inadequately protective labeling for chemigation applications, and the common occurrence of temperature inversions in Washington state during potato chemigation applications. Details about all of these incidents are provided in the Blondell and Hawkins review.

HED also conducted an extensive literature review to find additional information on metam sodium incidents. Calvert, et al. (2004) published "Acute Occupational Pesticide-Related Illness in the US, 1998-1999: Surveillance Findings From the SENSOR-Pesticides Program" which evaluated acute pesticide related illness as reported by seven member SENSOR-pesticide program states using a common case definition for pesticide illness. The report calculated acute pesticide-related illness incidence rates across multiple states. This is the first report of pesticide related illness incidence across more than one state. The states included in the report are: California, Texas, Oregon, New York, Florida, Louisiana, and Arizona. The numerator for the incidence calculation was the total number of illness cases and the denominator was obtained from the full time equivalent (FTE) estimates derived from the Current Population Survey conducted between 1998 and 1999. The incidence rates was 1.17 pesticide-related illnesses per 100,000 FTEs. The study also ranked the pesticides for which the largest number of acute occupational pesticide-related illnesses were reported. Metam sodium was ranked number 9 of the top 16 pesticide active ingredients thought to be responsible for the largest number of acute occupational pesticide related illnesses. Thirty-eight incidents attributed to metam sodium were reported across the seven SENSOR-pesticide states (Calvert et al., 2004).

A great deal of information is available concerning metam sodium incidents in California, from sources including CDPR reports and other scientific articles. In 1991, there was a major spill of metam sodium into the Sacramento River near the Cantara Loop rail curve in the state of California. Hundreds of people in the surrounding area were treated for the effects of exposure. Most individuals reported throat and eye irritation, dizziness, vomiting, shortness of breath, nausea, and headache. Other individuals reported chest tightness, cough, abdominal pain, diarrhea, skin rash, rapid breathing, tremulousness, and paraethesia. Spill researchers estimated exposure concentrations were likely in the range of 1400-1600 ppb. Three to four months after the spill, researchers found that exposed individuals had significantly higher blood pressure; increased neurological, memory and concentration problems; anxiety; depression; sleep disorders; headaches; visual and olfactory problems; and, dermatological gastrointestinal and cardiac symptoms than those who were not exposed (Bowler et al., as reported by Blondell and Hawkins, 2003). Other researchers investigating the effects of the metam sodium spill concluded that "the time course for symptom reports, large numbers of symptom reports, consistency of symptoms with known toxicologic endpoints, and comparability of symptom reports with exposure predictions favor the interpretation that MITC caused the health problems" (Kreutzer et al. as reported by Blondell and Hawkins, 2003). It is also noted that MITC is one of a small group of compounds with an irritation threshold that is lower than its odor threshold.

Other researchers reported that after this spill, adults who lived and worked near the spill cite experienced persistent respiratory disorders including irritant-induced asthma. Data collected from the medical records, history, physical examination, spirometry, and methacholine challenge testing and revealed 20 cases of persistent irritant induced asthma and 10 cases of persistent exacerbation of asthma. The 20 cases with new onset of asthma due to exposure to metam sodium included 17 cases that met the criteria for RADS (reactive airway dysfunction syndrome). For these cases, symptoms persisted from 3 to 14 months. Of the 10 patients with persistent aggravation of existing asthma, all patients still had the problems even 3-15 months after the spill as compared to baseline prior to exposure to metam sodium. The study authors concluded that both exposure concentration and duration of exposure were factors in the development of long-term respiratory health effects. The same study authors note that the Bhopal, India release of methyl isocyanate (MIC), a photolysis degradate of MITC, has resulted in acute irritative effects followed by other long-term respiratory effects. These effects included increased cough and phlegm, difficulty breathing, and evidence of reduced lung function. Based on laboratory measurements MIC represents 4-7% of the MITC in the air (Blondell and Hawkins, 2003).

In the last five years, a number of incidents have occurred in California involving drift exposure to worker or residential bystanders following agricultural applications of metam sodium or metam potassium. More detailed analyses of some of these incidents are available in reports and published studies including CDHS-OHB (2001; Cuyama incident), Goh and Barry (2002; Arvin incident), and O'Malley et al. (2004; Earlimart incident).

In addition, OPP received preliminary information on two 2003 incidents involving agricultural applications and bystander exposure. In Bakersfield, California, 15 people (including children) experienced symptoms following a shank injection application of metam sodium in a field across the street from their homes. Three sought medical care. Symptoms included difficulty breathing, sore throats, headaches, stinging and watery eyes, runny nose, flu-like symptoms. In Coachella Valley in Riverside county, at least nine residents reported symptoms to Hazmat responders following a sprinkler irrigation application of metam potassium more than 1300 feet from two mobile home parks. Three of the Hazmat responders also experienced symptoms. Symptoms included eye irritation and coughing.

Review of Metam Sodium Incident Reports. D293158, Blondell and Hawkins September 24, 2003

6.0 Non-Occupational Exposure Assessment and Characterization

Metam sodium and metam potassium produce the degradate methyl isothiocyanate (MITC). HED has assumed that the exposure and risk to MITC from metam potassium use are similar to that estimated in the assessment for MITC from metam sodium use. It should be noted that this assessment is based only on the risk associated with metam sodium and it's metabolite MITC; however, application of metam sodium may also result in exposure to other breakdown products that are volatile and have known toxicity including methyl isocyanate (MIC), hydrogen sulfide, and carbon disulfide. HED believes that risks for exposure to the breakdown products will be no worse than those estimated for MITC exposures.

This section describes the potential exposure scenarios associated with the use of metam sodium. These include residential bystander exposure from two key sources including: known sources from an application site (i.e., area sources such as at the edge of a treated field) and ambient air levels that result from many application(s) within a region where the sources are not quantified. There are no residential uses of metam sodium by homeowners so this aspect of the risk assessment focuses on those types of exposures that may occur from commercial uses of metam sodium that can lead to exposures to MITC in residential environments. *Section 6.1: Residential Bystander Exposure And Risk Estimates* describes how exposure and risk estimates were calculated for the general population who may be exposed living in proximity to individual application sites or within regions where metam sodium use routinely occurs. *Section 6.2: Bystander Risk Characterization* describes the factors that should be considered when interpreting the results of this risk assessment. *Section 6.3: Residue Profile* describes the residue data that were considered for the dietary risk assessment. *Section 6.4: Water Exposure/Risk Pathway* describes issues related to the potential for drinking water exposure.

6.1 Residential Bystander Exposure

Residential bystander exposure may occur because of emissions from treated fields or sewers. These emissions can travel to non-target areas which could lead to negative impacts on human health and will be referred to simply as bystander risks in this assessment. Bystander exposures can occur as a result of being in contact with residues that were emitted from a known source and also from non-quantified source(s) within a localized region. For clarity, a known source in this assessment is intended to represent area sources from a single application (e.g., a treated farm field). [Note: Metam sodium use practices often dictate that multiple, sequential applications such on large tracts of farmland occur which would be considered multiple known sources. At this time, HED has not developed a representative approach for addressing such situations but will further evaluate such situations during risk management in order to tailor results to particular risk management needs.]

When considering the potential risks of bystanders for known area or point sources from single applications (e.g., a farm field) it is important to understand that this has been an iterative process that reflects the evolution of HED's methodologies for calculating the potential risks associated with fumigant use. There are a number of volatility studies which quantified MITC emissions from metam sodium treated fields and facilities. However, these data are limited in their utility because they provide results only for the specific conditions under which the experiments were conducted. Therefore, to provide flexibility, HED also used ISCST3 or the Industrial Source Complex: Short-Term Model to develop risk estimates for bystanders associated with metam sodium uses (http://www.epa.gov/scram001/). [Note: Also refer to http://www.epa.gov/scram001/guidance/guide/appw_03.pdf for additional information concerning the development and validation of ISCST3.] In addition, in response to the Agency's methodologies based on ISCST3 for assessing risks for pre-plant soil fumigants, three other models that incorporate ISCST3 variability in weather and emissions (PERFUM, FEMS, SOFEA) were reviewed by the FIFRA SAP in August and September of 2004 (http://www.epa.gov/scipoly/sap/2004/index.htm). The SAP concluded that each of the three models could provide scientifically defensible results for risks associated with soil fumigation practices and also suggested modifications and additional data that could further refine risk estimates. For a number of reasons detailed below, PERFUM was used to evaluate bystander risks from pre-plant soil applications (http://www.epa.gov/opphed01/models/fumigant/). The reasons that PERFUM has been used in this assessment as opposed to FEMS or SOFEA include:

- A workable version of the PERFUM model that addressed the FIFRA SAP comments with appropriately formatted meteorological data was available in sufficient time to incorporate into this assessment;

- PERFUM had the capability to incorporate flux information for an array of chemicals in sufficient time to incorporate into this assessment and guidance for formatting such data was also available; and

- PERFUM provides distributional results for the acute duration of exposure, which is the key period of concern given the flux profile of MITC (from metam sodium applications) and its associated toxicity, with better resolution than the other models because it considers the peak emission periods and not entire emission profiles (which generally significantly lower acute risk estimates) or non-exposure days (which dilute exposures that are of acute concern by adding zeroes to the output distributions).

HED also believes PERFUM, as opposed to ISCST3, the way it has been used in this case, provides more appropriate information for risk managers for evaluating the risks associated with pre-plant soil fumigation and, as such, recommends PERFUM be the basis for risk management decisions rather than those generated with ISCST3. HED would also evaluate submissions based on the other models (i.e., FEMS or SOFEA) if detailed training accompanied any such submission.

For exposures from ambient air (i.e., attributable to many non-quantified application(s) in a region), air concentrations of MITC (resulting from dazomet, metam potassium, or metam sodium applications) are estimated from monitoring data collected to represent such conditions within regions of use.

Exposures from single application area (e.g., farmfields) sources for bystanders are described below in *Section 6.1.1: Bystander Exposures And Risks From Known Sources* while ambient air exposures are described below in *Section 6.1.2: Ambient Bystander Exposure From Multiple Regional Sources*.

6.1.1 Bystander Exposure from Known Point Sources

MITC is the major by-product of metam sodium and accounts for most of the fumigant activity. The MITC inhalation exposure database (from metam sodium applications) consists of eleven field volatility studies that measure off-site MITC air concentrations associated with metam sodium applications. The studies provide data from a variety of different application sites and for three different application methods (3 sprinkler, 4 shank injection, and 2 drip).

HED considered several field volatility studies in the development of the bystander assessment for metam sodium. Three studies quantified emissions from sprinkler irrigation applications in California (i.e., Bakersfield - standard seal, Bakersfield and San Joaquin - intermittent seal). Three studies quantified emissions from shank injection applications in California (i.e., Bakersfield - standard seal, Bakersfield and Lost Hills - intermittent seal). One study quantified emissions from shank injection application in Washington (i.e., Mount Vernon - roozen rig). Two studies quantified emissions from drip irrigation applications in California (i.e., Irvine - tarped and untarped). Each of these studies was deemed to be a sufficient quality for risk assessment purposes.

Residential bystander exposure may occur because of emissions due to single applications from known sources such as treated fields. The various techniques used to assess the exposures and risks are described below in *Section 6.1.1.1: Methods Used To Calculate Bystander Exposures And Risks From Known Sources*. The results calculated for all scenarios of interest based on the most appropriate method for that scenario are presented in *Section 6.1.1.2: Bystander Exposures And Risks From Known Sources*.

6.1.1.1 Methods Used To Calculate Bystander Exposures And Risks From Known Sources

HED's calculation of bystander exposures and risks from known sources has been an iterative process. Each of the methods used to estimate these types of exposures are described below along with a discussion of which method HED believes provides the best representation of the exposures and risks that could be expected from actual metam sodium use.

Three methods have been used including: direct use of air monitoring data from controlled volatility studies referred to as the *(1) Monitoring Data Method*, the use of ISCST3 referred to as the *(2) ISCST3 Modeling Method*, and the use of PERFUM referred to as the *(3) PERFUM Modeling Method*. Each method has been a critical element of HED's evaluation of metam sodium but HED also believes that a specific method best represents the risks that would be anticipated for metam sodium for each setting where it is used given the techniques that are currently available. Each method is described below along with a description of how each method was used and should be interpreted in the context of this assessment.

> ***(1) Monitoring Data Method*:** In the monitoring data method, air concentrations are estimated using actual air monitoring data from controlled volatility studies. In these studies, the fumigant is applied to a field, building, or other areas, and air samplers positioned in and around the treated area continuously sample the air by pulling the air through a filter (e.g., charcoal) which captures the chemical for later analysis. Sampling times can vary but generally range from about 4 to 12 hours, so that the samples represent the average air concentrations for the sampling intervals used. Usually shorter times are used at the beginning because fumigants generally quickly make it in to the atmosphere.
>
> There are several uncertainties associated with the use of the direct sampling method which limit its utility. First, the air concentrations represent only those for the conditions under which the study was carried out. Air concentrations around treated fields are

influenced by a number of factors including how a chemical is applied, application rate, techniques to control emissions (e.g., tarps, water seals), and weather conditions. Varying weather conditions, for example, can significantly change the air concentrations at specific sites around a treated area; and since there is such a large range of potential weather conditions which could exist, it is not possible for these studies to represent the entire range of potential exposures which could result from different weather situations. Second, the air concentrations are measured by fixed samplers positioned at various directions around the treated area, both downwind and upwind, as well as at points in between. Air concentrations downwind will be relatively high since the fumigant plume will be pushed by the wind in that direction, while concentrations upwind will be low or close to zero since the plume is pushed by the wind in the opposite direction. Therefore, there can be a very large difference between upwind and downwind air concentrations. For areas where there is a predominant wind direction, averaging of the air concentrations from these various samplers should not be done since persons around treated areas will generally be in one location relative to the wind and not exposed to an average of these concentrations. Third, samplers are positioned at specific distances from the treated area, and represent air concentrations only at those distances. Since air concentrations vary greatly by distance, the air concentrations estimated from direct measures represent a very narrow range of the possible levels to which people could be exposed. Results based on the *Monitoring Data Method* are presented in Appendix C. Overall trends in the monitoring data have also been used to characterize the results calculated with modeling methods and are referenced as appropriate. HED believes that results based on monitoring data provide estimates of exposure and risk that are representative of the conditions under which the data were collected and also which suffer limitations due to the number of samplers used and their placement. As such, HED does not believe that monitoring data provide the most informative approach for considering the risks associated with metam sodium use because other field conditions and risks at different distances from the source can be evaluated with modeling approaches.

(2) ISCST3 Modeling Method: The ISCST3 modeling method uses the Agency developed, Industrial Source Complex Short Term (ISCST3) model coupled with the monitoring data described above (which is used to determine a key ISCST3 input parameter known as flux - i.e., the numerical means to quantify emission rates from a treated field, building or structure) to model the range of concentrations which might be found under different conditions of application rate, weather, source size and shape (e.g., field size in acres), and distance from the treated field, building or structure. Before a modeling analysis can be done, one of the most important parameters for ISCST3, the flux or rate of pesticide emissions from the treated fields, buildings or structures per unit area per unit time, must be determined. As an example, for field applications it is usually expressed in units of micrograms per square meter per second (ug/m^2/sec). In essence, flux represents how quickly the pesticide moves or volatilizes into the surrounding atmosphere. Numerous factors can influence flux rates such as application rate, depth of soil injection, type of application (e.g., drip vs. soil injection vs. granule application), techniques used to control emissions (e.g., tarps, water seals), temperature, wind and weather conditions, soil type, and others. Flux is also difficult to determine. Three general methods are used to estimate flux which are discussed briefly below. The first two of these measure flux from sampling directly in treated fields, and the third is an indirect, back-calculating method that estimates flux using samples from downwind locations and solves for them using ISCST3. For MITC from metam sodium applications, flux estimates were completed using the indirect back-calculating method.

ISCST3 Flux Method 1: Chamber The first method is a direct sampling method for determining flux that uses emission data measured in a flux chamber placed in a treated field. A flux chamber is basically a box which encloses a small defined area of a treated field, from which air samples are obtained representing defined durations (e.g., air is pulled through a charcoal trap collecting emitted pesticide over a continuous length of time such as 4 hours). Since the surface area is defined by the area of the chamber, and the quantity of pesticide emitted per unit time is defined by the air concentration, this method directly measures flux. A possible issue with flux chambers is that the conditions within the chamber (e.g., temperature, wind, air stability) are not generally identical to those outside the chamber in the treated field; since flux rates can be significantly affected by these factors, flux rates measured in these chambers may not always represent actual flux rates in the field. Flux chambers are not often used for estimating flux and, in fact, no such field study data were available for use in this assessment.

ISCST3 Flux Method 2: Aerodynamic Flux A second direct method used is known as the aerodynamic flux method.[1] In this method, air samplers are set up in treated fields at various heights on a mast (e.g., 15, 30, 90, and 150 cm from the ground). Using measured air concentrations at these various heights, a vertical gradient of concentrations can be estimated for different time points, which can be integrated across all heights to estimate the flux rate at each time point after application. Some studies are available using this method to determine flux rates.

ISCST3 Flux Method 3: Indirect Back-Calculation The method most often used to determine flux rates is the indirect or back-calculation method. [Note: EPA essentially followed the CDPR technique. For more details, see http://www.cdpr.ca.gov/docs/empm/pubs/ehapreps/eh9903.pdf.] This method uses measured air concentrations taken in a typical field fumigation study in which air samplers are located at various positions around the field. The measured air concentrations, together with information about weather conditions which occurred when the samples were obtained, are used as inputs into the Industrial Source Complex Short Term model (ISCST3). The model assumes that these air concentrations result from a Gaussian plume, the plume being distributed around the treated field as a result of the wind and weather conditions. The model then estimates the flux rate which would be required to emit the plume in that manner and to obtain the air concentrations measured.

---

1 Majewski, MS, Glotfelty, DE, Seiber, JN. 1989. A comparison of the aerodynamic and the theoretical-profile-shape methods for measuring pesticide evaporation from soil. Atmospheric Environment, 23:929-938

Majewski, MS, Glotfelty, DE, 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.

Parmele, LH, Lemon, ER, Taylor, AW. 1972. Micrometerological measurement of pesticide vapor flux from bare soil and corn under field conditions. Water Air Soil Pollut. 1:433-451

Estimation of the flux for all application methods to be considered in an assessment is necessary before ISCST3 can be run. Other key inputs must also be defined such as the size and shape of a treated field, wind direction, wind speed, and atmospheric stability. ISCST3 calculates downwind air concentrations using hourly meteorological conditions that include wind speed and atmospheric stability. The lower the wind speed and the more stable the atmosphere, the higher the air concentrations are going to be close to a treated field. Conversely, if wind speed increases or the atmosphere is less stable, then air concentrations are lower in proximity to the treated field. Atmospheric stability is essentially a measure of how turbulent the atmosphere is at any given time. Stability is affected by solar radiation, wind speed, cloud cover, and temperature, among other factors. If the atmosphere is unstable, then more off-field/source movement of airborne residues is possible without a large increase in air concentrations because the residues are carried up into the atmosphere and moved away from the field or other source, thereby lowering the air concentration in proximity to the field/source. In the ISCST3 modeling method, to simplify modeling the transport of fumigant vapors from a source, a single wind direction, wind speed, and stability category are used for a given 4-hour period. HED has not determined if a particular set of meteorological conditions should be used for regulatory purposes, so results are presented based on a variety of different conditions.

A range of atmospheric conditions representing the continuum from relatively stable (low windspeed & calm) to unstable conditions (high windspeeds & unsettled) was evaluated using ISCST3 (Figure 1). Under relatively stable atmospheric conditions, the modeling produces results that represent highly exposed individuals (i.e., ISCST3, as used, results in exposure estimates at the upper percentiles of an anticipated exposure distribution). Two key inputs are the basis for this conclusion. First, only a constant downwind direction is considered which for MITC from metam sodium applications is 4 hours in a single direction with no fluctuation. This type of situation would be highly unlikely in any outdoor environment. Secondly, the quantitative inputs used to define atmospheric conditions are based on constant wind speed and atmospheric stability over a 4-hour period which also will not occur in an outdoor environment. Conversely, unsettled conditions may reduce risk estimates but it is believed that even these conditions can result in conservative estimates because wind direction is constrained to a single direction over a 4 hour period.

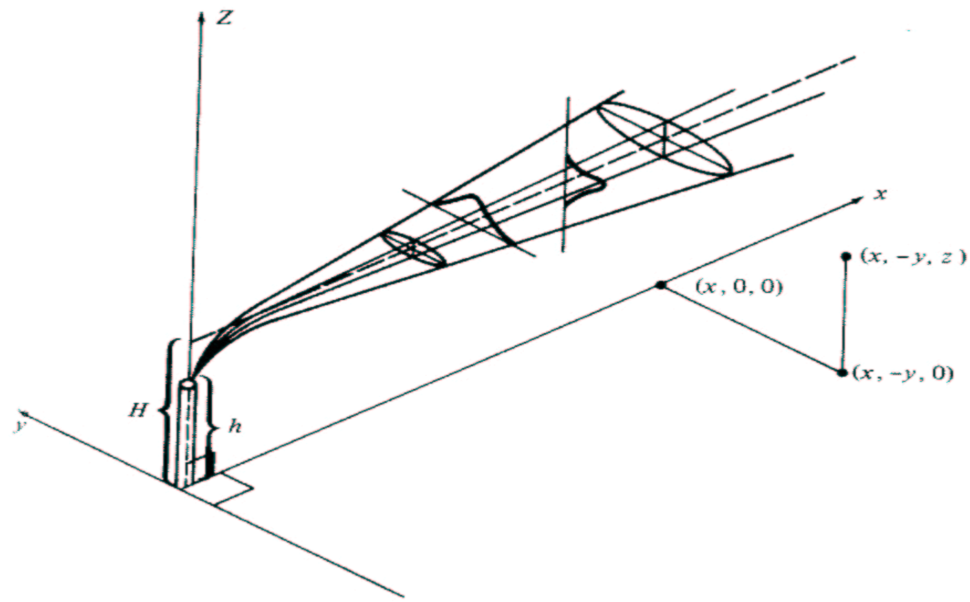


Figure 1: Illustration Of ISCST3 Gaussian Plume Approach

ISCST3 provides useful results because it allows estimation of air concentrations reflecting different conditions based on changing factors such as application rates, field sizes, downwind distances, wind and weather conditions, and other factors, which cannot be done using the monitoring data method described above. Results for the pre-plant soil fumigation uses of metam sodium (i.e., the major use pattern) based on the *ISCST3 Modeling Method* are presented in Appendix D but are not believed to be the most refined estimates of risk. As such, overall trends in the ISCST3 results have been used to characterize the results calculated using PERFUM (see below for more details) for pre-plant soil fumigations as appropriate in conjunction with the monitoring data described above. HED believes that results based on ISCST3 for the pre-plant soil fumigant uses of metam sodium provide more flexibility than the monitoring data but do not provide as realistic an estimate as that which can be provided using PERFUM because PERFUM accounts for fluctuations in meteorological data over 5 year periods and can also account for variability around flux measurements.

(3) PERFUM Modeling Method (For Pre-Plant Field Fumigations Only): The monitoring data and ISCST3 methods described above are deterministic methods which provide high-end point estimates of exposure and risk. OPP is coordinating with EPA's Office of Air, the CDPR, and others to evaluate and implement the PERFUM modeling approach based on ISCST3 which incorporates actual meteorological and flux data. [Note: HED would also evaluate submissions based on similar modeling approaches such as FEMS or SOFEA. See above for additional details.] PERFUM, or these other aforementioned models, allow users to develop an understanding of the distributions of potential bystander exposures and thus more fully characterize the range of risks resulting to bystanders around treated fields. In this assessment, the PERFUM model has been used in order to calculate differing percentiles of exposure only associated with pre-plant soil fumigation. As illustrated in Figure 2 below, ISCST3 is an integral part of the PERFUM model (for further details see http://www.epa.gov/scipoly/sap/2004/index.htm). The basic physics and code of ISCST3 remain unchanged. PERFUM essentially provides ISCST3 with daily meteorological data over the selected 5 years as well as flux estimates within the uncertainty of those data. PERFUM then uses this information to create distributional outputs for pre-defined receptor locations.

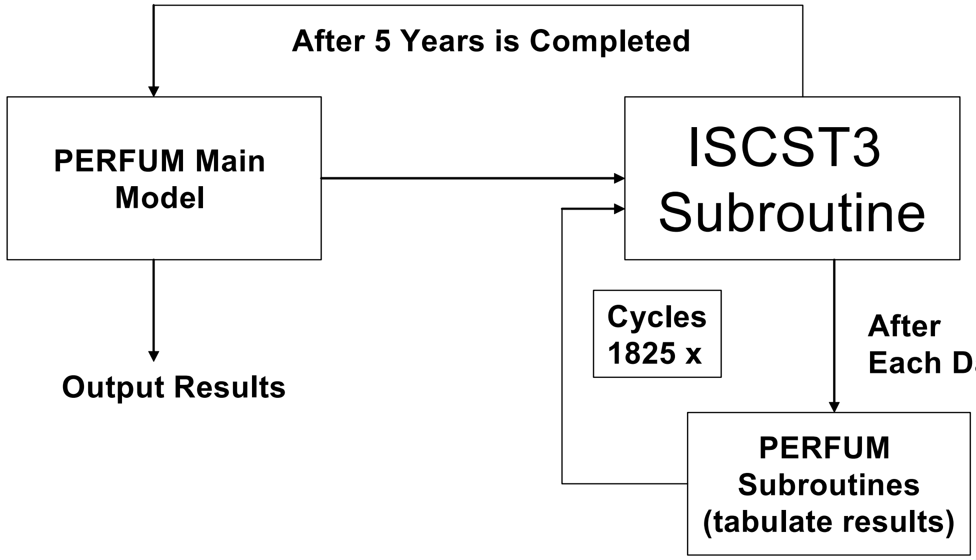


Figure 2: Operational Flowchart For PERFUM

As a result, many of the inputs used for PERFUM are similar to those used for the ISCST3 modeling method analysis described above (e.g., field sizes and back-calculated flux rates). One key differences is that PERFUM addresses the uncertainty associated with flux profiles in its calculations by sampling flux estimates for each calculation based on the coefficient of variation for those measurements. PERFUM also incorporates 5 years of meteorological data to generate a distribution of daily average concentrations that represent the possible range of air concentrations based on wind vectors from the measured data in a series of receptor locations described in Table 8 and Figure 3 below. PERFUM analyses were completed for several field sizes (i.e., 1 to 40 acres) but in most cases only the results for 1 and 40 acres were processed which represent the possible range of outcomes. In other cases, all results were processed so the impacts of changing field sizes could be more readily apparent. It is also thought that the general trend would apply generically to most situations. Field geometry (i.e., shape) was also investigated by completing analyses for 5 acre fields shaped like a square and a rectangle oriented on its side and also top to bottom. [Note: The maximum distance for which calculations are performed on each spoke in PERFUM is 1440 meters from the edge of the treated field.]

