UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

MEMORANDUM

Date: **May 21, 2004**

Subj: **Metam Sodium**: Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision Document.

PC Code: 039003 (Metam Sodium) and 068103 (MITC)

DP Barcode: D293331

From: Steven Weiss, Industrial Hygienist
Health Effects Division/Reregistration Branch 3 (7509C)

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

To: Carol Christensen, Risk Assessor
Health Effects Division/Registration Action Branch 2 (7509C)

The attached assessment is the occupational and non-occupational (residential) exposure and risk estimates for metam sodium and its major degradate MITC to support HED's reregistration eligibility decision (RED) document. The assessment includes mathematical and typographical errors identified in the April 2, 2004 assessment (D284269) identified by Tessenderlo Kerley, Inc., Taminco Inc., and AMVAC Chemical sent via E-mail on May 18, 2004. Excel spreadsheets used for several exposure and risk calculations will be sent separately ('tables 10 through 13.xls', 'tables 14 and 15.xls', 'ISC analysis.zip').

The data analysis included in this assessment was prepared by Versar, Inc under the supervision of HED. The assessment was reviewed by HED's Science Council for Exposure (ExpoSAC) to ensure compliance with current HED policy as well as ExpoSAC standard operating procedures (SOPs) for conducting occupational and residential exposure (ORE) assessments.

Table of Contents

Executive Summary

Metam sodium is an agricultural fumigant used to control weeds, nematodes, and fungi on a variety of crops. It is also registered as a root control agent for use in sewers and drains, as a vegetation control agent for shorelines and drained bodies of water (California special local needs label), and as a wood preservative. Methyl isothiocyanate (MITC) is the primary degradate of metam sodium and accounts for the fumigant activity. Human exposure and risk from wood treatment as well as other antimicrobial uses (i.e., metam potassium) that may result in MITC exposure will be assessed by OPP's Antimicrobial Division. This assessment estimates the risk for exposure to metam sodium and its primary degradate MITC from its use as an agricultural fumigant, as a vegetation control agent in California, and as a root control agent. The toxicological endpoints that were used to complete the occupational risk assessments for metam sodium and MITC are from the 4/2/04 HIARC report.

The short-term (non-cancer) **dermal risk** assessment for **metam sodium** is based on an oral NOAEL of 4.22 mg/kg/day from a oral developmental toxicity study in rats. The LOAEL of 16.88 mg/kg/day was based on reduced body weight gain and decreased food efficiency in maternal rats and increased incidence of skeletal observations and the increase in total resorption. The intermediate-term (non-cancer) dermal risk assessment for metam sodium is based on an oral NOAEL of 0.1 mg/kg/day from an oral chronic toxicity study in dogs. The study showed increased ALT and microscopic changes in the liver observed in female dogs. A dermal absorption rate of 2.5% is assumed.

The short- and intermediate-term (non-cancer) **inhalation risk** assessment for **metam sodium** is based on an NOAEL of 6.5 mg/m^3, which was defined in a 90-day inhalation study in rats. The LOAEL in females was 45 mg/m^3, based on histopathological changes in the naval passages and changes in clinical chemistry. Long-term exposure to metam sodium are not expected for current registered uses. Since the adverse effects for all studies utilized in the metam sodium dermal and inhalation risk assessments are female-specific, the average weight of adult females was used to estimate dose in the exposure assessments for adults.

The HIARC did not select a short-term **dermal** endpoint for **MITC**. 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. The short-, intermediate-, and long-term (non-cancer) **inhalation risk** assessment for **MITC** is based on an NOAEL of 20 mg/m^3 from a 28-day subchronic inhalation study in rats. The study results are based on persistent clinical signs, body weight changes, and gross and histopathological lesions.

HED's level of concern (LOC) for occupational non-cancer risk to metam sodium and MITC are margin of exposures (MOEs) of less than 100. The LOC for non-occupational non-cancer risk to MITC is 100.

Metam sodium is classified as a Class B2 carcinogen with a Q_1* of 1.98 x 10^{-1}. HED's level of concern for occupational cancer risk to metam sodium are cancer risks greater than 1 x 10^{-4} – with risks at or greater than 1 x 10^{-6} as the target. HED's level of concern (LOC) for nonoccupational cancer risk to MITC are cancer risks greater than 1 x 10^{-6}.

For metam sodium, occupational handler exposure estimates were based on surrogate data from: (1) the Pesticide Handlers Exposure Database (PHED); (2) Outdoor Residential Exposure Task Force (ORETF); and (3) California DPR's review of a sodium tetrathiocarbonate handler study. For MITC, handler exposure estimates were based on four chemical-specific handler studies that examined MITC exposures to handlers involved in metam sodium applications. MITC postapplication exposure estimates are based on data from eleven metam sodium field volatility studies. EPA's Industrial Source Complex (ISC) dispersion model was also used to estimate MITC air concentrations in and near treated fields. HED believes that the exposures calculated in this risk assessment are **high-end estimates** and do not underestimate the risk.

The estimated risks for exposure to metam sodium and MITC **exceed** HED's LOC for many of the occupational and non-occupational scenarios evaluated (i.e. dermal and inhalation MOE estimates for metam sodium are less than 100, inhalation MOE estimates for MITC are less than 100, and cancer risk estimates for metam sodium are greater than 1×10^{-6}).

There was a general pattern in terms of the MITC emission rates for the studies used in the ISC modeling. A ranking of highest-to-lowest emission rates for the application methods and sealing methods are: (1) sprinkler without water sealing, (2) sprinkler followed by standard water sealing , (3) shank injection without a seal, (4) shank injection followed by standard water sealing, (5) sprinkler followed by intermittent water sealing, (6) shank injection followed by intermittent water sealing, (7) drip irrigation without a tarp, and (8) drip irrigation with a tarp.

The results of ISC modeling indicate the distances estimated for non-occupational bystanders where the MOE is at least 100 may not be feasible for growers. For example, a 20 acre field treated at the maximum broadcast label rate (320 lb ai/A) results in the following distances for MOEs of at least 100: 1,600 meters **(1 mile)** for sprinkler applications followed by intermittent water sealing, 770 meters **(0.5 mile)** for shank injection followed by intermittent water sealing, and 300 meters **(980 feet)** for drip irrigation with a tarp.

In some instances, the risk based on ISC modeling for a given distance, application type, and sealing method may be much higher than the risk estimated directly from the air concentration measured in a field study. The point estimate risks were calculated using actual off-site measured air concentrations from field volatility studies. The duration of each sample ranged from 4 to 24 hours During the time the these concentrations were measured the wind speed, wind direction, wind stability, mixing height, and flux rate was not constant. With the current modeling approach, the off-site air concentrations were calculated by using model inputs for a constant flux rate (derived or reported from field volatility studies), constant wind speed (based on average 10th percentile of wind speed measured in growing regions in the U.S.) , constant wind direction, and a constant wind stability class (based on conservative assumptions used by California's Department of Pesticide Regulation, CDPR). Although the ISC modeling allows for estimation of concentrations at distances not measured in the field volatility studies, the results in some ways are more refined but also more conservative than point estimates. HED is in the process of working with the Office of Air, CDPR, EPA's Science Advisory Panel (SAP), registrants, and other stakeholders to further refine modeling approaches used for metam sodium and other fumigants (including the potential use of a probabilistic and/or distributional approach).

1.0 Occupational and Residential Exposure/Risk Assessment

1.1 Purpose

This document is the occupational and residential non-dietary exposure and risk assessment for the fumigant metam sodium and its primary degradate, methyl isothiocyanate (MITC) from its use as an agricultural fumigant, as a vegetation control agent in California, and as a root control agent.

1.2 Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is a potential for exposure to handlers (mixers, loaders, applicators) during use or to persons entering treated sites or exposed to vapors after application is complete. Toxicological endpoints were selected for short- and intermediate-term dermal and inhalation exposures to metam sodium. Toxicological endpoints were also selected for short-, intermediate-, and long-term inhalation exposures to MITC, which is a metam sodium degradate of toxicological concern. No dermal endpoint of concern was selected for MITC, even though dermal exposure to the vapor may occur. There is a significant potential for exposure in a variety of occupational agricultural and commercial settings as well as in residential bystander scenarios. Therefore, risk assessments are required for occupational handlers and for occupational and residential postapplication exposures that can occur as a result of metam sodium use.

1.3 Summary of Hazard Concerns

HED's Hazard Identification Assessment Review Committee (HIARC) met to determine appropriate toxicological endpoints of concern for metam sodium and its degradates. Methylisothiocyanate (MITC), the principle breakdown product, accounts for the fumigant activity of metam sodium. MITC is the primary soil degradate and mammalian metabolite of metam sodium. There are several toxicologically notable metabolites/degradates. Specifically, methyl isocyanate (MIC) is a photolysis degradate of the MITC which has been measured in ambient air in agricultural areas of California. Following soil application of metam sodium, both carbon disulfide (CS_2) and hydrogen sulfide (H_2S) can be formed – the relative amounts depend on the pH of the soil. Following oral exposure to metam sodium, rats metabolize approximately 20-25% of the dose (on a molar basis) to carbon disulfide. This assessment addresses the exposure and risk to metam sodium and MITC only.

The toxicological endpoints that were used to complete the occupational and residential risk assessments are summarized below which have been extracted from the latest Metam Sodium/ Dazomet/MITC HIARC report (4/2/04). Adverse effects were identified at all durations of exposure ranging from short-term (up to 30 days) to chronic durations (every working day). Cancer risks were calculated for metam sodium, since it is currently classified as a Group B_2 chemical.

1.3.1 Metam Sodium

Metam sodium is a soil fumigant where the use patterns can vary widely ranging from shorter-term through intermediate-term exposure durations. As such, when the HIARC recently evaluated the metam sodium hazard database, endpoints were selected to address each duration of exposure. Metam Sodium exposures are expected to occur primarily to occupational users.

Dermal Route (non-cancer)

The short-term dermal risk assessment (1 to 30 days of exposure) for metam sodium is based on an NOAEL of **4.22 mg/kg/day** from a oral developmental toxicity study in rats. The LOAEL of 16.88 mg/kg/day was based on reduced body weight gain and decreased food efficiency in maternal rats and increased incidence of skeletal observations and the increase in total resorption.

The intermediate-term dermal risk assessment for metam sodium is based on an NOAEL of 0.1 mg/kg/day from an oral chronic toxicity study in dogs. The study showed increased ALT and microscopic changes in the liver observed in female dogs. The NOAEL of 0.1 mg/kg/day was also selected for assessing long-term dermal exposures. However, based on metam sodium's current use pattern, long-term exposures (greater than 6 months) are not expected.

A dermal absorption factor of 2.5 percent was selected based on dermal absorption data from a metam sodium absorption study performed on rats. HED's level of concern (LOC) for dermal risk is 100 (i.e. a margins of exposure, MOE < 100 exceeds HED's level of concern)

Inhalation Route (non-cancer)

The short- and intermediate-term (non-cancer) inhalation risk assessment for metam sodium is based on an NOAEL of 6.5 mg/m^3 (1.11 mg/kg/day) which was defined in a 90-day inhalation study in rats. The LOAEL in females was 45 mg/m^3 (7.71 mg/kg/day) of metam sodium based on histopathological changes in the naval passages (i.e., mucigenic hyperplasia) and changes in clinical chemistry. The study results are based on sodium levels. Long-term exposure to metam sodium (i.e. greater than 6 months) are not expected for current registered uses.

Non-cancer Level of Concern (LOC)

HED's LOC for metam sodium exposure are MOEs of less than 100 (based on 10x to account for interspecies extrapolation to humans from the animal test species and another 10X to account for intraspecies sensitivity).

Cancer

The Health Effects Division Carcinogenicity Peer Review committee (CPRC) evaluated 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 B_2 - probable human carcinogen, based on statistically significant increases in malignant angiosarcomas in both sexes of the CD-1 mouse, supported by a similar tumor type (malignant hemangiosarcomas) in male Wistar rats. The CPRC recommended that for the purpose of risk characterization, a linear low dose extrapolation model be applied to the animal data for the quantification of human risk (Q_1*), based on the total incidence of angiosarcomas in male mice, at all sites combined. The most potent unit risk (Q_1*) is 1.98×10^{-1} in human equivalents converted from animals to humans by use of the 3/4's scaling factor.

Acute Toxicity

Metam sodium is classified as category III for acute oral, dermal, and inhalation toxicity. It is classified as category III for eye irritation potential and category IV for skin irritation potential. Results were negative for dermal sensitization in guinea pigs.

Body Weight

Since the adverse effects for all studies utilized in the metam sodium dermal and inhalation risk assessments are female-specific, the average weight of adult females (i.e., 60 kg) was used to estimate exposure.

1.3.2 Methyl Isothiocyanate (MITC)

Metam sodium forms MITC (methyl isothiocyanate) as its primary mammalian metabolite and primary soil degradate. As such, when the HIARC recently evaluated the MITC hazard database, endpoints were selected to address the same durations of exposure as metam sodium. Exposures can occur to occupational users and non-occupational populations, so both were considered in this assessment.

Dermal Route (non-cancer)

The HIARC did not select a short-term dermal endpoint for MITC since 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.

Inhalation Route (non-cancer)

The short-, intermediate-, and long-term (non-cancer) inhalation risk assessment for MITC is based on an NOAEL of **20 mg/m^3** that was defined in a 28-day subchronic inhalation study in rats. The study results are based on persistent clinical signs, body weight changes, and gross and histopathological lesions. Section 2.1.4.1 summarizes the calculation method used to estimate MITC inhalation MOEs.

Non-cancer Level of Concern (LOC)

HED's LOC for MITC occupational exposure are MOEs of less than 100. The LOC for

MITC non-occupational exposure are MOEs of less than 100 (based on an additional 10x uncertainty factor for missing DNT study).

Acute Toxicity

MITC is classified as category I for acute dermal and inhalation toxicity and as category II for acute oral toxicity. It is also classified as category I for eye irritation potential and skin irritation potential. There is no available study for dermal sensitization.

1.3.3 MITC Exposure from Dazomet Uses

Dazomet is a another soil fumigant product that produces MITC as its primary breakdown degradate. Annual use of dazomet in the US is reportedly significantly less than that of metam sodium. No data were submitted to HED for MITC exposure from dazomet uses. Therefore, quantitative exposure and risk estimates from Dazomet uses can not be completed at this time. Until further data is provided, HED assumes the exposure and risk to MITC from dazomet uses is similar to that estimated in this assessment for MITC from metam sodium uses.

Dazomet granular products such as Basamid are registered for use on lawns and ornamental plants in residential settings. Furthermore, an Internet search on 8/1/03 indicates that several lawncare sites recommend the use of Basamid for use on residential lawns. For example, the website for University of Florida, Institute of Food and Agricultural Sciences (http://edis.ifas.ufl.edu/LH033) says "Metam (Vapam) or dazomet (Basamid Granular) may be used by homeowners as a preplant herbicide treatment. These may be used with and without a plastic cover. If a cover is not available, cultivate the soil and keep moist for 1 week. Apply 1 to 2 pints of Vapam per 100 square feet using 2 gallons of water. Dazomet rate is 8 to 13 ounces of product per 100 square feet. Immediately irrigate to the depth control desired. If a cover is available, treat the soil in front of a rotary tiller. Cover the soil for 2 days after treatment. Planting may take place 14 to 21 days after treatment. Read and follow all label recommendations to the letter."

Based on the information from various home lawn care management websites and the lack of an explicit prohibition on product labels for use on residential sites, HED must assume that residential use of dazomet could occur. Since dazomet rapidly converts to MITC upon contact with soil, children's exposure to dazomet is not expected (i.e. via oral, dermal, inhalation routes). However, bystander inhalation exposure to MITC by children and adults living near a treated residential site could occur.

Dazomet granular products are not "restricted use" and therefore permit application by a homeowner. Current labels list Basamid formulations as being sold in 50-lb bags as well as 15- or 7.5-lb jugs. According to BASF, the 15- and 7.5-lb jugs were for a canceled tobacco use and now the only formulation available are 50-lb bags which would suggest that application by a homeowner is unlikely. Until the Registration Division can verify whether homeowners do NOT apply dazomet products, HED must assume that homeowners can be "handlers" and therefore may be exposed to dazomet (via dermal and inhalation) and MITC (predominately via inhalation).

1.3.4 MITC Exposure from Metam Potassium Uses

Metam potassium is a another soil fumigant product that produces MITC as its primary breakdown degradate. No data were submitted to HED for MITC exposure from metam potassium uses. Therefore, quantitative exposure and risk estimates from metam potassium uses can not be completed at this time.

Use patterns and exposure scenarios for metam sodium and metam potassium were compared and found to be substantially similar. Therefore, HED assumes the exposure and risk to MITC from metam potassium uses is similar to that estimated in this assessment for MITC from metam sodium uses.

1.3.5 Metam Sodium's Other Breakdown Products

This assessment is based only on the risk associated with metam sodium and it's major breakdown product MITC. However, it should be noted that application of metam sodium may also result in exposure to other breakdown products that are volatile compounds with known toxicity.

Methyl Isocyanate (MIC)	The OSHA PEL and ACGIH TLV is 0.05 mg/m3 (0.02 ppm) for an 8-hour TWA. California DPR established a "conditional 1-hour REL value of 0.99 ppb". The production of MIC from MITC in laboratory is reportedly about 7%. California's Air Resource Board reported that preliminary measurements of MIC following application of metam sodium revealed levels between 0.09 and 2.5 ppb, 4% of the MITC levels.
Hydrogen Sulfide (H_2S)	The OSHA PEL and ACGIH TLV is 14 mg/m^3 (10 ppm) for an 8-hour TWA. The 15-minute STEL is 21 mg/m^3 (15 ppm). California's Ambient Air Quality Standard is 30 ppb for a 1-hour average. California DPR reports measurements of H_2S after applications of metam sodium at levels reaching 76 ppb at 1 to 4 hours postapplication, becoming non-detectable at 5 to 7 hours and then rising again to 21 to 24 hours .
Carbon Disulfide (CS_2)	The current OSHA PEL for carbon disulfide is 20 ppm as an 8-hour TWA, 30 ppm as an acceptable peak concentration for 30-minutes, and 100 ppm as a maximum peak. ACGIH has assigned carbon disulfide a TLV of 10 ppm (31 mg/m3) for an 8-hour TWA (with a "Skin" notation). NIOSH has established REL of 1 ppm (3 mg/m3) as an 8-hour TWA (with a "Skin" notation).

California DPR reports measurements of CS_2 after applications of metam sodium at or below the LOD of 4 ppb.

1.3.6 Special FQPA Safety Factor(s)

Since metam sodium and MITC do not have published or proposed tolerances, the special FQPA safety factor is not applicable to risk assessments for these chemicals.

1.4 Incident Reports

An analysis of incident reports will be included in a separate memo by Jerrold Blondell.

1.5 Summary of Physical and Chemical Properties of Metam Sodium and MITC

1.5.1 Metam Sodium

Metam sodium (CAS registry number 137-42-8) is a colorless crystalline dihydrate with a molecular formula of $C_2H_4NNaS_2$ and a molecular weight of 129.18 g/mole. It is non-volatile with a vapor pressure of 21 mm Hg. Metam sodium is highly soluble in water, moderately soluble in methanol and ethanol, and practically insoluble in most other organic solvents.

1.5.2 MITC

Methyl isothiocyanate (CAS registry number 556-61-6) is yellowish in color and has a pungent odor likened to horseradish. The molecular formula of MITC is C_2H_3NS and the molecular weight is 73.11 g/mole. It is highly volatile with a vapor pressure of 16.0 mm Hg at 25°C. It is poorly soluble in water and readily soluble in most organic solvents.

1.6 Summary of Use Patterns and Formulations

Metam sodium products are described in this section.

1.6.1 End-Use Products

Based on pounds of active ingredient used, metam sodium is the third most widely used agricultural pesticide in the United States. Metam sodium has four major uses:

- an agricultural fumigant,
- a root control compound for use in drains and sewers,
- a vegetation control compound for use along drained ponds and lakes (California special local need registration), and
- a wood preservative

This assessment is concerned with its use as an agricultural fumigant, as a vegetation control agent in California, and as a root control agent. The wood preservative exposure and risk assessment is being completed separately.

For agricultural fumigation and vegetation control, metam sodium is formulated as a water-soluble concentrate or in aqueous solution. The formulation is highly buffered to prevent breakdown (hydrolysis) of the metam sodium. Once metam sodium is applied to soil or mixed with non-buffered water, it rapidly and completely breaks down to MITC and other degradates. In soil, metam sodium usually converts to MITC within one day following application with the decomposition rate depending on soil temperature, soil composition, and soil moisture. Warm soil temperature, increased clay or organic matter, small soil particle size, and low soil moisture facilitate rapid conversion of metam sodium to MITC. MITC accounts for the fumigant activity of metam sodium.

Metam sodium also is formulated as a water-soluble, surface-active formulation in combination with dichlobenil for use as a non-systemic foaming herbicide to rid sewer lines and drain systems of roots and other organic material.

1.6.2 Registered Use Categories and Sites

Metam sodium is an agricultural fumigant used to control weeds, nematodes, and fungi on a wide variety of crops. It is also registered as a root control agent for use in sewers and drains, and as a vegetation control agent for shorelines and drained bodies of water in California. MITC is the primary degradate of metam sodium and accounts for the fumigant activity. Both metam sodium and MITC are also registered as sterilization agents for treated wood, however, this use was not examined in this assessment. Human exposure and risk from wood treatment as well as other antimicrobial uses (i.e., metam potassium) that may result in MITC exposure will be assessed by OPP's Antimicrobial Division.

An analysis of the current labeling and available use information was completed by Special Review and Reregistration Division. Metam sodium is registered for use in a variety of occupational scenarios and thus occupational populations could be potentially exposed while making metam sodium applications. It is possible for occupational and residential populations to be exposed to MITC, the primary degradate of metam sodium, during postaplication time periods, but less likely for such populations to be exposed to metam sodium itself due to its rapid degradation when in contact with water or soil.

Table 1: Summary of Maximum Application Rates for Registered Metam Sodium Uses			
Crop/Site	Application Method	Maximum Label Rate[1]	
		Most Labels	Outlier Label
Ornamentals, turf, food, and fiber crops – large area applications	Tractor-drawn or Sprinkler Irrigation	320 lb ai/acre	338 lb ai/acre
	Drip Irrigation	239 lb ai/acre	320 lb ai/acre
Cotton, soybeans, and sugar beets	Tractor-drawn or Drip Irrigation	38 lb ai/acre	not applicable
Orchards (replant or transplant)	Tractor-drawn or Sprinkler Irrigation	320 lb ai/acre	not applicable
Peanuts CBR resistant cultivars	Tractor-drawn or Sprinkler Irrigation	32 lb ai/acre	not applicable
Peanuts – CBR-susceptible cultivars	Tractor-drawn or Sprinkler Irrigation	63.3 lb ai/acre	not applicable
Wheat and barley	Tractor-drawn or Sprinkler Irrigation	32 lb ai/acre	not applicable
Tobacco plant beds	Tractor-drawn or Sprinkler Irrigation	387 lb ai/acre	412 lb ai/acre
Small areas of ornamentals, food, fiber crops, seed beds, plant beds, and lawns	Tractor-drawn or Sprinkling Can	12 lb ai/1000 ft^2	not applicable
	Hose proportioner	8 lb ai/1000 ft^2	not applicable
Potting soil	Sprinkling Can[2]	4 lb ai/1000 ft^2	not applicable
	Cement Mixer and Shredder	0.012 lb ai/1 ft^3	not applicable
Tree replanting	Open Pour	16 lb ai/1000 ft^2	not applicable
Sewer roots	Foam Spray	0.212 lb ai/gallon	not applicable
Drained water bodies and shorelines (SLN 5481-466)	Power Sprayer (Handgun Sprayer)	8 lb ai/1000 ft^2	not applicable

[1] When more than one maximum rate is listed for a given crop/method, the lower rate was found on the majority of product labels. The higher rate represents the absolute highest rate found on any metam product label.
[2] Amvac label lists a rate of 1.5 pts of AMVAC per 50 sq ft of soil (4 lb ai/100 ft^2). HED assumed that this was a typo and the rate is 0.4 lb ai/100 ft^2.