Table 8: Receptor Points for Various Field Sizes In PERFUM				
Grid Type	**Field Size (acres)**	**Number of Spokes**	**Number of Rings**	**Number of Receptors (Spokes*Distances)**
Fine	1	96	28	2,688
	5	132	28	3,696
	10	152	28	4,256
	20	188	28	5,264
	40	232	28	6,496
Coarse	1	24	28	672
	5	33	28	924
	10	38	28	1,064
	20	47	28	1,316
	40	58	28	1,624
Note: Fine grid option was used for metam sodium analysis. **The maximum distance used for PERFUM calculations on each spoke is 1440 meters**.				

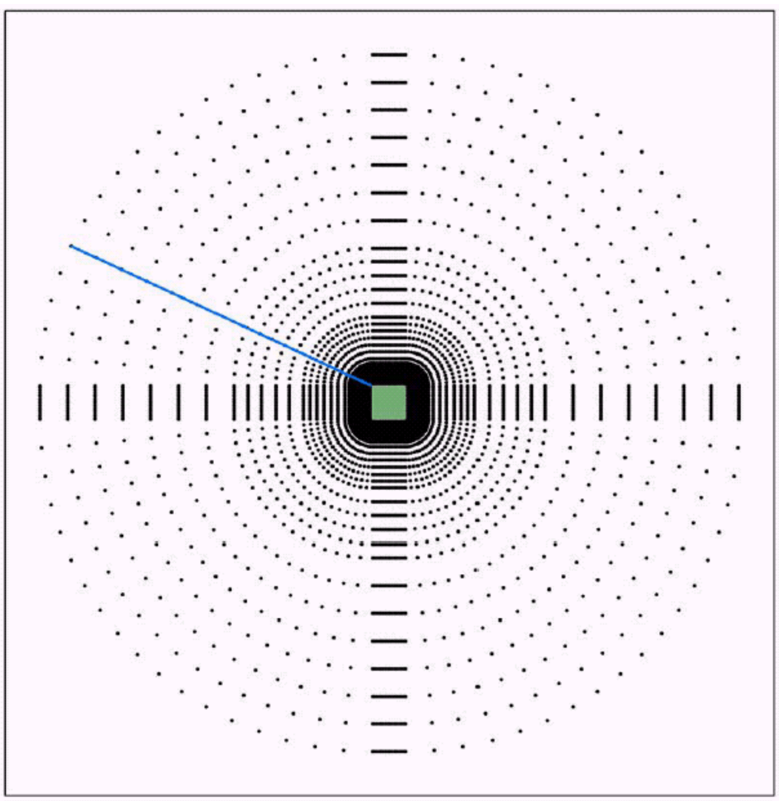


Figure 3: Receptor Grid for a 5 Acre Field [Note: 5 Acre field in the center, line is a spoke]

Since actual meteorological data are integrated into PERFUM for each analysis, data representative of the locations where metam sodium use is anticipated were identified and used in the analysis. It is anticipated that major use of metam sodium would occur in California and Washington (or elsewhere in the Pacific Northwest). Some use in Michigan and Florida is also anticipated. As a result, the following locations and sources of meteorological data were used in this assessment:

- Bakersfield, California (Source: ASOS or Automated Surface Observing System operated by the FAA) to represent inland California locations;
- Ventura, California (Source: CIMIS or California Irrigation Management Information System) to represent coastal California locations;
- Flint, Michigan (Source: NWS or National Weather Service) to represent central Michigan, and other upper midwest locations;
- Tallahassee, Florida (Source: NWS or National Weather Service) to represent inland Florida locations;
- Bradenton, Florida (Source: FAWN or Florida Automated Weather Network) to represent coastal Florida; and
- Mount Vernon, Washington (Source: NWS or National Weather Service) to represent southeastern Washington, and other Pacific northwest locations.

In this assessment, 5 years or 1825 days of meteorological data were considered in each calculation. Bradenton, Bakersfield, and Ventura data were in the range of 1997 through 2003, the Tallahassee and Flint data were in the late 1980s through early 1990s, and the Yakima data were from 1984-1988.. [Note: Please refer to the SAP background documents for PERFUM for further information concerning these data including how they were processed for incorporation into PERFUM and any quality control issues related to these data (http://www.epa.gov/scipoly/sap/2004/index.htm).] Figure 4 provides a comparison of the distributions of daily average windspeeds for selected stations in California and Florida. These can be used to help characterize the deterministic assessments and to illustrate different PERFUM results for the different stations. [Note: As an example, CADPR regulated MeBr at 1.4 m/s windspeed.]

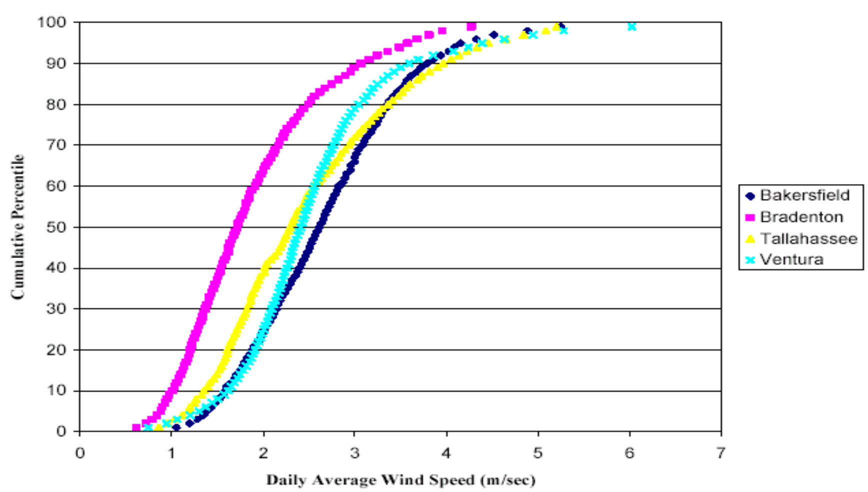


Figure 4: Distribution of Daily Average Windspeeds at Selected Meteorological Stations

Flux inputs (i.e., field

volatility or emissions) for PERFUM were treated in a manner similar to that used for the ISCST3 analysis described above. In the ISCST3 analysis for MITC from metam sodium applications, calculations were based on the emission profiles developed by HED using the indirect back calculation method. The same basic approach was used for the PERFUM assessment except that PERFUM requires distributions of flux data be used which allows changes to occur at appropriate times of day and also allows for distributional sampling based on the uncertainty in the flux data. PERFUM considers the uncertainties associated with daily flux profiles by probabilistically sampling flux based on the range defined by the coefficient of variation associated with those data, if available. Table 9 below provides a summary of the analyses that were completed using PERFUM.

Table 9: Summary Of PERFUM Analyses Completed For Metam Sodium

Flux Study Summary	Weather Station Location					
	Ventura, CA	Bakersfield, CA	Flint, MI	Tallahassee, FL	Bradenton, FL	Yakima, WA
Bakersfield, CA Sprinkler Irrigation - Standard Water Seal	X	X	X	X	X	X
Bakersfield, CA Sprinkler Irrigation - Intermittent Water Seal	X	X	X	X	X	X
San Joaquin, CA Sprinkler Irrigation - Intermittent Water Seal	X	X	X	X	X	X
Bakersfield, CA Shank Injection - Standard Water Seal	X	X	X	X	X	X
Bakersfield, CA Shank Injection - Intermittent Water Seal	X	X	X	X	X	X
Lost Hills, CA Shank Injection - Intermittent Water Seal	X	X	X	X	X	X
Mount Vernon, WA Shank Injection - Roozen Rig	X	X	X	X	X	X
Citra, FL Shank Injection - Tarped	NA	NA	X	X	X	X
Citra, FL Drip Irrigation - Tarped	NA	NA	X	X	X	X
Irvine, CA Drip Irrigation - Tarped	X	X	X	NA	NA	X
Irvine, CA Drip Irrigation - Untarped	X	X	X	X	X	X

X = analysis completed, NA = analysis not appropriate.

PERFUM calculates outputs based on each day's worth of meteorological data and the result is illustrated by Figure 5 which shows the distances from the field where airborne concentrations meet a threshold of concern around the entire perimeter of the field for each spoke in the model (i.e., the irregularly shaped line). The concentric circle represents an example 95^{th} percentile distance value around the perimeter (i.e., MOEs are not of concern for 95% of those exposed). The cross hatch area represents the locations where distances exceed the 95^{th} percentile value (i.e., MOEs are of concern at these distances for 5% of those exposed). These exceedances have been examined using the PERFUM MOE program which was used in conjunction with the air model itself (see SAP site for more details).

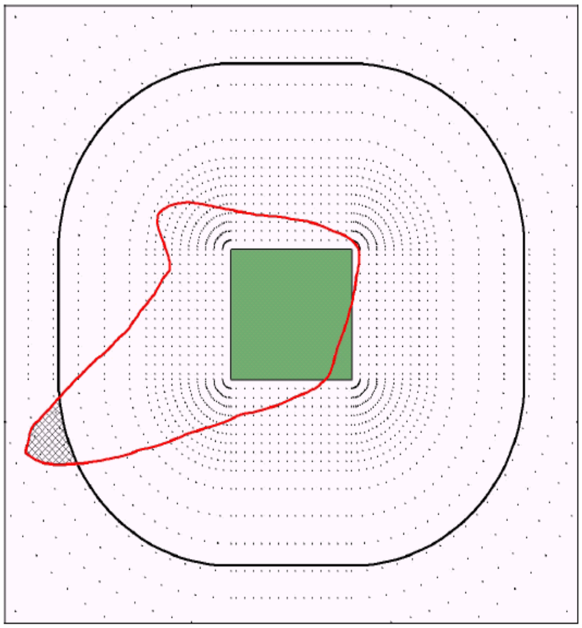


Figure 5: Example Daily PERFUM Output for a 5 Acre Field

PERFUM generates the type of output illustrated by Figure 5 for each 4-hour exposure period over a 5 year period (i.e., 10,950 4-hour exposure periods) then summarizes the information by providing two types of results including the *"Maximum Buffer"* distance and the *"Whole Field Buffer"* distance. Each is reported as a distribution. The *"Maximum Buffer"* distribution is based on the maximum distance needed to reach a threshold level of concern (i.e., HEC adjusted by uncertainty factor) calculated using PERFUM for each day (i.e., a distribution of the farthest single points on the irregular line for each day). This results in a distribution that contains 10,950 values and in this assessment, the results have been reported for selected percentiles from those distributions. The *"Whole Field Buffer"* is based on values from each day as well except the distances on which the distribution is based include those on each spoke where the threshold concentration is achieved for each day (i.e., a distribution of distances on all spokes or the distances on the irregular line where it intersects each spoke). The number of values in these distributions varies and it is based on 10,950 exposure periods multiplied by the number of spokes around the field which relates to field size (see Table 8 above). As with the *"Maximum Buffer"* distances, results from selected percentiles from the distribution have been reported.

6.1.1.2 Bystander Exposures And Risks From Known Sources

The risks for bystanders from various types of known sources (e.g., farm fields) are presented in this section. *Section 6.1.1.1: Methods Used To Calculate Bystander Exposures And Risks From Known Sources* describes a variety of approaches that were used to evaluate the risks to MITC from metam sodium use including field studies (i.e., ***Monitoring Data Method***) and modeling methods (i.e., ***ISCST3 Modeling Method*** or ***PERFUM Modeling Method***). Because of the refinements offered by the modeling approaches, it is believed that those results should be considered as the most appropriate for evaluating the risks associated with MITC from metam sodium applications. However, it should be noted that results from all of the approaches described above were used to characterize the range of risks associated with MITC from metam sodium applications and these results have been summarized in the appendices of this document for review purposes.

The ***PERFUM Modeling Method*** provides the most refined, scientifically defensible approach for calculating and characterizing risks because it incorporates actual weather data, uncertainty in flux, and links flux profiles to the appropriate time of day when calculating results. It is also based on the proven technology of ISCST3.

6.1.1.2.1 Bystander Exposures And Risks From Pre-Plant Agricultural Use

Exposures to bystanders from single pre-plant agricultural field fumigation events and their associated risks, calculated using the PERFUM modeling approach, are presented in this section. These exposures were also analyzed using the actual field study data and the deterministic ISCST3 approach. However, because of the distributional approach inherent in PERFUM it is believed that PERFUM provides the most refined results for this assessment.

The field study citations that pertain to this assessment as well as the analysis of the field study data are presented in ***Appendix C: Summary Data Sheets For Single Agricultural Field Fumigation Events***. Detailed results from ISCST3 are included as ***Appendix D: Downwind MITC Air Concentrations from Metam sodium Applications Estimated with ISCST3 for Pre-Plant Agricultural Uses***. Detailed results from PERFUM are included as ***Appendix E: MITC Air Concentrations from Metam sodium Applications Estimated with PERFUM for Pre-Plant Agricultural Uses***. [Note: The PERFUM and ISCST3 appendices themselves only contain a summary of the model outputs, they **do not** contain the detailed input and output files needed to complete calculations with ISCST3 or PERFUM. If so desired, these can be provided for review.]

The information presented in Appendix C pertaining to the use of the monitoring data is presented on a study by study basis. Appendix E is complex by comparison in that it contains subfiles which provide results for the various combinations of flux estimates and meteorological stations considered (see Table 9 for more details above). These include:

- **Appendix C. Summary Data Sheets For Single Agricultural Field Fumigation Events:** contains a summary table that provides risk calculations based on the data.

- **Appendix D. ISCST3 Analysis:** contains a summary of the ISCST3 results for all flux and meteorological combinations generated with ISCST3. Flux estimates that range across all DPR permit conditions were considered as were a range of meteorological conditions that spanned calm to turbulent weather. [Note: This appendix also contains a summary table that provides risk calculations based on the data where the acute HEC and target uncertainty factor of 10 have been used to solve for the distance where this concentration is met downwind from the treated field.]

- **Appendix E. PERFUM Analysis:** contains a summary of the PERFUM results for all flux and meteorological combinations.
    - **Appendix E/Appendix Tables 1 - 29 (Ventura CA):** contains PERFUM results for all field sizes, application rates, and flux profiles for Ventura, California meteorological data, also contains MOE summaries that range from the NOAEL (i.e., MOE = 1) to the full uncertainty factor (i.e., MOE=10).

    - **Appendix E/Appendix Tables 30 - 31 (Tallahassee FL):** contains PERFUM results for all field sizes, application rates, and flux profiles for Tallahassee, Florida meteorological data.

- **Appendix E/Appendix Tables 32 - 33 (Flint MI):** contains PERFUM results for all field sizes, application rates, and flux profiles for Flint, Michigan meteorological data.

- **Appendix E/Appendix Tables 34 - 35 (Bradenton FL):** contains PERFUM results for all field sizes, application rates, and flux profiles for Bradenton, Florida meteorological data.

- **Appendix E/Appendix Tables 36 - 37 (Bakersfield CA):** contains PERFUM results for all field sizes, application rates, and flux profiles for Bakersfield, California meteorological data.

- **Appendix E/Appendix Tables 38 - 66 (Yakima WA):** contains PERFUM results for all field sizes, application rates, and flux profiles for Yakima, Washington meteorological data, also contains MOE summaries that range from the NOAEL (i.e., MOE = 1) to the full uncertainty factor (i.e., MOE=10).

- **Appendix E/Appendix Tables 67 - 72:** contains PERFUM analyses that show general trends across the meteorological sites.

The analyses which were completed using PERFUM are based on the 60 combinations of flux and meteorological data which are available as described in Table 9 above. In addition, the impact of field size and shape, application rates, "whole vs. maximum buffer" statistics, and target concentrations (i.e., HECs coupled with uncertainty factor) were evaluated. The field sizes and shapes that were considered include:

- 1 acre (square, rectangle oriented on its side, rectangle oriented on its end);
- 5 acres (square, rectangle oriented on its side, rectangle oriented on its end);
- 10 acres (square);
- 20 acres (square); and
- 40 acres (square).

The application rates that were considered include 100 percent of the maximum rate (320 lb ai/acre) and, to evaluate a range, 75, 50, and 25 percent of the maximum rate were also considered. [Note: PERFUM outputs for the 25 percent rate were generated and are available but not summarized at this point. The impact changes in application rate has can be observed based on the available information.] In all cases, results for both maximum and whole buffer statistics (see Section 6.1.1.1 above for further information) were evaluated to allow for a broader range of risk characterization. The impact of altering target concentrations (i.e., the combination of HEC coupled with uncertainty factor) was also considered to allow for a broader characterization of the risks associated with MITC emissions from metam sodium applications. The combinations that were considered include (and in no way reflect any regulatory decision - the intent is to inform risk managers of the sensitivity of the results to changes in these factors):

- NOAEL HEC (0.22 ppm) and Uncertainty Factor = 10;
- NOAEL HEC (0.22 ppm) and Uncertainty Factor = 7.5;
- NOAEL HEC (0.22 ppm) and Uncertainty Factor = 5;
- NOAEL HEC (0.22 ppm) and Uncertainty Factor = 2.5; and
- NOAEL HEC (0.22 ppm) and Uncertainty Factor = 1.

It should be acknowledged that a myriad of micro-environmental conditions and factors can impact how MITC will volatilize and disperse from any given metam sodium treated field on a particular day. With this premise, it would be logical to evaluate basic factors which could influence flux (e.g., soil type, soil temperature, percent water, etc.) and also micro-climates (e.g., topography) and thus ultimately impact results. PERFUM, however, cannot easily address specific changes in these factors because it is not a 1st Principles Model where the approach would be to build a predictive tool from basic fate characteristics. Instead, PERFUM is an empirical model which utilizes field study and actual meteorological data to predict results and since field study data are the basis for the PERFUM predictions it follows that results based on empirical monitoring and those calculated with PERFUM would be similar (see guidance pertaining to air model validation at http://www.epa.gov/scram001/guidance/guide/appw_03.pdf for additional information).

It should also be acknowledged that the nomenclature incorporated into PERFUM uses the term "buffer zone" which equates to the distance downwind at which a specific target concentration (i.e., combination of HEC and UF) is met based on the desired statistical parameters. The use of this term does not imply any regulatory decision. In the context of this risk assessment, it should only be considered as the predicted distance for a specific target concentration. A number of differing factors were considered to evaluate the sensitivity of the results to changes in various inputs.

Based on the range of input parameters that have been considered in this analysis and the various outputs that are available, some general conclusions can be drawn with regard to the trends observed in the results including:

- Air concentrations do not appear to exceed a target concentration equivalent to either the NOAEL at the edge of treated fields (even large ones at high application rates). These results are consistent with what is generally observed after actual use (i.e., incidents that result in irreversible toxic effects to bystanders are infrequent). Many incidents are the result of misuse and/or infrequent environmental factors (e.g., extreme inversion conditions).

- The sensitivity of predicted air concentrations to changes in the available flux data appears to be well within an order of magnitude which is essentially mirrors the range in the emission rates used for this analysis that are provided in Table 9.

- The sensitivity of predicted air concentrations to changes in the meteorological data used appears to be well within an order of magnitude. Flint Michigan meteorological data seems to generally result in the lowest buffer distances which is logical given its routinely cooler temperatures compared to California and Florida. Possible differences may also be due to wind speed and the accompanying effects on stability class (e.g., it could be less stable at night in particular if it is more windy), and wind direction persistence.

- The sensitivity of predicted distance required to attain a target air concentration to changes in field size and application rates appears to be approximately a 1 to 1 relationship. For example, if field size doubles, then the distances predicted by PERFUM to meet a target concentration would also approximately double. Field shape does not appear to significantly impact results although this conclusion should be considered in the context that a few weather station locations were considered and there could be situations where the shape and orientation to a prevailing wind could have a significant impact (e.g., a field in a valley with a strong prevailing wind that crosses it longitudinally).

- The inputs that were used for the PERFUM analysis spanned a broad range of potential field conditions and PERFUM outputs offer users the opportunity to evaluate results based on a range of statistics. As such, depending upon the particular combinations of inputs and desired statistical outputs, distances at which target concentrations are met ranged from close proximity to a treated field out to 1440 meters which is the longest distance for which PERFUM can predict. For inputs that include high application rates, large field sizes, and high flux rates, particularly if the "maximum buffer statistic" is considered, the distances at which target concentrations are met often are equivalent to 1440 meters which is the longest distance for which PERFUM can predict. This is also observed at times for "whole field buffer statistics."

- PERFUM has the capability of evaluating how risks (i.e., MOEs) change at a specific location if different percentiles of exposure or other statistics are selected. It appears that, in general, risk estimates are not extremely sensitive to changes in the selected percentile at the upper percentiles of exposure (e.g., 95^{th} to 99^{th}). This phenomenon appears to be due to the flatness of the Gaussian curve upon which ISCST3 is based at the upper percentiles of exposure.

It is clear that given the number of possible permutations of PERFUM inputs and ways of presenting the outputs that there are many possible approaches for interpreting the results. The central goal, however, is to quantify how potential risks change with factors such as application method, distance from the treated field, percentile of exposure, selected statistical basis (i.e., whole vs. maximum buffer approach), application rate, and field size/shape. Each of these factors have been considered and very detailed results pertaining to each are available in the appendices referenced above. In order to summarize the analyses which have been completed and to illustrate the general approach, a selected number of tabular and graphical interpretations of the results are presented below.

The results presented in Figures 7, 8, and 9 below provide an example of how risks change in relation to uncertainty factors (i.e., target MOE), field size, percentile of exposure, distances from a treated field, and statistical basis (i.e., whole field vs. maximum buffer). Figures 7, 8, and 9 are based one of the 60 combinations of flux and meteorological data considered in this analysis (i.e., Ventura California CIMIS meteorological data and Bakersfield Shank Injection-Intermittent Seal Flux - see Table 9). Each figure presents results for various target MOEs which include: 1 (at the NOAEL), 2.5, 5, 7.5, and 10 (the full target MOE). Figure 7 presents results based on the "whole field buffer" approach for a 40 acre field. Figures 8 and 9 present results based on the "maximum buffer" approach for 1 and 40 acre fields, respectively. The distance at which the target concentration (i.e., HEC coupled with uncertainty factor) is reached is variable and clearly depends upon the desired statistical interpretation of the results. At very low percentiles of exposure and lower MOEs, target concentrations are met within 200 meters or so of the field's edge and even at the field's edge if the NOAEL is considered. In all of the examples under some conditions the predicted distances exceed 1000 meters and in many circumstances attain 1440 meters which is the farthest distance considered in PERFUM. The sort of analysis illustrated in Figures 7 through 9 has also been completed for all flux types using the Yakima Washington meteorological data and the trends in the results are similar.