Some product labels for ornamentals, turf, food, and fiber crops (large and small areas) and potting soil do not explicitly prohibit use in greenhouses and/or “confined areas.” The metam sodium registrants Amvac, Tessenderlo-Kerley Inc., Taminco, and Buckman have stated that they do not support use of metam sodium in enclosed greenhouses and are not aware of such a use in practice. Additionally, Amvac has stated that metam sodium may be used in non-enclosed greenhouses, that is, greenhouses with the structural supports in place but not the enclosing plastic, or in open structures with a roof but no sides. However, since not all metam product labels explicitly prohibit use in greenhouses and "confined areas", these uses could potentially occur.

1.6.3 Application Methods

Metam sodium is applied with several types of application equipment – the major methods are chemigation or tractor-drawn applications. Applications to smaller areas may be made with handheld equipment, including sprinkling cans, hose proportioners (hose-end sprayers), power sprayers (handgun sprayers), or foam injectors. Applications to potting soil may be made by adding it to soil in a cement mixer or by spraying it onto a soil stream as the soil is ejected from a shredder.

According to industry sources, **chemigation applications** of metam sodium are made using four main types of irrigation equipment – sprinkler, flood, furrow, and drip/trickle – with almost 90% applied with sprinkler irrigation systems.

C *Sprinkler irrigation* is a system in which water is applied by means of perforated pipes or nozzles operated under pressure so as to form a spray pattern;

C *Flood irrigation* is a system where the entire surface of the soil is covered by water;

C *Furrow irrigation* is a system where water is applied in furrows or rows resulting in partial surface flooding of the soil – this method of irrigation is normally used with clean-tilled crops;

C *Drip or trickle irrigation* is a system where water is applied at low pressure directly to the root zone of plants by means of applicators, such as orifices, emitters, porous tubing, or perforated pipe, that are placed either on or below the surface of the ground.

The **tractor-drawn applications** of metam sodium, according to industry sources, are made with either shank soil injection or rotary tiller application.

C *Shank soil injection* is a system where the fumigant is applied with knife-like blades called shanks. A tube carrying the product runs down the back of each shank to the opening. Since metam sodium only moves a few inches in the soil, sometimes the shanks have multiple openings to improve distribution. The metam sodium is injected below the surface of the soil and applied in a narrow band as the fumigation equipment moves across the field. Then usually the surface of the soil is sealed or compacted by pulling a ring roller, drag, or other device behind the fumigation equipment or by applying a thin layer of water over the soil surface.

C *Rotary tiller injection* is a system where the fumigant is sprayed on the surface of the soil, then incorporated into the soil with rotary tiller. The soil may be sealed by pulling a ring roller, drag, or other device behind the rotary tiller equipment or by applying a thin layer of water over the soil surface.

A "standard seal" is when water is applied immediately after the application of metam sodium and then continuously over several days. An "intermittent" seal is when water applied immediately after the application of metam sodium and then at different intervals for several days.

The **foam applications** are applied in isolated sections of the sewer system for approximately an hour. At the end of the treatment period, the solution is released into the main sewer system and the treated area is flushed with water. MITC is likely formed during the treatment process and may enter air spaces in the treatment area and in nearby sewer systems.

Metam sodium is applied to soil with **handheld equipment** such as sprinkling cans, hose-proportioners (i.e., hose-end sprayers), power sprayers (handgun sprayers), cement mixers, and shredders.

1.6.4 Mitigation Controls on Current Labels

Current metam sodium labels require applicators and other handlers involved in direct contact activities to wear the following personal protective equipment (PPE):

- coveralls over long-sleeved shirt and long pants;
- chemical-resistant gloves;
- chemical-resistant footwear plus socks;
- chemical-resistant headgear for overhead exposure;
- chemical-resistant apron during equipment cleaning or mixing/loading procedures (unless dry disconnect devices are used);
- face-sealing goggles, unless a full-face respirator is worn;
- a respirator with either an organic vapor removing cartridge with a prefilter approved for pesticides (MSHA//NIOSH approval number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).

PPE requirements for handlers using enclosed cabs for applications include:

- coveralls;
- shoes and socks;

If a pungent, rotten-egg odor can be detected inside the enclosed cab, the handlers must also wear the following:

- face sealing goggles, unless a full-face respirator is worn;
- a respirator with either an organic vapor removing cartridge with a prefilter approved for pesticides (MSHA//NIOSH approval number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).

Also, the PPE specified for use during direct contact activities must be available inside the enclosed cab during application and must be worn if the handler leaves the enclosed cab to perform any direct contact activity.

Metam sodium currently has a 48-hour entry prohibition period during which time only a few specific ***handling*** tasks are allowed to be performed (according to the current labels). They include assessing/adjusting the soil seal; assessing pest control, application technique, or application efficacy; and sampling air or soil. All other tasks are prohibited until the entry restriction is over. Handlers performing any of these tasks must wear the following PPE:

- coveralls over long-sleeved shirt and long pants;
- chemical resistant gloves;
- chemical resistant footwear plus socks;

If a pungent, rotten-egg odor can be detected outdoors, the handlers must also wear the following:

- face sealing goggles, unless a full-face respirator is worn;
- a respirator with either an organic vapor removing cartridge with a prefilter approved for pesticides (MSHA//NIOSH approval number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).

Fumigant warning signs must be posted at entrances to treated areas and workers must also be orally warned about the application.

Currently, EPA labels for metam sodium DO NOT require buffer zones for areas treated with metam sodium.

2.0 Occupational and Residential Exposures and Risks

It has been determined there is a potential for exposure to metam sodium and MITC in occupational scenarios from handling metam sodium products during the application process (i.e., mixer/loaders, applicators, and mixer/loader/applicators) and a potential for postapplication worker exposure to MITC from entering into or being near areas previously treated with metam sodium. As a result, risk assessments have been completed for occupational handler scenarios as well as postapplication occupational scenarios.

2.1 Occupational Handler Exposures and Risks

HED uses the term "handlers" to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct job functions or tasks related to applications and that exposures can vary depending on the specifics of each task. Job requirements (e.g., amount of chemical to be used in an application), the kinds of equipment used, the target being treated, and the level of protection used by a handler can cause exposure levels to differ in a manner specific to each application event.

Exposure scenarios can be thought of as ways of categorizing the kinds of exposures that occur related to the use of a chemical. The use of scenarios as a basis for exposure assessment is very common as described in the *U.S. EPA Guidelines For Exposure Assessment* (U.S. EPA; Federal Register Volume 57, Number 104; May 29, 1992). Information from the current labels; use and usage information; toxicology data; and exposure data were all key components in developing the exposure scenarios.

The first step in the handler risk assessment process is to identify the kinds of individuals that are likely to be exposed to metam sodium and MITC during the metam sodium application process. In order to do this in a consistent manner, HED has developed a series of general descriptions for tasks that are associated with pesticide applications. Tasks associated with occupational pesticide use (i.e., for "handlers") can generally be categorized using one of the following terms:

- **Mixers and/or Loaders:** these individuals perform tasks in preparation for an application. For example, prior to application, loaders would transfer metam sodium from the tank delivery truck into on-site field tanks for use in shank injection, rotary tiller, or chemigation equipment.

- **Applicators:** these individuals operate application equipment during the release of a pesticide product into the environment. These individuals can make applications using equipment such as shank injectors or rotary tillers.

- **Chemigation Monitors:** these individuals monitor chemigation applications and ensure that any clogged nozzles or errant spray patterns are fixed so that the pesticide is applied in the correct pattern.

- **Irrigators:** these individuals perform the application of a water seal after the metam sodium application occurs.

- **Mixer/Loader/Applicators and or Loader/Applicators:** these individuals are involved in the entire pesticide application process (i.e., they do all job functions related to a pesticide application event). These individuals would transfer metam sodium solution into application equipment and then also apply it.

Next, assessors must understand how exposures to metam sodium and MITC occur (i.e., frequency and duration) and how the patterns of these occurrences can cause the effects of the chemical to differ (referred to as dose response). Wherever possible, use and usage data determine the appropriateness of certain types of risk assessments (e.g., a chronic risk assessment is not warranted for a vast majority of metam sodium uses because chronic duration exposure patterns are not expected to occur). Other parameters are also defined from use and usage data such as application rates and application frequency. HED always completes non-cancer risk assessments using maximum application rates for each scenario because what is possible under the label (the legal means of controlling pesticide use) must be evaluated, for complete stewardship, in order to ensure there are no concerns for each specific use.

A chemical can produce different effects based on how long a person is exposed, how frequently exposures occur, and the level of exposure. It is likely that metam sodium and thus, MITC exposures can occur in a variety of patterns. HED believes that occupational metam sodium and MITC exposures can occur for short-term (exposures up to 30 days) to intermediate-term (exposures greater than 30 days up to several months) durations. HED completes both short- and intermediate-term assessments for occupational scenarios in essentially all cases because these kinds of exposures are likely and acceptable use and usage data are not available to justify deleting intermediate-term scenarios. Long-term handler exposures are not expected to occur for metam sodium. Separate toxicological endpoints of concern have been selected for short- and intermediate-term dermal metam sodium exposures. No dermal endpoint of concern was selected for MITC, however, dermal exposure to the vapor may occur. The same toxicological endpoint of concern has been selected for short-, intermediate- and long-term inhalation exposures to metam sodium, therefore the risk results for all inhalation durations of exposure are numerically identical. Likewise, the toxicological inhalation endpoint for MITC is the same for all exposure durations, resulting in the same risk result for all durations.

Occupational handler exposure assessments are completed by HED using different levels of personal protection. HED typically evaluates all exposures with a tiered approach. The lowest tier is represented by the baseline exposure scenario (i.e., long-sleeve shirt, long pants, shoes, and socks) followed by increasing the levels of personal protective equipment or PPE (e.g., gloves, double-layer body protection, and respirators) and engineering controls (e.g., enclosed cabs and closed mixing/loading systems). This approach is always used by HED in order to be able to define label language using a risk-based approach. In addition, the minimal level of adequate protection for a chemical is generally considered by HED to be the most practical option for risk reduction (i.e., over-burdensome risk mitigation measures are not considered a practical alternative).

2.1.1 Data and Assumptions For Handler Exposure Scenarios

2.1.1.1 Assumptions for Handler Exposure Scenarios

A series of assumptions and exposure factors served as the basis for completing the occupational handler risk assessments. Each assumption and factor is detailed below on an individual basis. The assumptions and factors used in the risk calculations include:

- No handler studies were provided to HED that directly measure exposure to metam sodium.

- For metam sodium, occupational handler exposure estimates were based on surrogate data from: (1) the Pesticide Handlers Exposure Database (PHED); (2) Outdoor Residential Exposure Task Force (ORETF); and (3) a sodium tetrathiocarbonate handler study (6/26/02 Draft Metam Sodium Risk Characterization Document).

- The studies in PHED are based on application rates significantly lower than what is used for many of the field applications of metam sodium. A linear extrapolation from the rates in PHED to the anticipated rates for metam sodium may overestimate the exposure to handlers.

C For MITC exposure assessments, exposure values were taken from four chemical-specific handler studies that examined MITC exposures to handlers involved in metam sodium applications.

C For assessing non-cancer risks from metam sodium exposures, the average body weight of an adult female handler (60 kilograms) is used, since the toxicological endpoint of concern is female-specific.

C For assessing cancer risks from metam sodium exposures, the average body weight of an adult handler (70 kilograms) is used, since the cancer endpoint is not sex-specific.

C For assessing non-cancer risks from MITC exposures, assumptions for handler's inhalation rates (i.e. minute volume) were based on the 1997 EPA Exposure Factors Handbook Volume III. Mean minute volumes recommended for short-term exposures during rest, sedentary, light, and moderate activities are 6.7, 8.3, 16.7, and 26.7 liters per minute, respectively.

C Commercial handlers (i.e. for hire applicators, large-scale private growers, cooperatives, etc.) who support metam sodium applications for ornamentals, food, and fiber crops and sewer treatment applications are assumed to be assumed for short- to intermediate-term exposure durations. Greater than 30 exposure days/year (intermediate term exposures) for commercial handler non-cancer exposures is based on high end values. All other handlers are assumed to be exposed for less than 30 days per year (i.e. short-term durations).

C For cancer assessments, it was assumed that commercial handlers (i.e., for hire applicators, large-scale private growers, cooperatives, etc.) who support metam sodium applications for ornamentals, food and fiber crops, and sewer treatment applications may be exposed to metam sodium for 20 days per year (based on average values). All other handlers were assumed to be exposed for 5 days per year (based on average values). All handlers were assumed to have a 35 year career and a 70 year lifespan.

C Generic protection factors (PFs) were used to calculate exposures when data were not available. For example, a 90 percent protection factor was assumed for the use of a respirator equipped with an organic-vapor-removing cartridge.

C Exposure factors used to calculate daily exposures to handlers are based on applicable data if available. For lack of appropriate data, values from a scenario deemed similar enough by the assessor might be used. As a example, for metam sodium handler exposures, PHED data for groundboom equipment were used to assess shank injection and rotary tiller applications. The nature of these application methods are believed to be similar enough to bridge the data.

C For metam sodium, short-term and intermediate-term handler risk assessments were completed based on the non-cancer toxicity endpoints that were identified by the HIARC. HED believes that there are exposure scenarios that fit each of these categories. For MITC only one non-cancer risk calculation was performed, since the inhalation endpoint of concern is the same for short-, intermediate-, and long-term MITC exposures and no dermal endpoint of concern was identified.

C Cancer risk assessments were completed using the Q_1* selected for metam sodium. The same Q_1* (after appropriate molar conversion) was used for MITC cancer assessments.

C For non-cancer assessments, HED assumes the maximum application rates allowed by labels in its risk assessments (see table 1). For cancer assessments, average/typical application rates provided by BEAD were used, if available. The following average application rates were provided by BEAD:

Crop/Use Site Treated	Avg/Typical Rate
Large areas of turfgrass	252 lbs ai/A
Large areas of ornamentals or food crops	108 lbs ai/A
Cotton, soybeans, and sugar beets	44.4 lbs ai/A
Peanuts	27.5 lbs ai/A
Wheat and barley	162 lbs ai/A *

* 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. **SRRD should verify the maximum label rate wheat and barley.**

C Occupational handler exposure is assumed to occur for 8 hours per day.

C For the non-cancer and cancer metam sodium handler exposure assessments, the daily areas treated were defined for each handler scenario (in appropriate units) by determining the amount that can be reasonably treated in a single day (e.g. acres, square feet, cubic feet, or gallons per day). When possible, the assumptions for daily areas treated is taken from the Health Effects Division Science Advisory Committee on Exposure SOP #9: Standard Values for Daily Acres Treated in Agriculture which was completed on July 5, 2000. However, no standard values are available for numerous scenarios. Assumptions for these scenarios are based on HED estimates and could be further refined from input from affected sectors.

Table 2: Handler Assumptions for "Area Treated Per Day"			
Application Method	Crop/Use Site	Area Treated per day	Source
Sprinkler irrigation	Ag Uses	350 acres	ExpoSac SOP #9 .
Drip	Ag Uses	100 acres	Estimate from CDPR 7/17/03.
Tractor - Shank Injection or Rotary Tiller	Ag Uses	80 to 128 acres	In MITC studies 80A treated in 5 hrs. (128 acres = 80 acres /5hrs x 8 hrs)
	Sod Farms	80 to 128 acres	In MITC studies 80A treated in 5 hrs. (128 acres = 80arces /5hrs x 8 hrs)
	Tobacco Beds	20 to 40 acres	MSTF Usage Report in US - average of 18 acres per day for soil injection (Also see note below *)
	Golf Courses	20 to 40 acres	Value for groundboom application to golf courses is 40 acres per day in ExpoSac SOP #9. In telone field volatility study (MRID 451207), 9 holes irregular shaped fairways (20.4 acres) were treated in 11 hours using tractor-drawn shank injection (5.12 gallons per acre) .
	Seed Beds, Plant Beds, Lawns, other small areas	0.5 to 5 acres	No data, HED estimate. Average lawn size in SOP #12 is 0.5 acre
Hose proportioner	Seed Beds, Plant Beds, Lawns	0.5 to 5 acres	No data, HED estimate. Average lawn size in SOP #12 is 0.5 acre. Value for handgun application on lawns and golf courses is 5 acres per day in ExpoSac SOP #9.
	Golf Courses	5 acres	Value for handgun application on lawns and golf courses is 5 acres per day in ExpoSac SOP #9 .
Open pour	Tree Re-planting	1,000 ft2	No data, HED estimate.
Sprinkler Can	Seed Beds, Plant Beds, Lawns, Potting Soil	1,000 ft2	No data, HED estimate.
Cement Mixer and Shredder	Potting Soil	54 ft3	Isofenphos RED.
Foam Spray	Sewers Roots	675 to 1,350 gallons	Dichlobenil ORE Assessments (D270052, D269093)
Power sprayer (Handgun sprayer)	Drained Water Bodies and Shorelines	5 acres	Value for handgun application on lawns and golf courses is 5 acres per day in ExpoSac SOP #9.

* In 1995, the NC Cooperative Extension Service stated that typical tobacco bed sizes of 100

square yards are used for each acre of tobacco (from http://www.epa.gov/spdpublc/mbr/casestudies/volume1/tobacco.html). All major tobacco producing states are abandoning the traditional, labor-intensive outdoor seedbed production in favor of greenhouse systems (Miner 1995, Nesmith 1995). North Carolina, with roughly 284,000 acres in production, is the nation's number one tobacco-producing state; in 1994, 54 percent of the state's seedlings were produced in greenhouses, with the majority of greenhouses using the float production method (Peedin 1994). This production method also prevails in Kentucky, the second largest tobacco-producing state. Approximately 70 percent of Kentucky's tobacco seedlings are produced in a greenhouse floatation system using hydroponics and soil-less mixtures (Nesmith 1995).

2.1.1.2 Exposure Data for Handler Exposure Scenarios

For metam sodium handler exposure assessments, all analyses were completed using data that were deemed to be a source of acceptable surrogate exposure data for the scenario in question.

HED uses a concept known as *unit exposure* as the basis for the scenarios used to assess handler exposures to pesticides. *Unit exposures* numerically represent the exposures one would receive related to an application. They are generally presented as (mg active ingredient exposure/pounds of active ingredient handled). HED has developed a series of unit exposures that are unique for each scenario typically considered in our assessments (i.e., there are different unit exposures for different types of application equipment; job functions; and levels of protection). The *unit exposure* concept has been established in the scientific literature and also through various exposure monitoring guidelines published by the U.S. EPA and international organizations such as Health Canada and OECD (Organization For Economic Cooperation and Development). The concept of unit exposures can be illustrated by the following example. If an individual makes an application using a low-pressure sprayer with either 10 pounds of chemical A or 10 pounds of chemical B using the same clothing and personal protective equipment, the exposures to chemicals A and B would be similar.

Pesticide Handler Exposure Database (PHED) Version 1.1 (August 1998): PHED was designed by a task force of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide regulation, and member companies of the American Crop Protection Association. PHED is a software system consisting of two parts -- a database of measured exposure values for workers involved in the handling of pesticides under actual field conditions and a set of computer algorithms used to subset and statistically summarize the selected data. Currently, the database contains values for over 1,700 monitored individuals (i.e., replicates)

Users select criteria to subset the PHED database to reflect the exposure scenario being evaluated. The subsetting algorithms in PHED are based on the central assumption that the magnitude of handler exposures to pesticides are primarily a function of activity (e.g., mixing/loading, applying), formulation type (e.g., wettable powders, granulars), application method (e.g., aerial, groundboom), and clothing scenarios (e.g., gloves, double layer clothing).

Once the data for a given exposure scenario have been selected, the data are normalized (i.e., divided by) by the amount of pesticide handled resulting in standard unit exposures (milligrams of exposure per pound of active ingredient handled). Following normalization, the data are statistically summarized. The distribution of exposure values for each body part (e.g., chest upper arm) is categorized as normal, lognormal, or "other" (i.e., neither normal nor lognormal). A central tendency value is then selected from the distribution of the exposure values for each body part. These values are the arithmetic mean for normal distributions, the geometric mean for lognormal distributions, and the median for all "other" distributions. Once selected, the central tendency values for each body part are composited into a "best fit" exposure value representing the entire body.

The unit exposure values calculated by PHED generally range from the geometric mean to the median of the selected data set. To add consistency and quality control to the values produced from this system, the PHED Task Force has evaluated all data within the system and has developed a set of grading criteria to characterize the quality of the original study data. The assessment of data quality is based on the number of observations and the available quality control data. These evaluation criteria and the caveats specific to each exposure scenario are summarized in Appendix A, Table A1. While data from PHED provide the best available information on handler exposures, it should be noted that some aspects of the included studies (e.g., duration, acres treated, pounds of active ingredient handled) may not accurately represent labeled uses in all cases. HED has developed a series of tables of standard unit exposure values for many occupational scenarios that can be utilized to ensure consistency in exposure assessments. Unit exposures are used which represent different levels of personal protection as described above. Protection factors were used to calculate unit exposure values for varying levels of personal protection if data were not available.

ORETF Handler Studies (MRID 449722-01): A report was submitted by the ORETF (Outdoor Residential Exposure Task Force) that presented data in which the application of various products used on turf by homeowners and lawncare operators (LCOs) was monitored. All of the data submitted in this report were completed in a series of studies. The study that monitored LCO exposure scenarios using a low pressure, high volume turf handgun (ORETF Study OMA002) is summarized below as is the study that monitored homeowner exposures while using a hose-end sprayer (ORETF Study OMA004).

OMA002: A mixer/loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using Dacthal as a surrogate compound to determine "generic" exposures to individuals applying a pesticide to turf with a low-pressure "nozzle gun" or "handgun" sprayer. Dermal and inhalation exposures were estimated using whole-body passive dosimeters and breathing-zone air samples on OVS tubes. Inhalation exposure was calculated using an assumed respiratory rate of 17 liters per minute for light work (NAFTA,1999), the actual sampling time for each individual, and the pump flow rate. All results were normalized for pounds active ingredient handled. A total of 90 replicates were monitored using 17 different subjects. Four different formulations of dacthal [75% wettable powder (packaged in 4 and 24 pound bags), 75% wettable powder in water soluble bags (3 pound bag), 75% water dispersable granules (2 pound bag) and 55% liquid flowable (2.5 gallon container)] were applied by five different LCOs to actual residential lawns at each site in three different locations (Ohio, Maryland, and Georgia) for a total of fifteen replicates per formulation.

An additional ten replicates at each site were monitored while they performed spray application only using the 75 percent wettable powder formulation. A target application rate of 2 pounds active ingredient was used for all replicates (actual rate achieved was about 2.2 pounds active ingredient per acre). Each replicate treated a varying number of actual client lawns to attain a representative target of 2.5 acres (1 hectare) of turf. The exposure periods averaged five hours twenty-one minutes, five hours thirty-nine minutes, and six hours twenty-four minutes, in Ohio, Maryland and Georgia, respectively. Average time spent spraying at all sites was about two hours. All mixing, loading, application, adjusting, calibrating, and spill clean up procedures were monitored, except for typical end-of-day clean-up activities, e.g. rinsing of spray tank, etc. Dermal exposure was measured using inner and outer whole body dosimeters, hand washes, face/neck washes, and personal air monitoring devices. All test subjects wore one-piece, 100 percent cotton inner dosimeters beneath 100 percent cotton long-sleeved shirt and long pants, rubber boots and nitrile gloves. Gloves are typically worn by most LCOs, and required by many pesticide labels for mixing and loading. Overall, residues were highest on the upper and lower leg portions of the dosimeters In general, concurrent lab spikes produced mean recoveries in the range of 78-120 percent, with the exception of OVS sorbent tube sections which produced mean recoveries as low as 65.8 percent. Adjustment for recoveries from field fortifications were performed on each dosimeter section or sample matrix for each study participant, using the mean recovery for the closest field spike level for each matrix and correcting the value to 100 percent. The unit exposure values are presented below. [Note the data were found to be lognormally distributed. As a result, all exposure values are geometric means.]