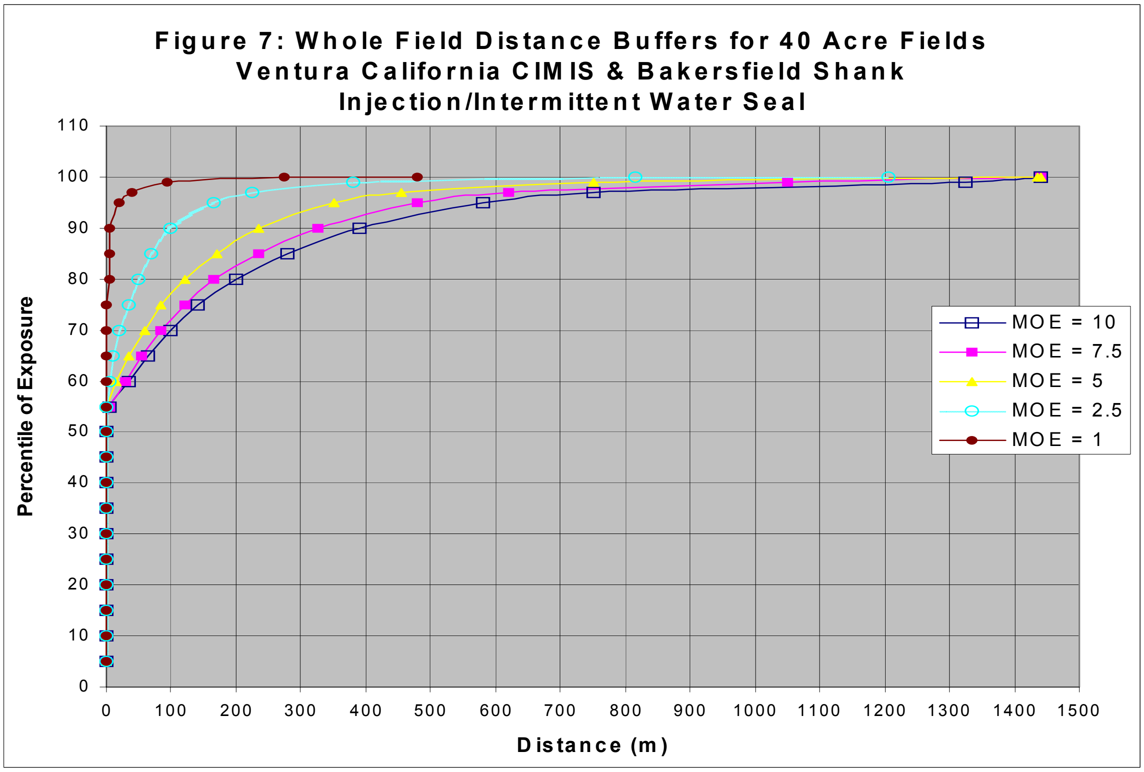


Figure 7: Whole Field Distance Buffers for 40 Acre Fields
Ventura California CIMIS & Bakersfield Shank
Injection/Intermittent Water Seal
Percentile of Exposure
Distance (m)
MOE = 10
MOE = 7.5
MOE = 5
MOE = 2.5
MOE = 1
0
10
20
30
40
50
60
70
80
90
100
110
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500

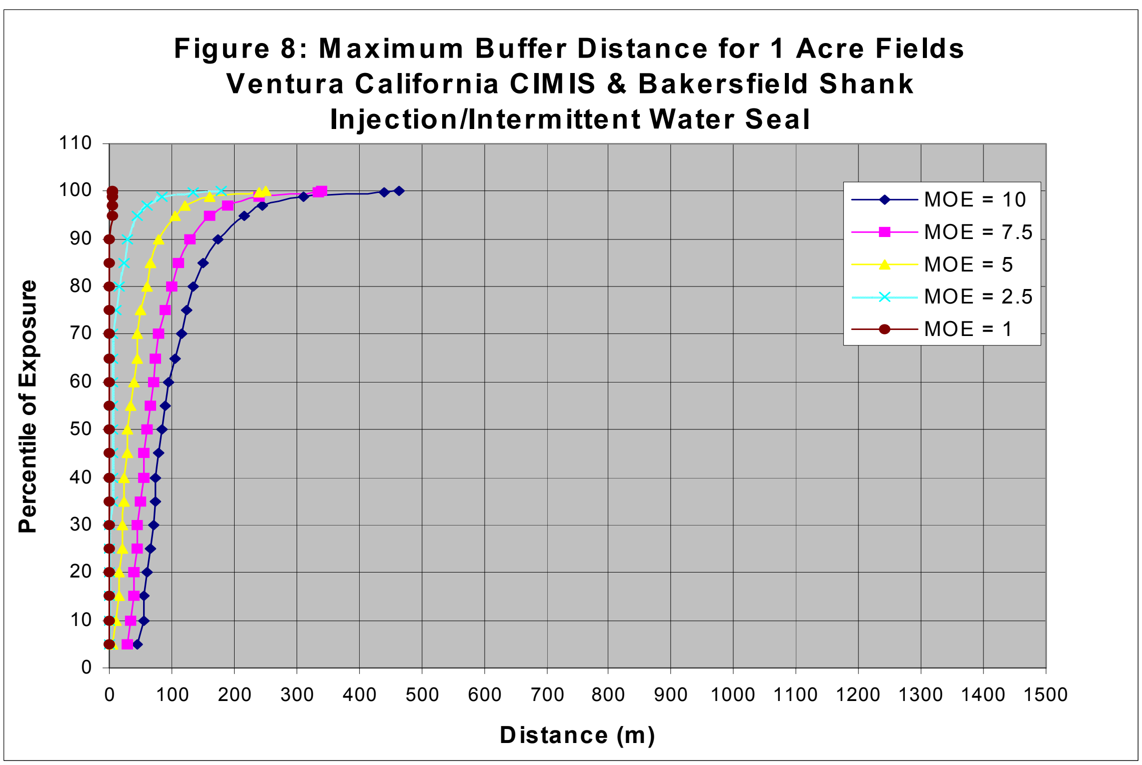


Figure 8: Maximum Buffer Distance for 1 Acre Fields
Ventura California CIMIS & Bakersfield Shank
Injection/Intermittent Water Seal
Percentile of Exposure
Distance (m)
MOE = 10
MOE = 7.5
MOE = 5
MOE = 2.5
MOE = 1
0
10
20
30
40
50
60
70
80
90
100
110
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500

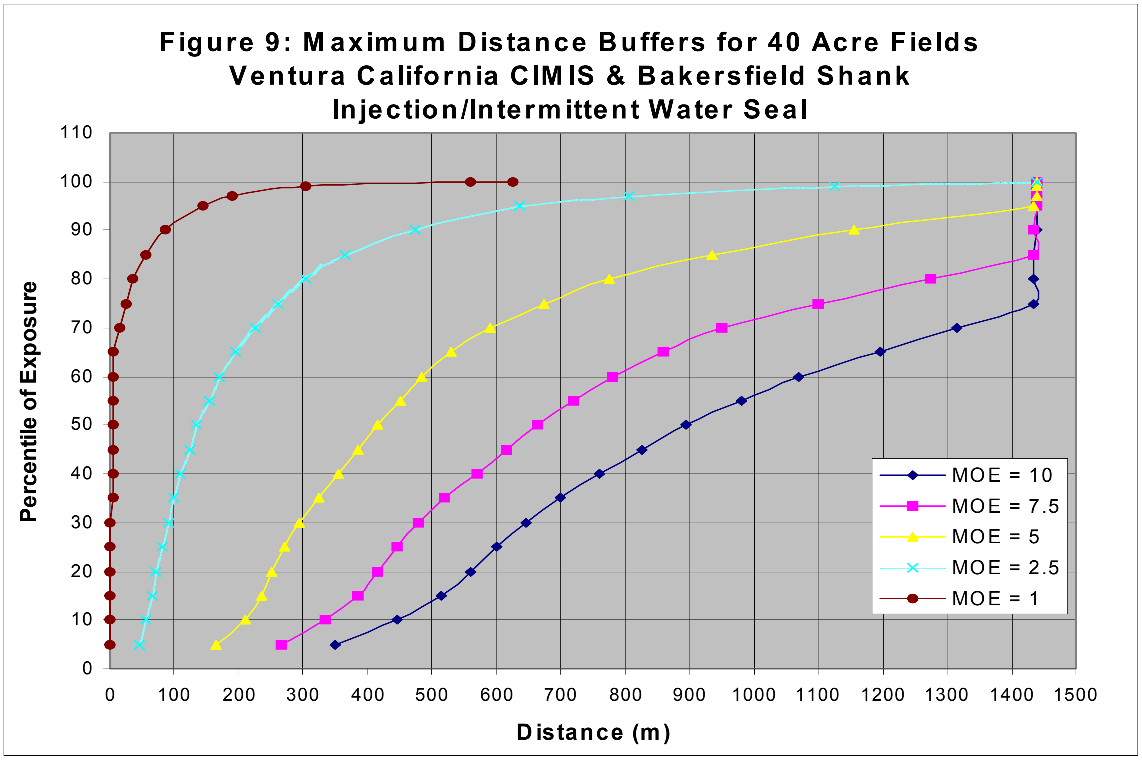


Fig
ure
s 10 and 11 are included to illustrate how for the 40 acre "whole field buffer" statistic results presented in Figure 7 compare with the results for another flux type at the same location (Figure 10 - Ventura CIMIS and Bakersfield Shank Injection-Intermittent Seal Flux) and at one other location for the same flux profile (Figures 11 Bakersfield Shank Injection-Intermittent Seal for Yakima Washington). The Ventura California and Yakima Washington sites were selected for this analysis because the majority of metam sodium use in the United States occurs in California and the Pacific Northwest. As indicated above, Appendix E contains much more detailed information should additional review be necessary. The information contained in Figures 10 and 11 reflect very similar results to those presented in Figure 7. In all cases, however, the MOE = 10 line predicts distances of several hundred meters (i.e., about 800 to 1,000 m) at upper percentile exposure levels.

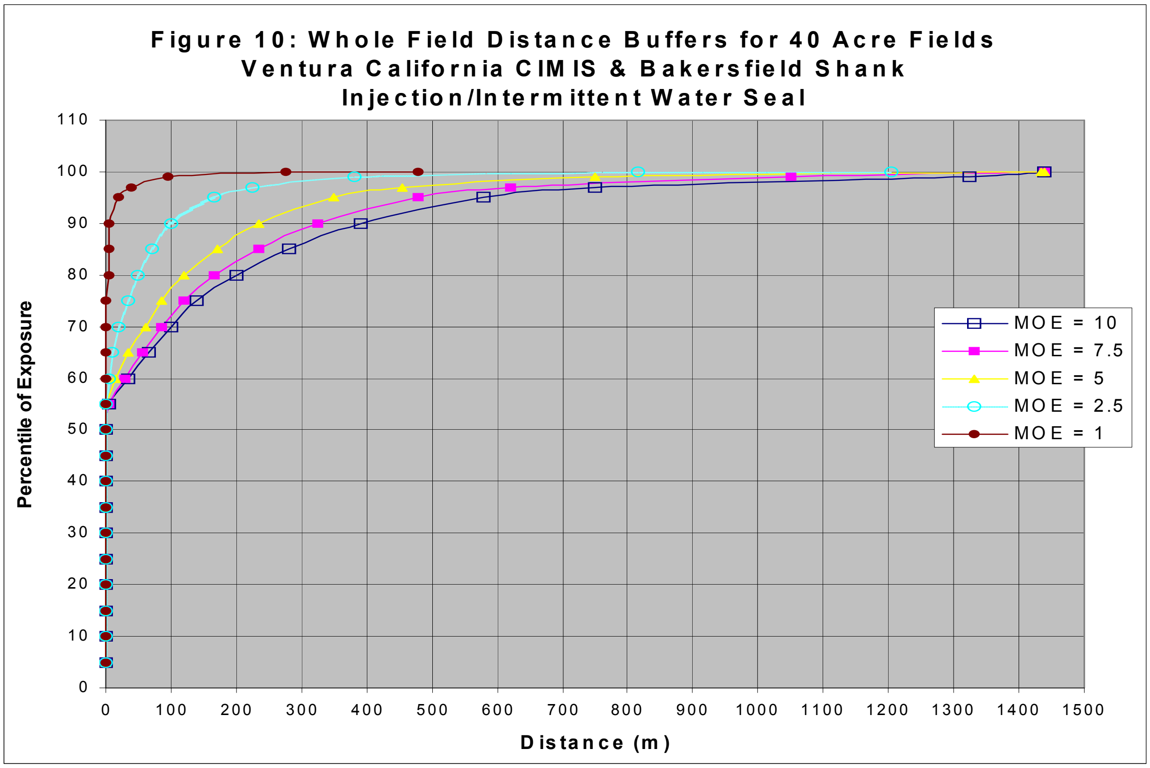


Figure 10: Whole Field Distance Buffers for 40 Acre Fields
Ventura California CIMIS & Bakersfield Shank
Injection/Intermittent Water Seal
Percentile of Exposure
Distance (m)
MOE = 10
MOE = 7.5
MOE = 5
MOE = 2.5
MOE = 1

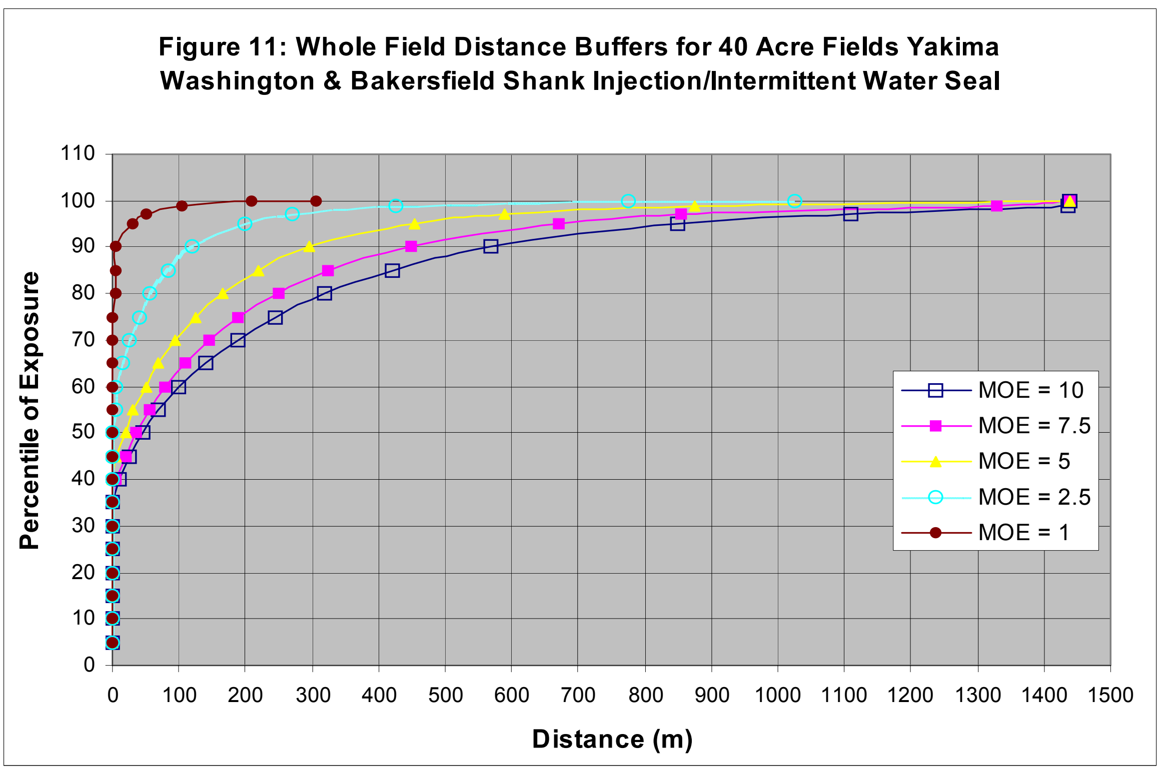
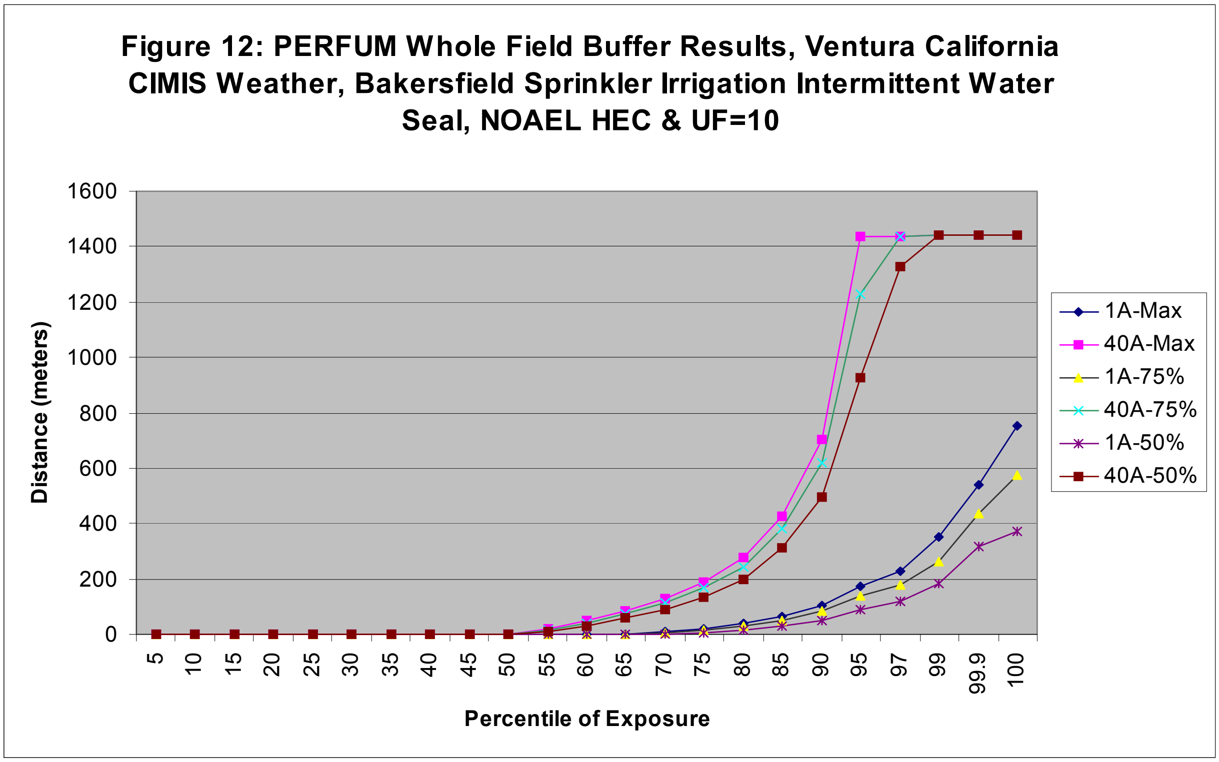


Figure 11: Whole Field Distance Buffers for 40 Acre Fields Yakima
Washington & Bakersfield Shank Injection/Intermittent Water Seal
Percentile of Exposure
Distance (m)
MOE = 10
MOE = 7.5
MOE = 5
MOE = 2.5
MOE = 1

An example of the basic analysis that was completed for each of the 60 combinations of flux and meteorological conditions evaluated in this assessment is presented below in Table 10 and Figure 12 using results based on Ventura California meteorological data and the bedded tarped flux profile to illustrate the approach. [Note: The results in Table 10 and Figure 12 reflect a target concentration of the NOAEL HEC and an uncertainty factor (or target MOE) of 10.] This table can also be used to illustrate how differences in application rate (i.e., results for the maximum rate as well as 75 and 50 percent of that rate), statistical basis (i.e., whole field and maximum "buffer" results), percentile of exposure, and field size can impact results. [Note: The appendices referenced above contain similar information for all combinations of flux and meteorological inputs (see Table 9) as well as results for additional field sizes (e.g., 5, 10 and 20 A). The information presented in Table 10 and Figure 12 was selected to illustrate the range of values considered.] The results presented in Table 10 and Figure 12 are markedly similar to those presented in Figures 7 through 11 in that a final "result" depends upon several factors including percentile of exposure, PERFUM statistical basis, application rate, and field size. Results also reflect the general trend in that lower exposure percentiles, application rates, and field sizes result in lower predicted distances to a selected target concentration (i.e., based on HEC and UF).

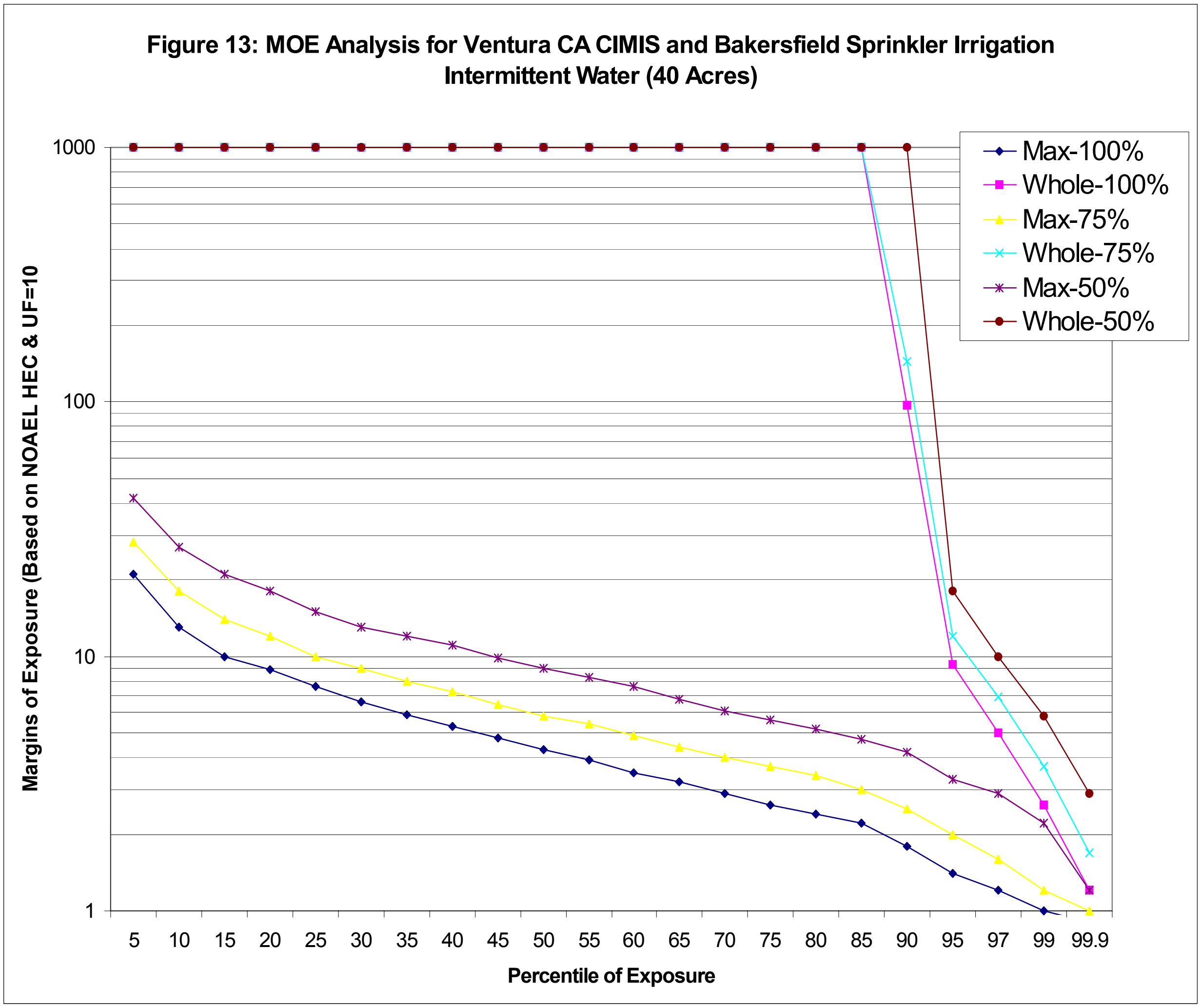
Table 10: Distances to Target concentration Based on NOAEL HEC & MOE=10 for Ventura CA Weather and Bakersfield Sprinkler Irrigation - Intermittent Water Seal Flux Data

Percentiles	Max (320 lb/Acre)		75% (240 lb/Acre)		50% (160 lb/Acre)	
	1 Acre Square	40 Acres Square	1 Acre Square	40 Acres Square	1 Acre Square	40 Acres Square
Maximum Buffer Distances (meters)						
75	295	> 1440	230	> 1440	150	> 1440
90	395	> 1440	305	> 1440	215	> 1440
95	450	> 1440	355	> 1440	255	> 1440
99	585	> 1440	480	> 1440	340	> 1440
99.9	780	> 1440	590	> 1440	395	> 1440
Whole Field Buffer Distances (meters)						
75	20	190	15	170	5	135
90	105	705	85	620	50	495
95	175	1435	140	1230	90	925
99	350	> 1440	265	> 1440	185	> 1440
99.9	540	> 1440	435	> 1440	315	> 1440



PERFUM is also capable of examining the changes observed in MOEs under different conditions for each basic analysis (i.e., each of the 60 combinations of flux and meteorological data) in a manner slightly different than illustrated above in Figures 7 through 9. In this analysis, the changes in risks are examined for specific locations relative to the PERFUM statistical basis (i.e., whole field or maximum buffer approach) or application rate (i.e., in all cases the target concentration is based on NOAEL HEC and UF=10). As a reminder, the cross-hatched area in Figure 5 represents exceedances from a pre-selected percentile of exposure which can be examined. Figure 13 below presents the results of such an analysis for the Ventura California meteorological and bedded tarped flux data as an example. The key conclusion to consider is that the changes in risks (i.e., MOEs) relative to changes in the percentile of exposure are relatively shallow which is an indication that if higher percentiles of exposure are selected to represent a specific location that risks do not dramatically change by orders of magnitude.

The analyses which have been completed using PERFUM are based on 6 weather station



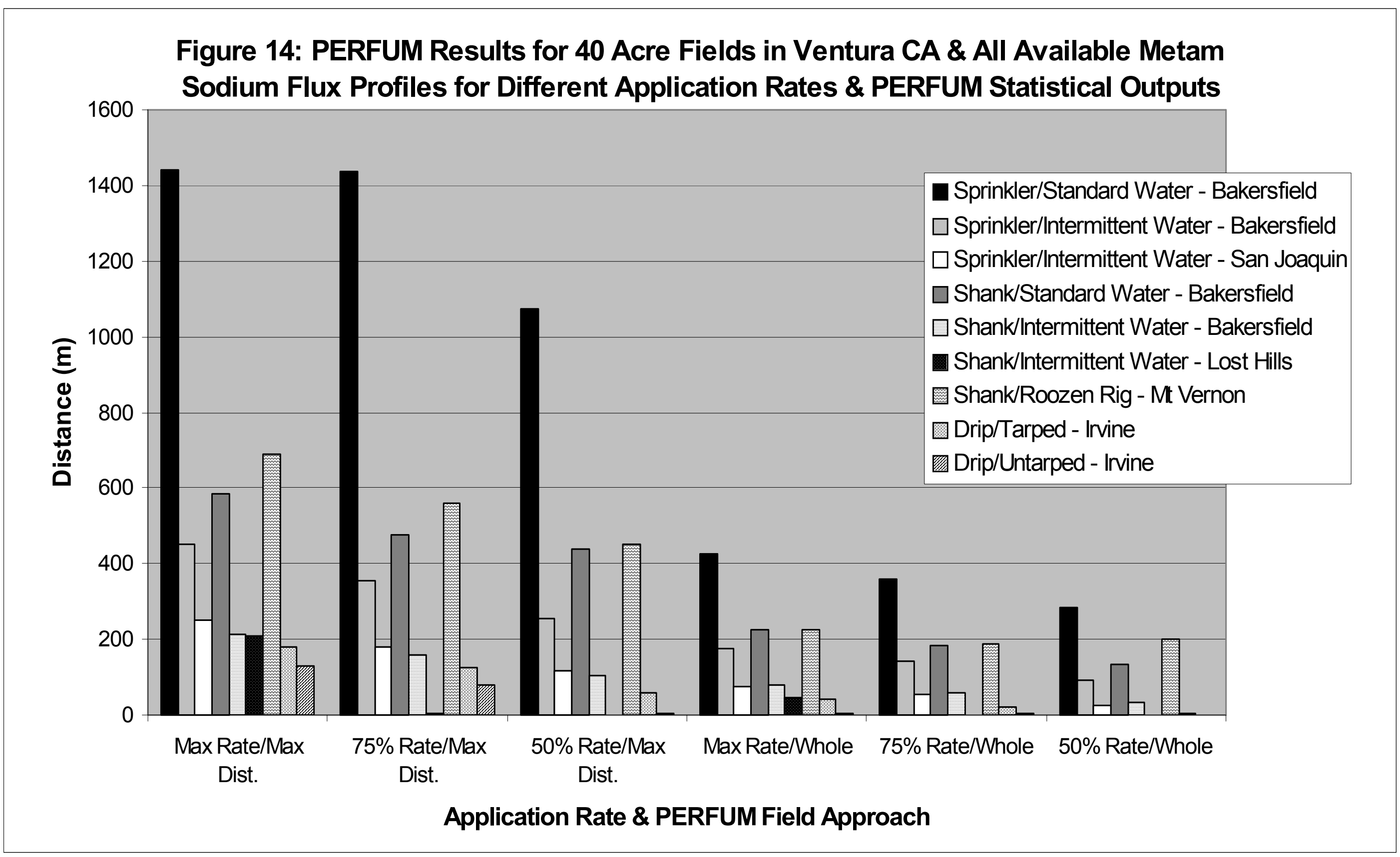
locations and two flux profiles. In order to broadly understand how differing combinations of application methods and emission control technologies (e.g., surface vs. incorporation), which are reflected in the flux profiles used for the analyses, and different weather conditions can impact results, it is necessary to group the outputs from PERFUM for comparative purposes. The first aspect to be examined was how differing flux profiles may impact results. This is considered in Table 11 and Figure 14 which present results for varying percentiles of exposure, field sizes, application rates, and PERFUM statistics (i.e., whole field and maximum "buffers") for all metam sodium flux profiles for a target concentration based on the NOAEL HEC and UF=10. [Note: 95th percentile results only are represented in Figure 14 but the basic trend would be expected to be similar for all percentiles of exposure.] The results demonstrate that distances to target concentrations decrease if application rates decrease or whole field buffers are considered instead of maximum buffer results as would be expected. Figure 14 also clearly illustrates that the use of intermittent water seal flux data (for both sprinkler irrigation and shank injection) result in lower predicted distances compared to the use of standard water seal flux profiles (again for both sprinkler irrigation and shank injection).