Table 3: Unit Exposure Values Obtained From ORETF LCO Handgun Studies (MRID 449722-01)

Type	(mg exp./lb ai handled)			
	Dermal			Inhalation
	Single Layer, No Gloves	Single Layer, Gloves	Double Layer, Gloves	
LCO Turfgun (EC Formulation)	0.69	0.48	0.25	0.0015

All unit exposure values are geometric means. Double layer value calculated using a 50% protection factor. Turfgun, no glove data were not back calculated using a 90 percent protection factor as it is deemed unreliable.

OMA004: A mixer/loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using diazinon (25% EC) as a surrogate compound to determine "generic" exposures to individuals applying a pesticide to turf with a garden hose-end sprayer. Surrogate chemicals were chosen by the Task Force for their representativeness based on physical chemical properties and other factors. The study was designed to simulate a typical application event for a homeowner applying pesticides to home lawns via a hose-end sprayer. Each replicate monitored the test subject treating 5,000 square feet of turf at a nominal application rate of 4 pounds active ingredient per acre and handling a total of 0.5 pounds active ingredient per replicate. The average time per replicate was 75 minutes. A total of 60 replicates were monitored using 30 test subjects (two replicates each). Thirty applicator replicates were monitored using a ready-to-use (RTU) product (Bug-B-Gon) packaged in a

32 fl. oz. screw-on container. These containers were attached to garden hose-ends. An additional 30 mixer/loader/applicator replicates were monitored using Diazinon Plus also packaged in 32 fl. oz. plastic bottles. This product required the test subjects to pour the product into dial-type sprayers (DTS) that were attached to garden hose-ends. Dermal and inhalation exposures were monitored using passive dosimetry (inner and outer whole body dosimeters, hand washes, face/neck wipes, and personal inhalation monitors with OVS tubes). The inner samples represent a single layer of clothing. Inhalation exposure was calculated using an assumed respiratory rate of 17 liters per minute for light work (NAFTA,1999), the actual sampling time for each individual, and the pump flow rate. No gloves were worn in any replicate. All results were normalized for the amount of active ingredient handled. The QA/QC data are within an acceptable range and the study results are corrected for field recoveries. The unit exposure values are presented below. [Note: All values are geometric means as the data were lognormally distributed.]

Table 4: Unit Exposure Values Obtained From ORETF Hose-End Sprayer Studies (MRID 449722-01)

Type	Dermal: Short Pants, Short Sleeved Shirt (mg exp./lb ai handled)	Inhalation (mg exp./lb ai handled)
Hose-end Sprayer	0.35	0.0071
All unit exposure values are geometric means.		

The metam sodium exposure for the occupational loading/applying of metam sodium using an hose-end proportioner was assessed using only the ORTEF data LCO turf gun data. This data were determined to be a better surrogate than the hose-end sprayer data because study participants in the turf gun study were trained LCOs wearing single or double layer clothes with gloves. The hose-end sprayer study was based clothing worn by homeowners (i.e. short-sleeve shirt, short pants, and no gloves).

For **MITC**, all handler exposure analyses were completed using MITC-specific inhalation exposure data taken from four metam sodium handler studies.

MRID No. 429584-01. *Worker Loader and Applicator Exposure from Field Applications of Metam-Sodium. May 26, 1993.*

HED Study Review - DP Barcode D285487

This study assessed worker inhalation exposure during the mixing/loading, and applying of the liquid fumigant Vapam®. Metam-sodium was applied to test sites in in Grant County, Washington from November 7 to 10, 1992. A rotary tiller was used to apply metam sodium to two different sites (10 acres and 65 acres) at an application rate of 319.9 lb active ingredient (ai) per acre and sprinkler injection applications were conducted on a 145 acre field at an application rate of 290 lb ai per acre. Ten loader and ten applicator replicates were conducted during the rotary tiller application method, and five loader and five applicator replicates were conducted during the sprinkler application method.

A tanker truck delivered approximately 3,593 gallons of bulk Vapam® to the sprinkler injection test site and approximately 2,184 gallons of bulk Vapam® to the rotary tiller test site. For each loader replicate, Vapam® was transferred from the tanker to a spray tank by attaching a hose from the tanker to the top of the spray tank. Application replicates were approximately four hours when using sprinkler injection method and one hour when using the rotary tiller injection application method. Between 494 and 668 pounds (lbs) ai were handled by each replicate using the rotary tiller injection method and between 1,906 and 2,449 lbs ai were handled by each worker using the sprinkler injection application method. Concentrations of the two volatile degradation products of metam-sodium methyl isothiocyannate (MITC) and carbon disulfide (CS_2) were measured in this study. Geometric mean inhalation MITC exposures (corrected for field recovery) were 5.85E-05 mg/lb ai handled (rotary tiller injection) and 7.31E-06 mg/lb ai handled (sprinkler injection) for mixers/loaders. Geometric mean inhalation MITC exposures (corrected for field recovery) for applicators were calculated to be 1.01E-03 mg/lb ai handled (rotary tiller injection) and 1.75 E-04 mg/lb ai handled (sprinkler injection). CS_2 residues were not detected at concentrations above the laboratory detection limit. This study met most of the Series 875.1300 Guidelines. The issues of concern were: (1) field fortification recoveries were high for four of the MITC samples collected on the second application day (135% and 165% at the sprinkler injection site and 295% and 465% at the rotary tiller injection site). The high levels could be due to background levels of MITC, as MITC was detected in control samples collected at the rotary tiller injection site; (2) laboratory fortified recoveries were low for two CS_2 samples (41% and 49%). The average recovery was 66.75%; (3) According to the current Vapam label, light watering until the soil is sealed or the use of a tarp for 48 hours is required. No soil seal was implemented in this study.

***MRID No. 429684-02**. Worker Mixer/Loader and Applicator Exposure from Field Applications of Metam-Sodium. July 16, 1992.*

HED Study Review - DP Barcode D285486

This study was designed to quantify mixer/loader and applicator exposure to two volatile degradation products of metam-sodium during field application of BUSAN® 1020 by shank injection and solid-set sprinkler injection. The two degradation products monitored were methyl isothiocyannate (MITC) and carbon disulfide (CS_2). This study was conducted in February 1992. Metam-sodium was applied at two different sites (20 acres and 30 acres) in Yuma County, Arizona using both open (replicates 1 to 6) and closed (replicates 7 to 10) cab shank injector which applied BUSAN® 1020 after the shanks had been fully inserted into the soil at the maximum application rate of 320 lb active ingredient (ai) per acre. For four of these replicates, the cab was equipped with a cellulose air filter, and for two of the replicates the cab was equipped with a charcoal air filter. The ten replicates for the sprinkler injection application were conducted on a 40 acre field in Yuma County, Arizona at an application rate of 320 lb ai per acre. A tanker truck delivered approximately 3,593 gallons of bulk BUSAN® 1020 to the sprinkler injection test site and approximately 2,184 gallons of bulk BUSAN® 1020 to the rotary tiller test site. A total of 1,590 gallons and 3530 gallons of BUSAN® 1020 was applied through shank injection and sprinkler injection, respectively. Between 271 and 637 pounds (lbs) ai were handled by each replicate using the shank injection method and between 635 and 1,272 lbs ai were handled by each worker using the sprinkler injection method. Geometric mean inhalation

MITC exposures (corrected for field recovery) for mixers/loaders were 4.07E-05 mg/lb ai handled (shank injection) and 4.16E-04 mg/lb ai handled (sprinkler injection). Geometric mean inhalation MITC exposures (corrected for field recovery) for applicators were calculated to be 1.70E-03 mg/lb ai handled (shank injection) and 3.26E-03 mg/lb ai handled (sprinkler injection). CS_2 residues were not detected in any of the mixer/loader samples. This study met most of the Series 875.1300 Guidelines. The issues of concern were: (1) there were only ten replicates monitored per activity for each application method; (2) field fortification recoveries were high (>110%) for five of the MITC samples collected during the sprinkler injection site; (3) field blank samples collected for MITC analysis for both trials were contaminated. According to the study author, contamination of the sprinkler control samples probably occurred when the pickup truck containing the metam-sodium was driven and parked near the control table and contamination of the shank control samples may be a result of interference by a pesticide, possibly an organophosphate, which was flown over a nearby field during the sampling; (4) According to the BUSAN® 1020 label, light watering until the soil is sealed or the use of a tarp for 48 hours is required. No soil seal was implemented in this study.

MRID No. 451239-02. *Determination of Methyl Isothiocyanate Inhalation Exposure to Workers as They Apply Metam-Sodium Through Shank Injection and Sprinkler Irrigation. December 14, 1999.*

HED Study Review - DP Barcode D273316

The study was designed to measure methyl isothiocyanate (MITC) inhalation exposure to workers applying or monitoring the application of VAPAM® HL by sprinkler irrigation or shank injection. The test substance was delivered to two different sites in Kern County, California by bulk tank truck and downloaded to farm tanks (5,600 gal capacity) positioned at each site. The test substance was applied at an application rate of 319.5 lbs ai/acre by sprinkler irrigation and 159.7 lbs ai/acre (319.5 lbs ai/treated acre) by shank injection. A total of six workers were monitored at two sites for three two-hour exposure periods. There were two workers per job function. Workers were either monitoring sprinkler application, applying metam-sodium by shank injection, or applying a water cap at the shank injection site by sprinkler irrigation. In addition, samples were taken from a stationary in-cab sampler at the shank injection site. It was not possible to calculate the exact amount of active ingredient each individual worker handled for the purpose of calculating a unit exposure value. Thus, for conservative reasons, the assumption was made that each worker was in contact with the total amount of metam-sodium applied to each site (6,390 lb ai at the sprinkler irrigation site and 12,780 lb ai at the shank injection site). The average MITC inhalation unit exposure values (corrected for field recovery) were 7.55E-05 mg/lb ai handled for applicators (shank injection), 2.11E-05 mg/lb ai handled for irrigators (shank injection), 2.88E-05 mg/lb ai handled for in-cab samples (shank injection), and 3.81 mg/lb ai handled for monitors (sprinkler irrigation). This study met most of the Series 875.1300 Guidelines. The issues of concern are: (1) the amount of ai handled per replicate was not reported; (2) most of the inhalation samples were at non-detectable concentrations and it could not be determined whether the method used was sensitive enough to capture the inhalation exposure or whether the monitoring period was long enough to capture significant amounts of residues; (3) details within the study report were vague concerning the actual procedures followed during the application process, the equipment used as per label requirements, and the clean-up process; (4) there were only three field fortification replicates per fortification level per site and only one field blank per site; (5) high level fortification recoveries (100 µg) were between 117.9 and 136.1 percent; and (6) average field fortification recoveries for the inhalation samples were low for the first and second applications. According to the Vapam®HL label, the test product should be sealed in the soil at the time of application by sprinkler irrigation or tarping. This study applied a ½ inch water cap immediately after each application (sprinkler irrigation and shank injection) and an additional ½ inch water cap was applied 24 hours after the sprinkler irrigation application.

MRID No. 457037-03. *Determination of Methyl Isothiocyanate Inhalation Exposure to Workers During Application of Metam-Sodium Through Shank Injection. March 1, 2001.*

HED Study Review - DP Barcode D290873

This study was designed to quantify loader/applicator, applicator "in-cab", and irrigator exposure to methyl isothiocyanate (MITC), the primary metabolite of metam sodium, during field application of Vapam® HL to soil by shank injection. The study was conducted in Kern county, California on June 13, 2000. VAPAM® HL soil fumigant was delivered to the test site by bulk tank truck and transferred to a 5,600 gallon farm tank. A total of 1,500 gallons of metam sodium was used during the shank injection application (4,520 gallons was delivered). Using a tractor, the test substance was applied once to a field intended for growing carrots at a rate of 75 gallons per treated acre (319.5 lb ai/treated acre). Following application, two workers applied a water cap to the site by sprinkler irrigation. Three loader/applicator replicates, three in-cab replicates, and six irrigator replicates were monitored for approximately 2 ½ to 3 hours. The worker both loaded the test substance into the application equipment (shank injection unit) and drove the tractor with the shank injection unit attached. The equipment used to collect the in-cab samples were left in the cab of the tractor during the exposure period. Two workers were monitored while they irrigated the field shortly after each of the three application replicates. During the irrigation activities, the workers routed water to sprinklers as necessary to water seal the field left behind the application equipment. The geometric mean MITC concentrations (corrected for field recovery) for the loader/applicator, in-cab, and irrigator replicates were 691, 604, and 232 $\mu g/m^3$, respectively. This study met most of the Series 875.1300 Guidelines. The potential issues of concern were: (1) the registrant did not provide the amount of the active ingredient handled per replicate; (2) the study was only conducted at one site; (3)only three to five replicates were conducted per work function; (4) only three samples were fortified at two field fortification levels; and (5) the registrant did not correct the data for field fortification recovery although the overall average recovery was less than 90%. According to the Vapam®HL label, the test product should be sealed in the soil at the time of application by sprinkler irrigation or tarping. Sprinkler irrigation was used as a soil cap at application in this study.

Other Metam Sodium Handler Surrogate Data

California DPR used surrogate data for sodium tetrathiocarbonate to estimate metam sodium handler exposure. Sodium tetrathiocarbonate is a soil fumigant applied by shank injection and chemigation. The sodium tetrathiocarbonate study (Pilling, Richard L., *Worker Exposure to Sodium Tetrathiocarbonate and to Carbon disulfide During Normal Application of GY-81*, 12/7/93) focused solely on dermal exposures pertaining to chemigation.

In this study GY-81 (active ingredient: sodium tetrathiocarbonate), containing cesium as a marker, was applied via irrigation at three separate locations utilizing three chemigation methods. One application was applied to grapes via furrow irrigation, one to grapes via drip irrigation, and one to oranges via mini-sprinklers. Each application was applied at the maximum allowable label application rate. Three volunteers were utilized in the study for each application: a mixer/loader and two applicators. The study used biomonitoring to measure the uptake of sodium tetrathiocarbonate in the body. Urine samples were collected from each volunteer and analyzed for 2-thiothiazolidine-4-carboxylic acid (TTCA)/creatinine ratio to monitor for possible dermal absorption of GY-81. External dosimetry was also utilized to monitor for surface exposure to sodium tetrathiocarbonate as well as hand and glove washings. All of these were analyzed for levels of cesium.

The study concluded that exposure to sodium tetrathiocarbonate during commercial applications of GY-81 was close to the limits of the method utilized in this study. The average dermal exposure value for sodium tetrathiocarbonate across all three trials of the study was found to be 2.27 mg/person/day from an average application rate of 136 lb ai/acre (6/14/02 CADPR Report). In order to utilize this data we had to convert the results to a dermal exposure value for metam sodium. It was assumed dermal exposure is directly proportional to application rate and using this assumption EPA was able to acquire dermal exposure values for the metam sodium scenarios. It was also necessary to convert this dermal exposure value via acres treated. The average acres treated in the study across the three trials was found to be 10.53 acres and this value was utilized to convert the dermal exposure a second time. This final dermal exposure was then utilized in the risk calculations.

HED notes the following issues with the sodium tetrathiocarbonate studies:

- The studies did not measure exposures to tetrathiocarbonate directly. Instead, cesium ions were added to the formulation. Estimation of dermal exposure per day was based on a proportionality between the initial tetrathiocarbonate concentration and the measured level of cesium ions.

- Cesium ions were either not detected or were below the level of quantitation in the occupational tasks examined in the surrogate exposure study. Consequently, values which reflect the limits of detection or quantitation were substituted for actual exposure values.

- The sodium tetrathiocarbonate was applied by chemigation (furrow, drip, and low-volume sprinklers) at a much lower application rate (range between 103 and 207 lb ai/A) than the maximum application rate for metam sodium for most crops (320 lb ai/A)

- The loaders in the sodium tetrathiocarbonate studies transferred the liquid pesticide from a mobile nurse tank into nurse tanks connected to the irrigation system using a mechanical transfer system. Therefore, these data are only applicable to loading metam sodium with engineering controls.

- The applicators in the sodium tetrathiocarbonate studies connected the nurse tanks to the irrigation system using a mechanical transfer system and they did not enter the treated area at any time during the chemigation application. Therefore, these data are only applicable to loading metam sodium with engineering controls.

- Only dermal exposures to sodium tetrathiocarbonate were measured.

2.1.2 Metam Sodium and MITC Handler Exposure Scenarios

It has been determined that exposure to pesticide handlers is likely during the occupational use of metam sodium in a variety of occupational environments. The anticipated use patterns and current labeling indicate several occupational exposure scenarios based on the types of equipment and techniques that can potentially be used to make metam sodium applications. The quantitative exposure/risk assessment developed for occupational handlers is based on the following scenarios. [Note: The scenario numbers correspond to the tables of risk calculations included in the occupational risk calculation aspects of the appendices. Metam sodium dermal and inhalation exposure was estimated using PHED or ORETF data. MITC inhalation exposure was estimating using MITC-specific data taken from four metam sodium handler studies]

Loader:
(1a) Loading Liquids to support Shank Injection Applications (**Metam:** PHED data; **MITC**-specific data: MRID # 42968402)
(1b) Loading Liquids to support Rotary Tiller Applications (**Metam:** PHED data; **MITC**-specific data: MRID # 42958401)
(1c) Loading Liquids to support Sprinkler Irrigation Applications (**Metam:** PHED data; **MITC**-specific data: MRID # 42968402 and 42958401)
(1d) Loading Liquids to support Drip Irrigation Applications (**Metam:** PHED data; **MITC**-specific data: MRID # 42968402 and 42958401)
(1e) Loading Liquids to support Sprinkler Irrigation Applications (**Metam:** Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11; **MITC:** no data)
(1f) Loading Liquids to support Drip Irrigation Applications (**Metam:** Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11; **MITC:** no data)

Applicator:
(2) Applying Liquids with Shank Injection Equipment (**Metam:** PHED data)
(2a) Applying Liquids with Shank Injection Equipment (Personal Pump Samplers) - enclosed cab with charcoal filter (**MITC**-specific data: MRID # 42968402)
(2b) Applying Liquids with Shank Injection Equipment (Personal Pump Samplers) - enclosed cab with cellulose filter (**MITC**-specific data: MRID # 42968402)
(2c) Applying Liquids with Shank Injection Equipment (Personal Pump Samplers) - open cab equipment (**MITC**-specific data: MRID # 42968402)

(2d) Applying Liquids with Shank Injection Equipment (In-cab Samplers) - enclosed cab with charcoal filter (MITC-specific data: MRID # 45123902 and 45703703)

(3) Applying Liquids with Rotary Tiller Equipment (**Metam:** PHED data)
(3a) Applying Liquids with Rotary Tiller Equipment (Personal Pump Samplers) - enclosed cab with charcoal filter (**MITC-**specific data: MRID # 42958401)
(3b) Applying Liquids with Rotary Tiller Equipment (Personal Pump Samplers) - enclosed cab with cellulose filter (**MITC-**specific data: MRID # 42958401)

Loader/Applicator:
(4a) Loading/Applying Liquids with open cab equipment (**Metam:** PHED data)
(4b) Loading/Applying Liquids with enclosed cab equipment (**Metam:** PHED data)
(4c) Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then Applying them via Shank Injection Equipment - enclosed cab with charcoal filter (**MITC-**specific data: MRID # 45123902)

(5a) Loading/Applying Liquids with open cab equipment (**Metam:** PHED data)
(5b) Loading/Applying Liquids with enclosed cab equipment (**Metam:** PHED data)

Chemigation Monitor:
(6) Monitoring Liquid Chemigation Applications (**Metam:** no data; **MITC-**specific data: MRID # 45123902, 42968402, and 42958401)

Soil-Seal Irrigator:
(7) Sealing Soil with Irrigation Water Following Shank Injection Applications Using Liquid Formulations (**Metam:** no data; **MITC-**specific data: MRID # 45123902 and 45703703)

Mixer/Loader/Applicator:
(8) Loading/Applying Liquids with Sprinkling Can Equipment (**Metam:** ORETF data; **MITC:** no data)
(9) Loading/Applying Liquids with Hose Proportioner Equipment (**Metam:** ORETF data; **MITC:** no data)
(10) Loading/Applying Liquids with Power Sprayer Equipment (**Metam:** ORETF data; **MITC:** no data)
(11) Loading/Applying Liquids with Cement Mixer Equipment (**Metam:** PHED data; **MITC:** no data)
(12) Loading/Applying Liquids with Shredder Equipment (**Metam:** PHED data; **MITC:** no data)
(13) Loading/Applying Liquids with Foaming Equipment (**Metam:** PHED data; **MITC:** no data)
(14) Loading/Applying Liquids to Tree Replant Sites (**Metam:** PHED data; **MITC:** no data)

2.1.3 Non-cancer Metam Sodium Handler Exposure and Assessment

The occupational handler exposure and non-cancer risk calculations are presented in this section.

2.1.3.1 Non-cancer Metam Sodium Handler Exposure and Risk Calculations

Non-cancer risks were calculated using the Margin of Exposure (MOE) which is a ratio of the daily dose to the toxicological endpoint of concern. Daily dose values are calculated by first calculating exposures by considering application parameters (i.e., rate and area treated) along with unit exposure values. Exposures were then normalized by body weight and adjusted for absorption factors as appropriate to calculate dose levels. Then MOEs were calculated.

Daily Exposure: The daily exposure and daily dose to handlers were calculated as described below. The first step was to calculate daily exposure (dermal or inhalation) using the following formula:

$$\text{Daily Exposure}\left(\frac{mg\ ai}{day}\right) = \text{Unit Exposure}\left(\frac{mg\ ai}{lb\ ai\ handled}\right) \times \text{Application Rate}\left(\frac{lbs\ ai}{area}\right) \times \text{Daily Area Treated}\left(\frac{area}{day}\right)$$

Where:

Daily Exposure	=	Amount (mg ai/day) deposited on the surface of the skin that is available for dermal absorption or amount inhaled that is available for inhalation absorption;
Unit Exposure	=	Unit exposure value (mg ai/lb ai) derived from August 1998 PHED Surrogate Exposure Table and from ORETF data;
Application Rate	=	Normalized application rate based on a logical unit treatment, such as acres, square feet, gallons, or cubic feet. Maximum values are generally used (lb ai/A, lb ai/sq ft, lb ai/gal, lb ai/cu ft); and
Daily Area Treated	=	Normalized application area based on a logical unit treatment such as acres (A/day), square feet (sq ft/day), gallons per day (gal/day), or cubic feet (cu ft/day).

Daily Dose: Daily dose (inhalation or dermal) was calculated by normalizing the daily dermal exposure value by body weight and accounting for dermal or inhalation absorption. For adult handlers using metam sodium, an average adult female body weight of 60 kilograms was used for all exposure scenarios, because the toxic effect was seen in sex-specific for females. Since the dermal and inhalation endpoints of concern are based on oral studies, a dermal and inhalation absorption rate is used to estimate the amount of metam sodium likely to be absorbed through the skin or through the lungs. A dermal absorption factor of 2.5 percent was used for all duration dermal calculations based on metam sodium dermal absorption studies in rats. Since the toxicological endpoint of concern is based on an inhalation study, no absorption factor is needed for inhalation dose calculations. Daily dose was calculated using the following formula:

$$\text{Average Daily Dose}\ (mg/kg/day) = \text{Daily Exposure}\left(\frac{mg\ ai}{day}\right) \times \left(\frac{\text{Absorption Factor}(\%/100)}{\text{Body Weight}\ (kg)}\right)$$

Where:

Average Daily Dose	=	Absorbed dose received from exposure to a pesticide in a given scenario (mg pesticide active ingredient/kg body weight/day);
Daily Exposure	=	Amount (mg ai/day) deposited on the surface of the skin that is available for dermal absorption or amount inhaled that is

		available for inhalation absorption;
Absorption Factor	=	A measure of the amount of chemical that crosses a biological boundary such as the skin or lungs (% of the total available absorbed); and
Body Weight	=	Body weight determined to represent the population of interest in a risk assessment (kg).