Table 11: Summary of Ventura California PERFUM Buffer Results for All Flux Types for 1 and 40 Acre Fields

Percentiles	Ventura Maximum PERFUM Buffer Results						Ventura Whole Field PERFUM Buffer Results					
	Max (320 lb/Acre)		75% (240 lb/Acre)		50% (160 lb/Acre)		Max (320 lb/Acre)		75% (240 lb/Acre)		50% (160 lb/Acre)	
	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres

	Square	Square	Square	Square	Square	Square	Square	Square	Square	Square	Square	Square
Sprinkler Irrigation Method												
Bakersfield - Standard Water Seal												
75	1340	> 1440	1105	> 1440	835	> 1440	25	210	20	200	20	185
90	1435	> 1440	1320	> 1440	980	> 1440	185	1435	165	1435	135	1435
95	> 1440	> 1440	1435	> 1440	1075	> 1440	425	> 1440	360	> 1440	285	> 1440
99	> 1440	> 1440	> 1440	> 1440	1295	> 1440	1105	> 1440	905	> 1440	690	> 1440
99.9	> 1440	> 1440	> 1440	> 1440	> 1440	> 1440	> 1440	> 1440	1425	> 1440	1065	> 1440
Bakersfield - Intermittent Water Seal												
75	295	> 1440	230	> 1440	150	> 1440	20	190	15	170	5	135
90	395	> 1440	305	> 1440	215	> 1440	105	705	85	620	50	495
95	450	> 1440	355	> 1440	255	> 1440	175	1435	140	1230	90	925
99	585	> 1440	480	> 1440	340	> 1440	350	> 1440	265	> 1440	185	> 1440
99.9	780	> 1440	590	> 1440	395	> 1440	540	> 1440	435	> 1440	315	> 1440
San Joaquin - Intermittent Water Seal												
75	155	> 1440	105	> 1440	55	1435	10	175	5	150	0	115
90	225	> 1440	150	> 1440	90	> 1440	45	770	30	645	10	485
95	250	> 1440	180	> 1440	115	> 1440	75	1435	55	1225	25	900
99	345	> 1440	270	> 1440	180	> 1440	150	> 1440	115	> 1440	65	> 1440
99.9	490	> 1440	360	> 1440	230	> 1440	255	> 1440	200	> 1440	135	> 1440
Shank Injection Application Method												
Bakersfield - Standard Water Seal												
75	450	> 1440	340	> 1440	300	> 1440	15	170	10	155	5	135
90	510	> 1440	395	> 1440	385	> 1440	105	1235	90	1070	65	850
95	585	> 1440	475	> 1440	440	> 1440	225	1435	185	1435	135	1435
99	740	> 1440	605	> 1440	515	> 1440	490	> 1440	395	> 1440	275	> 1440
99.9	1060	> 1440	850	> 1440	580	> 1440	705	> 1440	580	> 1440	430	> 1440
Bakersfield - Intermittent Water Seal												
75	125	1435	90	1100	50	675	15	140	10	120	5	85
90	175	> 1440	130	1435	80	1155	55	390	40	325	20	235
95	215	> 1440	160	> 1440	105	1435	80	580	60	480	35	350
99	310	> 1440	240	> 1440	160	> 1440	145	1325	115	1050	75	750
99.9	440	> 1440	335	> 1440	240	> 1440	270	> 1440	210	> 1440	140	1435
Lost Hills - Intermittent Water Seal												
75	115	1435	0	980	0	590	0	90	0	65	0	35
90	175	> 1440	5	1435	0	935	15	390	0	300	0	185
95	210	> 1440	5	> 1440	0	1150	45	720	0	555	0	350
99	270	> 1440	5	> 1440	5	1435	115	1430	5	1075	0	725
99.9	355	> 1440	50	> 1440	5	> 1440	215	> 1440	5	> 1440	5	1265
Mount Vernon - Roozen Rig												
75	405	> 1440	335	> 1440	295	> 1440	40	190	35	175	10	155
90	560	> 1440	465	> 1440	375	> 1440	145	1175	125	1050	110	875
95	690	> 1440	560	> 1440	450	> 1440	225	1435	190	1435	200	1435
99	985	> 1440	795	> 1440	570	> 1440	470	> 1440	385	> 1440	335	> 1440
99.9	1225	> 1440	950	> 1440	675	> 1440	875	> 1440	690	> 1440	535	> 1440
Drip Irrigation Application Method												
Irvine - Tarped												
75	90	1245	55	795	5	440	0	85	0	60	0	30
90	145	1435	100	1200	30	760	15	320	5	240	0	145
95	180	> 1440	125	1435	60	945	40	565	20	425	5	270
99	240	> 1440	170	> 1440	105	1280	100	1240	70	875	20	590

99.9	305	> 1440	225	> 1440	140	> 1440	190	> 1440	140	> 1440	75	1105
Irvine - Untarped												
75	65	955	5	665	0	390	0	45	0	25	0	5
90	110	1365	40	965	5	570	0	280	0	195	0	100
95	130	1435	80	1165	5	700	5	540	5	375	0	225
99	175	> 1440	115	1435	5	895	70	1115	5	820	5	500
99.9	205	> 1440	135	> 1440	5	1085	140	> 1440	95	1350	5	840



Along with evaluating the trends amongst different types of flux profiles at a specific location, it is also important to understand how meteorological differences might impact results. These trends have been examined in Table 12 and Figure 15 below in which results for varying percentiles of exposure, field sizes, weather station locations, and flux profiles are compared using PERFUM whole field "buffer" results based on a maximum application rate and a target concentration based on the NOAEL HEC and UF=10. [Note: 95th percentile results only are represented in Figure 15 but the basic trend would be expected to be similar for all percentiles of exposure. It would also be anticipated that use of maximum buffer results as well as fixing other factors in the analysis would not impact the general trends observed between weather station locations and flux profiles.] The results demonstrate that predicted distances to target concentrations decrease as fields get smaller or lower percentiles of exposure are considered as would be expected. Figure 15 clearly illustrates that the use of intermittent water seal flux data (for both sprinkler irrigation and shank injection) result in lower predicted distances compared to the use of standard water seal flux profiles (again for both sprinkler irrigation and shank injection). Figure 15 also clearly illustrates that results appear to be more sensitive to changes in flux as opposed to differences in meteorological data.

Table 12:Summary of All Location PERFUM Whole Field Buffer Results For All Flux Types With 1 And 40 Acre Fields at Maximum Application Rate of 320 lb ai/A

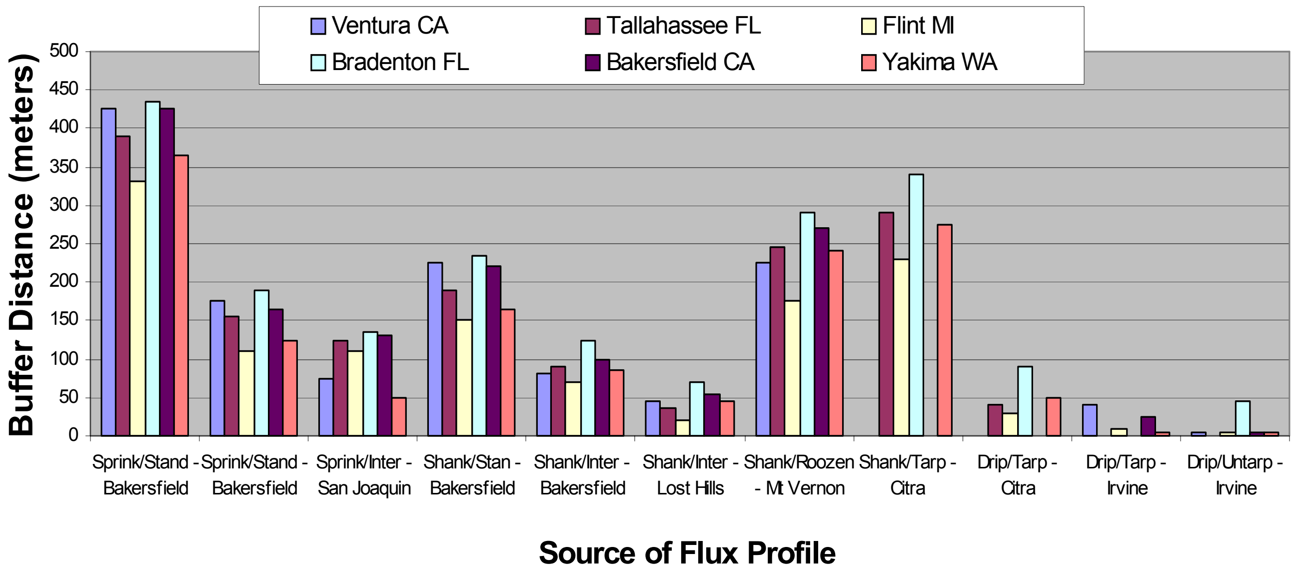
Whole Field PERFUM Buffer Results (meters) At Maximum Application Rate (320 lb ai/acre)												
Percentiles	Ventura California		Tallahassee Florida		Flint Michigan		Bradenton Florida		Bakersfield California		Yakima Washington	
	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres
Sprinkler Irrigation Method												
Bakersfield - Standard Water Seal												
75	25	210	30	300	40	315	25	235	55	440	55	475
90	185	1435	200	1435	190	1435	185	1340	235	1435	230	1435
95	425	> 1440	390	> 1440	330	> 1440	435	1435	425	> 1440	365	> 1440
99	1105	> 1440	915	> 1440	755	> 1440	1055	> 1440	960	> 1440	705	> 1440
99.9	> 1440	> 1440	1435	> 1440	1405	> 1440	> 1440	> 1440	1435	> 1440	1230	> 1440
Bakersfield - Intermittent Water Seal												
75	20	190	20	240	15	200	25	235	30	345	25	300
90	105	705	90	880	70	665	110	870	105	1070	80	865
95	175	1435	155	1435	110	1085	190	1435	165	1435	125	1400
99	350	> 1440	320	> 1440	220	> 1440	385	> 1440	315	> 1440	240	> 1440
99.9	540	> 1440	495	> 1440	415	> 1440	635	> 1440	465	> 1440	390	> 1440
San Joaquin - Intermittent Water Seal												
75	10	175	15	200	15	195	15	180	25	245	5	260
90	45	770	75	765	70	640	80	635	85	670	30	730
95	75	1435	125	1310	110	1030	135	1120	130	1150	50	1165
99	150	> 1440	250	> 1440	215	> 1440	260	> 1440	255	> 1440	110	> 1440
99.9	255	> 1440	470	> 1440	425	> 1440	460	> 1440	450	> 1440	190	> 1440

Table 12:Summary of All Location PERFUM Whole Field Buffer Results For All Flux Types With 1 And 40 Acre Fields at Maximum Application Rate of 320 lb ai/A

Whole Field PERFUM Buffer Results (meters) At Maximum Application Rate (320 lb ai/acre)

Percentiles	Ventura California		Tallahassee Florida		Flint Michigan		Bradenton Florida		Bakersfield California		Yakima Washington	
	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres	1 Acre	40 Acres
Shank Injection Application Method												
Bakersfield - Standard Water Seal												
75	15	170	20	235	20	215	15	215	30	340	30	330
90	105	1235	110	1015	90	795	115	915	130	1245	105	1120
95	225	1435	190	1435	150	1435	235	1435	220	1435	165	1435
99	490	> 1440	395	> 1440	330	> 1440	520	> 1440	395	> 1440	305	> 1440
99.9	705	> 1440	595	> 1440	550	> 1440	800	> 1440	560	> 1440	500	> 1440
Bakersfield - Intermittent Water Seal												
75	15	140	15	195	10	155	20	205	25	230	20	245
90	55	390	55	570	50	475	80	580	65	590	55	570
95	80	580	90	885	70	690	125	975	100	925	85	850
99	145	1325	165	1435	125	1315	220	> 1440	180	> 1440	160	1435
99.9	270	> 1440	285	> 1440	215	> 1440	365	> 1440	315	> 1440	290	> 1440
Lost Hills - Intermittent Water Seal												
75	0	90	0	110	0	65	0	130	5	160	5	150
90	15	390	10	380	5	235	35	450	35	390	30	350
95	45	720	35	615	20	400	70	750	55	595	45	535
99	115	1430	95	1115	65	910	140	1435	105	1230	95	1030
99.9	215	> 1440	180	> 1440	140	> 1440	255	> 1440	190	> 1440	175	> 1440
Mount Vernon - Roozen Rig												
75	40	190	40	370	20	305	40	225	60	450	60	500
90	145	1175	155	1425	105	1170	165	1155	175	1435	160	1435
95	225	1435	245	1435	175	1435	290	1435	270	> 1440	240	> 1440
99	470	> 1440	485	> 1440	375	> 1440	570	> 1440	540	> 1440	445	> 1440
99.9	875	> 1440	865	> 1440	670	> 1440	1045	> 1440	905	> 1440	770	> 1440
Drip Irrigation Application Method												
Irvine - Tarped												
75	0	85	N/A	N/A	0	60	N/A	N/A	0	130	0	80
90	15	320	N/A	N/A	5	205	N/A	N/A	5	375	5	265
95	40	565	N/A	N/A	10	345	N/A	N/A	25	580	5	430
99	100	1240	N/A	N/A	50	740	N/A	N/A	75	1005	50	785
99.9	190	> 1440	N/A	N/A	115	1435	N/A	N/A	140	> 1440	100	1275
Irvine - Untarped												
75	0	45	0	50	0	30	0	75	0	85	0	45
90	0	280	0	225	0	155	15	310	0	250	0	185
95	5	540	0	390	5	275	45	540	5	415	5	285
99	70	1115	5	725	25	620	100	1150	35	690	5	510
99.9	140	> 1440	35	1265	95	1360	170	> 1440	85	1100	50	870

Figure 15: PERFUM Whole Field Results For 1 Acre Fields Based on All Available Meteorological and Flux Data at Maximum Application Rate



Potentially, the size and shape of a treated field can also impact results. Using the Ventura California meteorological data, the relative impacts of altering field sizes from 1 to 40 acres was evaluated for each available flux study (Figure 16). Likewise, the impact of changing the shape of a treated field can potentially impact results. This parameter was investigated using different shaped 5 acre fields (i.e., square and "wide" and "long" rectangles oriented horizontally and vertically) and results for all flux studies also in conjunction with the Ventura California meteorological data (Figure 17). The results of the analysis which examined the impact of changing field sizes were expected in that buffer distances increased with larger fields. The slope of the curves for each flux study varied because of the different emission profiles associated with each. The higher the emissions, the larger the buffer distance required. The impact of changing field shapes was also investigated. It appears that at least for the Ventura California meteorological data and 5 acre fields that the shape did not significantly impact buffer distances. This probably indicates that there is not a prevailing wind direction for the Ventura California weather station and that wind vectors occurred in several directions over the time-frame of the analysis. It is possible that results would differ for different weather station locations and that more site specific analyses could be required if this parameter requires further investigation. It is also likely that results would be more pronounced with larger fields or if a weather station has a definite prevailing wind direction.

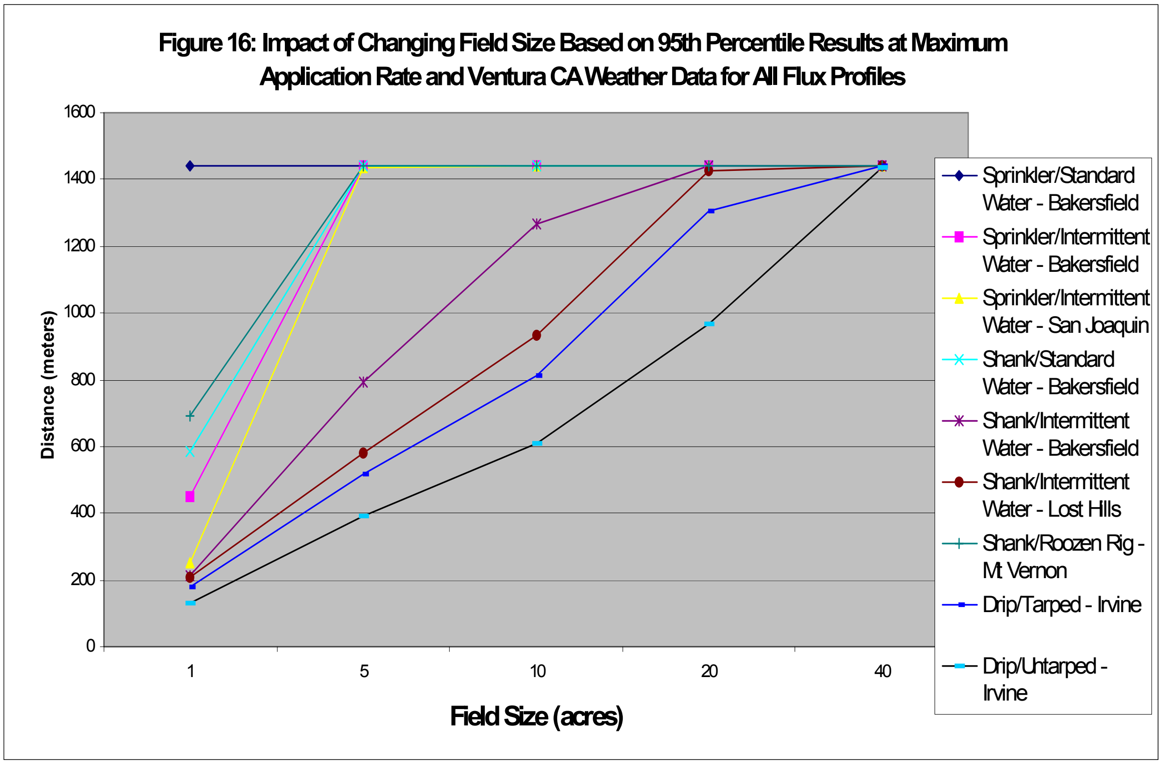


Figure 16: Impact of Changing Field Size Based on 95th Percentile Results at Maximum Application Rate and Ventura CA Weather Data for All Flux Profiles
Distance (meters)
1600
1400
1200
1000
800
600
400
200
0
1
5
10
20
40
Field Size (acres)
Sprinkler/Standard Water - Bakersfield
Sprinkler/Intermittent Water - Bakersfield
Sprinkler/Intermittent Water - San Joaquin
Shank/Standard Water - Bakersfield
Shank/Intermittent Water - Bakersfield
Shank/Intermittent Water - Lost Hils
Shank/Roozen Rig - Mt Vernon
Drip/Tarped - Irvine
Drip/Untarped - Irvine

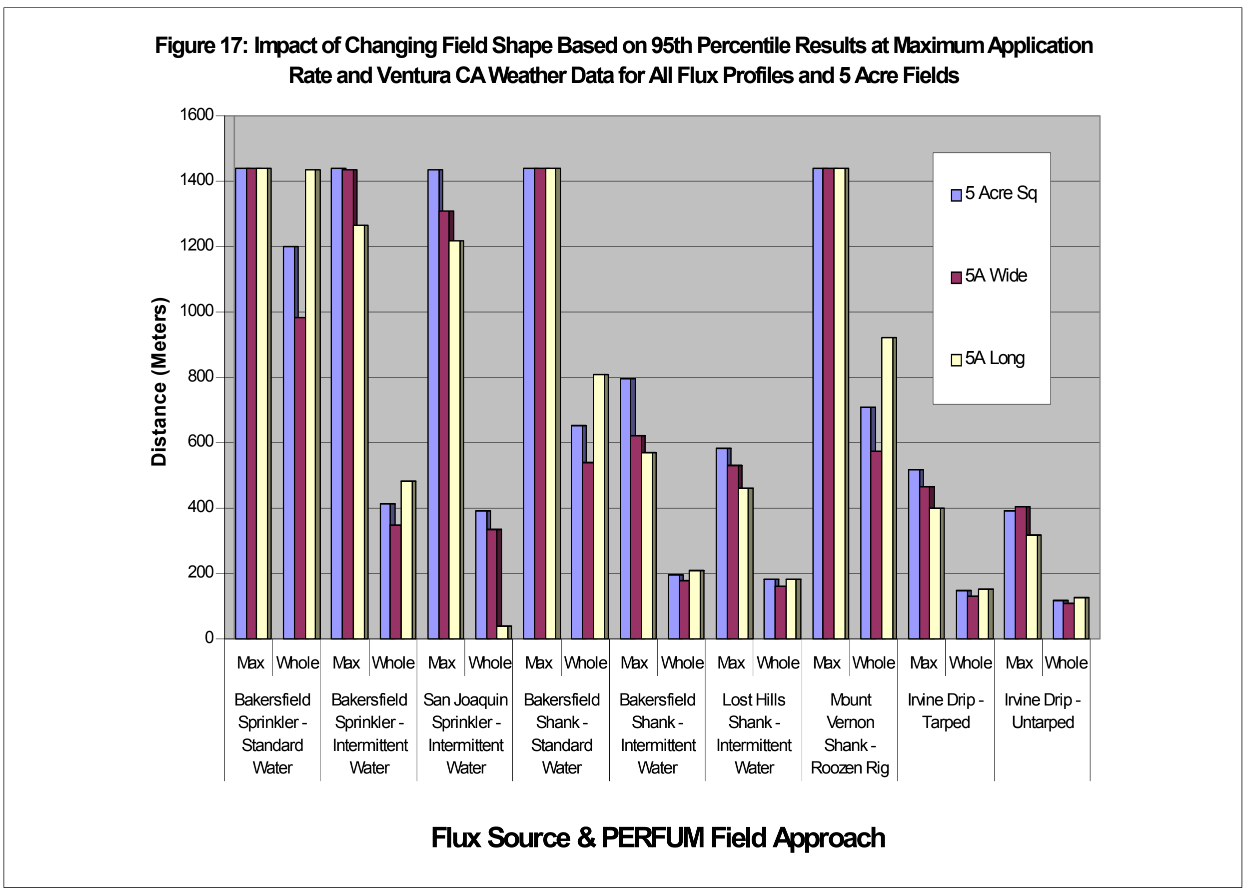


Figure 17: Impact of Changing Field Shape Based on 95th Percentile Results at Maximum Application Rate and Ventura CA Weather Data for All Flux Profiles and 5 Acre Fields
Distance (Meters)
1600
1400
1200
1000
800
600
400
200
0
5 Acre Sq
5A Wide
5A Long
Max
Whole
Bakersfield Sprinkler - Standard Water
Bakersfield Sprinkler - Intermittent Water
San Joaquin Sprinkler - Intermittent Water
Bakersfield Shank - Standard Water
Bakersfield Shank - Intermittent Water
Lost Hills Shank - Intermittent Water
Mount Vernon Shank - Roozen Rig
Irvine Drip - Tarped
Irvine Drip - Untarped
Flux Source & PERFUM Field Approach

In conclusion, it is clear that many different factors can impact the air concentrations in proximity to agricultural fields that have been treated with metam sodium and these include many of the factors which have been investigated in this analysis. It is important to acknowledge this issue because so many potential factors can impact results that it is important that stakeholders understand that the results of this analysis can be interpreted in many ways depending upon the factors which are considered. Many conclusions can be drawn but the key ones include: (1) at the edge of the treated fields that NOAEL HECs generally are not exceeded given proper use of metam sodium but conversely the distances predicted at the upper percentiles of exposure for MOEs = 10 are at 1440 meters for many scenarios; (2) the methods used to evaluate MITC exposure (from metam sodium applications) in this assessment generally agree and they are based on techniques that have been routinely used for regulatory purposes, they have also undergone significant review and validation; (3) the sensitivity of results to changes in key factors such as flux and meteorological conditions is generally not significant (i.e., it is generally well within an order of magnitude for the factors which have been evaluated); (4) PERFUM is an empirically based approach so the generation of additional flux and meteorological data would allow a broader analysis for other regions of the country and application techniques; and (5) the identification of a result, *per se*, for any sort of regulatory action would depend upon careful consideration of the variability and uncertainty associated with each as well as any particular merits associated with each.