Margins of Exposure: Finally, the calculations of daily dermal dose and daily inhalation dose received by handlers were then compared to the appropriate endpoint (i.e., NOAEL) to assess the total risk to handlers for each exposure route within the scenarios. All MOE values were calculated separately for dermal and inhalation exposure levels using the formula below:

$$MOE = \frac{NOAEL\ (mg/kg/day)}{Average\ Daily\ Dose\ (mg/kg/day)}$$

Where:

MOE	=	Margin of exposure, value used by HED to represent risk or how close a chemical exposure is to being a concern (unitless);
ADD	=	(Average Daily Dose) or the amount as absorbed dose received from exposure to a pesticide in a given scenario (mg pesticide active ingredient/kg body weight/day); and
NOAEL	=	Dose level in a toxicity study, where no observed adverse effects occurred (NOAEL) in the study

It is important to present risk values for each route of exposure (i.e., dermal or inhalation) in each scenario because it makes determining appropriate risk mitigation measures easier. For example, if overall risks are driven by dermal exposures and not inhalation, it is inadvisable to require respirators even though they may marginally reduce overall risks. A total MOE was not calculated because common toxicity endpoints were not used to calculate dermal and inhalation risks for each exposure duration.

2.1.3.2 Metam Sodium Non-cancer Risk Summary (using PHED, ORETF, and sodium tetrathiocarbonate data)

All of the non-cancer risk calculations for occupational metam sodium handlers completed in this assessment are included in Appendix A. A summary of the short- and intermediate-term risks for each exposure scenario are presented below in Tables 5 and 6, 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 1e: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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

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 5: 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	3,100
	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**

Table 5: 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 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	< 0.1	4	5	10	< 0.1	5	7
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	350 acres	< 0.1	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
	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
Loading Liquids to support Sprinkler Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11) (1e)	tobacco plant beds	412 lb ai/acre	40 acres	ND	ND	ND	**390**	ND	ND	ND
	tobacco plant beds	412 lb ai/acre	20 acres	ND	ND	ND	**780**	ND	ND	ND
	tobacco plant beds	387 lb ai/acre	40 acres	ND	ND	ND	**410**	ND	ND	ND
	tobacco plant beds	387 lb ai/acre	20 acres	ND	ND	ND	**830**	ND	ND	ND
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	350 acres	ND	ND	ND	54	ND	ND	ND
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	350 acres	ND	ND	ND	57	ND	ND	ND
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	350 acres	ND	ND	ND	**290**	ND	ND	ND
	wheat, barley	31.7 lb ai/acre	350 acres	ND	ND	ND	**570**	ND	ND	ND
	peanuts (CBR resistant cultivators)	32 lb ai/acre	350 acres	ND	ND	ND	**580**	ND	ND	ND
Loading Liquids to support Drip Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11) (1f)	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	100 acres	ND	ND	ND	**200**	ND	ND	ND
	ornamentals, food and fiber crops, turf (sod farm)	239 lb ai/acre	100 acres	ND	ND	ND	**270**	ND	ND	ND
	cotton, soybeans, sugar beets	38 lb ai/acre	100 acres	ND	ND	ND	**1700**	ND	ND	ND

Table 5: 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 5: 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 5: 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

Table 5: 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 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										
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	**5,400**	680,000	920,000	NF	**86,000**	860,000	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 cu ft	**5,400**	680,000	920,000	NF	**86,000**	860,000	NF

Table 5: 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 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**	3,900	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**	28,000	37,000	NF	**3,500**	35,000	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 1e: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 1f: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 6: 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				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	523 lb ai/acre	5 acres	< 0.1	4	5	11	33	**330**	480
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	0.3	40	54	**110**	**330**	3,300	4,800
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	< 0.1	< 0.1	< 0.1	1	2	20	29
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	< 0.1	< 0.1	1	1	3	32	47
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	< 0.1	< 0.1	< 0.1	1	2	21	31
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	< 0.1	< 0.1	1	1	3	34	49
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	< 0.1	1	2	3	11	**110**	160
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	< 0.1	2	3	6	17	**170**	250
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	< 0.1	2	3	6	18	**180**	260
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	< 0.1	3	5	9	29	**290**	420
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	< 0.1	3	3	7	21	**210**	310
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	< 0.1	4	6	11	34	**340**	490
	wheat, barley	31.7 lb ai/acre	128 acres	< 0.1	3	4	7	22	**220**	310
	wheat, barley	31.7 lb ai/acre	80 acres	< 0.1	4	6	11	35	**350**	500
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	< 0.1	< 0.1	0	1	2	20	29
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	< 0.1	< 0.1	1	1	3	32	47
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	< 0.1	< 0.1	< 0.1	1	2	21	31
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	< 0.1	< 0.1	1	1	3	34	49
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	< 0.1	< 0.1	< 0.1	< 0.1	1	7	11
	ornamentals, food and fiber crops	320 lb ai/acre	350 acres	< 0.1	< 0.1	< 0.1	< 0.1	1	8	11
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	350 acres	< 0.1	< 0.1	1	1	4	39	57
	wheat, barley	31.7 lb ai/acre	350 acres	< 0.1	1	1	3	8	79	**110**
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	350 acres	< 0.1	1	1	3	8	78	**110**
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	< 0.1	< 0.1	< 0.1	1	3	27	40
	ornamentals, food and fiber crops	239 lb ai/acre	100 acres	< 0.1	< 0.1	1	1	4	37	53
	cotton, soybeans, sugar beets	38 lb ai/acre	100 acres	< 0.1	3	4	7	23	**230**	330

Table 6: 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				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
Loading Liquids to support Sprinkler Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11) (1e)	ornamentals, food and fiber crops	338 lb ai/acre	350 acres	ND	ND	ND	1	ND	ND	ND
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	350 acres	ND	ND	ND	1	ND	ND	ND
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	350 acres	ND	ND	ND	7	ND	ND	ND
	wheat, barley	31.7 lb ai/acre	350 acres	ND	ND	ND	14	ND	ND	ND
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	350 acres	ND	ND	ND	14	ND	ND	ND
Loading Liquids to support Drip Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11) (1f)	ornamentals, food and fiber crops	320 lb ai/acre	100 acres	ND	ND	ND	5	ND	ND	ND
	ornamentals, food and fiber crops	239 lb ai/acre	100 acres	ND	ND	ND	6	ND	ND	ND
	cotton, soybeans, sugar beets	38 lb ai/acre	100 acres	ND	ND	ND	40	ND	ND	ND
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	54	**540**	930
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	66	66	83	**180**	**540**	5,400	9,300
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	0.4	< 0.1	1	1	3	33	56
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	0.6	1	1	2	5	52	90
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	0.4	< 0.1	1	1	4	35	60
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	0.7	1	1	2	6	55	95
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	2	2	3	6	18	**180**	300
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	3	3	4	10	28	**280**	480
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	4	4	5	10	29	**290**	500
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	6	6	7	16	47	**470**	800
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	4	4	5	12	35	**350**	600
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	7	7	9	19	55	**550**	950
	wheat, barley	31.7 lb ai/acre	128 acres	4	4	5	12	35	**350**	600
	wheat, barley	31.7 lb ai/acre	80 acres	7	7	9	19	56	**560**	960
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	< 0.1	1	1	3	33	56
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	0.6	1	1	2	5	52	90
	ornamentals, food and fiber crops	320 lb ai/acre	128 acres	0.4	< 0.1	1	1	4	35	60
	ornamentals, food and fiber crops	320 lb ai/acre	80 acres	0.7	1	1	2	6	55	95

Table 6: 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				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	523 lb ai/acre	5 acres	0.1	2	3	NA	31	**310**	NA
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	1	16	25	NA	**310**	3,100	NA
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	< 0.1	< 0.1	< 0.1	NA	2	19	NA
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	< 0.1	< 0.1	< 0.1	NA	3	30	NA
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	< 0.1	< 0.1	< 0.1	NA	2	20	NA
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	< 0.1	< 0.1	< 0.1	NA	3	32	NA
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	< 0.1	1	1	NA	10	**100**	NA
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	0.1	1	1	NA	16	**160**	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	0.1	1	1	NA	17	**170**	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	0.1	1	2	NA	27	**270**	NA
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	0.1	1	2	NA	20	**200**	NA
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	0.1	2	3	NA	32	**320**	NA
	wheat, barley	31.7 lb ai/acre	128 acres	0.1	1	2	NA	20	**200**	NA
	wheat, barley	31.7 lb ai/acre	80 acres	0.1	2	3	NA	32	**320**	NA

Table 6: 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				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	523 lb ai/acre	5 acres	NA	NA	NA	1	NA	NA	**110**
	small areas of ornamentals, food, fiber crops	523 lb ai/acre	0.5 acres	NA	NA	NA	10	NA	NA	**1,100**
	ornamentals, food and fiber crops	338 lb ai/acre	128 acres	NA	NA	NA	< 0.1	NA	NA	7
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	NA	NA	NA	< 0.1	NA	NA	11
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	128 acres	NA	NA	NA	< 0.1	NA	NA	7
	ornamentals, food and fiber crops, orchard (replant/transplant)	320 lb ai/acre	80 acres	NA	NA	NA	< 0.1	NA	NA	12
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	128 acres	NA	NA	NA	< 0.1	NA	NA	37
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	80 acres	NA	NA	NA	1	NA	NA	59
	cotton, soybeans, sugar beets	38 lb ai/acre	128 acres	NA	NA	NA	1	NA	NA	62
	cotton, soybeans, sugar beets	38 lb ai/acre	80 acres	NA	NA	NA	1	NA	NA	99
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	128 acres	NA	NA	NA	1	NA	NA	73
	peanuts (CBR susceptible cultivators)	32 lb ai/acre	80 acres	NA	NA	NA	1	NA	NA	120
	wheat, barley	31.7 lb ai/acre	128 acres	NA	NA	NA	1	NA	NA	74
	wheat, barley	31.7 lb ai/acre	80 acres	NA	NA	NA	1	NA	NA	**120**
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	< 0.1	< 0.1	< 0.1	NA	2	19	NA
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	< 0.1	< 0.1	< 0.1	NA	3	30	NA
	ornamentals, food and fiber crops	320 lb ai/acre	128 acres	< 0.1	< 0.1	< 0.1	NA	2	20	NA
	ornamentals, food and fiber crops	320 lb ai/acre	80 acres	< 0.1	< 0.1	< 0.1	NA	3	32	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	< 0.1	NA	NA	7
	ornamentals, food and fiber crops	338 lb ai/acre	80 acres	NA	NA	NA	< 0.1	NA	NA	11
	ornamentals, food and fiber crops	320 lb ai/acre	128 acres	NA	NA	NA	< 0.1	NA	NA	7
	ornamentals, food and fiber crops	320 lb ai/acre	80 acres	NA	NA	NA	< 0.1	NA	NA	12
Chemigation Monitor										
Monitoring Chemigation Applications Using Liquid Formulation (6)	No Metam Sodium specific data is available for this scenario.									
Irrigator										
Irrigating Following Shank Injection Applications (7)	No Metam Sodium specific data is available for this scenario.									

Table 6: 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				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
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	**550**	No Data	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	< 0.1	1	NF	40	**400**	NF
	small areas of ornamentals, food, fiber crops	350 lb ai/acre	0.5 acres	2	3	6	NF	**400**	4,000	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	**310**	3,100	NF
	sewer roots	0.212 lb ai/gal	675 gallons	0.6	73	99	NF	**610**	6,100	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	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
Inhalation Baseline: No respirator
OV Respirator: NIOSH/MSHA-approved cartridge or cannister respirator with an organic-vapor removing filter and dust/mist prefilter.

2.1.4 Non-cancer MITC Handler Exposure and Risk Assessment

The occupational handler exposure and non-cancer risk calculations for MITC are presented in this section.

2.1.4.1 Non-cancer MITC Handler Exposure and Risk Calculations

The inhalation MOEs for MITC were calculated using the following "Route-Specific Inhalation MOE" equation:

Where:

$$MOE = \frac{NOAEL\ (\mu g/m^3)\ x\ D_A}{Inhalation\ Exposure\ Concentration\ (\mu g/m^3)\ x\ D_H\ x\ \left(\frac{Human\ MV_{ACTUAL}}{Human\ MV_{REST}}\right)}$$

Where:

NOAEL	=	Inhalation endpoint of concern for MITC in ($\mu g/m^3$)
D_A	=	Duration of daily animal exposure in study (hrs/day)
Inhal Exp Con	=	Inhalation exposure concentration from the MITC handler studies ($\mu g/m^3$)
D_H	=	Duration of daily human exposure (hrs/day)
MV_{ACTUAL}	=	Minute Volume for exposure scenario (L/min)
MV_{REST}	=	Minute Volume at rest (L/min)

(Equation is based on 6/10/98 HED memo from J. Whalan/HED to M. Stasikowski/HED, Inhalation Risk Characterizations with Aggregate Risk Index)

This equation accounts for the differences in the duration of daily exposure for animals (D_A) and humans (D_H), and the increased respiration and exposure that results from the increased activity. The sources used for this assessment expressed the NOAEL and human exposure air concentrations in ppm, µg/L, and $\mu g/m^3$ (i.e. HIARC endpoints and exposure data). When MOEs were calculated these values were all converted to $\mu g/m^3$.

2.1.4.2 Non-cancer MITC Risk Summary

All of the non-cancer risk data for occupational MITC exposure utilized in this assessment are included in Appendix C.

Short- and Intermediate-term Inhalation Risks

For the agricultural crop scenarios using MITC-specific data, MOEs are less than 100 for the following scenarios:

Scenario 2a: Applying Liquids via Shank Injection Equipment - Personal Sampler Pumps (enclosed cab with charcoal filter) MRID# 42968402

- ornamentals, food, and fiber crops, turf (sod farms/golf courses) at 338 lb ai/acre and 320 lb ai/acre

Scenario 2b: Applying Liquids via Shank Injection Equipment - Personal Sampler Pumps (enclosed cab with cellulose filter) MRID# 42968402

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

Scenario 2d: Applying Liquids via Shank Injection Equipment - In-cab Sampler Pumps (enclosed cab with charcoal filter) MRID# 45123902 and 45703703

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 523 lb ai/acre
- tobacco plant beds at 412 lb ai/acre and 387 lb ai/acre
- ornamentals, food, and fiber crops, turf (sod farms/golf courses) at 338 lb ai/acre and 320 lb ai/acre
- orchards (replant/transplant) at 320 lb ai/acre
- peanuts-CBR susceptible cultivators at 63.3 lb ai/acre

Scenario 3a: Applying Liquids via Rotary Tiller Equipment - Personal Sampler Pumps (enclosed cab with charcoal filter) MRID# 42968402

- ornamentals, food, and fiber crops, turf (sod farms/golf courses) at 338 lb ai/acre and 320 lb ai/acre

Scenario 3b: Applying Liquids via Rotary Tiller Equipment - Personal Sampler Pumps (enclosed cab with cellulose filter) MRID# 42968402

- ornamentals, food, and fiber crops, turf (sod farms/golf courses) at 338 lb ai/acre and 320 lb ai/acre

Scenario 4c: Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then Applying them via Rotary Tiller Equipment (enclosed cab with charcoal filter) MRID# 45123902

- small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns at 523 lb ai/acre

- tobacco plant beds at 412 lb ai/acre and 387 lb ai/acre
- ornamentals, food, and fiber crops, turf (sod farms/golf courses) at 338 lb ai/acre and 320 lb ai/acre
- orchards (replant/transplant) at 320 lb ai/acre
- peanuts-CBR susceptible cultivators at 63.3 lb ai/acre
- cotton, soybeans, sugar beets at 38 lb ai/acre

For the mixer/loader/applicator scenarios in commercial and small scale agricultural settings, HED currently has no data on exposure to MITC when using handheld equipment. Therefore, the risks to handlers were not assessed at this time.

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
Loader						
Transferring Water Soluble Liquids from Tank Delivery Truck to Shank Injection Equipment (closed system): MRID# 42968402 (1a)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	16.7	**140**	1400
	tobacco plant beds	412 lb ai/acre	3	16.7	59	**590**
	tobacco plant beds	387 lb ai/acre	3	16.7	63	**630**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	16.7	27	**270**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	16.7	28	**280**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	16.7	**140**	1400
	cotton, soybeans, sugar beets	38 lb ai/acre	8	16.7	**240**	2400
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	16.7	**280**	2800
	wheat, barley	31.7 lb ai/acre	8	16.7	**290**	2900
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (closed system): MRID# 42958401 (1b)	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	16.7	16	**160**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	320 lb ai/acre	8	16.7	17	**170**
Transferring Water Soluble Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Sprinkler irrigation Nurse Tank (closed system): MRID# 42968402 and 42958401 (1c)	tobacco plant beds	412 lb ai/acre	3	16.7	46	**460**
	tobacco plant beds	387 lb ai/acre	3	16.7	49	**490**
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	8	16.7	21	**210**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	8	16.7	22	**220**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	16.7	**110**	1100
	wheat, barley	31.7 lb ai/acre	8	16.7	**220**	2200
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	16.7	**220**	2200

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baselin e	OV Respirator 90% PF
Transferring Water Soluble Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to Drip Irrigation Nurse Tank: surrogate data from MRID# 42968402 and 42958401 (1d)	ornamentals, food and fiber crops, turf (sod farm)	320 lb ai/acre	8	16.7	22	**220**
	ornamentals, food and fiber crops, turf (sod farm)	239 lb ai/acre	8	16.7	30	**300**
	cotton, soybeans, sugar beets	38 lb ai/acre	8	16.7	**190**	1900

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
Applicator: Personal Pump Samplers						
Applying Water Soluble Liquids via Shank Injection Equipment-Personal Sampler Pumps (enclosed cab with charcoal filter): MRID# 42968402 (2a)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	8.3	**270**	NA
	tobacco plant beds	412 lb ai/acre	3	8.3	**110**	NA
	tobacco plant beds	387 lb ai/acre	3	8.3	**120**	NA
	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	52	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	55	**NA**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	**280**	NA
	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	**460**	NA
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**550**	NA
	wheat, barley	31.7 lb ai/acre	8	8.3	**550**	NA
Applying Water Soluble Liquids via Shank Injection Equipment-Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	8.3	40	**NA**
	tobacco plant beds	412 lb ai/acre	3	8.3	17	**NA**
	tobacco plant beds	387 lb ai/acre	3	8.3	18	**NA**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	7.7	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	8.1	**NA**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	41	**NA**
	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	68	**NA**
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	81	**NA**
	wheat, barley	31.7 lb ai/acre	8	8.3	82	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment-Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	8.3	82	**820**
	tobacco plant beds	412 lb ai/acre	3	8.3	35	**350**
	tobacco plant beds	387 lb ai/acre	3	8.3	37	**370**
	ornamentals, food and fiber crops, turf (sod farm/golf	338 lb ai/acre	8	8.3	16	**160**

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
	course)					
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	17	**170**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	85	**850**
	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	**140**	1400
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**170**	1700
	wheat, barley	31.7 lb ai/acre	8	8.3	**170**	1700
Applying Water Soluble Liquids via Shank Injection Equipment-In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	8.3	65	NA
	tobacco plant beds	412 lb ai/acre	3	8.3	28	**NA**
	tobacco plant beds	387 lb ai/acre	3	8.3	29	**NA**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	13	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	13	**NA**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	67	**NA**
	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	**110**	NA
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**130**	NA
	wheat, barley	31.7 lb ai/acre	8	8.3	**130**	NA
Applying Water Soluble Liquids via Rotary Tiller Equipment-Personal Sampler Pumps(enclosed cab with charcoal filter): MRID# 42958401 (3a)	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	20	**NA**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	320 lb ai/acre	8	8.3	21	**NA**
Applying Water Soluble Liquids via Rotary Tiller Equipment (enclosed cab with cellulose filter): 42958401 (3b)	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	19	**NA**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	320 lb ai/acre	8	8.3	20	**NA**
Loader/Applicator						

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
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): MRID# 45123902 (4c)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	8.3	52	**NA**
	tobacco plant beds	412 lb ai/acre	3	8.3	22	**NA**
	tobacco plant beds	387 lb ai/acre	3	8.3	24	**NA**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	10	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	11	**NA**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	54	**NA**
	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	90	**NA**
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**110**	NA
	wheat, barley	31.7 lb ai/acre	8	8.3	**110**	NA

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
Chemigation Monitor						
Monitoring Water Soluble Liquid Chemigation applications: MRID# 45123902, 42968402, and 42958401 (6)	tobacco plant beds	412 lb ai/acre	3	8.3	83	**830**
	tobacco plant beds	387 lb ai/acre	3	8.3	89	**890**
	ornamentals, food and fiber crops, turf (sod farm)	338 lb ai/acre	8	8.3	38	**380**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320 lb ai/acre	8	8.3	40	**400**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	**200**	2000
	wheat, barley	31.7 lb ai/acre	8	8.3	**410**	4100
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**400**	4000
Irrigator						
Irrigating Following Shank Injection Application: MRID# 45123902 and 45703703 (7)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523 lb ai/acre	1	8.3	**170**	1700
	tobacco plant beds	412 lb ai/acre	3	8.3	73	**730**
	tobacco plant beds	387 lb ai/acre	3	8.3	78	**780**
	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	34	**340**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	35	**350**
	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	**180**	1800
	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	**300**	3000
	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**350**	3500
	wheat, barley	31.7 lb ai/acre	8	8.3	**360**	3600
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	No MITC specific exposure data is available for this scenario			
	potting soil	4 lb ai/1000 sq ft	No MITC specific exposure data is available for this scenario			

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF LCO handgun data - occupational) (9)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	No MITC specific exposure data is available for this scenario			
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre				
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	No MITC specific exposure data is available 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	No MITC specific exposure data is available for this scenario			

Table 7: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary						
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs	
					Baseline	OV Respirator 90% PF
Mixing/Loading/Applying Liquids via shredder (using PHED Mixer/Loader data for Open-pour Liquids) (12)	potting soil	0.012 lb ai/cu ft	No MITC specific exposure data is available 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	No MITC specific exposure data is available for this scenario			
	sewer roots	0.212 lb ai/gal				
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	No MITC specific exposure data is available for this scenario			

* MOEs that do not exceed HED's level of concern are shown in bold.

NA Not Applicable

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 Time exposed per day (hrs/day) varies with scenario as follows:

- All agricultural crops are expected to be treated for 8 hours per day based on 80 to 128 acres (shank injection), 350 acres (sprinkler irrigation), 100 acres (drip irrigation) being treated per day. This also includes golf course turf based on a telone field volatility study (MRID 451207), 9 holes irregular shaped fairways (20.4 acres) were treated in 11 hours using tractor-drawn shank injection.
- Tobacco plant beds are expected to be treated for no more than 3 hours per day based on 20 to 40 acres being treated per day.
- Small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns are expected to be treated for 1 hour per day based on 0.5 to 5 acres treated per day.

2.1.5 Cancer Metam Sodium Handler Exposure and Risk Assessment

This section presents the occupational handler exposure and cancer risk assessment from metam sodium.

2.1.5.1 Cancer Metam Sodium Handler Exposure and Risk Calculations

Cancer risks resulting from exposures to metam sodium were calculated using a linear low-dose extrapolation approach in which a *Lifetime Average Daily Dose* (LADD) is first calculated and then compared with a Q_1* that has been calculated for metam sodium based on dose response data ($Q_1* = 1.98 \times 10^{-1}$ $(mg/kg/day)^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADD values. Section 2.1.3.1 describes how the ADD values were first calculated for the non-cancer MOEs. These values also serve as the basis for the cancer risk estimates. Dermal and inhalation ADD values were first added together to obtain combined ADD values. LADD values were then calculated and compared to the Q_1* to obtain cancer risk estimates.

Lifetime Average Daily Dose: To calculate the carcinogenic risk from absorbed average daily dose, the values must be amortized over the working lifetime of occupational handlers. Current use patterns indicate that application occurs once per crop cycle (preplant/pre-transplant). HED considered two distinct handler populations in the cancer risk assessment:

- medium- to small-scale growers who would handle metam sodium approximately 5 days per year, and
- commercial (for-hire) applicators and large-scale private growers (e.g., cooperatives) who would handle metam sodium approximately 20 days per year.

Finally, a 35 year career and a 70 year lifespan were used to complete the calculations. LADD values were calculated using the following equation:

$$LADD = ADD \times \frac{Exposure\ Frequency}{365\ Days\ per\ Year} \times \frac{Exposure\ Duration}{Lifetime}$$

Where:

Lifetime Average Daily Dose	=	The amount as absorbed dose received from exposure to a pesticide or degradate in a given scenario over a lifetime (mg/kg/day, also referred to as LADD);
Average Daily Dose	=	The amount as absorbed dose received from exposure to a pesticide or degradate in a given scenario on a daily basis (mg/kg/day, also referred to as ADD);
Exposure Frequency	=	The annual frequency of exposure to an individual (days/year);

Exposure Duration	=	The amount of a lifetime that an individual is exposed (35 years for Occupational); and
Lifetime	=	The average life expectancy of an individual (70 years).

Cancer Risks : Finally, cancer risk calculations were completed by comparing the LADD values to the Q_1* for metam sodium (Q_1* = 1.98 x 10^{-1} (mg/kg/day)$^{-1}$). Small- and medium-scale growers were estimated to handle metam sodium for 5 days per year and commercial handlers or large-scale growers were estimated to handler metam sodium for 20 days per year. Cancer risks were calculated using the following equation:

$$Cancer\ Risk = LADD \times Q1*$$

Where:

Cancer Risk	=	Probability of excess cancer cases over a lifetime (unitless);
Lifetime Average Daily Dose	=	The amount as absorbed dose received from exposure to a pesticide or degradate in a given scenario over a lifetime (mg//kg/day); and
Q_1*	=	Quantitative dose response factor used for linear, low-dose response cancer risk calculations (mg/kg/day)$^{-1}$.

HED has defined a range of acceptable cancer risks based on a policy memorandum issued in 1996 by then Office of Pesticide Programs director, Mr. Dan Barolo. This memo refers to a predetermined quantified "level of concern" for occupational carcinogenic risk. In summary, this policy memo indicates occupational carcinogenic risks that are 1 x 10^{-6} or lower require no risk management action. For those chemicals subject to reregistration, HED is to carefully examine uses with estimated risks in the 10^{-6} to 10^{-4} range to seek ways of cost-effectively reducing risks. If carcinogenic risks are in this range for occupational handlers, increased levels of personal protection would be warranted as is commonly applied with non-cancer risk estimates (e.g., additional PPE or engineering controls). Carcinogenic risks that remain above 1.0 x 10^{-4} at the highest level of mitigation appropriate for that scenario remain a concern.

2.1.5.2 Metam Sodium Cancer Risk Summary

Metam sodium cancer risks for **noncommercial** handlers and **commercial** handlers are summarized below in Tables 8 and 9, respectively. All the cancer risk calculations for occupational handlers exposed to metam sodium completed in this assessment are included in the appendices. 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 **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)

- 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 1f: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 x 10^{-4}** and **1.0 x 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 1e: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- tobacco plant beds at 20 acres treated per day (387 lb ai/acre)
- 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)
- 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 1f: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 $\mathbf{1.0 \times 10^{-6}}$ 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 8: 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-OVRespirator 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 (mechanicaltransfersystem)(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
Loading Liquids to support Sprinkler Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11) (1e)	tobacco plant beds	387 lb ai/acre	20 acres	ND	ND	ND	ND	ND	5.9E-06
	orchard replant/transplant sites	320 lb ai/acre	350 acres	ND	ND	ND	ND	ND	8.6E-05
	turf (sod farms)	252 lb ai/acre	350 acres	ND	ND	ND	ND	ND	6.8E-05
	wheat, barley [d]	162 lb ai/acre	350 acres	ND	ND	ND	ND	ND	1.0E-04
	ornamentals and food crops	108 lb ai/acre	350 acres	ND	ND	ND	ND	ND	2.9E-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	350 acres	ND	ND	ND	ND	ND	1.7E-05
	peanuts	27.5 lb ai/acre	350 acres	ND	ND	ND	ND	ND	1.4E-05

Table 8: 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-OVRespirator 90% PF	Eng Control
Loading Liquids to support Drip Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11) (1f)	turf (sod farms)	252 lb ai/acre	100 acres	ND	ND	ND	ND	ND	1.9E-04
	ornamentals and food crops	108 lb ai/acre	100 acres	ND	ND	ND	ND	ND	2.7E-05
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	ND	ND	ND	ND	ND	1.2E-05

Table 8: 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-OVRespirator 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	1.36E-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

Table 8: 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-OVRespirator 90% PF	Eng Control
	peanuts	27.5 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.4E-04
Transferring Water Soluble Liquids from Tank Delivery Truckto Rotary Tiller Equipment (mechanical transfersystem) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with opencab) (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
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, fibercrops, 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, fibercrops, 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, fibercrops, 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

Table 8: 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-OVRespirator 90% PF	Eng Control
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

S **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 1e: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- ornamentals, food, and fiber crops at 350 acres treated per day (108 lb ai/acre)

Scenario 1f: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 **1.0×10^{-4}** and **1.0×10^{-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 1e: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Sprinkler irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 1f: Transferring Liquids from Tank Delivery Truck to Pick-up Truck and Subsequent Transfer to Drip Irrigation Nurse Tank (mechanical transfer system) - (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)

- 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 $\mathbf{1.0 \times 10^{-6}}$ at maximum feasible mitigation.

Table 9: 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 Truckto 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 Truckto 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 Truckand 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 Truckand 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
Loading Liquids to Support Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data, Study # 770AA11) (1e)	wheat, barley [d]	162 lb ai/acre	350 acres	ND	ND	ND	ND	ND	4.0E-04
	ornamentals and food crops	108 lb ai/acre	350 acres	ND	ND	ND	ND	ND	1.2E-04
	cotton, soybeans, sugar beets n)	44.4 lb ai/acre	350 acres	ND	ND	ND	ND	ND	6.9E-05
	peanuts	27.5 lb ai/acre	350 acres	ND	ND	ND	ND	ND	5.6E-05

Table 9: 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
Loading Liquids to Support Drip Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data, Study # 770AA11) (1f)	ornamentals and food crops	108 lb ai/acre	100 acres	ND	ND	ND	ND	ND	1.1E-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	ND	ND	ND	ND	ND	5.0E-05
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
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

Table 9: 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
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 9: 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.								

Table 9: 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 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

S **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 The average rates reported for wheat and barley (162 lb ai/A) is significantly higher than the maximum label rate (31.7 lb ai/A). HED estimated non-cancer and cancer rates with the maximum label rate since legally that is the maximum that can be applied.
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.

2.1.6 Summary of Risk Concerns and Data Gaps for Handlers

There are many occupational handler scenarios for metam sodium and MITC that have risks associated with them that are above HED's level of concern for non-cancer and cancer risk assessments. In addition, many occupational handler scenarios for metam sodium and MITC have data gaps.

2.1.6.1 Summary of Risk Concerns

The handler risk assessment for metam sodium and MITC indicates risk concerns for many handler scenarios, particularly when the application rate exceeds approximately 65 pounds active ingredient per acre.

For the majority of **agricultural scenarios**, including applications to ornamentals, food, and feed crops (at 320 and 338 lb ai/A) to tobacco plant beds (387 and 408 lb ai/A) and turf (at 320 and 338 lb ai/A), risks are of concern even at maximum risk mitigation for most cancer and non-cancer assessments for exposures to metam sodium and for most cancer and non-cancer assessments for exposures to MITC. Cancer risks exceed HED's level of concern for **all loader/applicator scenarios** even with maximum risk mitigation for metam sodium and MITC exposures to both noncommercial and commercial handlers. This loader/applicator risk concern is particularly significant, since industry sources indicate that approximately 90% of handlers who apply metam sodium with a tractor also did the mixing and loading.

For the applications in **commercial** (i.e., sewer system) **and small scale agricultural settings** (i.e., sprinkling can, hose proportioner, potting soil, and tree replant scenarios), the non-cancer and cancer risks to metam sodium are below HED's level of concern at some level of protection for most scenarios. There are no data available to assess non-cancer and cancer risks to MITC for these application techniques.

2.1.6.2 Summary of Data Gaps

Metam Sodium

No metam-sodium-specific data were available for handler exposure. Surrogate exposure data were used for all metam sodium assessments.

For metam sodium non-cancer and cancer exposure and risk assessments for the large agricultural scenarios, data from the Pesticide Handler Exposure Database (PHED) were used, as a surrogate, for all loading, applying, and loading/applying scenarios. These data may overestimate inhalation risks to handlers from metam sodium exposures, since the MITC handler data indicates that some metam sodium has degraded to MITC and therefore would no longer be available for inhalation as metam sodium. However, HED has no data to indicate what, if any, reduction in metam sodium inhalation risks would result.

The studies in PHED are based on application rates significantly lower than what is used for many of the field applications of metam sodium. A linear extrapolation from the rates in PHED to the anticipated rates for metam sodium may overestimate the exposure to handlers.

In metam sodium non-cancer and cancer exposure and risk assessments for the commercial (sewer) and small-scale agricultural (hose-proportioner, sprinkling can, potting soil, and tree replant) scenarios, surrogate data from PHED and the Outdoor Exposure Residential Task Force (ORETF) were used. For the potting soil and tree replant scenarios, PHED data for open pour mixing/loading of liquid formulations was used in the assessments. These data are based on large-scale mixing/loading operations in a large-scale agricultural setting and may not be a close surrogate for the exposures in the smaller scale settings with vastly different equipment. These should all be considered data gaps.

<u>MITC</u>

MITC-specific handler exposure data were available for some handler scenarios. The MITC-specific data were used in all applicable scenarios.

For MITC non-cancer and cancer exposure and risk assessments for the large agricultural scenarios, MITC-specific data were available for the following scenarios:

S loading to support shank injection applications,
S loading to support rotary tiller applications,
S loading/applying for sprinkler irrigation,
S loading/applying for drip irrigation,
S applying with shank injection equipment,
S applying with rotary tiller equipment,
S loading and then applying with power sprayer equipment,
S loading and then applying with shank injection equipment,
S loading and then applying with rotary tiller equipment, and
S monitoring sprinkler irrigation applications.

While there were some concerns about the MITC-specific data, including a small number of replicates for certain scenarios, these data were considered suitable for use in the MITC handler non-cancer and cancer risk assessments for the large agricultural scenarios.

In MITC non-cancer and cancer exposure and risk assessments for the commercial (sewer) and small-scale agricultural (hose-proportioner, sprinkling can, potting soil, and tree replant) scenarios, no MITC-specific or surrogate data were available. Data from PHED and the Outdoor Exposure Residential Task Force (ORETF) were not considered reasonable surrogates, since the data for these two sources is based on active ingredients with low volatility. Therefore, these data were not used for the MITC assessment. As a result, HED was unable to estimate exposure and risk to MITC in these scenarios and these all should be considered data gaps. HED is concerned about exposures to MITC in these settings, since the equipment is handheld or in close proximity to the handlers' breathing zone.

Additional metam sodium and MITC handler data gaps exist for the following scenarios:

- applying via flood irrigation;
- applying via furrow irrigation;
- compacting by a ring roller or other device;
- laying tarps as soil seals immediately following an application;
- removing tarps from treated fields several days following an application;
- applying a water seal immediately following an application; and
- aerating or loosening the soil several days following an application.
- greenhouse applications

HED has no chemical-specific or reasonable surrogate data to estimate exposure and risk to metam sodium and MITC during these handler activities and these all should be considered data gaps. HED is concerned about exposures to metam sodium and MITC for tasks requiring entry into treated fields immediately following an application, since such entry is likely to result in dermal exposures to metam sodium and significant inhalation exposures to MITC. HED is also concerned about handler exposures during tasks requiring the removal or disruption of the soil seal – even several days following application, since significant inhalation exposures to MITC may occur when the seal is broken and the trapped MITC is allowed to escape.

2.1.7 Recommendations For Refining Occupational Handler Risk Assessment

In order to refine this occupational 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 PHED (e.g., because of low replicate numbers or data quality) should also be considered based on the data gaps identified above and based on a review of the quality of the data used in this assessment.

2.2 Occupational and Residential Postapplication Exposures and Risks

Metam sodium is applied in:

- large-scale agricultural settings with shank injection, rotary tiller, or chemigation equipment,
- small- or medium-scale agricultural settings with sprinkling can, hose proportioner, cement mixer, shredder, or open pour equipment, and
- commercial settings with foam applications equipment.

Once mixed with water or added to soil, metam sodium rapidly breaks down into several degradates – with the key degradate being MITC.

2.2.1 Data/Assumptions for Postapplication Exposure Scenarios

2.2.1.1 Assumptions for Postapplication Exposure Scenarios

A series of assumptions and exposure factors served as the basis for completing the postapplication MITC risk assessments. The assumptions and factors used in the risk calculations include:

C **Application Rates:** An application rate of 320 lb ai/acre was assumed for all postapplication exposure estimates (non-cancer risk and cancer risk assessments). HED adjusted the MITC-specific study data for differences in application rate using a simple proportional approach. This approach seems to be the most appropriate given the data that are available and is commonly used in Agency postapplication risk assessments.

C **Exposure Duration:**
- S For non-cancer occupational non-cancer and cancer risk estimates, an exposure duration of **8 hours** is used;
- S For non-occupational bystander non-cancer risk estimates, an exposure duration range of **16.4 and 2 hours** are used, representing an estimate of time spent indoor and outdoors at one's residence, respectively (based on values from the 1997 EPA Exposure Factor Handbook recommendation for time spent indoor and outdoors at one's residence). These values are based on the Tseng and Klepis (1996) - National Human Activity Pattern Survey (NHAPS) and represent the 50th percentile values from the study data. The 90th percentile values for time spent indoors and outdoors is **23.3** and **6** hours per day, respectively;
- S For non-occupational bystander cancer risk estimates, an exposure duration of 16.4 is used (based on values from the 1997 EPA Exposure Factor Handbook recommendation for time spent indoor at one's residence).

• **Minute Volumes:** Postapplication occupational and residential minute volumes assumptions were based on the 1997 EPA Exposure Factors Handbook Volume III. Mean minute volume values recommended for short-term exposures during rest, sedentary, light, and moderate activities are 6.7, 8.3, 16.7, and 26.7 liters per minute, respectively. Mean minute volume values recommended for chronic (e.g., cancer) exposures is 9.3 liters per minute.

- S For occupational non-cancer postapplication estimates, a minute volume of 16.7 liters per minute was used– representing light to moderate work activities;
- S For occupational cancer risk postapplication estimates, a minute volume of 9.3 liters per minute (representing a mixture of rest, sedentary, and light activities) was used;
- S For non-cancer bystander risk estimates to adults, a minute volume of 16.7 liters per minute (representing light activities) was used for the 2-hour exposure duration period and a minute volume of 8.3 liters per minute (representing sedentary activities) was used for the 16.4-hour exposure duration period;
- S For cancer bystander risk estimates to adults, a minute volume of 9.3 liters per minute (representing a mixture of rest, sedentary, and light activities) was used;

- For non-cancer bystander risk estimates to children, a minute volume of 16.7 liters per minute (representing light activity) was used for the 2-hour exposure duration period and a minute volume of 6.7 liters per minute (representing a mixture of rest and sedentary, work activities) was used for the 16.4-hour exposure duration period.

- **Indoor versus Outdoor Exposures:** An MITC-specific study (*Determination of Ambient MITC Residues in Indoor and Outdoor Air in Townships near Fields with Metam Sodium.* June, 1999) conducted following applications of metam sodium indicated that MITC indoor and outdoor air concentration levels are approximately equal over an exposure period, therefore the risks apply equally to persons outdoors or inside buildings.

- **Levels of Concern:** HED has established the following levels of concern (LOC) for postapplication risks:
  - margin of exposure of less than 100 for occupational non-cancer risks;
  - margin of exposure of less than 100 for non-occupational (bystander) non-cancer risks;
  - cancer risk greater than 1×10^{-4} (and reasonable mitigation to reach 1×10^{-6}) for occupational cancer assessments; and
  - cancer risk greater than 1×10^{-6} for non-occupational adult (bystander) cancer assessments.

2.2.1.2 Data for Postapplication Exposure Scenarios

Metam sodium produces MITC gas when applied to soil. Several studies were submitted to EPA that measured MITC air concentration levels following applications of metam sodium with tractor-drawn or chemigation equipment. The air concentration levels were measured at various time periods following application (e.g., 2 hours, 8 hours, 24 hours, etc.), at various distances from the edge of the treated field (e.g., 15 meters, 150 meters, 300 meters, etc.) and in various directions from the treated field (e.g., north, south, east, west, etc.). In all, eleven postapplication exposure studies were submitted – five were conducted following metam sodium applications using shank injection equipment, five were conducted following metam sodium applications using sprinkler irrigation equipment, and one was conducted following metam sodium applications using drip irrigation equipment. In some of the studies, the application was sealed into the soil with water immediately following application, in other studies the application was intermittently (i.e., thin seal of water applied on consecutive days) sealed into the soil with water, and in still other studies, no soil seal was applied. HED had several QA/QC issues with the studies and concerns about some methodologies and inconsistencies. However, the studies were used to estimate postapplication exposure to MITC. The following is a summary of the postapplication exposure studies used in this assessment:

MRID No. 457037-04. *Determination of Methyl Isothiocyanate Offsite Air Movement from the Application of Metam-Sodium Through Shank Injection. March 1, 2001.*

HED Study Review - DP Barcode D290246

The purpose of this study was to assess the offsite air movement of metam-sodium when applied to soil by shank injection to a plot in Lost Hills, California. Specifically, the monitoring was conducted to determine the levels of methyl isothiocyanate, MITC, a metabolite of metam sodium. VAPAM® HL was applied once at a rate of 75 gallons per treated acre (319.5 lbs ai/treated acre) using a tractor to a 40 acre field intended for growing carrots. Field work was conducted between June 13 and June 17, 2000. Individual samples were collected from 16 sampling stations (six sampling intervals per day for four days). The stations were placed offsite at the following locations: 150 m and 300 m (around all sides), 500 m and 700 m (on a diagonal to the southeast) and 700 m (on a diagonal to the southwest). MITC values ranged from 0.17 $\mu g/m^3$ to 181.51 $\mu g/m^3$ throughout the monitoring period. These values were not corrected for field fortification recoveries as all applicable recoveries were >90%. The study met most of the applicable EPA study guidelines. The following issues of potential concern were identified: 1) the study was conducted at only one test site; 2) only individual samples were collected at each sampling station and samples were only collected offsite (not collected within the treated area); and 3) field fortification samples were spiked in the laboratory and shipped frozen to the test site rather than being spiked concurrently in the field with the test samples. According to the Vapam®HL label, the test product should be sealed in the soil at the time of application by sprinkler irrigation or tarping. On the evening of the application, a ½ inch water cap was applied to the plot.

MRID No. 457037-05. *Santa Barbara County Pilot Study of Intermittent Sealing for a Shank Injection Application. December 18, 2001.*

HED Study Review - DP Barcode D290247

This pilot study is a non-GLP pilot study. It was designed to determine the effects of a ground application of metam-sodium. It also examined the effects that intermittent water sealing (performed after application) has on MITC emissions. A shank injection of Sectagon 42®, a liquid containing 42.2% metam sodium, was made to two selected fields, both of which were ten acres in size, in Santa Barbara County, California. The effects were determined by measuring the amounts of methyl isothiocyanate (MITC), the primary breakdown product, in the surrounding air. The purpose of the study was to determine MITC concentrations when metam sodium was injected into the soil under warm air and warm soil conditions. Application was made at a rate of 75 gallons per treated acre (316.5 lbs ai per treated acre). Four air sampling stations were set up at a distance of 150 meters from the fields edge (one each in the northeast corner, the southeast corner, the northwest corner, and the southwest corner), and ambient air monitoring was conducted every 4 hours for a total of 7 sampling intervals. MITC values ranged from 0.0 $\mu g/m^3$ to 15.7 $\mu g/m^3$ at Site 1 and 0 $\mu g/m^3$ to 14.3 $\mu g/m^3$ at Site 2. These values were not corrected for field fortification recoveries because no recoveries were included in the study. Twenty-four hour TWAs were calculated for each sampling location. Because sampling intervals were of various durations, samples collected during the course of the application process, and after the application were used together to calculate one 24-hour TWA. Only one 24 hour TWA could be calculated for each sampling location due to the limited number of sampling intervals. The 24-hour TWAs for Site 1 were 1.78 $\mu g/m^3$ (Station A), 3.72 $\mu g/m^3$ (Station B), 3.60 $\mu g/m^3$ (Station C), and 3.91 $\mu g/m^3$ (Station D). The 24-hour TWAs for Site 2 were 1.38 $\mu g/m^3$

(Station A), 2.39 μg/m^3 (Station B), 3.17 μg/m^3 (Station C), and 2.23 μg/m^3 (Station D). This non-GLP pilot study was not performed under the compliance guidelines for field volatility studies and as a result, numerous criteria were not met. The following issues of potential concern were identified:(1) There were no quality control samples collected or analyzed with this study; (2) There was no study protocol provided; (3) Duplicate samples were only collected during one sampling interval at the four sampling locations per interval for this study; (4) No field blank samples were collected for this study; and (5) Sampling for this study did not continue until the nature of the dissipation curve was clearly established. According to the Sectagon label, the test product should be sealed in the soil at the time of application by irrigation or tarping. In this study, two different types of irrigation sealing schedules were used to mitigate possible air emissions.

No MRID, Test Report No. C92-070A. *Ambient Air Monitoring in Contra Costa County During March 1993 After an Application of Metam Sodium to a Field. July 14, 1993.*

HED Study Review - DP Barcode D281774

This study was designed to determine the effects of a shank injection application of metam sodium to a field in Contra Costa County, California. The purpose of the study was to determine MITC concentrations when metam sodium was injected into the soil under cool air and cool soil conditions. Vapam® was applied at a rate of 18 gallons of formulation per acre (57.2 lbs ai/acre). A single application was made by a tractor over three days to a 95 acre field. On each of the three days of the application, air monitoring was conducted prior to, during, and after the metam sodium soil injection. A sampling train was set up at each of three sampling locations and set at a flow rate of 2 liters per minute. The three samplers were setup 15 yards from the fields edge (one to the north, one to the southeast, and one to the southwest). On each day of application, sample tubes were changed before application began in the morning, once during the application, and then after the application ended for the day, resulting in a total of 8 sampling intervals (including background sampling interval). The duration of the sampling intervals ranged from 115 minutes (background sampling) to 950 minutes (last sampling interval). Significant levels of MITC were detected at all three sampling locations during and after the application of metam sodium. MITC values ranged from 0.051 μg/m^3 to 242 μg/m^3. These values were not corrected for field fortification recoveries because no recoveries were included in the study. The study met most of the applicable EPA study guidelines. The following issues of potential concern were: (1) field fortification and concurrent laboratory fortification samples were not used during this study; (2) the study author did not provide information on the validation of the methods used in the study; (3) the study was not conducted at the maximum application rate; (4) duplicate samples were collected at three sampling locations per interval for the study; however, only one of the duplicates were analyzed; (5) the study did not continue until the nature of the dissipation curve was clearly established; and (6) According to the Vapam label, light watering until the soil is sealed or the use of a tarp for 48 hours is required. In this study, no seal was implemented to mitigate possible air emissions following the application.

No MRID. Test Report No. C92-070B. *Ambient Air Monitoring for MITC in Kern County During Summer 1993 After a Ground Injection Application of Metam-Sodium to a Field. April*

27, 1994.

HED Study Review - DP Barcode D281778

This study was designed to determine the effects of a shank injection application of metam-sodium to a field in Kern County, California. The purpose of the study was to determine MITC concentrations when metam sodium was injected into the soil under warm air and warm soil conditions. Soil-Prep® was applied at a rate of 155 lbs ai/acre. A single application was made by a tractor over three days to an 85 acre field. On each of the three days of the application, air monitoring was conducted prior to, during, and after the metam sodium soil injection. Four air samplers were set up (one at each cardinal compass point) approximately 40 yards from the fields edge and set at a flow rate of 2 liters per minute. Ambient air monitoring was conducted for a total of 9 sampling intervals (three sampling intervals per day for three days). Significant levels of MITC were detected at all four sampling locations during and after the application of metam sodium. MITC values ranged from 1.2 $\mu g/m^3$ to 880 $\mu g/m^3$. These values were not corrected for field fortification recoveries because no recoveries were included in the study. The study met most of the applicable EPA study guidelines. The following issues of potential concern were: (1) quality control samples were not collected or analyzed; (2) the study was not conducted at the maximum application rate; (3) duplicate samples were collected at four sampling locations per interval for this study; however, only one of the duplicates were analyzed; (4) only one field blank sample was collected and analyzed; (5) the study did not continue until the nature of the dissipation curve was clearly established; and (6) samples from sampling Series 3 and 4 were exposed to high temperatures resulting in lower than expected residue values. In this study, no seal was implemented to mitigate possible air emissions following the application.