6.1.2 Ambient Bystander Exposure From Non-Point Sources

Exposures from ambient air that occur from non-point sources of MITC were estimated from monitoring data collected to represent conditions at a regional level. The California Air Resources Board (CARB) generated most of the data considered in this analysis. CARB is a widely recognized institution for these types of programs and it is part of the California Environmental Protection Agency. CARB conducts air monitoring studies for various types of chemicals throughout California. The available ambient studies for MITC conducted by CARB can be described as targeted monitoring that is typically completed upon request to provide information related to specialized issues such as fumigant exposures in areas of high use during the season of use. Additional data were considered that were generated in townships after specific application events (e.g Bakersfield/Kern County 1997 and 1998, Lompoc 2000). [Note: The MITC ambient air monitoring studies included in this assessment do not distinguish the source of MITC as coming from applications of metam sodium, metam potassium, or dazomet.]

For ease and clarity, HED has opted by convention to describe the available ambient bystander data used in this assessment as follows:

> **(1) "CARB Data":** includes all targeted monitoring data generated by both CARB and private research focused on areas of high MITC use in the season of use.

6.1.2.1 Exposures From Regionally Targeted Non-Point Source Ambient Air Monitoring

In 2000 and 2001, the CDPR requested that the CARB conduct a series of studies to quantify ambient levels of MITC (http://www.cdpr.ca.gov/docs/empm/pubs/tac/requests.htm).

> "Because most of California's pesticide applications normally occur in agricultural areas and are seasonal in nature, ARB conducts the monitoring studies to collect data during the worst-case situation - in the areas of high use during the season of peak use - instead of collecting samples throughout the State. This "worst-case" information can then be used to determine the ambient exposures of those people living near places where pesticides are used."

For the targeted ambient air analysis, HED evaluated different durations of exposure including single day acute exposures, short- and intermediate-term exposures, and chronic exposures. Since samples were collected 3 to 5 times per week from each station, and the contribution of specific applications could not be determined, the statistics were calculated by station and not on a regional basis. Risks from acute exposures were calculated using the maximum 24 hour TWA values measured at each station and comparing them to the acute HEC.

Risks from short-/intermediate-term exposures (i.e., same HEC and uncertainty factors apply to both durations) were calculated using the 24-hour study mean for samples taken over the course of the use season and comparing them to the short-/intermediate-term HEC. Concentrations over the course of a season monitored in these studies did not vary extensively. This supposition is supported physically because these studies spanned high use seasons in high use areas and use would not be expected to dramatically change at these locations during use seasons.

Chronic exposure estimates were also calculated using the targeted non-point source ambient data. These calculations should be considered as rangefinder estimates of exposure as none of the available ambient studies adequately reflect long-term monitoring of MITC in these areas. Specifically, short- and intermediate-term estimates were amortized to reflect a potential for exposure of 180 days out of each calendar year in order to calculate chronic estimates of exposure. This was determined based on the approximate use patterns for metam sodium over a year in high use areas. This approach does introduce the potential for significant uncertainty into the estimates, however, HED views the potential for chronic exposures in high use regions as significant and has addressed this scenario in order to be health protective. Because there are many uncertainties associated with the approach used in this assessment it is difficult to determine how these estimates either over- or under-predict actual chronic exposures for those living in high use areas. There are several factors that should be considered:

- Monitoring was specifically targeted toward areas of high use, this limits the populations for which these types chronic exposure estimates could be applied (i.e., for those living in such regions);

- More refined amortization approaches on a regional basis could be possible with use data, especially in California, but in most regions such data are not available; and

- Targeted monitoring was conducted during selected seasons of high use, but because the data are limited, the impacts of changing conditions (e.g., from different pest pressures, use patterns, or extended seasons) cannot be quantified, especially for different regions of the country with different climates, which could lead to potentially missing higher end exposures under some conditions.

The results for acute exposures (single day exposures), for the all of the monitoring stations considered, do not exceed HED's level of concern (MOEs < 10). For results for the short- and intermediate-term exposures (24-hour study mean exposures), the only locations that exceeded HED's level of concern (MOEs < 30) were indoor and outdoor samples collected in the summer of 1997 in Bakersfield. The results for the chronic exposures (24-hour study mean exposures), the only locations that exceeded HED's level of concern (MOEs < 30) were indoor and outdoor samples collected in the summer of 1997 and winter of 1998 in Bakersfield.

Table 13: Results of California Ambient Monitoring In High Use Areas							
Study	Duration of Samples/Study	Location	n	MITC Concentration Average (ppm)		MOEs	
				Max	Mean	Acute[6]	ST/IT [7]
Bakersfield/Kern County, summer (1997) [1]	12 hour samples (am and pm for 5 days) during known applications in May, Jun, July and August	Lamont - Houses	43[1]	0.0097	0.0059	23	28
		Lammont - Environment	14[1]	0.0050	0.0025	44	65
		Weedpatch - Environment	12[1]	0.0094	0.0047	23	35
		Shafter - Houses	45[1]	0.013	0.0066	17	25
		Shafter - Environment	15[1]	0.015	0.0077	15	21
Bakersfield/Kern County, winter (1998) [1]	12 hour samples (am and pm for 4 to 5 days) during known applications in Jan and March	Lamont - Houses	16[1]	0.0019	0.0012	116	136
		Weedpatch - Environment	8[1]	0.0017	0.0016	130	102
		Arvin - Houses	15[1]	0.0014	0.00070	158	233
		Arvin - Environment	6[1]	0.00030	0.00010	733	1623
Lompac (1998) [2]	12 hour samples colleted in am and pm (8/31 and 9/9 to 9/13)	Central	60[2]	0.00019	Insufficient data to calculate average	1138	Insufficient data to calculate
		Northeast		0.000064		3474	
		Northwest		0.000064		3474	
		Southwest		0.000087		2538	
		West		0.00034		653	
Lompac (2000) [3]	8 and 16 hour samples collected for days after 6 applications in Jan, Feb, Oct, and Nov (72hr sampling period beginning start of application. 8hr for day and 16hrs for night)	Central	173[3]	0.00011	0.000016	1953	10362
		Northeast		0.00010	0.000027	2207	5939
		Northwest		0.00038	0.000061	577	2661
		Southwest		0.00015	0.000010	1493	16233
		West		0.00040	0.000039	552	4162
Kern (2001) [4]	24 hour samples collected on 33 sample days during 8 week period that coincided with fumigation use prior to carrot planting (Samples were collected 4 days per week on a random basis)	ARB	198[4]	0.00057	0.00019	388	840
		ARV		0.0015	0.00037	150	439
		CRS		0.00010	0.00007	2200	2319
		MET		0.0014	0.00014	153	1133
		MVS		0.0074	0.00010	30	158
		VSD		0.0032	0.00061	69	268
Monterey/Santa Cruz (2001) [5]	24 hour samples. 32 sample days at 6 sites during 8 week period that coincided with fumigation use prior to strawberry planting (Samples were collected 4 days per week on a random basis)	6 sites (CHUT, LJET, MEST, PMST, SALT, SEST)	192[5]	0.00014	0.000070	1535	2319

1 Bakersfield/Kern County (1997/98), CDPR's HS-1806. (results taken from http://www.cdpr.ca.gov/docs/whs/pdf/hs1806.pdf)

2 Lompoc (1998), 50 samples were non-detects (results taken directly from http://www.cdpr.ca.gov/docs/dprdocs/lompoc/lexpdata.pdf)

3 Lompac 2000), Forty-three% of samples were non-detects, 19% Trace, 39% quantified (results taken directly from Table 11 in http://www.cdpr.ca.gov/docs/dprdocs/lompoc/vol2_fumigants/volume2_march2003.pdf)

4 Kern (2001), Eighty-eight Samples > LOQ of 0.42, LOQ > 68 samples > LOD, 41samples < LOD, 2 samples invalid. LOQ =0.42 ug/m3. ½ of LOQ used for DET or <MDL (results extracted from http://www.cdpr.ca.gov/docs/empm/pubs/tac/tacpdfs/chlormitc03.pdf)

5 Monterey/Santa Cruz (2001), One sample at SEST site > EQL, 2 samples at SEST site had detectable results, 186 samples < MDL, 3 samples invalid. LOQ =0.42 ug/m3. ½ of LOQ used for DET or <MDL (results taken from http://www.cdpr.ca.gov/docs/empm/pubs/tac/tacpdfs/chlor_metsod04.pdf)

6 Acute bystander MOEs were estimated using an HEC of 0.22, where an MOE of 10 or more does not exceed HED's level of concern.

7 Short- and intermediate-term bystander MOEs were estimated using an HEC of 0.16, where an MOE of 30 or more does not exceed HED's level of concern.

6.2 Bystander Risk Characterization

There are several issues that should be considered in the interpretation of the above assessments for off-target releases of MITC from metam sodium applications. The first is that most of the data used for this analysis have been generated in California; however, metam sodium is used in many regions of the country. Therefore, the results based on California data and agricultural practices were used to represent the rest of the country due to a lack of adequate information for any other region. It is unclear what potential impacts this extrapolation might have on the risk assessment, however, the California data is most likely worst case in nature. For example, available data seem to indicate that factors such as soil type and other environmental conditions might affect the rate at which MITC is emitted from metam sodium treated fields or other sources. Meteorological conditions such as differences in humidity, levels of solar radiation, and atmospheric stability also impact ambient concentrations.

Another factor that should be considered in the interpretation of these results is the data quality associated with the inputs and other factors used in the calculations. For most of the data, HED believes that the data and other information used are of reasonable quality for risk assessment purposes.

Several factors need to be considered in the interpretation of the results associated with known sources. In all sectors a tiered approach was used to evaluate risks using monitoring data and either the ISCST3 or PERFUM. HED believes that PERFUM provides the most refined estimates of risk (for pre-plant soil fumigations) because it can consider actual weather data and also integrate flux distributions and uncertainties. Monitoring data were also integrated into the assessment for each use sector as flux rates needed for PERFUM and ISCST3 analyses to be completed were based on these data. Analysis of the data itself, in general, indicated some risks that exceed HED's level of concern. Use of monitoring data, however, are limited because it does directly not allow extrapolation to differing distances downwind or to varying climatic conditions. Use of either the PERFUM or ISCST3 models provide much more flexibility in that it allows extrapolations to varying locations and under different climatic conditions. These types of results allow for much more informed risk management decisions. The ISCST3 model itself is a publically vetted tool that is currently used by the Agency's Office of Air for regulatory purposes (see *Technology Transfer Network Support Center for Regulatory Air Models* (http://www.epa.gov/scram001/tt22.htm#isc). The information provided regarding ISCST3 should be explored in detail for a more complete examination of the uncertainties associated with this model. PERFUM has also been publically vetted through the FIFRA SAP and it should also be reiterated that the basic dispersion algorithm upon which it is based is ISCST3. The specific inputs for the model calculations affect results and the inputs should be carefully evaluated in order to quantify how changes in inputs may impact results. For example, for ISCST3 analyses the key input factors for pre-plant agricultural uses were field size, flux/emission rates, atmospheric stability, and windspeed. Wind direction is another factor which also should be considered. The field sizes used by HED in this assessment were 1 to 40 acres which is well within the range of what could be treated on a daily basis. There are uncertainties associated with point estimates of flux/emission rates for specific application techniques which is another varying factor. The flux rates which were used have been verified by HED in an independent analysis of the available data. The reality is that there is a large distribution of flux rates which is a phenomenon inherent in the nature of these types of data which may be due to several factors including use of a constant wind vector during the back-calculation of flux, variability of certain meteorological elements such as cloud cover, and in some cases estimates being used for application areas because active applications overlap field sample collection.

The values used for the ISCST3 assessment yield conservative air concentration estimates because considering a constant flux rate does not allow for diurnal/nocturnal changes that may occur, which when coupled with the appropriate wind speed and stability category, can result in lower concentrations. Additionally, the maximum application rate was considered coupled with the median emission ratio which also provided a conservative estimate for flux. The meteorological inputs for ISCST3 also will provide a conservative estimate of exposure because the wind direction is considered to be perpendicular (pointed downwind) to the treated field for the entire 4 hours represented in the calculation. This is not a normal situation in the atmosphere for most locations. There is normally a prevailing wind with directional changes over the course of a typical day, especially when diurnal and nocturnal differences are noted. HED did not recommend a specific set of meteorological conditions for this assessment but instead provided a range of results for different conditions. Different meteorological databases were evaluated SAMSON & CIMIS using data from various locations for comparative purposes. The lower 10th percentile windspeeds for a 4 hour period in that analysis ranged from approximately 2 to 5.5 mph depending upon the location. The windspeeds used by HED ranged from approximately 2 to 10 mph. Overall, HED believes that the ISCST3 approach used to evaluate potential exposures from a known source can be considered conservative. It is believed, however, that the range of selected input values and outputs represent what could reasonably occur in agriculture given proper field and climatological conditions. In addition to the use of ISCST3, PERFUM was used to evaluate the key pre-plant field fumigation uses of metam sodium. PERFUM provides distributional outputs which allows users to actively select percentiles of exposure, statistical basis (e.g., whole field or maximum buffers), and other factors when determining a level for regulatory action. Finally, as indicated above, the identification of a result, *per se*, using PERFUM for any sort of regulatory action would depend upon careful consideration of the variability and uncertainty associated with each as well as any particular merits of the inputs associated with each.

Several factors also need to be considered in the interpretation of the results associated with the assessment of exposures from ambient air. It is clear from the characterization of the data provided by CARB that some data represent highly targeted monitoring in a region during the season of use. Because of these criteria, the results should be considered conservative in nature for California. Finally, one issue that should be considered in the interpretation of the estimates for ambient air is that California has a number of restrictions and systems in place where the overall goal is to reduce environmental emissions from fumigant use. As such, it is difficult to quantify how the results presented above may apply to other regions of the country who do not have these types of programs in place

HED notes that the CDPR has performed risk assessments for both MITC and metam sodium. While there are many similarities between the two assessments, there are also some distinctions, particularly concerning the hazard characterization of MITC. The non-cancer endpoints used by CDPR are lower than HED (3X-66X lower than HED). These differences arise primarily from two issues: 1) utilization of the human acute eye irritation study for quantitative risk assessment, and 2) interpretation of the effects observed in the 28-day inhalation rat study for purposes of quantitative risk assessment. A fundamental difference underlying these issues concerns the interpretation of toxic effects primarily related to irritation. Another dissimilarity is the respective regulatory entities definition of exposure durations for hazard and exposure assessment, i.e., CDPR's use of 1- to 8-hour acute exposure durations.

6.3 Residue Profile

There is no reasonable expectation of finite residues to be incurred in/on food and feed crops when metam sodium and potassium are used as preplant soil fumigants, so these uses are considered to be non-food uses, and tolerances are not needed. (Refer to Section 3.1.) For additional information please see Appendix F (S. Kinard, D293347).

Along with the uses on all crops, there are also existing antimicrobial uses for metam sodium, metam potassium, and MITC. Metam sodium can be used in paper pulp to control bacteria and fungal slime in the pulp slurries and to inhibit the growth of bacteria in papermaking equipment. Similarly, there is a current use of metam potassium in sugarcane processing to inhibit the growth of bacteria on the processing equipment, and MITC is registered for use as a wood preservative (e.g., telephone poles). For paper pulp and sugarcane uses, there are numerous processing steps (e.g., boilers, evaporators, vacuum pans, recrystalization, additional dryers, bulk storage, etc.) that occur after the addition of metam sodium and potassium involving high temperatures; that combined with the volatility of the residue of concern (MITC), HED believes that there is no reasonable expectation of finite residues to be incurred in/on sugar, sugarcane products, or food packaged in treated paper products. These uses, along with the MITC telephone pole use, have been assessed by OPP's Antimicrobial Division (Metam Potassium: Dietary Risk Assessment of Antimicrobial Uses for the Reregistration Eligibility Decision Document, T. McMahon and C. Walls, July 13, 2004).

6.4 Water Exposure/Risk Pathway

Environmental fate data suggest that there is a low potential for the parent compound metam sodium or metam potassium to be present in drinking water due to the rapid degradation of metam sodium/potassium to MITC in the environment. However, MITC is very soluble in water and its low adsorption in soil suggests that leaching to ground water and/or transport to surface water may be a potential problem under flooded conditions. Therefore, a qualitative drinking water assessment was performed.

Under most field conditions, the potential for significant ground water contamination of MITC is unlikely due to its volatilization and fast degradation in soil. Based on available non-targeted monitoring data, MITC was not detected in the ground water samples within the USA. MITC can also potentially move to surface water through runoff under an intense rainfall and/or if continuous irrigation occurs right after metam sodium application. However, the Henry's Law Constant of 1.79 x 10-4 atm-m^3/mol for MITC suggests that it will be volatilized quickly from surface water. Based on environmental fate data, the residual contents in soils, and monitoring data, Agency does not expect MITC to adversely impact the drinking water sources such as surface water and ground water.

7.0 Aggregate Risk Assessment

The physical/chemical characteristics, the environmental fate data, and results of metabolism studies in plants assure that there is no reasonable expectation of finite residues to be incurred in/on food and drinking water when these products are applied according to label directions. Therefore, this fumigant does not require food tolerances and is not subject to the amendments to the FFDCA promulgated under the Food Quality Protection Act of 1996; therefore, an aggregate risk assessment is not required.

8.0 Cumulative Risk Assessment and Characterization

In September, 2001, OPP presented a draft paper entitled “The Grouping of a Series of Dithiocarbamate Pesticides Based on a Common Mechanism of Toxicity” to the FIFRA Scientific Advisory Panel (SAP). Although metam sodium is a mono-methyl compound, this pesticide was included in the evaluation. Overall, the panel concluded that at present time, there is not sufficient evidence to group the dithiocarbamate pesticides based on a common mechanism of action for purposes of cumulative risk assessment.

For information regarding EPA’s efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA’s Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA’s website at http://www.epa.gov/pesticides/cumulative/.

9.0 Occupational Exposure

This section of the risk assessment focuses on potential exposures and risk to occupational handlers, to occupational reentry workers who could be exposed when entering metam sodium-treated areas to perform crop-production tasks, and to occupational bystanders who could be exposed when performing crop-production tasks near (but not inside) metam sodium-treated areas. Based on available metam sodium air concentration data, HED has concerns about occupational handlers performing the application tasks in the field as well as workers performing tasks inside and near – but outside of – metam sodium-treated areas. Air concentration levels from metam sodium-specific handler exposure monitoring studies were used to estimate occupational handler risks. It should be noted that much of the handler exposure monitoring data used in the occupational exposure estimates reflects the use of some engineering controls such as tarps, tractor cabs, deep injection, or other devices. The duration of exposure had little impact on the overall results of this assessment. Exposure estimates obtained through modeling were used to estimate occupational bystander risks. At this time, HED has no data to assess potential exposures and risks to occupational reentry workers.

It is important to consider that in this assessment worker exposure monitoring data have been used directly for risk assessment purposes. In a typical pesticide handler assessment, HED uses normalized estimates of exposures based on similar equipment and with similar levels of protective equipment or clothing. Additionally, in typical post-application worker assessments, exposures are scaled based on how residues decay over time. These approaches have not been used in the occupational assessments presented below due to methodological issues. For example, it is not clear how changes in various parameters or conditions (e.g., temperature, emission reduction methods such as tarps or application methods) may impact exposures. It is also not clear how time after application can be used for scaling exposures from one day to the next because worker exposures may be inherently related to the conditions of the field under which monitoring has occurred. Current requirements for entry of post-application workers into previously treated fields are dictated by the Worker Protection Standard as described in PR 93-7. For metam sodium, such workers are excluded for 48 hours after treatment. Refinement of time-based entry requirements is pending related to the investigation of factors that may impact exposures over time and development of an appropriate methodology for such analyses.

9.1 Occupational Handler Exposure

For metam sodium, handler exposure estimates were based on surrogate data from: (1) the Pesticide Handlers Exposure Database (PHED) and (2) the Outdoor Residential Exposure Task Force (ORETF). For MITC, handler exposure estimates were based on four chemical-specific handler studies that examined MITC exposures to handlers involved in metam sodium applications.

9.1.1 Occupational Handler Point Exposure Estimates for Pre-plant Agricultural Field Fumigations

Metam Sodium

Risks exceed HED's level for the majority of agricultural scenarios, including applications to ornamentals, food, and feed crops, tobacco plant beds, and turf even at maximum risk mitigation for most cancer and non-cancer assessments for exposures to metam sodium. Tables 1, 2, 3, and 4 found in Appendix F summarize the estimated exposures and risks.

MITC

Acute Exposures: Durations of the handler air samples ranged from 1 to 254 minutes depending on the task. Acute risks (MOEs) were calculated by comparing the maximum air concentration level of MITC at an individual sample point to the toxicological human equivalent concentration (HEC) selected for acute exposures.

Short- and Intermediate-term Exposures: To calculate the short-and intermediate-term risks to handlers, the geometric mean air concentration level of MITC was calculated across all sites for each different handler task and method of application. This geometric mean air concentration level was then compared to the HEC selected for short- and intermediate-term exposures to calculate the short- and intermediate-term risks (MOEs).

Handler Risk Summary: A summary of the MOEs estimated for handler exposures to MITC is included in Table 14. Acute risks to handlers exceed HED's level of concern (MOE < 10) for most of the tasks assessed. Short-term risks to handlers also exceed HED's level of concern (MOE < 30) for most of the tasks assessed.

The estimated MOEs do not reflect the reduction of inhalation exposure resulting from the use of respirators or additional mitigation controls that were not used in the studies. HED typically shows MOEs for handlers wearing respirators (when feasible) with a protection factor (PF) of

10. It is assumed that a respirator with a PF of 10 will reduce concentrations of MITC in the breathing zone by 90%.

Table 14: MITC Handler MOEs Calculated from Study Point Estimates for Pre-plant Agricultural Field Fumigations

Exposure Scenario	MRID(s) used to Access Scenario	(n)	Sample time (mins)		MITC (ug/m3)		MOEs		PF 10 Respirator MOEs [1]	
			Min	Max	Max	GM	Acute	ST/IT	Acute	ST/IT
Loader										
Transferring Water Soluble Liquids from Tank Delivery Truck to Shank Injection Equipment	**429684-02***	10	3	17	1157	212	0.57	9.6	5.7	96
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment	429584-01	10	3	11	1751	314	0.38	6.5	3.8	65
Transferring Water Soluble Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Chemigation Nurse Tank	**429684-02***	10	43	78	2739	440	0.24	4.6	2.4	46
	429584-01	5	8	12	125	342	5.3	5.9	53	59
Transferring Water Soluble Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Drip Irrigation Nurse Tank	**429684-02***	10	43	78	2739	440	0.24	4.6	2.4	46
	429584-01	5	8	12	125	342	5.3	5.9	53	59
Applicator										
Applying Water Soluble Liquids via Shank Injection Equipment-Personal Sampler Pumps (enclosed cab with charcoal filter)	**429684-02***	2	1	78	284	222	2.3	9.2	23	92
Applying Water Soluble Liquids via Shank Injection Equipment-Personal Sampler Pumps (enclosed cab with cellulose filter)	**429684-02***	4	1	74	1791	1486	0.37	1.4	3.7	14
Applying Water Soluble Liquids via Shank Injection Equipment-Personal Sampler Pumps (open cab)	**429684-02***	4	1	77	3851	719	0.17	2.8	1.7	28
Applying Water Soluble Liquids via Shank Injection Equipment-In-cab Sampler Pumps (enclosed cab with charcoal filter)	451239-02/457037-03	9	1	176	664	454	1	4.5	10	45
Applying Water Soluble Liquids via Rotary Tiller Equipment-Personal Sampler Pumps(enclosed cab with charcoal filter)	42958401	5	63	72	2493	596	0.26	3.4	2.6	34
Applying Water Soluble Liquids via Rotary Tiller Equipment (enclosed cab with cellulose filter)	42958401	5	56	63	1218	567	0.54	3.6	5.4	36
Loader/Applicator										
Transferring Water Soluble Liquids from Tank Delivery Truck to Shank Injection Equipment (closed system) and then applying them via Shank Injection Equipment (enclosed cab with charcoal filter)	451239-02	9	81	174	1220	566	0.54	3.6	5.4	36
Chemigation Monitor										
Monitoring Water Soluble Liquid Chemigation Applications	451239-02/429584-01	10	121	241	349	102	1.9	20	19	200
	429684-02*	10	0.85	254	2806	891	0.23	2.3	2.3	23
Irrigator										
Irrigating Following Shank Injection Application	451239-02/457037-03	11	107	202	329	171	2	12	20	120

[1]Acute MOEs are based on the maximum concentration
[2]ST/IT MOEs are based on the geometric mean concentration
*429684-02 may not be reflective of current cultural practices

9.1.2 Occupational Handler Point Exposure Estimates for Potting Soil

Fumigation

HED currently has no exposure data to assess MITC handler exposures during the application of metam sodium to potting soil.

9.1.3 Occupational Handler Point Exposure Estimates for Sewer Fumigation

HED has concerns for handler's MITC exposures during the applications of metam sodium to sewers. At this time there has been no data submitted to HED regarding MITC air concentration levels during applications to sewers. However, an internet search conducted by HED did reveal two exposure studies performed in Australia that measured MITC during the application of Vaporooter. A formal request was made by SRRD to the Australian Pesticides and Veterinary Medicines Authority (APVMA) to obtain a copy of these studies. Table 12 summarizes the acute and ST MOEs estimated from exposure tables posted on APVMA's website. http://www.apvma.gov.au/chemrev/methamsodium2attach.shtml.