No MRID, Test Report No. C94-046A. *Ambient Air Monitoring for MIC and MITC After a Soil Injection Application of Metam Sodium in Kern County During August 1995. May 20, 1997.*

HED Study Review - DP Barcode D281790

The purpose of this study was to assess the offsite air movement of metam sodium when applied to soil by direct injection to a plot in Kern County, California. Specifically, the monitoring was conducted to determine the levels of MITC and MIC, a metabolite of MITC. Soil-Prep® was applied once at a rate of 155 lbs ai/acre using a tractor to an 80 acre field intended for growing carrots. Background samples were collected one day prior to the application and individual samples were collected from five sampling stations (two sampling intervals per day for three days) set at a flow rate of 2 liters per minute. The stations were placed offsite at each of the four cardinal compass points: 39 feet North, 39 feet South (2 stations), 36 feet East, and 60 feet West of the field. MITC values ranged from 0.64 $\mu g/m^3$ to 250 $\mu g/m^3$; MIC values ranged from 0.60 $\mu g/m^3$ to 5.80 $\mu g/m^3$ throughout the monitoring period. These values were not corrected for field fortification recoveries because spikes were not fortified concurrently in the field. The study met most of the applicable EPA study guidelines. The following issues of potential concern were: (1) the study was not conducted at the maximum application rate; (2) the soil at the test site was not characterized; (3) detailed information regarding application equipment was not provided; (4) only individual samples were collected at each sampling station and samples were only collected from a distance offsite (not collected within the treated area); and (5) sampling did not continue until the nature of the dissipation curve was clearly established. In this study, no seal was implemented to mitigate possible air emissions following the application.

MRID No. 457037-02. *Determination of Methyl Isothiocyanate Offsite Air Movement from the Chemigation of Metam-Sodium Through Sprinkler Irrigation. January 10, 2002.*

HED Study Review - DP Barcode D290245

The purpose of this study was to assess offsite air movement of metam-sodium when applied by chemigation to a bare ground field. The test site for this study was located in the southern San Joaquin Valley of California in Kern County on a bare ground field maintained by Grimmway Farms. Metam CLR™ was applied once by sprinkler irrigation using WTC model number G-50, 230 sprinklers at a rate of 74.6 gallons per treated acre (317.05 lb ai/acre) to a 17.63 acre field. Individual samples were collected from 16 sampling stations (six sampling intervals per day for four days). Field work was conducted between August 21 and August 25, 2001. Sampling stations were located at 137 m and 274 m around all sides of the field, and at 274 m, 411 m, and 549 m on a diagonal to the southeast, and at 274 m and 530 m on a diagonal southwest of the field. MITC values at all the sampling sites ranged from 0.20 µg/m^3 to 227.9 µg/m^3 throughout the monitoring period. These values were not corrected for field fortification recoveries because spikes were not fortified concurrently in the field (field fortification recoveries were >90%). The study met most of the applicable EPA study guidelines. The following issues of potential concern were identified: 1) the study was conducted at only one site; 2) the soil samples were not characterized; 3) samples were not collected within the treated area; 4) a clear dissipation curve was not established over the 96-hour monitoring period; and 5) field fortification samples were spiked in the laboratory and shipped frozen to the test site rather than being spiked concurrently in the field with the test samples. According to the Metam CLR label, a seal should be implemented immediately after application. In this study, a ½ inch water seal was applied immediately following the application. On the day after application, a 1/4 inch seal was applied.

MRID No. 457037-06. *Lancaster Pilot Study of Intermittent Sealing for a Sprinkler Irrigation Application. December 18, 2001.*

HED Study Review - DP Barcode D290249

This was a non-GLP study designed to determine the effects of a chemigation application of metam-sodium. It also examined the effects that intermittent water sealing (performed after application) has on MITC emissions. A chemigation application of Sectagon 42® was made to two selected fields, both of which were 16 acres in size, in Lancaster, California. The effects were determined by measuring the amounts of MITC in the surrounding air. The purpose of the pilot study was to determine MITC concentrations when metam sodium was applied via chemigation to the soil under warm air and warm soil conditions. Application was made at a rate of 75 gallons per acre (316.5 lb ai/acre). There were two types of irrigation sealing schedules used to mitigate possible air emissions. Site one was irrigated with 1/6 inch of water seven times over the course of the monitoring period and site 2 was irrigated with ½ inch of water immediately following application and another ½ inch 1 day later in the monitoring period. Four air samplers were set up (one at each cardinal compass point) around each field, and ambient air monitoring was conducted for a total of six sampling intervals. MITC values ranged from 0.42 $\mu g/m^3$ to 210.7 $\mu g/m^3$ at Site 1 and 0.056 $\mu g/m^3$ to 252.9 $\mu g/m^3$ at Site 2. These values were not corrected for field fortification recoveries because no recoveries were included in the study. This non-GLP pilot study was not performed under the compliance guidelines for field volatility studies and as a result, numerous criteria were not met. The following issues of potential concern were identified: (1) there were no quality control samples collected or analyzed with this pilot study; (2) a pilot study protocol was not provided; (3) a product label was not provided; (4) duplicate samples were only collected during one sampling interval at the four sampling locations per interval; (5) no field blank samples were collected; and (6) sampling did not continue until the nature of the dissipation curve was clearly established. According to the Sectagon label, the test product should be sealed in the soil at the time of application by irrigation or tarping. In this study, irrigation sealing was used to mitigate possible air emissions.

MRID No. 457037-07. *Panama Lane Pilot Study of Intermittent Sealing for a Chemigation Application. December 18, 2001.*

HED Study Review - DP Barcode D290251

This was a non-GLP study designed to determine the effects of a ground application of metam-sodium. It also examined the effects that intermittent water sealing (performed after application) has on MITC emissions. A chemigation application of VAPAM was made to two selected fields, both of which were 12 acres in size, in Kern County, California and the effects were determined by measuring the amounts of methyl isothiocyanate (MITC) in the surrounding air. The purpose of the pilot study was to determine MITC concentrations when metam sodium was applied via chemigation equipment to the soil under warm air and warm soil conditions. The application was made at a rate of 203 pounds active ingredient per acre. Four air sampling stations were set up (one at each cardinal compass point) 150 meters from the fields edge and ambient air monitoring was conducted for a total of 12 sampling intervals (plus one duplicate). MITC values ranged from 0 $\mu g/m^3$ to 395.9 $\mu g/m^3$ at Site 1 and 0 $\mu g/m^3$ to 736.3 $\mu g/m^3$ at Site 2. These values were not corrected for field fortification recoveries because no recoveries were included in the study. This pilot study was not performed under the compliance guidelines for field volatility studies and as a result, numerous criteria were not met. The following issues of potential concern were identified: 1) there were no quality control samples collected or analyzed with the study; 2) a study protocol was not provided; 3) a product label was not provided with the study; therefore, the maximum application rate could not be determined; 4) duplicate samples were not collected; and 5) sampling did not continue until the nature of the dissipation curve was clearly established. According to other Vapam labels, the test product should be sealed in the soil at the time of application by sprinkler irrigation or tarping. In this study, no soil sealing was used to mitigate possible air emissions.

MRID No. 457037-08. *Orange County Drip Application Study Modeling Results Prepared for the Metam-Sodium Task Force. December 18, 2001.*

HED Study Review - DP Barcode D290252

This was a non-GLP study. The purpose of this summary report was to interpret air quality data in the University of Nevada study, "Determination of MITC in Air Downwind of Field Treated with Metam Sodium by Drip Irrigation." Air quality data were compared to supplementary data on soil and meteorological conditions to estimate emission rates of MITC as a function of time. An additional objective was to evaluate tarp versus non-tarp off-gassing rates for drip applications. Two fields, one tarped and one untarped, were selected for use in the application monitoring in the University of Nevada study. The fields were located southeast of Irvine, California. The tarped field was approximately 4 acres and the untarped field was approximately 12 acres. Vapam® HL was applied at a rate of 75 gallons per acre (319.5 lb ai/acre). Pre-irrigation and irrigation following the application was not performed. Ten air monitoring stations were placed around each field approximately 10, 20, 20, 50, and 150 feet from the edge of the field. The sampling pumps were set to an airflow rate of 2 L/min. A total of six sampling periods were utilized in this study, one at the time of application and at 4, 8, 24, 36, and 48 hours posttreatement. The data show levels of MITC ranging from less than the detection limit to 89.2 $\mu g/m^3$ at the untarped field and from less than the detection limit to 114 $\mu g/m^3$ at the tarped field. These values were not corrected for field fortification recoveries because raw data were not provided in the study. The summary report provided emission rates, calculated based on a ratio of average measured concentrations to average modeled concentrations times the normalized emission rate used in the model. The modeled values were computed using the ISCST3 dispersion model. Emission rates were reported to range from 1.9 to 11.6 $\mu g/m^3$/sec for the tarped field and from 0.8 to 8.3 $\mu g/m^3$/sec for the untarped field. Due to low recoveries of MITC (70.0 to 80.9), these emission rates were scaled up by 25%. The summary report did not provide detailed information on the field study and as a result, numerous criteria were not met. The following issues of potential concern were identified: 1) no study protocol were provided; 2) raw data were not provided; and 3) the LOQ was not provided. According to the Vapam®HL label, the test product should be sealed in the soil at the time of application by sprinkler irrigation or tarping. In this study, tarping consisted of a field tarped with a 1.5 mm plastic mulch.

MRID No. 426599-01. *Field Volatility of Metam-Sodium During and After Applications. January 26, 1993.*

HED Study Review - DP Barcode D281787

The purpose of this study was to assess the offsite air movement of methyl isothiocyanate (MITC), the primary breakdown product of metam sodium, following application to a field. BUSAN® 1020 was applied once by solid fixed-set sprinklers at a rate of 100 gallons per acre (318 lbs ai/acre) to a 7 acre fallow field in Madera County, California from May 2 through 4, 1992. The site was pre-irrigated 90 minutes prior to the application. Air sampling for MITC concentrations was conducted using personal air sampling pumps located 5, 25, 125, and 500 meters from the downwind edge of the application zone. At each test site, duplicate samples were collected every four hours during the application and for two days following the application. MITC values (corrected for field recovery) ranged from 8.6 to 1300 $\mu g/m^3$. The highest MITC residues were detected during the first sampling interval following the application and MITC levels dropped considerably 20 hours after field application. Dissipation half-life values were 7.91 hours (r^2 = 0.934), 7.46 hours (r^2 = 0.915), 7.25 hours (r^2 = 0.548), and 9.96 hours (r^2 = 0.778) for the 5 m, 25 m, 125 m, and 500 m downwind samplers, respectively. The study met most of the applicable EPA study guidelines. The following issues of potential concern were identified: (1) only one test site was used; (2) air monitoring was not done in the center of the treated field and samplers were not placed at all four cardinal compass points from the center; (3) the power generator failed during the 8 to 12 hour sampling interval; (4) field fortification samples were said to represent storage stability as well; however, analysis dates are not known and the order they were analyzed in relation to the field samples in not known; and (5) According to the product label, the test product should be sealed in the soil immediately after the application. Following the application, no soil sealing was used to mitigate possible air emissions.

No MRID. *Air Monitoring for Methyl Isothiocyanate During a Sprinkler Application of Metam-sodium. June 1994.*

HED Study Review - DP Barcode D290254

This study is a non-GLP study. The purpose of this study was to monitor MITC, hydrogen sulfide (H_2S), and carbon disulfide (CS_2) air concentrations during a field application of metam-sodium. Vapam® ICI Soil Fumigant was applied once by sprinkler irrigation (chemigation) at a rate of 318 lbs ai/acre to a 19 acre site in Kern County, California. The site was pre-irrigated a few hours prior to the application. Air sampling for MITC concentrations was conducted using personal air sampling pumps located off the perimeter of the treated area at three approximate distances of 5, 75, and 150 meters. A charcoal sorbent tube, with a silica gel tube mounted in front, was attached to each air sampling pump to collect residues during the application (6 hours), watering-in (1.5 hours), and then followed with three consecutive 6-hour and four consecutive 12-hour sampling intervals. MITC values ranged from below the detection limit (2.43 $\mu g/m^3$) to 8,253 $\mu g/m^3$ throughout the monitoring period. The period when the highest MITC concentrations were found was during the application of the test product. The second highest MITC concentrations occurred during the sampling interval which followed the “watering-in” of the test product. The study met most of the applicable EPA study guidelines. The following issues of potential concern were identified: (1) the percentage of active ingredient was not reported and the properties of the pesticide (i.e., vapor pressure volatility, water solubility, adsorption to soil, and texture) were not addressed; (2) only one site was used in this study; (3) samples were not collected from the center of the treated field and sampling stations were positioned 1.2 meters above the ground. However, one or two randomly located replicate samples were collected alongside a primary sample during each interval for method comparison; (4) sampling pumps were run at a sample flow rate of approximately only 0.25 liters per minute (Lpm); (5) the study reported that the sampling pumps were calibrated at the beginning of each sampling period but did not specify whether they were checked at the end of each sampling interval; (6) two 12-hour background samples were collected prior to the application. In addition, retention and breakthrough studies were not discussed in this study. A complete set of field recoveries consisting of at least one blank control sample and three or more each of a low-level and high-level fortifications was not provided in this study. Quality control recoveries for one level of fortification were provided but not discussed; (7)

storage stability data were not provided; and (8) raw residue data were not corrected for the continuous quality control recovery data provided in Appendix C of the report (89% for silica and 88% for charcoal). Following the application, soil sealing was used to mitigate possible air emissions.

HED notes the following limitations/issues with the above studies:

All of the field volatility studies were conducted in California. Currently, CDPR has a technical information bulletin (TIB) for metam sodium application that identifies certain application practices for the application of metam sodium (i.e regarding water sealing, air temperature, wind speed, time of application, etc.). As noted in the study summaries, these practices were not followed in all of the 11 studies. DPR's TIB does apply to other states where metam sodium is used.

Three of studies are pilot studies (MRIDs 457037-05, 457037-06, and 457037-07). The MSTF claims that these three studies do not reflect currently used intermittent sealing methods.

The MSTF reported that in the 1994 study, 'Air Monitoring for Methyl Isothiocyanate During a Sprinkler Application of Metam-sodium' (DP Barcode D290254) a nocturnal inversion occurred. They also report that the application was conducted with air temperatures that exceeded 90 F.

Although several of the studies may not be reflect current application practices or may not be compliant with current CDPR's TIB requirements and EPA labels, they were included the risk estimates included in Section 2.2.4 for comparative historical purposes. Risk estimates using ISC modeling (Section 3.0) were based on the best available exposure study for each application type and sealing method.

2.2.2 Parameters Affecting Postapplication Inhalation Exposures

Several factors influence the air concentration levels of MITC following metam sodium applications to agricultural fields, including:

- the rate at which MITC is formed during the degradation of metam sodium,
- the rate at which MITC is released from treated soil into the atmosphere, and
- the amount of metam sodium applied in a geographic area.

Factors that influence the rate at which MITC is formed during the degradation of metam sodium include:

- the pH of the soil,
- the moisture level of the soil, and
- the temperature of the soil.

Factors that influence the rate at which MITC is released from treated soil into the atmosphere, include:

- the type and effectiveness of the soil seal, if any – seals range from tarpaulins, soil compaction with rollers or drags, and adding a layer of water immediately following application and/or for a few days following application;
- the type of application – application can be by shank injection, rotary tiller, sprinkler irrigation, or through various handheld or stationary equipment;
- the texture and content of the soil – clay soils and soils high in organic matter tend to inhibit release of MITC, whereas loose textured soils tend to release MITC, and
- soil moisture levels – soils with high moisture levels tend to inhibit release of MITC, whereas low moisture soils tend to release MITC
- time of application, night versus day, and atmospheric conditions.

Factors that influence the amount of metam sodium applied in a geographic area, include:

- Size (acres) of the area treated in a day;
- Number of consecutive days metam sodium is applied in a geographic area; and
- Application rate – the pounds of metam sodium applied per acre.

Note: that the size or frequency of applications among separate owner/operators in a geographic area is not limited or specified by current pesticide labeling.

2.2.3 Occupational and Residential Postapplication Exposures

Once metam sodium applied to soil or mixed with non-buffered water, it rapidly and completely breaks down to MITC and other degradates. In soil, metam sodium usually converts to MITC within one day following application with the decomposition rate depending on soil temperature, soil composition, and soil moisture. Warm soil temperature, increased clay or organic matter, small soil particle size, and low soil moisture facilitate rapid conversion of metam sodium to MITC. MITC accounts for the fumigant activity of metam sodium.

2.2.3.1 Postapplication Dermal Exposures

The Worker Protection Standard for Agricultural Pesticides prohibits entry into a treated area by any person – other than a trained and appropriately PPE-equipped pesticide handler – until inhalation risks are no longer a concern. Therefore, only handlers are permitted to enter treated areas to perform tasks, such as:

- sealing the soil with water, tarpaulins, drags, or rollers;
- removing the tarpaulin seal; and
- aerating treated soil.

Entry into metam-sodium-treated areas by unprotected persons will not be permitted until all metam sodium has degraded into MITC and MITC inhalation exposures are no longer a concern. As a consequence, HED does not anticipate that postapplication dermal exposures to metam sodium will occur in agricultural settings and, therefore, no postapplication dermal risks were calculated for metam sodium.

HED also does not anticipate dermal exposures to metam sodium applied as a foam to sewers. Unauthorized personnel are not expected to be in sewers.

2.2.3.2 Postapplication Inhalation Exposures Immediately Following Field Applications

HED anticipates that a wide array of individuals potentially can be exposed via the inhalation route to MITC by working in or near and/or living near areas that have been treated with metam sodium. MITC-specific studies provided inhalation postapplication exposure data for MITC. These studies examined MITC air concentration levels at measured distances from the edge of a treated field at various time periods immediately after following metam sodium applications. Unfortunately, most of the studies measured MITC air concentration levels for only the first few days following application and most studies did not continue to measure MITC levels until the limit of detection was achieved. In addition, in some instances, MITC air concentration levels measured on the third or fourth day following application were higher than MITC levels measured on the first or second days. As a result, HED has no data to indicate how many days following metam sodium applications that MITC air concentration levels are a concern to occupational workers and residential bystanders near the treated fields.

HED believes that postapplication exposures to MITC can occur over several days following a single metam sodium application and may occur over several weeks if several fields near a work or residential environment are treated consecutively within a short time span. For example, adjacent or contiguous agricultural fields in a localized area might be treated with metam sodium over a several week period. Individuals working in nearby field or working/living in nearby buildings may be exposed to the off-gassing of MITC over an extended period of time. In such situations, intermediate-term postapplication exposures to MITC are possible. However, at this time, the inhalation endpoint of concern for MITC is the same for short-, intermediate-, and long-term MITC exposures, therefore, only one postapplication non-cancer risk calculation was performed.

2.2.3.3 Postapplication Inhalation Exposures Following Soil Aeration

HED also has concerns about postapplication inhalation exposures to MITC following removal of the soil seal and/or soil aeration. Metam sodium label instructions recommend sealing the soil immediately following application. (Some labels require the use of a tarpaulin if the application is applied near (within one-half mile) of populated areas such as residential areas, schools, hospitals, commercial or office buildings, factories, etc.) Sealing methods include applying irrigation water and/or plastic tarpaulins or packing soil with a roller or drag. Metam sodium labels recommend for heavy soils that users cultivate sealed areas approximately 5 to 7 days following application to aerate the soil (see page 8 of Vapam HL Soil Fumigant Label EPA Reg No 5481-468 dated 1/6/2004 under heading ‘Cultivation of Soil Before Planting’). Labels also indicate that planting or transplanting cannot occur for 14 to 30 days following application – with the longer period applicable to soils that were sealed following application or to soils that are heavy, wet, or cold.

Based on the labeling information and on the postapplication study data that indicate significantly lower MITC air concentration levels near fields where the soils have been sealed immediately following metam sodium applications, HED believes that MITC air concentration levels may spike again when the soil seal is removed and/or the soil is aerated. At this time, HED has no data to indicate MITC air concentration levels in or near metam-sodium-treated fields when the soil seal is removed or the soil is aerated.

2.2.3.4 Postapplication Exposures Following Potting Soil Treatments

HED has concerns about postapplication exposures to occupational workers and non-occupational bystanders following applications to potting soil. HED believes that these applications are likely to take place in sheltered settings, such as sheds, where air circulation is somewhat restricted. However, at this time there are no data about MITC air concentration levels following applications to potting soil.

2.2.3.5 Postapplication Exposures Following Sewer Treatments

HED has concerns about postapplication exposures to occupational workers and non-occupational bystanders following applications to sewers. HED believes that exposures to non-occupational bystanders may occur if there are cracks in the sewer structure that would permit MITC to escape the sewer confinement. HED also is concerned about entry by occupational workers into treated sewers before MITC levels have dissipated. However, at this time there are no data about MITC air concentration levels following applications to sewers.

2.2.4 MITC Occupational and Residential Postapplication Exposure Scenarios

2.2.4.1 MITC Occupational Postapplication Exposure Scenarios

Traditional postapplication occupational exposure assessments concentrate on postapplication dermal exposures to treated surfaces. However, in the postapplication exposure assessment following metam sodium applications, HED is concerned about inhalation exposures to MITC to occupational workers who are performing tasks:

Workers In Treated Areas: The Worker Protection Standard for Agricultural Pesticides (WPS) completely prohibits occupational workers and other persons from entering treated areas following applications of fumigant pesticides until inhalation exposures are no longer a concern. The entry prohibition is applicable to the area (i.e., field) to which the fumigant was applied. Entry into fumigant-treated is permitted for handlers only and only when they are performing one of the following tasks: adding or adjusting a soil seal, to check on air concentration levels, or to aerate the treated area.

Workers Near Treated Areas: Based on available MITC air concentration data, HED has concerns about occupational workers performing tasks near – but outside of – a metam-sodium-treated field. The WPS does not address situations involving workers performing tasks outside the treated area. These workers may be employees of the owner/operator of the agricultural establishment where the application is taking place, but they also may be employees on another nearby worksite.

2.2.4.2 MITC Residential Postapplication Exposure Scenarios

Based on available MITC air concentration data, HED has concerns about non-occupational bystanders located near – but outside of – a metam-sodium-treated field. These may be adults or children who live and/or work near the treated field.

2.2.5 Non-cancer MITC Occupational and Residential Postapplication Risks

The non-cancer occupational and residential postapplication exposure and risk estimates were calculated using the "Route-Specific Inhalation Margin of Exposure (MOE) method. MOEs were calculated for each individual air sample concentration.

2.2.5.1 Non-cancer MITC Occupational and Residential Postapplication Risk Calculations

For formulas used to calculate the inhalation non-cancer risk (MOEs), see section 2.1.4.1.

2.2.5.2 Summary of MITC Occupational Non-cancer Postapplication Risks

HED's level of concern for occupational postapplication risks is a margin of exposure of less than 100. A summary of the MITC postapplication risks to occupational worker resulting from applications of metam sodium by shank injection and by sprinkler irrigation are presented below in Tables 10 and 11.

MOEs of less than 100 during at least one or more 8-hour periods were calculated for following scenarios:

Shank Injection Applications

- **where the soil is sealed with water** for a few data collection points (e.g., down-wind locations) from two air concentration studies at distances of 150 meters and 300 meters (study maximums of 150 and 700 meters respectively) from the edge of the treated field ; and
- **where no soil seal is used** for many data collection points from three air concentration study at all distances (study maximums of 13.7, 18.3, and 36.6 meters, respectively) from the edge of the field.