Table 20: Handler MOEs for MITC Exposure from Sewer Use

Study	Sample	MITC Conc (ppm)	Acute MOE[1]	ST MOE
Sheers R (1994) Melbourne Water - Sanafoam Vaporooter Trial, 7 November 1994	Operator breathing zone exposure	0.27	1	1
	At point of application	22	<1	na
	Two manholes downstream (approx. 300 m)	0.017	36	na
	At point of application - 24 hours post-application	0.023	26	na
Sheers R (1995) Melbourne Water - Sanafoam Vaporooter Trial, 13-14 February 1995, ICI Australia Operations Pty Ltd.	Operator breathing zone exposure	< 0.017	13	10
	Operator breathing zone exposure	< 0.027	8	7
	Operator breathing zone exposure	0.057	4	3
	At point of application - 30 mins post application	2.6	<1	na
	At point of application - 90 mins post application	1.3	<1	na
	At point of application - 180 mins post application	6.8	<1	na
	At point of application - 270 mins post application	4.4	<1	na
	At point of application - 360 mins post application	0.87	1	na
	At point of application - 24 hours post-application	< 0.010	60	na

[1] Acute MOEs for breathing zones samples based on NOAEL of 0.22 ppm. For other samples (less than 15 mins) acute MOEs based on 0.60 ppm). ST MOE were not estimated for static measure measurements.

9.2 Occupational Reentry Worker Exposures

9.2.1 Pre-plant Agricultural Field Fumigation

HED examined workers reentering treated areas 48 hours after treatment. Using the flux rates from the appropriate studies at 48 hours, HED estimated the maximum concentration occurring at the edge of the treated field using ISC and the wind speed/stability categories used in the previous analysis. Table 21 shows the acute MOEs for maximum concentrations occurring in treated fields 48 hours after treatment.

Table 21: Estimated Acute MOEs based on Maximum ISC Calculated Air Concentrations (µg/m^3) after 48 hours

Application Method	Field Size (acres)	Meteorological Conditions									
		1 m/s 2.3 mph	1.4 m/s 3.1 mph	1.8 m/s 4 mph	2.2 m/s 5 mph	2.7 m/s 6 mph	3.1 m/s 7 mph	3.6 m/s 8 mph	4.0 m/s 9 mph	4.5 m/s 10 mph	4.5 m/s 10 mph
		Stab D	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab B
Sprinkler Irrigation, Standard Seal	1	2	4	5	6	8	9	10	12	13	18
	5	2	3	4	5	6	7	8	9	11	15
	10	1	3	4	5	6	7	8	9	10	13
	20	1	3	4	4	5	6	7	8	9	12
	40	1	3	3	4	5	6	7	7	8	12
Sprinkler Irrigation, Intermittent Seal	1	7	14	18	22	28	31	37	41	47	60
	5	6	12	15	18	22	25	30	33	37	51
	10	5	10	13	17	21	24	28	30	35	47
	20	5	10	12	15	19	21	25	28	31	44
	40	4	9	12	14	17	20	24	25	29	41
Shank Injection, Standard Seal	1	<1	<1	1	1	1	1	1	1	1	2
	5	<1	<1	<1	1	1	1	1	1	1	1
	10	<1	<1	<1	<1	1	1	1	1	1	1
	20	<1	<1	<1	<1	1	1	1	1	1	1
	40	<1	<1	<1	<1	<1	1	1	1	1	1
Shank Injection, Intermittent Seal	1	6	11	14	17	21	24	29	31	37	47
	5	4	9	12	14	17	20	23	25	29	39
	10	4	8	11	13	16	18	21	24	26	37
	20	4	8	10	12	15	17	19	22	24	35
	40	3	7	9	11	14	16	18	20	23	31
Drip Irrigation, Tarped Field	1	5	11	14	17	21	24	28	30	35	47
	5	4	9	11	13	17	19	22	24	28	39
	10	4	8	10	12	15	17	21	23	25	35
	20	3	7	9	12	14	16	19	21	24	33
	40	3	7	9	11	13	15	17	19	22	30
Drip Irrigation, Untarped Field	1	6	12	16	19	24	28	31	35	39	55
	5	5	10	13	15	19	22	25	29	31	44
	10	4	9	12	14	17	20	24	25	29	41
	20	4	8	11	13	16	18	21	24	26	37
	40	4	8	10	12	15	17	20	22	25	35

9.2.2 Potting Soil Fumigation

HED currently has no exposure data to assess MITC occupational reentry worker exposures following applications to potting soil.

9.2.3 Sewer Fumigation

HED currently has no exposure data to assess MITC occupational reentry worker exposures following applications to sewers.

10.0 Data Needs and Label Requirements

10.1 Toxicology

The MITC database is incomplete for pesticidal uses of MITC *per se*, and additional data requirements may be imposed. The following studies on MITC have been identified as data gaps:

1. Acute neurotoxicity study in rat via inhalation with pathological evaluation of the complete respiratory tract.

2. Two generation reproduction study in rat via inhalation with pathological evaluation of the complete respiratory tract. This study should also include a subchronic neurotoxicity component with functional battery and motor activity measurements using the F0 animals. If the F1 animals exhibit developmental neurotoxicity then the F2 generation should be evaluated for the standard developmental neurotoxicity parameters.

3. In vivo cytogenetic assay

4. Repeat of the unscheduled DNA synthesis assay

5. Carcinogenicity study in rats via the inhalation route

6. Carcinogenicity study in mice via the inhalation route

There are no outstanding metam sodium (metam potassium) toxicological data requirements.

10.2 Residue Chemistry

There are a number of product chemistry data requirements listed in the Product Chemistry Chapter for both metam sodium and metam potassium manufacturing products, see chart below. There are no residue chemistry requirements for either metam sodium or metam potassium.

Product	EPA Reg. No.	Registrant	OPPTS Guideline Requirements
Metam sodium (039003)			
42.5% FI	1448-107	Buckman Laboratories, Inc.	830.7050-UV/visible absorption
44% FI	5481-469	Amvac Chemical Corporation	830.6313 (Stability), 7050 (UV/visible absorption), and 7840 (water solubility)
42% FI	5481-416		
42% EP	45728-16	Taminco, Inc.	None
42.2% FI	61842-4	Tessenderlo Kerley, Inc.	830.1670 (formation of impurities), 1700 (preliminary analysis), and 6313 (stability)
Metam potassium (039002)			
54% FI	1448-74	Buckman Laboratories, Inc.	830.1700(preliminary analysis), 6302 (color), 6303 (physical state), 6304 (odor), 6313 (stability), 7000 (pH), 7050 (UV/visible absorption), 7200/7220 (melting point/boiling point), 7300 (density), 7370 (dissociation constant in water), 7550 (partition coefficient), 7840 (water solubility), and 7950 (vapor pressure)
54% FI	5481-484	Amvac Chemical Corporation	830.6313 (stability), 7050 (UV/visible absorption), 7220 (boiling point), 7370 (dissociation constant), 7550 (partition coefficient), 7840 (water solubility), and 7950(vapor pressure)
MITC (068103)			
97% EP	69850-1	MLPC International	830.1620 (description of product/process) and 7050 (UV/visible absorption)

10.3 Occupational and Residential Exposure

The assessment of occupational and residential risks associated with the use of metam sodium is complex. Additional data are required. These data include both occupational monitoring of various workers in different industry sectors and data to better assess exposures in the general population (i.e., more flux studies performed in different regions of the nation). The types of data, guideline citations, and examples of the scenarios which need to be addressed are presented below. Final determination of the scenarios should be made in consultation with HED.

OPPTS Guideline 875.1100 - Dermal exposure for applicators (outdoors)

Metam Sodium: Pre-Plant Field - (e.g., mixer/loader, tractor drivers, water sealers, aerators)
Greenhouse (potting soil) - (e.g., mixer/loader, fumigators, media handlers, aerators)
Sewers - (e.g., mixer/loader, fumigators)

OPPTS Guideline 875.1300 - Inhalation exposure for applicators (outdoors)

Metam Sodium: Pre-Plant Field - (e.g., mixer/loader, tractor drivers, water sealers, aerators)

MITC: Pre-Plant Field - (e.g., applying via flood and furrow irrigation, tractor drivers, water sealers, aerators, tarpers)

OPPTS Guideline 875.1400 - Inhalation exposure for applicators (indoors)

Metam Sodium: Greenhouse (potting soil) - (e.g., mixer/loader, fumigators, media handlers, aerators)
Sewers - (e.g., mixer/loader, fumigators)

MITC: Greenhouse (potting soil) - (e.g., fumigators, media handlers, aerators)
Sewers - (e.g., fumigators)

OPPTS Guideline 875.2500 - Inhalation exposure for postapplication workers

MITC: Pre-Plant Field - (e.g., planters)

Appendix A: Toxicity Profile

Note to Reader: 3rd Revised Toxicology Disciplinary Chapter for: Metam Sodium (PC Code 039003) and Methyl isothiocyanate (MITC, PC Code 068103) August 19, 2004. TXR No.: 0050771

Appendix B: Methodologies for Inhalation Risk Calculations and Human Equivalent Concentration Arrays

Note to Reader:	Inhalation risk calculations are found in "Toxicity endpoint selection and inhalation dosimetry calculations for metam sodium, metam sodium, and MITC. August 19, 2004." TXR No: 0051475. Array tables from this document are provided below.

Table 1a RfC Array for MITC NON-OCCUPATIONAL RISK ASSESSMENTS														
Relevant Study			LOAEL[b] (ppm)	NOAEL[c] (ppm)	Da[d]	Dh[e]	Wa[f]	Wh[g]	RGDR[h, j]	HEC[i] (ppm)	Inter	Intra	Other UF	HEC/UFs (ppm)
Short- & Intermediate- Term														
28-day inhalation study in rat	Systemic		6.8	1.7	6	24	5	7	1	0.30	3	10	NA	0.01
	Local	ET	34	6.8	6	24	5	7	0.14	0.16	3	10	NA	0.0054
		TB	34	6.8	6	24	5	7	1.46	1.73	3	10	NA	0.058
Long- Term														
28-day inhalation study in rat	Systemic		6.8	1.7	6	24	5	7	1	0.30	3	10	10[a]	0.001
	Local	ET	34	6.8	6	24	5	7	0.14	0.16	3	10	10[a]	0.00054
		TB	34	6.8	6	24	5	7	1.46	1.73	3	10	10[a]	0.0058

a Subchronic to chronic uncertainty factor
b LOAEL: Lowest-observed-adverse-effect level
c NOAEL: No-observed-adverse-effect level
d Da: Duration (hours) of exposure to laboratory animals
e Dh: Duration (hours) of exposure to humans
f Wa: Number of days/week for animal exposures during the study
g Wh: Number of days/week for expected human exposures
h RGDR: Regional gas-dose ratio
i HEC: Human equivalent concentration
j RGDRs based on equations and defaults (when appropriate) in USEPA (1994), mean body weight for male and female Wistar rats.

Table 1b RfC Array for MITC OCCUPATIONAL RISK ASSESSMENTS														
Relevant Study			**LOAEL[b] (ppm)**	**NOAEL[c] (ppm)**	**Da[d]**	**Dh[e]**	**Wa[f]**	**Wh[g]**	**RGDR[h,]**	**HEC[i] (ppm)**	**Inter**	**Intra**	**Other UF**	**HEC/UFs (ppm)**
Short- & Intermediate- Term														
28-day inhalation study in rat	Systemic		6.8	1.7	6	8	5	5	1	1.28	3	10	NA	0.043
	Local	ET	34	6.8	6	8	5	5	0.14	0.68	3	10	NA	0.022
		TB	34	6.8	6	8	5	5	1.46	7.29	3	10	NA	0.24
Long- Term														
28-day inhalation study in rat	Systemic		6.8	1.7	6	8	5	5	1	3.83	3	10	10[a]	0.0043
	Local	ET	34	6.8	6	8	5	5	0.14	0.68	3	10	10[a]	0.0022
		TB	34	6.8	6	8	5	5	1.46	7.29	3	10	10[a]	0.024

a Subchronic to chronic uncertainty factor
b LOAEL: Lowest-observed-adverse-effect level
c NOAEL: No-observed-adverse-effect level
d Da: Duration (hours) of exposure to laboratory animals
e Dh: Duration (hours) of exposure to humans
f Wa: Number of days/week for animal exposures during the study
g Wh: Number of days/week for expected human exposures
h RGDR: Regional gas-dose ratio
i HEC: Human equivalent concentration
j RGDRs based on equations and defaults (when appropriate) in USEPA (1994), mean body weight for male and female Wistar rats.

Appendix C: Summary Datasheets For Single Agricultural Field Fumigation Events

HED used air concentration data from the six most representative field volatility studies to estimate the acute exposure and risk to the residential bystander. Studies that do not reflect current use practices (i.e, application via sprinkler irrigation without a water seal) or field volatility studies in which there are some data quality or consistency issues (i.e, application via shank injection without a water seal) were not included. The six studies provided data from six different application sites, three types of application equipment (shank injection, sprinkler irrigation, and drip irrigation), and four sealing options (standard water seal, intermittent water seal, tarped, and untarped). Risks were estimated using the study data for six distinct application/sealing/method combinations:

- Sprinkler Applications with standard water sealing
- Sprinkler Applications with intermittent water sealing
- Shank Injection Applications with standard water sealing
- Shank Injection Applications with intermittent water sealing
- Drip Applications with a tarp
- Drip Applications with no sealing

Acute Exposures: The key route of exposure for MITC is inhalation. Data for MITC following applications of metam sodium were collected at 4-hour intervals for four days in most studies. Acute risks were estimated as Margins of Exposures (MOEs) and were calculated by comparing each individual sample point to the toxicological human equivalent concentration (HEC) selected for acute exposures. The air concentration levels at a given data collection point often fluctuate over an extended period of time, depending on temperature, wind speed and direction, and other meteorological and environmental variables.

For acute exposures, Appendix C/Appendix Table 1 indicates:

- the number of MOEs calculated at a given distance (‘n’ is the total number of the samples at a given distance),
- the range of MOEs (minimum and maximum) at a given distance, and
- the number of sample stations at a given distance with concentrations that result in MOEs less than 10. (An MOE of 10 or more does not exceed HED’s level of concern for acute exposures.)

Bystander Risk Summary: In almost every study, there was at least one time period (and sometimes a substantial fraction of time periods) where the acute risk exceeds HED’s level of concern.

D318051/Appendix C/Appendix Table 1: Bystander MOEs Calculated from Study Point Estimates for Pre-plant Agricultural Field Fumigations at 3 to 1,000 Meters from the Edge of the Treated Field							
Application Equipment	Type of Seal	Study Location (Year)/ MRID/Soil Type	Distance from Field (meters)	Acute MOEs			
				n	(n) < 10	Min	Max
Sprinkler	Standard Water Seal	Kern County (1999) 457037-01: Site 1 Sandy Loam Soil	150	72	37	1	13200*
			300	72	27	1	13200*
			700	72	12	2	13200*
			1000	48	2	5	13200*
	Intermittent Water Seal	Kern County (2001) 457037-02 Silt Loam Soil	137	96	20	3	4299
			274	192	10	4	4514
			411	24	0	17	4281
			549	24	0	17	4281
Shank Injection	Standard Water Seal	Kern County (1999) 457037-01: Site 2 Sandy Loam Soil	150	72	24	1	13200*
			300	72	17	1	13200*
			700	72	17	1	13200*
			1000	48	2	5	13200*
	Intermittent Water Seal	Lost Hill (2001) 457037-04 Clay Loam	150	116	9	2	1973
			300	187	6	3	1993
			500	24	0	12	1617
			700	48	0	17	1637
Drip	none	Orange County (1997) 457037-08: Site 1 Soil type not specified	3	20	0	15	375
			6.1	10	1	7	60
			15.2	10	1	7	63
			45.7	10	0	12	93
	Tarp	Orange County (1997) 457037-08: Site 2 Soil type not specified	3	18	1	8	440
			6.1	12	1	6	13200*
			15.2	12	1	9	13200*
			45.7	12	1	8	252

The samples times ranged from 152 to 334 minutes and averaged 241 minutes.
* Air concentrations used to estimate MOEs were based on ½ the LOQ value.

D318051/Appendix C/Appendix Table 2: Metam Sodium Exposure Bibliography	
Citation	**MRID**
Gosselin, Paul H. (1999) MEMO: Lompoc Exposure Data (http://www.cdpr.ca.gov/docs/dprdocs/lompoc/lexpdata.pdf)	No MRID
Holdsworth, Mark T. and Sullivan, David A. (2001) Orange County Drip Application Study Monitoring Results.	45703708
Holdsworth, Mark T. and Sullivan, David A. (2004) Metam Sodium - Study of Roozen Shank Injection Rig at the Washington Bulb Co. Site Mount Vernon, Washington.	46379201
Holdsworth, Mark T. and Sullivan, David A. (2003) Bakersfield, CA Shank Injection and Chemigation Trials for Metam Sodium (USDA CSREES Project #74)	No MRID
Merricks, Ph.D., D. Larry. (1999) Determination of Methyl Isothiocyanate Inhalation Exposure to Workers as They Apply Metam-Sodium through Shank Injection and Sprinkler Irrigation.	45123902
Merricks, Ph.D., D. Larry. (2001) Determination of Methyl Isothiocyanate Offsite Air Movement from the Application of Metam-Sodium through Shank Injection.	45703704
Merricks, Ph.D., D. Larry. (2002) Determination of Methyl Isothiocyanate Offsite Air Movement from the Chemigation of Metam-Sodium through Sprinkler Irrigation.	45703702
Merricks, Ph.D., D. Larry. (2002) Determination of Methyl Isothiocyanate Offsite Air Movement from the Application of Metam-Sodium through Shank Injection and Sprinkler Irrigation.	45703701
Merricks, Ph.D., D. Larry. (2003) Determination of Methyl Isothiocyanate Inhalation Exposure to Workers During Application Metam-Sodium through Shank Injection.	45703703
Pan-Huang, Yun. (2003) Ambient Air Monitoring for Chloropicrin and Breakdown Products of Metam Sodium in Kern County - Summer 2001 (http://www.cdpr.ca.gov/docs/empm/pubs/tac/tacpdfs/chlormitc03.pdf)	No MRID
Pan-Huang, Yun. (2003) Ambient Air Monitoring for Chloropicrin and Breakdown Products of Metam Sodium in Monterey and Santa Cruz Counties (results taken from http://www.cdpr.ca.gov/docs/empm/pubs/tac/tacpdfs/chlor_metsod04.pdf)	No MRID
Rosenheck, Leah. (1993) Worker Loader and Applicator Exposure From Field Applications of Metam Sodium	42958401
Rosenheck, Leah. (1993) Worker Mixer/Loader and Applicator Exposure From Field Applications of Metam Sodium	42968402
Sheers, Robert. (1995) Melbourne Water - Sanafoam Vaporooter Trial February 13 and 14 (Unreleased paper)	No MRID
Sheers, Robert. (1995) Melbourne Water - Sanafoam Vaporooter Trial November 7 (Unreleased paper)	No MRID
Thongsinthusak, Thomas. (2003) ESTIMATION OF EXPOSURE OF PERSONS IN CALIFORNIA TO METHYL ISOTHIOCYANATE (http://www.cdpr.ca.gov/docs/whs/pdf/hs1806.pdf)	No MRID

Appendix D: Downwind MITC Air Concentrations from Metam Sodium Applications Estimated with ISCST3 for Pre-Plant Agricultural Uses

In order to better characterize the risks associated with the use of metam sodium for various conditions (e.g., distance from emission source, atmospheric conditions, application method, etc.), exposures have been calculated using the Agency's ISCST3 model. In these analyses, the monitoring data described in Appendix C were first used to estimate flux rates which are key inputs into the model. Flux rates, are measures of how fast MITC moves into the atmosphere from a metam sodium application area. Once flux rates were determined they were then incorporated back into ISCST3.

The risk estimates (MOEs or Margins of Exposure) presented below represent results for the acute duration of exposure because they compare 4 hour concentrations calculated with ISCST3 to the acute HEC (i.e., 0.22 ppm with a total uncertainty factor of 10).

Results for various field sizes, application methods (with distinct emission ratios or fraction of the applied material emitted per unit of time); wind speed; atmospheric stability and distances downwind are presented below in Appendix D/Appendix Table 1. Appendix D/Appendix Table 1 demonstrates that for the majority of cases considered, risks exceed HED's level of concern (MOEs <10) for distances less than 500 meters downwind of the treated field. MOEs decrease as field sizes increase while MOEs increase as the atmosphere becomes less stable leading to conditions where more off-target drift can occur.

D318051/Appendix D/Appendix Table 1: Acute Bystander MOEs[1] Calculated from the ISC Model for Distances Downwind from Pre-plant Agricultural Field Fumigations

Application Method	Emission Ratio (%)	Field Size (Acres)	Distance (m)	Meteorological Conditions									
				1 m/s 2.3 mph	1.4 m/s 3.1 mph	1.8 m/s 4 mph	2.2 m/s 5 mph	2.7 m/s 6 mph	3.1 m/s 7 mph	3.6 m/s 8 mph	4.0 m/s 9 mph	4.5 m/s 10 mph	4.5 m/s 10 mph
				Stab D	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab B
Sprinkler Irrigation, Standard Seal	2	1	25	<1	<1	<1	<1	1	1	1	1	1	1
			100	<1	1	1	1	1	2	2	2	2	4
			500	2	6	8	10	12	14	17	18	21	47
		40	25	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
			100	<1	<1	<1	<1	<1	<1	1	1	1	1
			500	<1	1	1	1	1	1	1	2	2	3
Sprinkler Irrigation, Intermittent Seal	1	1	25	1	1	2	2	2	3	3	3	4	5
			100	1	3	4	5	6	6	8	8	9	16
			500	7	24	31	39	47	55	60	66	83	165
		40	25	<1	<1	1	1	1	1	1	1	2	2
			100	<1	1	1	1	2	2	2	2	3	4
			500	1	2	3	3	4	5	5	6	7	12
Shank Injection, Standard Seal	2	1	25	<1	1	1	1	2	2	2	2	3	4
			100	1	2	3	3	4	5	6	6	7	12
			500	5	18	23	28	35	39	47	51	55	132
		40	25	<1	<1	<1	1	1	1	1	1	1	2
			100	<1	1	1	1	1	1	2	2	2	3
			500	1	2	2	2	3	3	4	4	5	9
Shank Injection, Intermittent Seal	1	1	25	1	2	3	4	4	5	6	7	8	11
			100	2	6	7	9	11	13	15	17	18	31
			500	13	47	60	73	94	110	132	132	165	330
		40	25	<1	1	1	2	2	2	3	3	3	4
			100	1	2	2	3	3	4	4	5	5	8
			500	2	4	5	6	8	9	10	12	13	23
Drip Irrigation, Tarped Field	<1	1	25	2	5	6	8	9	11	12	14	15	22
			100	5	12	15	19	23	26	30	35	39	66
			500	28	94	132	165	220	220	220	330	330	660
		40	25	1	2	3	3	4	4	5	6	6	9
			100	1	3	4	5	6	7	9	9	11	16
			500	3	8	11	13	16	18	21	24	26	47
Drip Irrigation, Untarped Field	<1	1	25	3	7	9	11	14	16	19	21	24	33
			100	8	18	23	29	35	39	47	51	60	94
			500	41	165	220	220	330	330	330	330	660	660
		40	25	1	3	4	5	6	7	8	9	10	14
			100	2	5	6	8	10	11	13	14	16	24
			500	5	12	16	19	24	28	33	37	41	73

[1] Acute bystander MOEs were calculated using an HEC of 0.22 ppm, where an MOE of 10 or more does not exceed HED's level of concern.

Appendix E: MITC Air Concentrations from Metam Sodium Applications Estimated with PERFUM for Pre-Plant Agricultural Uses

Appendix F: Metam Sodium Residue Chemistry Chapter

Appendix G: Occupational Risks for Metam Sodium Associated With Agricultural Fumigations

All of the non-cancer risk calculations for occupational short- and intermediate-term risks for metam sodium handlers are summarized below in **Tables 1** and **2**, respectively.

<u>Occupational Metam Sodium Risk Summary:</u>

Short-term Dermal Risks

For the agricultural crop scenarios using PHED data, the short-term dermal MOEs for handlers **are less than 100** for the following scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre) and at 40 acres treated per day (387 lb ai/acre)
- ornamentals, food, and fiber crops, and turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system)

- tobacco plant beds at 40 acres treated per day (412 lb ai/acre and 387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 350 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 350 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 350 acres treated per day (63.3 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (320 lb ai/acre and 239 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre and 387 lb ai/acre)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 128 acres treated per day (31.7 lb ai/acre)

Scenario 4b: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA closed cab data)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 5 acres treated per day (523 lb ai/acre)
- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre and 387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 80 and 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 80 and 128 acres treated per day (31.7 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 5b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

For the mixer/loader/applicator scenarios in commercial and small scale agricultural settings, the short-term dermal MOEs are **less than 100** for the following scenarios:

Scenario 9: Mixing/Loading/Applying Liquids via hose proportioner (using ORETF LCO hand-gun data-occupational)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns at 5 acres treated per day (350 lb ai/acre)

Scenario 10: Mixing/Loading/Applying Liquids via power sprayer (using ORETF LCO handgun data-occupational)

- drained water bodies and shorelines at 5 acres treated per day (350 lb ai/acre)

Short-term Inhalation Risks

For the agricultural crop scenarios using PHED data, the short-term inhalation MOEs for handlers **are less than 100** for the following scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre) and at 40 acres treated per day (387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day ()
- peanuts-CBR susceptible cultivators at 128 acres treated per day (63.3 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system)

- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre) and at 40 acres treated per day (387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 350 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 350 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 350 acres treated per day (63.3 lb ai/acre)
- peanuts-CBR resistant cultivators at 350 acres treated per day (32 lb ai/acre)
- wheat, barley at 350 acres treated per day (31.7 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops, turf (sod farms) at 100 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- tobacco plant beds at 40 acres treated per day (412 lb ai/acre and 387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical

transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre and 387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 128 acres treated per day (63.3 lb ai/acre)

Scenario 4b: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA closed cab data)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 5 acres treated per day (523 lb ai/acre)
- tobacco plant beds at 20 and 40 acres treated per day (412 lb ai/acre and 387 lb ai/acre)
- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 80 and 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 80 and 128 acres treated per day (31.7 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 5b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops, turf (sod farms) at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- turf (golf courses) at 20 and 40 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

For the mixer/loader/applicator scenarios in commercial and small scale agricultural settings, the short-term inhalation MOEs are **greater than 100** at some level of personal protection.

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary

Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Loader										
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) (1a)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	5 acres	1.3	**170**	230	450	21	**210**	310
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	0.5 acres	13	**1,700**	2,300	4,500	**210**	2,100	3100
	tobacco plant beds	412 lb ai/acre	40 acres	0.2	27	36	71	3	34	49
	tobacco plant beds	412 lb ai/acre	20 acres	0.4	53	72	**140**	7	67	97
	tobacco plant beds	387 lb ai/acre	40 acres	0.2	28	38	76	4	36	52
	tobacco plant beds	387 lb ai/acre	20 acres	0.5	57	77	**150**	7	72	**100**
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	0.1	10	14	27	1	13	19
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	0.1	16	22	44	2	21	30
	turf (golf course)	338 lb ai/acre	40 acres	0.3	33	44	87	4	41	59
	turf (golf course)	338 lb ai/acre	20 acres	0.5	65	88	**170**	8	82	**120**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	128 acres	0.1	11	15	29	1	14	20
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	80 acres	0.1	17	23	46	2	22	31
	turf (golf course)	320 lb ai/acre	40 acres	0.3	34	47	92	4	43	63
	turf (golf course)	320 lb ai/acre	20 acres	0.6	69	93	**180**	9	87	**130**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	0.4	54	74	**150**	7	68	99
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	0.7	87	**120**	230	11	**110**	160
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	0.7	91	**120**	240	11	**110**	160
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	1.1	**140**	200	390	18	**180**	260
	peanuts (CBR resistant cultivators)	32 lb ai/acre	128 acres	0.9	**110**	150	290	14	**140**	200
	peanuts (CBR resistant cultivators)	32 lb ai/acre	80 acres	1.4	**170**	230	460	22	**220**	310
	wheat, barley	31.7 lb ai/acre	128 acres	0.9	**110**	150	290	14	**140**	200
	wheat, barley	31.7 lb ai/acre	80 acres	1.4	**170**	230	460	22	**220**	320
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) (1b)	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	0.1	10	14	27	1	13	19
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	0.1	16	22	44	2	21	30
	turf (golf course)	338 lb ai/acre	40 acres	0.3	33	44	87	4	41	59
	turf (golf course)	338 lb ai/acre	20 acres	0.5	65	88	**170**	8	82	**120**
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	128 acres	0.1	11	15	29	1	14	20
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	80 acres	0.1	17	23	46	2	22	31
	turf (golf course)	320 lb ai/acre	40 acres	0.3	34	47	92	4	43	63
	turf (golf course)	320 lb ai/acre	20 acres	0.6	69	93	**180**	9	87	**130**
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system) (1c)	tobacco plant beds	412 lb ai/acre	40 acres	0.2	27	36	71	3	34	49
	tobacco plant beds	412 lb ai/acre	20 acres	0.4	53	72	**140**	7	67	97
	tobacco plant beds	387 lb ai/acre	40 acres	0.2	28	38	76	4	36	52
	tobacco plant beds	387 lb ai/acre	20 acres	0.5	57	77	**150**	7	72	**100**
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	350 acres	<1	4	5	10	<1	5	7
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	350 acres	<1	4	5	11	1	5	7
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	350 acres	0.2	20	27	53	3	25	36

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary										
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
	wheat, barley	31.7 lb ai/acre	350 acres	0.3	40	54	**110**	5	50	72
	peanuts (CBR resistant cultivators)	32 lb ai/acre	350 acres	0.3	39	53	**110**	5	50	72
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Drip Irrigation Nurse Tank (mechanical transfer system) (1d)	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	100 acres	0.1	14	19	37	2	17	25
	ornamentals, food and fiber crops, turf (sod farm)	239 lb ai/acre	100 acres	0.2	18	25	49	2	23	34
	cotton, soybeans, sugar beets	38 lb ai/acre	100 acres	0.9	**120**	160	310	15	**150**	210

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary

Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Applicator										
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	5 acres	**280**	280	350	770	34	**340**	590
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	0.5 acres	**2800**	2,800	3,500	7,700	340	**3,400**	5,900
	tobacco plant beds	412 lb ai/acre	40 acres	44	44	56	**120**	6	55	94
	tobacco plant beds	412 lb ai/acre	20 acres	88	88	**110**	250	11	**110**	190
	tobacco plant beds	387 lb ai/acre	40 acres	47	47	59	**130**	6	58	**100**
	tobacco plant beds	387 lb ai/acre	20 acres	93	93	**120**	260	12	**120**	200
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	17	17	21	47	2	21	36
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	27	27	34	75	3	33	57
	turf (golf course)	338 lb ai/acre	40 acres	54	54	68	**150**	7	67	**110**
	turf (golf course)	338 lb ai/acre	20 acres	**110**	110	140	300	13	**130**	230
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	128 acres	18	18	22	49	2	22	38
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	80 acres	28	28	36	79	4	35	61
	turf (golf course)	320 lb ai/acre	40 acres	57	57	72	**160**	7	70	**120**
	turf (golf course)	320 lb ai/acre	20 acres	**110**	110	140	320	14	**140**	240
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	89	89	**110**	250	11	**110**	190
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	**140**	140	180	400	18	**180**	310
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	**150**	150	190	420	19	**190**	320
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	**240**	240	300	670	30	**300**	510
	peanuts (CBR resistant cultivators)	32 lb ai/acre	128 acres	**180**	180	220	490	22	**220**	380
	peanuts (CBR resistant cultivators)	32 lb ai/acre	80 acres	**280**	280	360	790	35	**350**	610
	wheat, barley	31.7 lb ai/acre	128 acres	**180**	180	230	500	22	**220**	380
	wheat, barley	31.7 lb ai/acre	80 acres	**290**	290	360	800	35	**350**	610
Applying Water Soluble Liquids via Rotary Tiller Equipment (using PHED groundboom data) (3)	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	17	17	21	47	2	21	36
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	27	27	34	75	3	33	57
	turf (golf course)	338 lb ai/acre	40 acres	54	54	68	**150**	7	67	**110**
	turf (golf course)	338 lb ai/acre	20 acres	**110**	110	140	300	13	**130**	230
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	128 acres	18	18	22	49	2	22	38
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	80 acres	28	28	36	79	4	35	61
	turf (golf course)	320 lb ai/acre	40 acres	57	57	72	**160**	7	70	**120**
	turf (golf course)	320 lb ai/acre	20 acres	**110**	110	140	320	14	**140**	240

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary										
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Loader/Applicator										
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data) (4a) [d]	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	5 acres	4.4	68	**110**	NA	20	**200**	NA
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	0.5 acres	44	**680**	1,100	NA	**200**	2,000	NA
	tobacco plant beds	412 lb ai/acre	40 acres	0.7	11	17	NA	3	31	NA
	tobacco plant beds	412 lb ai/acre	20 acres	1.4	22	34	NA	6	62	NA
	tobacco plant beds	387 lb ai/acre	40 acres	0.7	11	18	NA	3	33	NA
	tobacco plant beds	387 lb ai/acre	20 acres	1.5	23	36	NA	7	66	NA
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	0.3	4	7	NA	1	12	NA
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	0.4	7	10	NA	2	19	NA
	turf (golf course)	338 lb ai/acre	40 acres	0.9	13	21	NA	4	38	NA
	turf (golf course)	338 lb ai/acre	20 acres	1.7	26	42	NA	8	76	NA
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	128 acres	0.3	4	7	NA	1	13	NA
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	80 acres	0.5	7	11	NA	2	20	NA
	turf (golf course)	320 lb ai/acre	40 acres	0.9	14	22	NA	4	40	NA
	turf (golf course)	320 lb ai/acre	20 acres	1.8	28	44	NA	8	80	NA
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	1.4	22	35	NA	6	63	NA
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	2.3	35	56	NA	10	**100**	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	2.4	37	58	NA	11	**110**	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	3.8	58	93	NA	17	**170**	NA
	peanuts (CBR resistant cultivators)	32 lb ai/acre	128 acres	2.8	43	69	NA	13	**130**	NA
	peanuts (CBR resistant cultivators)	32 lb ai/acre	80 acres	4.5	69	**110**	NA	20	**200**	NA
	wheat, barley	31.7 lb ai/acre	128 acres	2.8	44	69	NA	13	**130**	NA
	wheat, barley	31.7 lb ai/acre	80 acres	4.5	70	**110**	NA	20	**200**	NA

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary										
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA with closed cab) (4b) [d]	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	5 acres	NA	NA	NA	44	NA	NA	73
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	0.5 acres	NA	NA	NA	**440**	NA	NA	**730**
	tobacco plant beds	412 lb ai/acre	40 acres	NA	NA	NA	7	NA	NA	12
	tobacco plant beds	412 lb ai/acre	20 acres	NA	NA	NA	14	NA	NA	23
	tobacco plant beds	387 lb ai/acre	40 acres	NA	NA	NA	7	NA	NA	12
	tobacco plant beds	387 lb ai/acre	20 acres	NA	NA	NA	15	NA	NA	25
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	NA	NA	NA	3	NA	NA	4
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	NA	NA	NA	4	NA	NA	7
	turf (golf course)	338 lb ai/acre	40 acres	NA	NA	NA	8	NA	NA	14
	turf (golf course)	338 lb ai/acre	20 acres	NA	NA	NA	17	NA	NA	28
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	128 acres	NA	NA	NA	3	NA	NA	5
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	80 acres	NA	NA	NA	4	NA	NA	7
	turf (golf course)	320 lb ai/acre	40 acres	NA	NA	NA	9	NA	NA	15
	turf (golf course)	320 lb ai/acre	20 acres	NA	NA	NA	18	NA	NA	30
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	NA	NA	NA	14	NA	NA	23
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	NA	NA	NA	22	NA	NA	38
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	NA	NA	NA	23	NA	NA	39
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	NA	NA	NA	37	NA	NA	63
	peanuts (CBR resistant cultivators)	32 lb ai/acre	128 acres	NA	NA	NA	28	NA	NA	46
	peanuts (CBR resistant cultivators)	32 lb ai/acre	80 acres	NA	NA	NA	44	NA	NA	74
	wheat, barley	31.7 lb ai/acre	128 acres	NA	NA	NA	28	NA	NA	47
	wheat, barley	31.7 lb ai/acre	80 acres	NA	NA	NA	45	NA	NA	75
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [d]	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	0.3	4	7	NA	1	12	NA
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	0.4	7	10	NA	2	19	NA
	turf (golf course)	338 lb ai/acre	40 acres	0.9	13	21	NA	4	38	NA
	turf (golf course)	338 lb ai/acre	20 acres	1.7	26	42	NA	8	76	NA
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	128 acres	0.3	4	7	NA	1	13	NA
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	80 acres	0.5	7	11	NA	2	20	NA
	turf (golf course)	320 lb ai/acre	40 acres	0.9	14	22	NA	4	40	NA
	turf (golf course)	320 lb ai/acre	20 acres	1.8	28	44	NA	8	80	NA
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with closed cab) (5b) [d]	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	128 acres	NA	NA	NA	3	NA	NA	4
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	80 acres	NA	NA	NA	4	NA	NA	7
	turf (golf course)	338 lb ai/acre	40 acres	NA	NA	NA	8	NA	NA	14
	turf (golf course)	338 lb ai/acre	20 acres	NA	NA	NA	17	NA	NA	28
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	128 acres	NA	NA	NA	3	NA	NA	5
	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	80 acres	NA	NA	NA	4	NA	NA	7
	turf (golf course)	320 lb ai/acre	40 acres	NA	NA	NA	9	NA	NA	15
	turf (golf course)	320 lb ai/acre	20 acres	NA	NA	NA	18	NA	NA	30
Chemigation Monitor										

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary										
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Monitoring Chemigation Applications Using Liquid Formulation (6)	No Metam Sodium data is available for this scenario.									
Soil Seal Irrigator										
Sealing Soil with Irrigation Water Following Shank Injection Applications Using Liquid Formulations (7)	No Metam Sodium data is available for this scenario.									
Mixer/Loader/Applicator										
Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data - occupational) (8)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	12 lb ai/1000 sq ft	1000 sq ft	**150**	ND	ND	NF	**350**	ND	NF
	potting soil	4 lb ai/1000 sq ft	1000 sq ft	**450**	ND	ND	NF	**1,000**	ND	NF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF LCO hand-gun data - occupational) (9)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	5 acres	8.4	12	23	NF	25	**250**	NF
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	0.5 acres	84	**120**	230	NF	**250**	2,500	NF
Mixing/Loading/Applying Water Soluble Liquids via power sprayer (using ORETF LCO hand-gun data - occupational) (10)	drained water bodies and shorelines	350 lb ai/acre	5 acres	8.4	12	23	NF	25	**250**	NF
Mixing/Loading/Applying Liquids via cement mixer (using PHED Mixer/Loader data for Open-pour Liquids) (11)	potting soil	0.012 lb ai/cu ft	54 cu ft	**5400**	680,000	920,000	NF	**86,000**	860,000	NF

Table 1. Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary										
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Mixing/Loading/Applying Liquids via shredder (using PHED Mixer/Loader data for Open-pour Liquids) (12)	potting soil	0.012 lb ai/cu ft	54 cu ft	**5400**	680,000	920,000	NF	**86,000**	860,000	NF
Mixing/Loading/Applying Liquid with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids) (13)	sewer roots	0.212 lb ai/gal	1350 gallons	12	**1,500**	2,100	NF	**190**	1,900	NF
	sewer roots	0.212 lb ai/gal	675 gallons	24	**3,100**	4,200	NF	**390**	3900	NF
Mixing/Loading/Applying Liquids via Open Pour (using PHED Mixer/Loader data for Open-pour Liquids) (14)	tree replanting	16 lb ai/1000 sq ft	1000 sq ft	**220**	28000	37000	NF	**3500**	35000	NF

Footnotes

* MOEs that do not exceed HED's level of concern are shown in bold.
NA Not Applicable
ND No Data
NF Not Feasible
a Target for all crops is the soil except for turf, which may be applied to the foliar surface when the goal is to destroy the existing turf.
b Application rates are the maximum application rates determined from EPA registered labels for metam sodium.
c Amount handled per day values are HED estimates of acres, square feet, or cubic feet treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry sources, and HED estimates.
d May over estimate exposure, PHED data is based on open pour mixing/loading.

Dermal Baseline: Long-sleeve shirt, long pants, and no gloves
PPE-G: Baseline plus chemical-resistant gloves.
PPE-G,DL: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves
Eng Controls: Closed mixing/loading system or enclosed cab
Inhalation Baseline: No respirator
OV Respirator: NIOSH/MSHA-approved cartridge or cannister respirator with an organic-vapor removing filter and dust/mist prefilter.

Intermediate-term Dermal Risks

For the agricultural crop scenarios, intermediate dermal MOEs for handlers are **less than 100** for the following scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- small areas of ornamentals, food, fiber crops at 5 acres treated per day (523 lb ai/acre)
- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 80 and 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 80 and 128 acres treated per day (31.7 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 350 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 350 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 350 acres treated per day (63.3 lb ai/acre)
- peanuts-CBR resistant cultivators at 350 acres treated per day (32 lb ai/acre)
- wheat, barley at 350 acres treated per day (31.7 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (38 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- small areas of ornamentals, food, fiber crops at 5 acres treated per day (523 lb ai/acre)
- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 80 and 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 80 and 128 acres treated per day (31.7 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- small areas of ornamentals, food, fiber crops at 0.5 and 5 acres treated per day (523 lb ai/acre)
- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchards (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 80 and 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 80 and 128 acres treated per day (31.7 lb ai/acre)

Scenario 4b: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA closed cab data)

- small areas of ornamentals, food, fiber crops at 0.5 and 5 acres treated per day (523 lb ai/acre)
- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)
- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 80 and 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 80 and 128 acres treated per day (31.7 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 5b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

For the mixer/loader/applicator scenarios in commercial and small scale agricultural settings, the intermediate-term dermal MOEs are **less than 100** for the following scenarios:

Scenario 8: Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data-occupational)

- small areas of ornamentals, food, fiber crops at 1000 ft^2 treated per day (12 lb ai/1000 ft^2)

Scenario 9: Mixing/Loading/Applying Liquids via Hose Proportioner (using ORETF handgun data-occupational)

- small areas of ornamentals, food, fiber crops at 0.5 and 5 acres treated per day (350 lb ai/acre)

Scenario 13: Mixing/Loading/Applying Liquids with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids)

- sewer roots at 675 and 1,350 gallons handled per day (0.212 lb ai/gal)

Intermediate-term Inhalation Risks

For the agricultural crop scenarios using PHED data, the intermediate-term inhalation MOEs for handlers **are less than 100** for the following scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchard (replant/transplant) at 80 and 128 acres treated per day (320 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 350 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- orchard (replant/transplant) at 350 acres treated per day (320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 350 acres treated per day (63.3 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 4b: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)
- peanuts-CBR susceptible cultivators at 80 and 128 acres treated per day (63.3 lb ai/acre)

- cotton, soybeans, sugar beets at 80 and 128 acres treated per day (38 lb ai/acre)
- peanuts-CBR resistant cultivators at 128 acres treated per day (32 lb ai/acre)
- wheat, barley at 128 acres treated per day (31.7 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

Scenario 5b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops at 80 and 128 acres treated per day (338 lb ai/acre and 320 lb ai/acre)

For the mixer/loader/applicator scenarios in commercial and small scale agricultural settings, all intermediate-term inhalation MOEs **are greater than 100** at some level of personal protection.

Table 2: Non-cancer Intermediate-term Metam Sodium Occupational Handler Risk Summary

Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs			
				Baseline	PPE-G	PPE-G,DL	Eng Cont
Loader							
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) (1a)	small areas of ornamentals, food, fiber crops	523 lb ai/acre	5 acres	<1	4	5	11
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	0.3	40	54	**110**
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	<1	<1	<1	1
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	<1	<1	1	1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	<1	<1	<1	1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	<1	<1	1	1
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	<1	1	2	3
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	<1	2	3	6
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	<1	2	3	6
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	<1	3	5	9
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	<1	3	3	7
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	<1	4	6	11
	wheat, barley	31.7 lb ai/acre	128 acres	<1	3	4	7
	wheat, barley	31.7 lb ai/acre	80 acres	<1	4	6	11
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) (1b)	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	<1	<1	0	1
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	<1	<1	1	1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	<1	<1	<1	1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	<1	<1	1	1
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system) (1c)	ornamentals, food and fiber crops	338 lb ai/acre	350 acres	<1	<1	<1	<1
	ornamentals, food and fiber crops	320 lb ai/acre	350 acres	<1	<1	<1	<1
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	350 acres	<1	<1	1	1
	wheat, barley	31.7 lb ai/acre	350 acres	<1	1	1	3
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	350 acres	<1	1	1	3
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Drip Irrigation Nurse Tank (mechanical transfer system) (1d)	ornamentals, food and fiber crops	320 lb ai/acre	100 acres	<1	<1	<1	1
	ornamentals, food and fiber crops	239 lb ai/acre	100 acres	<1	<1	1	1
	cotton, soybeans, sugar beets	38 lb ai/acre	100 acres	<1	3	4	7

Table 2: Non-cancer Intermediate-term Metam Sodium Occupational Handler Risk Summary							
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs			
				Baseline	PPE-G	PPE-G,DL	Eng Cont
Applicator							
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	small areas of ornamentals, food, fiber crops	523 lb ai/acre	5 acres	7	7	8	18
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	66	66	83	**180**
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	0.4	<1	1	1
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	0.6	1	1	2
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	0.4	<1	1	1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	0.7	1	1	2
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	2	2	3	6
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	3	3	4	10
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	4	4	5	10
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	6	6	7	16
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	4	4	5	12
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	7	7	9	19
	wheat, barley	31.7 lb ai/acre	128 acres	4	4	5	12
	wheat, barley	31.7 lb ai/acre	80 acres	7	7	9	19
Applying Water Soluble Liquids via Rotary Tiller Equipment (using PHED groundboom data) (3)	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	0.4	<1	1	1
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	0.6	1	1	2
	ornamentals, food and fiber crops	320 lb ai/acre	128 acres	0.4	<1	1	1
	ornamentals, food and fiber crops	320 lb ai/acre	80 acres	0.7	1	1	2

Table 2: Non-cancer Intermediate-term Metam Sodium Occupational Handler Risk Summary							
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs			
				Baseline	PPE-G	PPE-G,DL	Eng Cont
Loader/Applicator							
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data) (4a) [d]	small areas of ornamentals, food, fiber crops	523 lb ai/acre	5 acres	<1	2	3	NA
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	1	16	25	NA
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	<1	<1	<1	NA
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	<1	<1	<1	NA
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	<1	<1	<1	NA
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	<1	<1	<1	NA
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	<1	1	1	NA
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	<1	1	1	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	<1	1	1	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	<1	1	2	NA
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	<1	1	2	NA
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	<1	2	3	NA
	wheat, barley	31.7 lb ai/acre	128 acres	<1	1	2	NA
	wheat, barley	31.7 lb ai/acre	80 acres	<1	2	3	NA
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA with closed cab) (4b) [d]	small areas of ornamentals, food, fiber crops	523 lb ai/acre	5 acres	NA	NA	NA	1
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	NA	NA	NA	10
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	NA	NA	NA	<1
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	NA	NA	NA	<1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	NA	NA	NA	<1
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	NA	NA	NA	<1
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	NA	NA	NA	<1
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	NA	NA	NA	1
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	NA	NA	NA	1
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	NA	NA	NA	1
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	NA	NA	NA	1
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	NA	NA	NA	1
	wheat, barley	31.7 lb ai/acre	128 acres	NA	NA	NA	1
	wheat, barley	31.7 lb ai/acre	80 acres	NA	NA	NA	1
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [d]	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	<1	<1	<1	NA
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	<1	<1	<1	NA
	ornamentals, food and fiber crops	320 lb ai/acre	128 acres	<1	<1	<1	NA
	ornamentals, food and fiber crops	320 lb ai/acre	80 acres	<1	<1	<1	NA
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with closed cab) (5b) [d]	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	NA	NA	NA	<1
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	NA	NA	NA	<1
	ornamentals, food and fiber crops	320 lb ai/acre	128 acres	NA	NA	NA	<1
	ornamentals, food and fiber crops	320 lb ai/acre	80 acres	NA	NA	NA	<1
Chemigation Monitor							
Monitoring Chemigation Applications Using Liquid Formulation (6)	No Metam Sodium specific data is available for this scenario.						

Table 2: Non-cancer Intermediate-term Metam Sodium Occupational Handler Risk Summary							
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs			
				Baseline	PPE-G	PPE-G,DL	Eng Cont
Irrigator							
Irrigating Following Shank Injection Applications (7)	No Metam Sodium specific data is available for this scenario.						
Mixer/Loader/Applicator							
Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data - occupational) (8)	small areas of ornamentals, food, fiber crops	12 lb ai/1000 sq ft	1000 sq ft	4	ND	ND	NF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF LCO hand-gun data - occupational) (9)	small areas of ornamentals, food, fiber crops	350 lb ai/acre	5 acres	0.2	<1	1	NF
	small areas of ornamentals, food, fiber crops	350 lb ai/acre	0.5 acres	2	3	6	NF
Mixing/Loading/Applying Water Soluble Liquids via power sprayer (using ORETF LCO hand-gun data - occupational) (10)	drained water bodies and shorelines	350 lb ai/acre	5 acres	No intermediate-term handler MOEs were calculated for this scenario.			
Mixing/Loading/Applying Liquids via cement mixer (using PHED Mixer/Loader data for Open-pour Liquids) (11)	potting soil	0.012 lb ai/cu ft	54 cu ft	No intermediate-term handler MOEs were calculated for this scenario.			
Mixing/Loading/Applying Liquids via shredder (using PHED Mixer/Loader data for Open-pour Liquids) (12)	potting soil	0.012 lb ai/cu ft	54 cu ft	No intermediate-term handler MOEs were calculated for this scenario.			
Mixing/Loading/Applying Liquid with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids) (13)	sewer roots	0.212 lb ai/gal	1350 gallons	0.3	36	49	NF
	sewer roots	0.212 lb ai/gal	675 gallons	0.6	73	99	NF

Table 2: Non-cancer Intermediate-term Metam Sodium Occupational Handler Risk Summary							
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs			
				Baseline	PPE-G	PPE-G,DL	Eng Cont
Mixing/Loading/Applying Liquids via Open Pour (using PHED Mixer/Loader data for Open-pour Liquids) (14)	tree replanting	16 lb ai/1000 sq ft	1000 sq ft	No intermediate-term handler MOEs were calculated for this scenario.			

Footnotes

* MOEs that do not exceed HED's level of concern are shown in bold.
NA Not Applicable
ND No Data
NF Not Feasible
a Target for all crops is the soil except for turf, which may be applied to the foliar surface when the goal is to destroy the existing turf.
b Application rates are the maximum application rates determined from EPA registered labels for metam sodium.
c Amount handled per day values are HED estimates of acres, square feet, or cubic feet treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry sources, and HED estimates.
d May over estimate exposure, PHED data is based on open pour mixing/loading.

Dermal Baseline: Long-sleeve shirt, long pants, and no gloves
PPE-G: Baseline plus chemical-resistant gloves.
PPE-G,DL: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves
Eng Controls: Closed mixing/loading system or enclosed cab

For IT Inhalation MOEs, See ST tables. ST and IT have same NOAEL (1.11 mg/kg/day).

Metam Sodium Cancer Risk Summary

Metam sodium cancer risks for **noncommercial** handlers and **commercial** handlers are summarized below in **Tables 3** and **4**, respectively. For cancer risk estimates, it was assumed that noncommercial and commercial handlers are exposed for 5 and 20 days/year respectively.