Sprinkler irrigation applications

- **where soil is sealed with water** for many data collection points in two separate studies at distances of 5, 71, 75, 77, 82, 150, and 150 meters (study maximums of 150 meters) from the edge of the field ;
- **where soil is intermittently sealed with water** for many data collection points in three separate studies at distances of 137, 150, 274, and 530 meters (study maximums of 150, 150, and 549 meters, respectively) from the edge of the field – ; and
- **where soil is not sealed with water** for many data collection points from one air concentration study at all distances (study maximum of 500 meters) from the edge of the field.

Drip irrigation applications:

- **where soil is not sealed** for two data collection points from one air concentration study at distances of 6.1 and 15.2 meters (study maximum of 45.7 meters) from the edge of the field.

Table 10: Non-cancer Occupational Postapplication MITC Risk Summary Following Shank Injection Applications

Postapplication Exposure Study	Sampler Distance from edge of Field (meters)	Type of Seal	Number of MOEs $ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
8 Hour MITC Exposure Summary [a]						
MRID# 457037-05: SITE 1	150	Intermittent Seal	22	22	380	34000
MRID# 457037-05: SITE 2	150	Intermittent Seal	21	21	420	34000
MRID# 457037-04	150	Intermittent Seal	106	116	17	18000
	300		180	187	30	18000
	500		24	24	110	15000
	700		48	48	150	15000
C94-046A	11	No soil seal.	4	6	14	640
	11.9		14	16	12	4800
	18.3		5	6	44	3600
C92-070A	13.7	No soil seal.	9	21	4.5	21000
C92-070B	18.3	No soil seal.	12	24	3.4	2500
	36.6		5	8	15	2100

Footnotes

a Assessment assumes a minute volume of 16.7 liters per minute for all scenarios.

b MOEs were calculated for each individual air sample concentration.

Table 11: Non-cancer Occupational Postapplication MITC Risk Summary Following Chemigation Applications							
Postapplication Exposure Study	Application Equipment	Sampler Distance from Edge of Field (meters)	Type of Seal	Number of MOEs $ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
8 Hour MITC Exposure Summary [a]							
MRID# 426599-01 (All Samplers on downwind edge of field.)	Sprinkler	5	No soil seal.	4	13	4.8	230
		25		5	13	5.8	200
		125		5	13	7.4	570
		500		11	13	37	3100
MRID# 457037-06; Site 1	Sprinkler	150	Intermittent Seal	21	24	29	14000
MRID# 457037-06; Site 2	Sprinkler	150	Standard Seal	23	24	24	11000
MRID# 457037-07; Site 1	Sprinkler	150	Intermittent Seal	35	51	9.6	20000
MRID# 457037-07; Site 2	Sprinkler	150	Standard Seal	34	50	5.1	22000
MRID# 457037-02	Sprinkler	137	Intermittent Seal	81	96	27	39000
		274		199	216	26	41000
		411		24	24	160	39000
		530		22	24	80	39000
		549		24	24	160	39000
HED Study Review D290254	Sprinkler	5	Standard Seal	17	38	0.74	2500
		82		8	10	39	2300
		75		8	11	40	2100
		77		7	9	30	2300
		71		6	11	0.85	2200
		150		14	18	1.4	2300
MRID# 457037-08; Site 1	Drip irrigation	3	Untarped	20	20	130	3400
		6.1		9	10	68	550
		15.2		9	10	68	580
		45.7		10	10	110	850
MRID# 457037-08; Site 2	Drip irrigation	3	Tarped	20	20	110	120000
		6.1		10	10	270	120000
		15.2		10	10	130	120000
		45.7		10	10	130	2300

Footnotes

a Assessment assumes a minute volume of 16.7 liters per minute for all scenarios.

b MOEs were calculated for each individual air sample concentration.

2.2.5.3 Summary of MITC Non-occupational (Bystander) Non-cancer Postapplication Risks

HED's level of concern for non-occupational (bystander) postapplication risks is a margin of exposure of less than 100. A summary of the MITC postapplication risks to adult and children bystanders resulting from applications of metam sodium by shank injection and by chemigation are presented below in Tables 12, 13, 14, and 15.

Risks to Adult Bystanders Following Shank Injection Applications

Adult bystander MITC inhalation MOEs of less than 100 were calculated during at least one or more 2- and 16.4-hour periods for following scenarios:

- **for 2-hour exposures (outdoors) where the soil is sealed with water** for a few data collection points (e.g., downwind locations) from one air concentration studies at distances of 150 and 300 meters (study maximum of 700 meters) from the edge of the treated field; and
- **for 2-hour exposures (outdoors) where no soil seal is used** for many data collection points from three air concentration study at distances of 11, 11.9, 13.7, 18.3, and 36.6 meters (study maximums of 13.7, 18.3, and 36.6 meters, respectively) from the edge of the field;
- **for 16.4-hour exposures (indoors) where the soil is sealed with water** for several data collection points from one air concentration study at distances of 150 and 300 meters (study maximum of 700 meters) from the edge of the treated field; and
- **for 16.4-hour exposures (indoors) where no soil seal is used** for most data collection points from three air concentration study at distances of 11, 11.9, 13.7, 18.3, and 36.6 meters (study maximums of 13.7, 18.3, and 36.6 meters, respectively) from the edge of the field.

Table 12: Shank Injection Adult Bystander MITC Risk Summary

Postapplication Exposure Study	Sampler Distance from Edge of Field (meters)	Type of Seal	Number of MOEs $ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
2 Hour MITC Exposure Summary [a]						
MRID# 457037-05: SITE 1	150	Intermittent Seal	22	22	1500	130000
MRID# 457037-05: SITE 2	150	Intermittent Seal	21	21	1700	140000
MRID# 457037-04	150	Intermittent Seal	112	116	66	72000
	300		187	187	120	73000
	500		24	24	440	59000
	700		48	48	600	60000
C94-046A	11.0	No Soil Seal	5	6	58	2600
	11.9		14	16	50	19000
	18.3		6	6	170	14000
C92-070A	13.7	No Soil Seal	14	21	18	84000
C92-070B	18.3	No Soil Seal	16	24	14	9900
	36.6		7	8	59	8300
16.4 Hour MITC Exposure Summary [b]						
MRID# 457037-05: SITE 1	150	Intermittent Seal	4	4	1400	2200
MRID# 457037-05: SITE 2	150	Intermittent Seal	4	4	1900	4500
MRID# 457037-04	150	Intermittent Seal	17	20	44	15000
	300		31	32	98	15000
	500		4	4	560	14000
	700		8	8	550	14000

Table 12: Shank Injection Adult Bystander MITC Risk Summary						
Postapplication Exposure Study	Sampler Distance from Edge of Field (meters)	Type of Seal	Number of MOEs $ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
C94-046A	11.0	No Soil Seal	2	3	24	390
	11.9		7	9	18	2600
	18.3		2	3	63	1400
C92-070A	13.7	No Soil Seal	2	3	11	270
C92-070B	18.3	No Soil Seal	2	9	4.5	190
	36.6		1	3	16	870

Footnotes

a Assumed a minute volume of 16.7 liters per minute for all 2-hour scenarios.

b Assumed a minute volume of 8.3 liters per minute for all 16.4-hour scenarios.

c MOEs were calculated for each individual air sample concentration.

Risks to Adult Bystanders Following Sprinkler irrigation Applications:

Adult bystander MITC inhalation MOEs of less than 100 were calculated during at least one or more 2- and 16.4-hour periods for following scenarios:

Sprinkler irrigation applications

- **for 2-hour exposures (outdoors) where soil is sealed with water** for many data collection points from three air concentration study at distances of 5, 82, and 150 meters (study maximums of 150 meters for all three studies) from the edge of the field;
- **for 2-hour exposures (outdoors) where soil is intermittently sealed with water** for many data collection points in one study at a distance of 150 meters (study maximum of 150 meters) from the edge of the field; and
- **for 2-hour exposures (outdoors) where soil is not sealed with water** for most data collection points from one air concentration study at distances of 5, 25, and 125 meters (study maximum of 500 meters) from the edge of the field;
- **for 16.4-hour exposures (indoors) where soil is sealed with water** for most data collection points from two air concentration studies at distances of 5, 71, 75, 82, and 150 meters (study maximum of 150 meters for both studies) from the edge of the field;
- **for 16.4-hour exposures (indoors) where soil is intermittently sealed with water** for most data collection points in two separate studies at distances of 137, 150, and 274 meters (study maximums of 150 and 549 meters, respectively) from the edge of the field; and
- **for 16.4-hour exposures (indoors) where soil is not sealed with water** for most data collection points from one air concentration study at all distances (study maximum of 500 meters) from the edge of the field.

Table 13: Chemigation Adult Bystander MITC Risk Summary							
Postapplication Exposure Study	Application Equipment	Sampler Distance from Edge of Field	Type of Seal	Number of MOEs $ 100	Total Number of MOEs	Minimum MOE	Maximum MOE

		(meters)					
2 Hour MITC Exposure Summary [a]							
MRID# 426599-01	Sprinkler	5	No soil seal.	8	13	19	910
		25	No soil seal.	8	13	23	780
		125	No soil seal.	10	13	29	2300
		500	No soil seal.	13	13	150	12000
MRID# 457037-06; Site 1	Sprinkler	150	Intermittent Seal	24	24	110	57000
MRID# 457037-06; Site 2	Sprinkler	150	Standard Seal	23	24	95	430000
MRID# 457037-07; Site 1	Sprinkler	150	Intermittent Seal	47	51	39	80000
MRID# 457037-07; Site 2	Sprinkler	150	Standard Seal	43	50	20	87000
MRID# 457037-02	Sprinkler	137	Intermittent Seal	96	96	110	160000
		274	Intermittent Seal	216	216	110	160000
		411	Intermittent Seal	24	24	620	160000
		530	Intermittent Seal	24	24	320	160000
		549	Intermittent Seal	24	24	630	160000

HED Study Review D290254	Sprinkler	5	Standard Seal	21	38	3	9900
		71	Standard Seal	10	10	160	9200
		75	Standard Seal	11	11	160	8600
		77	Standard Seal	9	9	120	9000
		82	Standard Seal	7	11	3.4	8800
		150	Standard Seal	15	18	5.5	9400
MRID# 457037-08; Site 1	Drip Irrigation	3	Untarped	20	20	530	14000
		6.1	Untarped	10	10	270	2200
		15.2	Untarped	10	10	270	2300
		45.7	Untarped	10	10	430	3400
MRID# 457037-08; Site 2	Drip Irrigation	3	Tarped	20	20	420	480000
		6.1	Tarped	10	10	1100	480000
		15.2	Tarped	10	10	530	480000
		45.7	Tarped	10	10	510	9200
16.4 Hour MITC Exposure Summary [a]							
MRID# 426599-01	Sprinkler	5	No soil seal.	0	2	11	65
		25	No soil seal.	0	2	10	50
		125	No soil seal.	0	2	17	95
		500	No soil seal.	1	2	86	390
MRID# 457037-06; Site 1	Sprinkler	150	Intermittent Seal	4	4	140	57000
MRID# 457037-06; Site 2	Sprinkler	150	Standard Seal	4	4	130	930
MRID# 457037-07; Site 1	Sprinkler	150	Intermittent Seal	4	8	41	640
MRID# 457037-07; Site 2	Sprinkler	150	Standard Seal	4	8	20	460
MRID# 457037-02	Sprinkler	137	Intermittent Seal	14	16	93	15000
		274	Intermittent Seal	35	36	55	28000
		411	Intermittent Seal	4	4	400	870
		530	Intermittent Seal	4	4	360	1100
		549	Intermittent Seal	4	4	570	1200
HED Study Review D290254	Sprinkler	5	Standard Seal	6	12	2.1	2300
		71	Standard Seal	2	3	97	2100
		75	Standard Seal	2	3	67	2900
		77	Standard Seal	3	3	140	2000
		82	Standard Seal	1	3	3.3	220
		150	Standard Seal	4	5	4.9	3300
MRID# 457037-08; Site 1	Drip Irrigation	3	Untarped	8	8	200	1500
		6.1	Untarped	3	4	95	430
		15.2	Untarped	4	4	110	520
		45.7	Untarped	4	4	130	720
MRID# 457037-08; Site 2	Drip Irrigation	3	Tarped	8	8	170	2000
		6.1	Tarped	4	4	420	120000
		15.2	Tarped	4	4	240	12000
		45.7	Tarped	4	4	180	1100

Footnotes

a Assumed a minute volume of 16.7 liters per minute for all two-hour scenarios.

b Assumed a minute volume of 8.3 liters per minute for all 16.4-hour scenarios.

c MOEs were calculated for each individual air sample concentration.

Risks to Children Bystanders Following Shank Injection Applications

Child bystander MITC inhalation MOEs of less than 100 were calculated during at least one or more 2- and 16.4-hour periods for following scenarios:

- **for 2-hour exposures (outdoors) where the soil is sealed with water** for several data collection points from one air concentration study at distances of 150 and 300 meters (study maximum of 700 meters) from the edge of the treated field; and
- **for 2-hour exposures (outdoors) where no soil seal is used** for many data collection points from three air concentration study at all distances (study maximums of 13.7, 18.3, and 36.6 meters, respectively) from the edge of the field;
- **for 16.4-hour exposures (indoors) where the soil is sealed with water** for several data collection points from one air concentration study at distances of 150 and 300 meters (study maximum of 700 meters) from the edge of the treated field; and
- **for 16.4-hour exposures (indoors) where no soil seal is used** for most data collection points from three air concentration study at all distances (study maximums of 13.7, 18.3, and 36.6 meters, respectively) from the edge of the field.

Table 14: Children Bystander MITC Risk Summary Following Shank Injections						
Postapplication Exposure Study	**Sampler Distance from edge of Field (meters)**	**Type of Seal**	**Number of MOEs $ 100**	**Total Number of MOEs**	**Minimum MOE**	**Maximum MOE**
2 Hour MITC Exposure Summary [a]						
MRID# 457037-05: SITE 1	150	Intermittent Seal	22	22	1100	100000
MRID# 457037-05: SITE 2	150	Intermittent Seal	21	21	1300	100000
MRID# 457037-04	150	Intermittent Seal	109	116	49	54000
	300		185	187	89	54000
	500		24	24	330	44000
	700		48	48	450	45000
C94-046A	11.0	No soil seal.	5	6	43	1900
	11.9		14	16	37	14000
	18.3		6	6	130	11000
C92-070A	13.7	No soil seal.	14	21	13	63000
C92-070B	18.3	No soil seal.	14	24	10	7400
	36.6		5	8	44	6200
16.4 Hour MITC Exposure Summary [b]						
MRID# 457037-05: SITE 1	150	Intermittent Seal	4	4	1300	2100
MRID# 457037-05: SITE 2	150	Intermittent Seal	4	4	1800	4100
MRID# 457037-04	150	Intermittent Seal	17	20	41	14000
	300		31	32	90	14000
	500		4	4	520	13000
	700		8	8	510	13000
C94-046A	11.0	No soil seal.	1	3	22	360
	11.9		7	9	17	2400
	18.3		2	3	58	1300
C92-070A	13.7	No soil seal.	2	3	10	250
C92-070B	18.3	No soil seal.	2	9	4.2	180
	36.6		1	3	15	810

Footnotes

a The 2 hour exposure period utilized a minute volume of 16.7 liters per minute for all scenarios.
b The 16.4 hour exposure period utilized a minute volume of 6.7 liters per minute for all scenarios.
c MOEs were calculated for each individual air sample concentration.

Risks to Children Bystanders Following Sprinkler irrigation Applications:

Child bystander MITC inhalation MOEs of less than 100 were calculated during at least one or more 2- and 16.4-hour periods for following scenarios:

Sprinkler irrigation applications

- **for 2-hour exposures (outdoors) where soil is sealed with water** for many data collection points from three air concentration studies at distances of 5, 77, 82, and 150 meters (study maximum of 150 meters for all three studies) from the edge of the field;
- **for 2-hour exposures (outdoors) where soil is intermittently sealed with water** for many data collection points in three separate studies at distances of 137, 150, and

274 meters (study maximums of 150, 150, and 549 meters, respectively) from the edge of the field; and

- **for 2-hour exposures (outdoors) where soil is not sealed with water** for most data collection points from one air concentration study at all distances (study maximum of 500 meters) from the edge of the field.
- **for 16.4-hour exposures (indoors) where soil is sealed with water** for most data collection points from two air concentration study at distances of 5, 71, 75, 82, and 150 meters (study maximums of 150 meters for both studies) from the edge of the field;
- **for 16.4-hour exposures (indoors) where soil is intermittently sealed with water** for most data collection points in two separate studies at distances of 137, 150, and 274 meters (study maximums of 150 and 549 meters, respectively) from the edge of the field; and
- **for 16.4-hour exposures (indoors) where soil is not sealed with water** for most data collection points from one air concentration study at all distances (study maximum of 500 meters) from the edge of the field.

Drip irrigation applications:

- **for 16.4-hour exposures (indoors) where soil is not sealed** for most collection points from one air concentration study at distances of 6.1 and 15.2 meters (study maximum of 45.7 meters) from the edge of the field.

Table 15: Children Bystander MITC Risk Summary Following Chemigation Applications

Postapplication Exposure Study	Application Equipment	Sampler Distance from Edge of Field (meters)	Type of Seal	Number of MOEs ≥ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
2 Hour MITC Exposure Summary [a]							
MRID# 426599-01 (All Samplers on downwind edge of field.)	Chemigation	5	No soil seal.	8	13	14	680
	Chemigation	25	No soil seal.	7	13	17	580
	Chemigation	125	No soil seal.	10	13	22	1700
	Chemigation	500	No soil seal.	13	13	110	9300
MRID# 457037-06; Site 1	Chemigation	150	Intermittent Seal	23	24	85	43000
MRID# 457037-06; Site 2	Chemigation	150	Standard Seal	23	24	71	320000
MRID# 457037-07; Site 1	Chemigation	150	Intermittent Seal	45	51	29	60000
MRID# 457037-07; Site 2	Chemigation	150	Standard Seal	42	50	15	65000
MRID# 457037-02	Chemigation	137	Intermittent Seal	95	96	80	120000
	Chemigation	274	Intermittent Seal	215	216	79	120000
	Chemigation	411	Intermittent Seal	24	24	470	120000
	Chemigation	530	Intermittent Seal	24	24	240	120000
	Chemigation	549	Intermittent Seal	24	24	470	120000
HED Study Review D290254	Chemigation	5	Standard Seal	21	38	2.2	7400
	Chemigation	71	Standard Seal	10	10	120	6900
	Chemigation	75	Standard Seal	11	11	120	6400
	Chemigation	77	Standard Seal	8	9	89	6700
	Chemigation	82	Standard Seal	7	11	2.5	6600
	Chemigation	150	Standard Seal	15	18	4.1	7000
MRID# 457037-08; Site 1	Drip irrigation	3	Untarped	20	20	400	10000
	Drip irrigation	6.1	Untarped	10	10	200	1600
	Drip irrigation	15.2	Untarped	10	10	200	1700
	Drip irrigation	45.7	Untarped	10	10	320	2500
MRID# 457037-08; Site 2	Drip irrigation	3	Tarped	20	20	320	360000
	Drip irrigation	6.1	Tarped	10	10	820	360000
	Drip irrigation	15.2	Tarped	10	10	390	360000
	Drip irrigation	45.7	Tarped	10	10	380	6900

Table 15: Children Bystander MITC Risk Summary Following Chemigation Applications

Postapplication Exposure Study	Application Equipment	Sampler Distance from Edge of Field (meters)	Type of Seal	Number of MOEs $ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
16.4 Hour MITC Exposure Summary [b]							
MRID# 426599-01 (All Samplers on downwind edge of field.)	Chemigation	5	No soil seal.	0	2	9.8	60
	Chemigation	25	No soil seal.	0	2	11	52
	Chemigation	125	No soil seal.	0	2	16	88
	Chemigation	500	No soil seal.	1	2	79	360
MRID# 457037-06; Site 1	Chemigation	150	Intermittent Seal	4	4	130	43000
MRID# 457037-06; Site 2	Chemigation	150	Standard Seal	4	4	120	860
MRID# 457037-07; Site 1	Chemigation	150	Intermittent Seal	4	8	38	590
MRID# 457037-07; Site 2	Chemigation	150	Standard Seal	4	8	18	430
MRID# 457037-02	Chemigation	137	Intermittent Seal	14	16	86	14000
	Chemigation	274	Intermittent Seal	35	36	51	26000
	Chemigation	411	Intermittent Seal	4	4	370	800
	Chemigation	530	Intermittent Seal	4	4	330	1000
	Chemigation	549	Intermittent Seal	4	4	520	1100
HED Study Review D290254	Chemigation	5	Standard Seal	6	12	1.9	2200
	Chemigation	71	Standard Seal	2	3	89	1900
	Chemigation	75	Standard Seal	2	3	62	2700
	Chemigation	77	Standard Seal	3	3	130	1800
	Chemigation	82	Standard Seal	1	3	3.1	200
	Chemigation	150	Standard Seal	4	5	4.5	3000
MRID# 457037-08; Site 1	Drip irrigation	3	Untarped	8	8	180	1400
	Drip irrigation	6.1	Untarped	3	4	88	400
	Drip irrigation	15.2	Untarped	3	4	98	480
	Drip irrigation	45.7	Untarped	4	4	120	660
MRID# 457037-08; Site 2	Drip irrigation	3	Tarped	8	8	160	1900
	Drip irrigation	6.1	Tarped	4	4	390	110000
	Drip irrigation	15.2	Tarped	4	4	220	11000
	Drip irrigation	45.7	Tarped	4	4	170	1000

Footnotes

a The 2 hour exposure period utilized a minute volume of 16.7 liters per minute for all scenarios.

b The 16.4 hour exposure period utilized a minute volume of 6.7 liters per minute for all scenarios.
c MOEs were calculated for each individual air sample concentration.

2.2.7 Postapplication Summary and Data Gaps

2.2.7.1 Summary of Postapplication Risks

The results of the occupational and residential postapplication non-cancer risk assessment indicate MOEs of less than 100 for many of scenarios. With respect to application equipment, data indicate that drip irrigation applications are the most effective in reducing release of MITC, shank injection applications are moderately effective in reducing release of MITC, and sprinkler irrigation applications are the least effective in reducing release of MITC. HED has no data for rotary tiller applications or for handheld/stationary equipment.

With respect to soil seals, data indicate that plastic tarpaulin seals are the most effective in inhibiting release of MITC, water seals are moderately effective in inhibiting release of MITC (they evaporate, unless reapplied); rolling and dragging to compact soil is moderately effective in inhibiting release of MITC, if done correctly; and unsealed soil tends to release MITC.

2.2.7.2 Postapplication Assessment Data Gaps and Uncertainties

Several studies were submitted to EPA that measured MITC air concentration levels following applications of metam sodium with tractor-drawn or chemigation equipment. The air concentration levels were measured at various time periods following application (e.g., 2 hours, 8 hours, 24 hours, etc.), at various distances from the edge of the treated field (e.g., 15 meters, 150 meters, 300 meters, etc.) and in various directions from the treated field (e.g., north, south, east, west, etc.). In all, eleven postapplication exposure studies were submitted – five were conducted following metam sodium applications using shank injection equipment, five were conducted following metam sodium applications using sprinkler irrigation equipment, and one was conducted following metam sodium applications using drip irrigation equipment. In some of the studies, the application was sealed into the soil with water immediately following application, in other studies the application was intermittently (i.e., thin seal of water applied on consecutive days) sealed into the soil with water, and in still other studies, no soil seal was applied. HED had several QA/QC issues with the studies and concerns about some methodologies and inconsistencies.

HED had no data to assess postapplication occupational and bystander exposure to MITC following applications of metam sodium when the soil-seal is removed several days after application. Since the amount of MITC produced from metam sodium is directly related to the application rate, HED is concerned that sealing the soil merely delays the release of MITC into the air. Therefore, even though soil seals greatly reduce the air concentration levels of MITC immediately following application, HED is concerned that removal of the seal and aerating the soil will release MITC air concentration levels of concern. HED has no data on MITC air concentration levels following removal of soil seals and subsequent soil aeration.

HED also has no data to accurately assess the distance from the edge of a treated field where exposure to MITC is no longer of concern. Available data did not assess air concentration levels at distances of sufficient length to permit HED to calculate the distance at which MOEs are at least 100.