Cancer risks for ***noncommercial handlers*** are greater than $\mathbf{1.0 \times 10^{-4}}$ at maximum feasible mitigation for the following handler scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- orchards (replant/transplant) at 100 acres treated per day (320 lb ai/acre)
- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler Irrigation Nurse Tank (mechanical transfer system)

- orchards (replant/transplant) at 350 acres treated per day (320 lb ai/acre)
- turf (sod farms) at 350 acres treated per day (252 lb ai/acre)
- wheat, barley at 350 acres treated per day (162 lb ai/acre)
- ornamentals, food, and fiber crops at 350 acres treated per day (108 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- tobacco plant beds at 100 acres treated per day (387 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- tobacco plant beds at 100 acres treated per day (387 lb ai/acre)
- orchards (replant/transplant) at 100 acres treated per day (320 lb ai/acre)
- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)

Scenario 4b: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA closed cab data)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 5 acres treated per day (523 lb ai/acre)
- tobacco plant beds at 100 acres treated per day (387 lb ai/acre)
- orchards (replant/transplant) at 100 acres treated per day (320 lb ai/acre)

- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)
- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)

Scenario 5b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA closed cab data)

- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)
- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 9: Mixing/Loading/Applying Liquids via Hose Proportioner (using ORETF handgun data-occupational)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns at 5 acres treated per day (350 lb ai/acre)

Scenario 10: Mixing/Loading/Applying Liquids via Power Sprayer (using ORETF handgun data-occupational)

- drained water bodies and shorelines at 5 acres treated per day (350 lb ai/acre)

Cancer risks for ***noncommercial handlers*** are between **1.0×10^{-4}** and **1.0×10^{-6}** at maximum feasible mitigation for the following handler scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 5 acres treated per day (523 lb ai/acre)
- tobacco plant beds at 20 acres treated per day (387 lb ai/acre)
- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler Irrigation Nurse Tank (mechanical transfer system)

- tobacco plant beds at 20 acres treated per day (387 lb ai/acre)
- cotton, soybeans, and sugar beets at 350 acres treated per day (44.4 lb ai/acre)
- peanuts at 350 acres treated per day (27.5 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 5 acres treated per day (523 lb ai/acre)
- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)
- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- turf (sod farms) at 100 acres treated per day (252 lb ai/acre)
- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)
- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 5 acres treated per day (523 lb ai/acre)
- turf (golf courses) at 20 acres treated per day (252 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
  peanuts at 100 acres treated per day (27.5 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 8: Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data-occupational)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns at

1000 square feet treated per day (12 lb ai/1000 ft^2)
- potting soil at 1000 square feet treated per day (4 lb ai/1000 ft^2)

Scenario 9: Mixing/Loading/Applying Liquids via Hose Proportioner (using ORETF hose-end data-occupational)
- small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns at 0.5 acres treated per day (350 lb ai/acre)

Scenario 13: Mixing/Loading/Applying Liquids with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids)
- sewer roots at 675 and 1,350 gallons (0.212 lb ai/gallon)

Cancer risks for ***noncommercial handlers*** are less than **1.0×10^{-6}** at some level of mitigation for the following handler scenarios:

Scenario 11: Mixing/Loading/Applying Liquids via Cement Mixer (using PHED Mixer/Loader data for Open-pour Liquids)
- potting soil at 54 cubic feet treated per day (0.012 lb ai/1000 ft^3)

Scenario 12: Mixing/Loading/Applying Liquids via Shredder (using PHED Mixer/Loader data for Open-pour Liquids)
- potting soil at 54 cubic feet treated per day (0.012 lb ai/1000 ft^3)

Scenario 14: Mixing/Loading/Applying Liquids via Open Pour (using PHED Mixer/Loader data for Open-pour Liquids)
- tree replanting at 1000 square feet treated per day (16 lb ai/1000 ft^2)

Table 3. Summary of Noncommercial Handlers Cancer Risks to Metam Sodium

Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Noncommercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Mixer/Loader									
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) (1a)	small areas of seed beds, plant beds	523 lb ai/acre	5 acres	3.7e-03	9.0e-05	8.2e-05	3.5e-05	2.8e-05	1.5e-05
	tobacco plant beds	387 lb ai/acre	20 acres	1.1e-02	2.7e-04	2.4e-04	1.0e-04	8.2e-05	4.5e-05
	orchard replant/transplant sites	320 lb ai/acre	100 acres	4.6e-02	1.1e-03	1.0e-03	4.3e-04	3.4e-04	1.8e-04
	turf (sod farms)	252 lb ai/acre	100 acres	3.6e-02	8.7e-04	7.9e-04	3.4e-04	2.7e-04	1.5e-04
	turf (golf courses)	252 lb ai/acre	20 acres	7.2e-03	1.7e-04	1.6e-04	6.8e-05	5.3e-05	2.9e-05
	wheat, barley [d]	162 lb ai/acre	100 acres	2.3e-02	5.6e-04	8.2e-05	3.5e-05	2.8e-05	1.5e-05
	ornamentals and food crops	108 lb ai/acre	100 acres	1.5e-02	3.7e-04	3.4e-04	1.5e-04	1.1e-04	6.2e-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	6.3e-03	1.5e-04	1.4e-04	6.0e-05	4.7e-05	2.6e-05
	peanuts	27.5 lb ai/acre	100 acres	3.9e-03	9.5e-05	8.7e-05	3.7e-05	2.9e-05	1.6e-05
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) (1b)	turf (sod farms)	252 lb ai/acre	100 acres	3.6e-02	8.7e-04	7.9e-04	3.4e-04	2.7e-04	1.5e-04
	turf (golf courses)	252 lb ai/acre	20 acres	7.2e-03	1.7e-04	1.6e-04	6.8e-05	5.3e-05	2.9e-05
	ornamentals and food crops	108 lb ai/acre	100 acres	1.5e-02	3.7e-04	3.4e-04	1.5e-04	1.1e-04	6.2e-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	6.3e-03	1.5e-04	1.4e-04	6.0e-05	4.7e-05	2.6e-05
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system) (1c)	tobacco plant beds	387 lb ai/acre	20 acres	1.1e-02	2.7e-04	2.4e-04	1.0e-04	8.2e-05	4.5e-05
	orchard replant/transplant sites	320 lb ai/acre	350 acres	1.6e-01	3.9e-03	3.5e-03	1.5e-03	1.2e-03	6.5e-04
	turf (sod farms)	252 lb ai/acre	350 acres	1.3e-01	3.0e-03	2.8e-03	1.2e-03	9.3e-04	5.1e-04
	wheat, barley [d]	162 lb ai/acre	350 acres	8.1e-02	1.9e-03	1.8e-03	7.6e-04	6.0e-04	3.3e-04
	ornamentals and food crops	108 lb ai/acre	350 acres	5.4e-02	1.3e-03	1.2e-03	5.1e-04	4.0e-04	2.2e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	350 acres	2.2e-02	5.3e-04	4.9e-04	2.1e-04	1.6e-04	9.0e-05
	peanuts	27.5 lb ai/acre	350 acres	1.4e-02	3.3e-04	3.0e-04	1.3e-04	1.0e-04	5.6e-05
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Drip Irrigation Nurse Tank (mechanical transfer system) (1d)	turf (sod farms)	252 lb ai/acre	100 acres	3.6e-02	8.7e-04	7.9e-04	3.4e-04	2.7e-04	1.5e-04
	ornamentals and food crops	108 lb ai/acre	100 acres	1.5e-02	3.7e-04	3.4e-04	1.5e-04	1.1e-04	6.2e-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	6.3e-03	1.5e-04	1.4e-04	6.0e-05	4.7e-05	2.6e-05

Table 3. Summary of Noncommercial Handlers Cancer Risks to Metam Sodium									
Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Noncommercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Applicator									
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	small areas of seed beds, plant beds	523 lb ai/acre	5 acres	5.5e-05	5.5e-05	5.1e-05	2.1e-05	1.8e-05	8.5e-06
	tobacco plant beds	387 lb ai/acre	20 acres	3.4e-04	3.4e-04	3.2e-04	1.3e-04	1.1e-04	5.3e-05
	orchard replant/transplant sites	320 lb ai/acre	100 acres	6.8e-04	6.8e-04	6.3e-04	2.6e-04	2.2e-04	1.0e-04
	turf (sod farms)	252 lb ai/acre	100 acres	5.3e-04	5.3e-04	5.0e-04	2.1e-04	1.7e-04	8.2e-05
	turf (golf courses)	252 lb ai/acre	20 acres	1.1e-04	1.1e-04	9.9e-05	4.1e-05	3.4e-05	1.6e-05
	wheat, barley [d]	162 lb ai/acre	100 acres	3.4e-04	3.4e-04	3.2e-04	1.4e-04	1.1e-04	5.3e-05
	ornamentals and food crops	108 lb ai/acre	100 acres	2.3e-04	2.3e-04	2.1e-04	8.9e-05	7.3e-05	3.5e-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	9.4e-05	9.4e-05	8.7e-05	3.6e-05	3.0e-05	1.4e-05
	peanuts	27.5 lb ai/acre	100 acres	5.8e-05	5.8e-05	5.4e-05	2.3e-05	1.9e-05	9.0e-06
Applying Water Soluble Liquids via Rotary Tiller Equipment (using PHED groundboom data) (3)	turf (sod farms)	252 lb ai/acre	100 acres	5.3e-04	5.3e-04	5.0e-04	2.1e-04	1.7e-04	8.2e-05
	turf (golf courses)	252 lb ai/acre	20 acres	1.1e-04	1.1e-04	9.9e-05	4.1e-05	3.4e-05	1.6e-05
	ornamentals and food crops	108 lb ai/acre	100 acres	2.3e-04	2.3e-04	2.1e-04	8.9e-05	7.3e-05	3.5e-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	9.4e-05	9.4e-05	8.7e-05	3.6e-05	3.0e-05	1.4e-05
Loader/Applicator									
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data) (4a) [e]	small areas of seed beds, plant beds	523 lb ai/acre	5 acres	1.2e-03	1.4e-04	1.1e-04	7.9e-05	5.2e-05	NA
	tobacco plant beds	387 lb ai/acre	20 acres	3.5e-03	4.1e-04	3.3e-04	2.3e-04	1.5e-04	NA
	orchard replant/transplant sites	320 lb ai/acre	100 acres	1.4e-02	1.7e-03	1.4e-03	9.6e-04	6.4e-04	NA
	turf (sod farms)	252 lb ai/acre	100 acres	1.1e-02	1.3e-03	1.1e-03	7.6e-04	5.0e-04	NA
	turf (golf courses)	252 lb ai/acre	20 acres	2.3e-03	2.7e-04	2.1e-04	1.5e-04	1.0e-04	NA
	wheat, barley [d]	162 lb ai/acre	100 acres	7.3e-03	8.6e-04	6.9e-04	4.9e-04	3.2e-04	NA
	ornamentals and food crops	108 lb ai/acre	100 acres	4.9e-03	5.7e-04	4.6e-04	3.3e-04	2.2e-04	NA
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	2.0e-03	2.3e-04	1.9e-04	1.3e-04	8.9e-05	NA
	peanuts	27.5 lb ai/acre	100 acres	1.2e-03	1.5e-04	1.2e-04	8.3e-05	5.5e-05	NA
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA with enclosed cab) (4b) [e]	small areas of seed beds, plant beds	523 lb ai/acre	5 acres	NA	NA	NA	NA	NA	1.3e-04
	tobacco plant beds	387 lb ai/acre	20 acres	NA	NA	NA	NA	NA	3.9e-03
	orchard replant/transplant sites	320 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.6e-03
	turf (sod farms)	252 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.3e-03
	turf (golf courses)	252 lb ai/acre	20 acres	NA	NA	NA	NA	NA	2.5e-04
	wheat, barley [d]	162 lb ai/acre	100 acres	NA	NA	NA	NA	NA	8.1e-04
	ornamentals and food crops	108 lb ai/acre	100 acres	NA	NA	NA	NA	NA	5.4e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	NA	NA	NA	NA	NA	2.2e-04
	peanuts	27.5 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.4e-04
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [e]	turf (sod farms)	252 lb ai/acre	100 acres	1.1e-02	1.3e-03	1.1e-03	7.6e-04	5.0e-04	NA
	turf (golf courses)	252 lb ai/acre	20 acres	2.3e-03	2.7e-04	2.1e-04	1.5e-04	1.0e-04	NA
	ornamentals and food crops	108 lb ai/acre	100 acres	4.9e-03	5.7e-04	4.6e-04	3.3e-04	2.2e-04	NA
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	2.0e-03	2.3e-04	1.9e-04	1.3e-04	8.9e-05	NA

Table 3. Summary of Noncommercial Handlers Cancer Risks to Metam Sodium

Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Noncommercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with closed cab) (5b) [e]	turf (sod farms)	252 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.3e-03
	turf (golf courses)	252 lb ai/acre	20 acres	NA	NA	NA	NA	NA	2.5e-04
	ornamentals and food crops	108 lb ai/acre	100 acres	NA	NA	NA	NA	NA	5.4e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	NA	NA	NA	NA	NA	2.2e-04
Chemigation Monitor									
Monitoring Chemigation Applications Using Liquid Formulation (6)	No Metam Sodium data is available for this scenario.								
Soil Seal Irrigator									
Sealing Soil with Irrigation Water Following Shank Injection Applications Using Liquid Formulations (7)	No Metam Sodium data is available for this scenario.								
Mixer/Loader/Applicator									
Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data - occupational) (8)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	12 lb ai/1000 sq ft	1000 sq ft	3.6e-05	ND	ND	ND	ND	NF
	potting soil	4 lb ai/1000 sq ft	1000 sq ft	1.2e-05	ND	ND	ND	ND	NF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF hand-gun data - occupational) (9)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	5 acres	6.4e-04	4.6e-04	2.6e-04	4.1e-04	2.2e-04	NF
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	0.5 acres	6.4e-05	4.6e-05	2.6e-05	4.1e-05	2.2e-05	NF
Mixing/Loading/Applying Water Soluble Liquids via power sprayer (using ORETF LCO hand-gun data - occupational) (10)	drained water bodies and shorelines	350 lb ai/acre	5 acres	6.4e-04	4.6e-04	2.6e-04	4.1e-04	2.2e-04	NF
Mixing/Loading/Applying Liquids via cement mixer (using PHED Mixer/Loader data for Open-pour Liquids) (11)	potting soil	0.012 lb ai/cu ft	54 cubic feet	9.3e-07	2.2e-08	2.0e-08	8.7e-09	6.8e-09	NF
Mixing/Loading/Applying Liquids via shredder (using PHED Mixer/Loader data for Open-pour Liquids) (12)	potting soil	0.012 lb ai/cu ft	54 cubic feet	9.3e-07	2.2e-08	2.0e-08	8.7e-09	6.8e-09	NF
Mixing/Loading/Applying Liquid with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids) (13)	sewer roots	0.212 lb ai/gal	1350 gallons	4.1e-04	9.8e-06	9.0e-06	3.9e-06	3.0e-06	NF
	sewer roots	0.212 lb ai/gal	675 gallons	2.0e-04	4.9e-06	4.5e-06	1.9e-06	1.5e-06	NF
Mixing/Loading/Applying Liquids via Open Pour (using PHED Mixer/Loader data for Open-pour Liquids) (14)	tree replanting	16 lb ai/1000 sq ft	1000 sq ft	2.3e-05	5.5e-07	5.0e-07	2.2e-07	1.7e-07	NF

Footnotes

–	**Noncommercial handler** exposure was considered to be 5 days per year for 35 years over a 70 year lifetime.
NA	Not Applicable
ND	No Data
NF	Not Feasible
a	Target for all crops is the soil except for turf, which may be applied to the foliar surface when the goal is to destroy the existing turf.
b	Application rates are the typical application rates provided by USDA (2001) for metam sodium where possible. If typical rates were not available, the maximum label rates were used in place of typical rates.
c	Amount handled per day values are HED estimates of acreage treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres Treated in Agriculture," industry input, and HED estimates.
d	The average rates reported by USDA in 2001 for wheat and barley (162 lb ai/A) is significantly higher than the maximum label rate (31.7 lb ai/A) for control of "certain root diseases caused by early season fungi." However, HED notes that wheat and barley also can be treated at the application rate on the label for ornamentals, food, and fiber crops (338 or 320 lb ai/A). Therefore, HED estimated cancer rates with the 162 lb ai/A label rate since that is the rate reported by USDA as the average rate for wheat and barley.
e	May over estimate exposure, PHED data is based on open pour mixing/loading.

Dermal Baseline:	Long-sleeve shirt, long pants, and no gloves
PPE-G:	Baseline plus chemical-resistant gloves.
PPE-G,DL:	Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves
Eng Controls:	Closed mixing/loading system or enclosed cab
Inhalation Baseline:	No respirator
OV Respirator:	NIOSH/MSHA-approved cartridge or cannister respirator with an organic-vapor removing filter and dust/mist prefilter.

Cancer risks for ***commercial handlers*** are greater than **1.0 x 10^{-4}** at maximum feasible mitigation for the following handler scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)

Scenario 1c: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 350 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 350 acres treated per day (44.4 lb ai/acre)
- wheat, barley at 350 acres treated per day (162 lb ai/acre)
- peanuts at 350 acres treated per day (27.5 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)

Scenario 4a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)

Scenario 4b: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)
- wheat, barley at 100 acres treated per day (162 lb ai/acre)

Scenario 5a: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA open cab data)

- ornamentals, food, and fiber crops at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 5b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (using PHED groundboom MLA closed cab data)

- ornamentals, food, and fiber crops, turf (sod farms) at 100 acres treated per day (108 lb ai/acre)
- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 8: Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data-occupational)

- small areas of ornamentals, food, fiber crops at 1000 square feet treated per day (12 lb ai/1000 ft^2)

Scenario 9: Mixing/Loading/Applying Liquids via Hose Proportioner (using ORETF hand-gun data-occupational)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns at 5 acres treated per day (350 lb ai/acre)

Cancer risks for ***commercial handlers*** are between **1.0 x 10^{-4}** and **1.0 x 10^{-6}** at some level of mitigation for the following handler scenarios:

Scenario 1a: Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system)

- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)

Scenario 1b: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system)

- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 1d: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system)

- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 2: Applying Liquids via Shank Injection Equipment (using PHED groundboom data)

- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)
- peanuts at 100 acres treated per day (27.5 lb ai/acre)

Scenario 3: Applying Liquids via Rotary Tiller Equipment (using PHED groundboom data)

- cotton, soybeans, sugar beets at 100 acres treated per day (44.4 lb ai/acre)

Scenario 9: Mixing/Loading/Applying Liquids via Hose Proportioner (using ORETF hose-end data-occupational)

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns at 0.5 acres treated per day (350 lb ai/acre)

Scenario 13: Mixing/Loading/Applying Liquids with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids)

- sewer roots at 675 and 1,350 gallons handled per day (0.212 lb ai/gallon)

There are no handler scenarios where cancer risks for ***commercial handlers*** are less than **1.0 x 10^{-6}** at maximum feasible mitigation.

Table 4. Summary of Commercial Handler Cancer Risks to Metam Sodium									
Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Commercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Mixer/Loader									
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) (1a)	wheat, barley [d]	162 lb ai/acre	100 acres	9.3e-02	2.2e-03	2.0e-03	8.7e-04	6.8e-04	3.7e-04
	ornamentals and food crops	108 lb ai/acre	100 acres	6.2e-02	1.5e-03	1.4e-03	5.8e-04	4.6e-04	2.5e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	2.5e-02	6.1e-04	5.6e-04	2.4e-04	1.9e-04	1.0e-04
	peanuts	27.5 lb ai/acre	100 acres	1.6e-02	3.8e-04	3.5e-04	1.5e-04	1.2e-04	6.4e-05
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) (1b)	ornamentals and food crops	108 lb ai/acre	100 acres	6.2e-02	1.5e-03	1.4e-03	5.8e-04	4.6e-04	2.5e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	2.5e-02	6.1e-04	5.6e-04	2.4e-04	1.9e-04	1.0e-04
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system) (1c)	wheat, barley [d]	162 lb ai/acre	350 acres	3.2e-01	7.8e-03	7.1e-03	3.1e-03	2.4e-03	1.3e-03
	ornamentals and food crops	108 lb ai/acre	350 acres	2.2e-01	5.2e-03	4.8e-03	2.0e-03	1.6e-03	8.7e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	350 acres	8.9e-02	2.1e-03	2.0e-03	8.4e-04	6.6e-04	3.6e-04
	peanuts	27.5 lb ai/acre	350 acres	5.5e-02	1.3e-03	1.2e-03	5.2e-04	4.1e-04	2.2e-04
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Drip Irrigation Nurse Tank (mechanical transfer system) (1d)	ornamentals and food crops	108 lb ai/acre	100 acres	6.2e-02	1.5e-03	1.4e-03	5.8e-04	4.6e-04	2.5e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	2.5e-02	6.1e-04	5.6e-04	2.4e-04	1.9e-04	1.0e-04
Applicator									
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	wheat, barley [d]	162 lb ai/acre	100 acres	1.4e-03	1.4e-03	1.3e-03	5.3e-04	4.4e-04	2.1e-04
	ornamentals and food crops	108 lb ai/acre	100 acres	9.1e-04	9.1e-04	8.5e-04	3.5e-04	2.9e-04	1.4e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	3.8e-04	3.8e-04	3.5e-04	1.5e-04	1.2e-04	5.8e-05
	peanuts	27.5 lb ai/acre	100 acres	2.3e-04	2.3e-04	2.2e-04	9.0e-05	7.4e-05	3.6e-05
Applying Water Soluble Liquids via Rotary Tiller Equipment (using PHED groundboom data) (3)	ornamentals and food crops	108 lb ai/acre	100 acres	9.1e-04	9.1e-04	8.5e-04	3.5e-04	2.9e-04	1.4e-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	3.8e-04	3.8e-04	3.5e-04	1.5e-04	1.2e-04	5.8e-05

Table 4. Summary of Commercial Handler Cancer Risks to Metam Sodium									
Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Commercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Loader/Applicator									
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data) (4a) [e]	wheat, barley [d]	162 lb ai/acre	100 acres	2.9e-02	3.4e-03	2.8e-03	2.0e-03	1.3e-03	NA
	ornamentals and food crops	108 lb ai/acre	100 acres	2.0e-02	2.3e-03	1.8e-03	1.3e-03	8.6e-04	NA
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	8.0e-03	9.4e-04	7.6e-04	5.4e-04	3.5e-04	NA
	peanuts	27.5 lb ai/acre	100 acres	5.0e-03	5.8e-04	4.7e-04	3.3e-04	2.2e-04	NA
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA with enclosed cab) (4b) [e]	wheat, barley [d]	162 lb ai/acre	100 acres	NA	NA	NA	NA	NA	3.2e-03
	ornamentals and food crops	108 lb ai/acre	100 acres	NA	NA	NA	NA	NA	2.2e-03
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	NA	NA	NA	NA	NA	8.9e-04
	peanuts	27.5 lb ai/acre	100 acres	NA	NA	NA	NA	NA	5.5e-04
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [e]	ornamentals and food crops	108 lb ai/acre	100 acres	2.0e-02	2.3e-03	1.8e-03	1.3e-03	8.6e-04	NA
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	8.0e-03	9.4e-04	7.6e-04	5.4e-04	3.5e-04	NA
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with closed cab) (5b) [e]	ornamentals and food crops	108 lb ai/acre	100 acres	NA	NA	NA	NA	NA	2.2e-03
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	NA	NA	NA	NA	NA	8.9e-04
Chemigation Monitor									
Monitoring Chemigation Applications Using Liquid Formulation (6)	No Metam Sodium specific data is available for this scenario.								
Soil Seal Irrigator									
Sealing Soil with Irrigation Water Following Shank Injection Applications Using Liquid Formulations (7)	No Metam Sodium specific data is available for this scenario.								
Mixer/Loader/Applicator									

Table 4. Summary of Commercial Handler Cancer Risks to Metam Sodium									
Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Commercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data - occupational) (8)	small areas of ornamentals, food, fiber crops	12 lb ai/1000 sq ft	1000 sq ft	1.5e-04	ND	ND	ND	ND	NF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF hand-gun data - occupational) (9)	small areas of ornamentals, food, fiber crops	350 lb ai/acre	5 acres	2.5e-03	1.8e-03	1.1e-03	1.6e-03	8.7e-04	NF
	small areas of ornamentals, food, fiber crops	350 lb ai/acre	0.5 acres	2.5e-04	1.8e-04	1.1e-04	1.6e-04	8.7e-05	NF
Mixing/Loading/Applying Water Soluble Liquids via Power Sprayer (using ORETF hand-gun data - occupational) (10)	No commercial cancer risks were calculated for this scenario.								
Mixing/Loading/Applying Liquid via Cement Mixer (using PHED Mixer/Loader data for Open-pour Liquids) (11)	No commercial cancer risks were calculated for this scenario.								
Mixing/Loading/Applying Liquid via Shredder (using PHED Mixer/Loader data for Open-pour Liquids) (12)	No commercial cancer risks were calculated for this scenario.								
Mixing/Loading/Applying Liquid with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids) (13)	sewer roots	0.212 lb ai/gal	1350 gallons	1.6e-03	3.9e-05	3.6e-05	1.5e-05	1.2e-05	NF
	sewer roots	0.212 lb ai/gal	675 gallons	8.2e-04	2.0e-05	1.8e-05	7.7e-06	6.0e-06	NF
Mixing/Loading/Applying Liquid via Open Pour (using PHED Mixer/Loader data for Open-pour Liquids) (14)	No commercial cancer risks were calculated for this scenario.								

Footnotes

– **Commercial handler** exposure was considered to be 20 days per year for 35 years over a 70 year lifetime.

NA Not Applicable

ND No Data

NF Not Feasible

a Target for all crops is the soil except for turf, which may be applied to the foliar surface.

b Application rates are the typical application rates provided by USDA (2001) for metam sodium where possible. If typical rates were not available, the maximum label rates were used in place of typical rates.

c Amount handled per day values are HED estimates of acreage treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Acres

Treated in Agriculture”.

d