Data uncertainties, include insufficient information on the influence of the following on MITC air concentration levels immediately following metam sodium applications:

- wind speed and direction,
- air and soil temperature,
- application rate,
- tarpaulins as a soil seal,
- size of treated area,
- indoor versus outdoor exposures, and
- various application equipment and application techniques.

All postapplication exposure and risk estimates in this assessment are based on a **single treated field.** The exposure and risk for exposure from multiple treated fields **was not** factored in any of the calculations used in this assessment.

There was no data submitted to evaluate applications in small areas such as greenhouses (with open sides) or lawns.   These are also considered data gaps.

3.0 Postapplication Occupational and Residential (Bystander) Exposures and Risks Based on Dispersion Modeling

Since the available methyl isothiocyanate (MITC) data were insufficient to permit HED to establish the distance from the perimeter of treated fields where risks would not be a concern to occupational agricultural workers or bystanders and individuals performing re-entry activities, HED used the Industrial Source Complex (ISC) dispersion model to estimate ambient MITC air concentrations in and near treated fields. The ISC permitted HED to factor into the MITC postapplication exposure and risk assessment some of the items listed as uncertainties for the traditional postapplication risk assessment, including wind speed, wind direction, air temperature, and size of treated area. The model was used to predict MITC air concentration levels at varying distances from the perimeter of metam-sodium-treated fields – and permitted HED to estimate what distances were necessary to achieve risks levels that were not of concern to occupational agricultural workers or bystanders.

3.1 Data/Assumptions for Postapplication Dispersion Modeling

3.1.1 Assumptions for Postapplication Dispersion Modeling

A series of assumptions and exposure factors served as the basis for completing the postapplication dispersion modeling for MITC. The assumptions and factors used in the model include:

- **ICS Analysis Exposure Durations:**
  - For *occupational workers performing tasks near treated areas,* an exposure duration of **8 hours** is used;
  - For *occupational workers reentering treated areas,* exposure durations of **8 and 1 hours** is used;
  - For *non-occupational bystanders*, exposure durations of **24, 16.4, and 2 hours** are used, representing an estimate of time spent indoor and outdoors at one's residence, respectively (based on values from the 1997 EPA Exposure Factor Handbook recommendation for time spent indoor and outdoors at one's residence). These values are based on the Tsang and Klepis (1996) - National Human Activity Pattern Survey (NHAPS) and represent the 50th percentile values from the study data. The 90th percentile values for time spent indoors and outdoors is **23.3** and **6** hours per day, respectively.

- **Minute volume:** Postapplication occupational and residential minute volume assumptions were based on the 1997 EPA Exposure Factors Handbook Volume III. Mean minute volumes recommended for short-term exposures during rest, sedentary, light, and moderate activities are 6.7, 8.3, 16.7, and 26.7 liters per minute, respectively. Mean minute volumes recommended for chronic (e.g., cancer) exposures is 9.3 liters per minute.

  - For *occupational workers performing tasks near treated areas*, a minute volume of 16.7 liters per minute (representing light activities) was used for the 8-hour exposure duration period;

S For *occupational workers reentering treated areas*, a minute volume of 16.7 liters per minute (representing light activities) was used for the 1-hour exposure duration period and a minute volume of 8.3 liters per minute (representing sedentary activities) was used for the 16 hour exposure duration period;

S For *non-occupational bystanders*, a minute volume of 16.7 liters per minute (representing light activities) was used for the 2-hour exposure duration period and a minute volume of 8.3 liters per minute (representing sedentary activities) was used for the 16 and 24 hour exposure duration periods.

- **Levels of Concern:** HED has established the following levels of concern (LOC) for postapplication risks:

  S margin of exposure $100 for occupational non-cancer risks;

  S margin of exposure of $100 for non-occupational (bystander) non-cancer risks;

- **Size of Treated Areas:** Sizes of treated areas from the different field volatility studies ranged from 4 acres to 80 acres. The ratio of the field lengths to the field widths for the treated fields in the field volatility studies ranged from 1:1 to 16:1. For the sake of simplicity, it was assumed that the treated areas were square and that one side was oriented from North to South with the origin at the southwest corner. Analysis were performed for treated-areas sizes of 1, 5, 10, 20, 40, 80, and 100 acres. Table 16 depicts the treated-areas sizes and the associated side dimensions that were used in the analysis.

Table 16: Field Sizes and Corresponding Side Dimension Used in Regional Analysis

Field Size (acres)	Side Dimension (m)
1	64
5	142
10	201
20	285
40	402
80	569
100	636

- **Meteorological Data:** ISC requires the use of hourly meteorological data to determine the ambient air concentrations surrounding a treated area. Specifically, the concentrations predicted by ISC are most dependent on wind speed, wind direction, and air stability category. To determine the most conservative, but realistic, concentration emitting from a treated area, it was assumed that the wind direction and speed, and the air stability category were constant for the time period of concern. For this analysis, a constant stability category of D was used for the 2- and 8-hour ISC runs and a constant stability category of C was used for 16- and 24-hour ISC runs. Wind direction was assumed to be constant for the time periods in question at 180 degrees.

Previous research has indicated that metam sodium and methyl bromide are used as soil fumigants in the following States: Virginia, Florida, Georgia, North Carolina, South Carolina, Kentucky, Wisconsin, Michigan, California, Idaho, Washington, and Oregon. HED collected wind speed data for 5 years (1986 - 1990) from the Solar and Meteorological Surface Observation Network (SAMSON) CD-ROMS for 60 meteorological stations located in 10 of those eleven states. Meteorological stations are part of the National Weather Service and tend to be located at airports of buildings located in cities throughout the state. The data is collected at or above 20 feet. The California wind speed data were not collected because the State of California's Department of Pesticide Registration has developed standard wind speeds that are to be used with ISC to analyze soil fumigant impacts. These wind speeds were developed using data collected for the California Irrigation Management Information System (CIMIS). CIMIS has a network of stations, approximately 2 meters in height, located in agricultural areas throughout the state, collecting various meteorological data for growers to use in applying pesticides. While the two sets of meteorological data may vary in type of location and at the height of collection, HED felt the data collected was representative of the regions in questions and were the best available data for air modeling.

For each SAMSON meteorological station, HED collected five years of data and determined the 10th percentile values for the hourly wind speed. The data incorporates wind speeds from all 12 months of the year and all 24 hours of the day. HED acknowledges that for most of the regions metam use would not occur during winter months and that wind speeds are generally lower at night. However, after determining the 10th percentile value, HED went back to the original data and determined that the 10th percentile value did occur during times of the year when metam use was viable and during times of the day when higher flux rates could occur. The average of the 10th percentile values was then calculated for each EPA region. The calculated wind speed values for the different EPA regions are depicted in Table 17.

Lastly, after discussions with MSTF, a rural mixing height of 735 meters was used during modeling to account vertical mixing during "C"stability conditions.

Table 17: Wind Speed Used in Regional Analysis

Region	Average 10th Percentile Wind Speed (m/s) 2 hour*	Average 10th Percentile Wind Speed (m/s) 16 and 24 hours

3	0.72	2.12
4	1.12	1.95
5	1.50	2.44
9	1.00	1.4
10	0.95	1.99

Notes:
* - For wind speed values less than 1 m/s, ISC will use a default values of 1 m/s.

3.1.2 Determining Flux Rates for Use in Postapplication Dispersion Modeling

For those studies where sufficient information was available to estimate the flux rates for MITC being released from treated fields, the following study-specific information were entered into the appropriate ISC input files, along with a constant flux rate of 0.01 g/m^2-s:

- the dimensions of the treated fields,
- the locations of the sampler masts, and
- the available meteorological data for the period in question

The air concentrations predicted from the model were compared to the measured concentrations reported in the field volatility study. The estimated flux rates were determined by dividing the average measured value by the average modeled value and multiplying the result by the model flux rate (0.01 g/m^2-s) and by a conversion factor of 1x10^6 : g/g. Least squares and major axis regressions were also performed on the measured and modeled data and the results were similar to those obtained using the aforementioned averaging method. The averaging method was also used to estimate the flux rate in the five studies where flux rates were reported. These techniques are consistent with the methodology outlined in California's Department of Pesticide Regulation's Workbook for Gaussian Modeling Analysis of Air Concentration Measurements.

To estimate the risk from potential MITC inhalation exposure to non-occupational bystanders, HED estimated the MITC air concentration using 2-, 16.4-, and 24-hour time frames. However, flux rates were estimated using 4-hour periods, starting from the time the soil fumigant is first applied to 48 hours after the start of application. Average estimates were determined for 16- and 24-hours using the 4-hour flux rates. A 2-hour estimate could only be determined assuming that the flux rate remained constant over the 4 hours. Because ISC provides estimates of hourly concentrations, it was also assumed that 16-hour concentrations were equal to the 16.4 hour concentrations.

The risk for potential inhalation exposure to occupational agricultural workers performing tasks near treated fields was estimated from an average 8-hour flux rate using the 4-hour flux rates, similar to the method mentioned above for non-occupational bystanders.

To determine the flux rates for a particular application method, HED employed a three-step approach, HED:

- first normalized all of the 4-hour flux rates using the maximum agricultural application rate for metam sodium of 320 lbs ai/acre (not including applications to turf or to tobacco planting beds), to normalize the study application rates to the maximum agricultural rate.
- then estimated the maximum 4-, 8-, 16-, and 24-hour average flux rates for each field volatility study.
- lastly compared field studies with similar application and sealing methods and the largest flux rates for the 4-, 8-, 16-, and 24-hour time periods were selected.

It should be noted that because of the way data were reported in the drip irrigation study, some of the flux rates had to be estimated for missing time periods. As a result, the average flux rate values appear higher for tarped fields than they do for untarped fields.

3.1.3 Flux Rates for Postapplication Dispersion Modeling

Metam sodium produces MITC gas when applied to soil. Several studies were submitted to EPA that measured MITC air concentration levels following applications of metam sodium with tractor-drawn or chemigation equipment. The air concentration levels were measured at various time periods following application (e.g., 2 hours, 8 hours, 24 hours, etc.), at various distances from the edge of the treated field (e.g., 15 meters, 150 meters, 300 meters, etc.) and in various directions from the treated field (e.g., north, south, east, west, etc.). In all, eleven postapplication exposure studies were submitted – five were conducted following metam sodium applications using shank injection equipment, five were conducted following metam sodium applications using sprinkler irrigation equipment, and one was conducted following metam sodium applications using drip irrigation equipment. In some of the studies, the application was sealed into the soil with water immediately following application, in other studies the application was intermittently (i.e., thin seal of water applied on consecutive days) sealed into the soil with water, and in still other studies, no soil seal was applied. HED had several QA/QC issues with the studies and concerns about some methodologies and inconsistencies.

Flux rates (i.e., the emission rate of MITC from the treated area divided by the size of the treated area) were estimated directly for five of the ten studies. Three of the remaining five studies provided enough information that MITC flux rates could be estimated using the ISC model. A list of the studies is provided in Table 18. Summaries of the flux rates, both reported and estimated, are provided in Tables 19, 20, and 21.

Table 18: Summary of Field Volatility Studies Used in Metam Sodium Ambient Air Concentration Analysis						
Study ID	**Application Method**	**Application Rate (lbs ai/acre)**	**Study Date**	**Application Time**	**Seal Type**	**Flux Rate Determined?**
457037-02	Sprinkler irrigation	318	8/21/2001	Day 1, 05:00 - 11:30	Intermittent	No
457037-06	Sprinkler irrigation	320	3/13/2000	Day 1, 07:30 - 12:30	Intermittent and Standard	Yes
457037-07	Sprinkler irrigation	203	6/20/2001	Day 1, 05:00 - 11:00	Intermittent and Standard	Yes
EH94-02	Sprinkler irrigation	320	8/3/1993	Day 1, 19:40 - Day 2, 01:40	Standard	No
426599-01	Sprinkler irrigation	320	5/2/1992	Day 1, 16:52 - 20:52	Standard	Yes
457037-01	Shank Injection Sprinkler irrigation	160*** 320	12/14/1999	Day 1, 07:30 - 11:30	Standard Standard	Yes**
457037-04	Shank Injection	160***	6/13/2000	Day 1, 06:50 - 11:40	Intermittent	No
457037-05	Shank Injection	160***	5/23/2000	Day 1, 07:30 - 11:30	Intermittent and Alternate	Yes
C94-046A*	Shank Injection	155	8/23/1995	Day 1, 12:00 - 24:00	None	No
457037-8	Drip Irrigation	320	2/3/1997	Day 1, 18:00 - 22:00	Tarped and Untarped Fields	Yes

* - Insufficient information to estimate flux rate.

** - Report provided did not include flux rates. Flux rates for study found in supplemental report.

*** - For shank injection, only 50% of the field was treated. Therefore, the application rates of 320 lbs ai/treated acre were converted to 160 lbs ai/total acre by dividing by 2.

Table 19: Flux Rates (in μg/m^2-s) Reported and Estimated from Field Volatility Studies for Sprinkler Irrigation

Day	Period (Start Hour and End Hour)	457037-01		457037-02		457037-06				457037-07				EH94-02		426599-01	
		Standard Seal		Intermittent Seal		Intermittent Seal		Standard Seal		Intermittent Seal		Standard Seal		Standard Seal		Standard Seal	
Flux Rate Reported or Estimated?		Reported	%[1]	Estimated	%	Reported	%	Reported	%	Reported	%	Reported	%	Estimated	%	Reported	%
1	0 - 4	35.85	1	60.45	2	21.1	1	16	1	77.63	5	89.77	6	297	12	0.0296	0
1	4 - 8	91.65	5	12.56	3	NR	-	NR	-	34.09	7	148.8	15	274	23	0.0757	0
1	8 - 12	41.42	7	53.42	5	45.5	3	36.7	2	159.19	17	318.325	35	127	28	0.0555	0
1	12 - 16	119.3	12	26.91	6	NR	-	NR	-	16.97	18	320.525	55	86	31	0.0482	0
1	16 - 20	66.77	15	11.38	6	34.7	4	22.2	3	17	19	212.23	68	45	33	0.0193	0
1	20 - 24	232.25	24	9.73	6	NR	-	NR	-	15.85	20	135.28	77	58	36	0.0169	0
2	0 - 4	7.21	24	21.22	7	12.9	5	12.8	4	21.47	21	NR	-	38	37	0.0107	0
2	4 - 8	62.26	26	3.20	7	NR	-	NR	-	31.29	23	NR	-	18	38	0.0085	0
2	8 - 12	41.42	28	17.48	8	3.2	5	4.6	4	27.38	25	NR	-	18	39	0.0045	0
2	12 - 16	40.98	30	13.19	9	NR	-	NR	-	16.97	26	NR	-	14	39	0.0035	0
2	16 - 20	51	32	5.54	9	2.6	5	1.9	4	17	27	NR	-	11	40	0.0029	0
2	20 - 24	6.29	32	1.83	9	NR	-	NR	-	25.26	29	NR	-	11	40	0.0018	0

NR - Not reported or was not estimated.
1. % indicates the Cumulative percentage lost from the total amount applied.

Table 20: Flux Rates (in mg/m²-s) Reported and Estimated from Field Volatility Studies for Shank Injection									
Day	Period (Start Hour and End Hour)	457037-01		457037-04		457037-05			
		Standard Seal		Intermittent Seal		Intermittent Seal		Alternate Seal	
Flux Rate Reported or Estimated?		Reported	%[1]	Estimated	%	Reported	%	Reported	%
1	0 - 4	3.5	0	6.03	0	7.41	1	8.73	1
1	4 - 8	21.42	2	28.37	3	NR	-	NR	-
1	8 - 12	15.95	3	30.91	5	30.54	3	25.65	3
1	12 - 16	51.07	7	15.35	6	19.75	5	11.36	4
1	16 - 20	64.26	13	3.92	7	0.59	5	3.04	4
1	20 - 24	32.86	15	10.25	8	NR	-	NR	-
2	0 - 4	3.5	15	2.58	8	0.65	5	1.25	4
2	4 - 8	5.2	16	3.95	8	NR	-	NR	-
2	8 - 12	5.04	16	6.47	3	4.03	6	3.8	5
2	12 - 16	82.71	23	3.29	9	NR	-	NR	-
2	16 - 20	64.26	28	1.56	9	0	6	0.16	5
2	20 - 24	63.29	33	2.30	9	NR	-	NR	-

NR - Not reported or was not estimated.
1. % indicates the Cumulative percentage lost from the total amount applied.

Table 21: Flux Rates (in mg/m²-s) Reported and Estimated from Field Volatility Studies for Drip Irrigation					
Day	Period (Start Hour and End Hour)	457037-08			
		Tarped Field		Untarped Field	
Flux Rate Reported or Estimated?		Reported	%[1]	Reported	%
1	0 - 4	14.93	1	3.68	0
1	4 - 8	10.61 *	1	6.54 *	0
1	8 - 12	6.29	1	9.39	1
1	12 - 16	3.87	1	3.98	1
1	16 - 20	3.87**	2	3.98**	1
1	20 - 24	3.87**	2	3.98**	1
2	0 - 4	3.7	2	10.36	2
2	4 - 8	NR	-	NR	-
2	8 - 12	NR	-	NR	-
2	12 - 16	2.35	2	2.05	2
2	16 - 20	NR	-	NR	-
2	20 - 24	NR	-	NR	-

NR - Not reported or was not estimated.

Notes:
* - No values were reported for this period. Values were calculated by taking the average of Periods 0-4 and 8-12 for Day 1, assuming linearity between two periods.
** - No values were reported during these periods. It was assumed that the flux rates for these periods were the same as those reported in Period 12-16 for Day 1.
1. % indicates the Cumulative percentage lost from the total amount applied.

To be conservative, HED selected the maximum flux rates from the aforementioned studies for the different application methods, sealing methods, and time periods of concern. Pilot studies were excluded from consideration. These studies included 457037-05, 457037-06, and 457037-07. However, because the only available data for drip irrigation was from a pilot study, Study 457037-08 was included in the flux rate analysis. The remaining studies were analyzed to determine the maximum flux rates. For example, for sprinkler irrigation, standard seal, the maximum flux rates occurred in study 457037-01. The maximum 2-hour flux rate occurred during Day 1, between hours 20 and 24. The maximum 8-hour flux rate occurred during Day 1, between hours 16 and 24. The maximum 16-hour flux rate occurred during Day 1, between hours 8 and 24. And, the maximum 24-hour flux rate occurred during Day 1, between hours 0 and 24.

To normalize the flux rates for various application and sealing methods, the maximum application rate of 320 lbs ai/acre was used. The flux rates are shown in Table 22.

Table 22: Flux Rates Used in Regional Analysis

Application Method	Conditions	Study Basis	Study Application Rate (lbs ai/acre)	2-hour Flux Rate (ug/m^2-s)	8-hour Flux Rate (ug/m^2-s)	16-hour Flux Rate (ug/m^2-s)	24-hour Flux Rate (ug/m^2-s)
Reported Flux Rates							
Sprinkler irrigation	Standard Seal	457037-01	320	232	149	115	98
	Intermittent Seal	457037-02	318	61	40	38	29
Shank Injection	Standard Seal	457037-01	160	83	74	54	37
	Intermittent Seal	457037-04	160	31	30	20	16
Drip Irrigation	Tarped	457037-08	320	15	13	9	7
	Untarped	457037-08	320	10	8	6	5
Normalized Flux Rates							
Sprinkler irrigation	Standard Seal	457037-01	320	232	149	115	98
	Intermittent Seal	457037-02	320	61	40	38	29
Shank Injection	Standard Seal	457037-01	160*	83	74	54	37
	Intermittent Seal	457037-04	160*	31	30	20	16
Drip Irrigation	Tarped	457037-08	320	15	13	9	7
	Untarped	457037-08	320	10	8	6	5

* - Equivalent to 320 lbs ai/treated acre.

3.2 MITC Occupational and Residential Postapplication Exposure Scenarios

3.2.1 MITC Occupational Postapplication Exposure Scenarios

Traditional postapplication occupational exposure assessments concentrate on postapplication dermal exposures to treated surfaces. However, in the postapplication exposure assessment following metam sodium applications, HED is concerned about inhalation exposures to MITC to occupational workers who are performing tasks:

- in treated areas, and
- near treated areas.

Workers Entering into Treated Areas: The Worker Protection Standard for Agricultural Pesticides (WPS) completely prohibits occupational workers and other persons from entering treated areas following applications of fumigant pesticides until inhalation exposures are no longer a concern. The entry prohibition is applicable to the area (i.e., field) to which the fumigant was applied. Entry into fumigant-treated is permitted for handlers only and only when they are performing one of the following tasks: adding or adjusting a soil seal, to check on air concentration levels, or to aerate the treated area. Therefore, to protect occupational workers from postapplication exposure following metam sodium applications, HED needs to determine when inhalation exposures to MITC fall below and remain below HED's level of concern Based on those determinations, HED can establish an entry prohibition period – a period that begins with start of the metam sodium application and extends at least until the soil is aerated (approximately five to seven days) and the MITC has dissipated. The owner/operator of agricultural establishment with the treated field and the employer of the occupational workers are jointly responsible for keeping the workers out of the treated area until reentry is permitted.

Workers Performing Tasks Near Treated Areas: Based on available MITC air concentration data, HED has concerns about occupational workers performing tasks near – but outside of – a metam-sodium-treated field. The WPS does not address situations involving workers performing tasks outside the treated area. These workers may be employees of the owner/operator of the agricultural establishment where the application is taking place, but they also may be employees on another nearby establishment. In the latter situation, the owner/operator has no legal authority over the occupational workers on another establishment. Therefore, an entry prohibition for occupational workers performing tasks near treated fields is not feasible. To protect such occupational workers, HED needs to determine the distance from the edge of the treated field where inhalation exposures to MITC are above HED's level of concern at any time from the start of the application until the soil is aerated and the MITC dissipates.

3.2.2 MITC Residential Postapplication Exposure Scenarios

Based on available MITC air concentration data, HED has concerns about non-occupational bystanders located near – but outside of – a metam-sodium-treated field. These may be adults or children who live and/or work near the treated field. To protect such persons, HED needs to determine the distance from the edge of the treated field where inhalation exposures to MITC are above HED's level of concern at any time from the start of the application until the soil is aerated and the MITC dissipates.

3.3 Non-cancer MITC Inhalation Risks for Non-occupational Bystanders

HED ran ISC for each of the various application and sealing methods, treated-area sizes, and regions to estimate the downwind distance to the concentration of concern for non-occupational bystanders. The concentration of concern (COC) is the highest MITC air concentration level that results in MOEs that are not a concern to HED (i.e. concentration where MOE is at least 100 assuming a given minute volume and exposure duration). Using a target inhalation MOE of 100 and minute volumes of 16.7, 8.3, and 8.3 L/min for 2-, 16-, and 24-hour time periods, respectively, HED calculated the following MITC air concentration levels of concern:

- 240 ug/m3 for 2-hours;
- 59.1 ug/m3 for 16-hours; and,
- 40.4 ug/m3 for 24-hours.

Tables 23, 24, 25, 26, 27, and 28 depict the distances for the various applications methods, sealing methods, and EPA Regions that bystanders must remain from the edge of the treated area in order to achieve risks that are not of concern.

Tables 23 and 24 indicate that for 2-, 16- and 24-hr time frames, sprinkler irrigation applications – primarily due to the high flux rates – resulted in lengthy distances (greater than 1,600 meters for treating 20+ acres in most circumstances when a standard seal is utilized) from the treated area until the concentrations of concern were achieved.

Table 23: Sprinkler irrigation, Standard Seal, MOE=100

Acreage	Distance (m) (2-hr 240 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	666	619	508	666	666
5	1,818	1,675	1,350	1,818	1,818
10	2,869	2,647	2,139	2,869	2,869
20	4,599	4,235	3,411	4,599	4,599
40	7,323	6,751	5,450	7,323	7,323
80	11,785	10,845	8,746	11,785	11,785
100	13,767	12,667	10,190	13,767	13,767

Acreage	Distance (m) (16-hr 59.1 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	353	372	322	459	368
5	849	895	774	1,103	884
10	1,245	1,314	1,136	1,618	1,297
20	1,831	1,932	1,671	2,379	1,907
40	2,679	2,827	2,445	3,481	2,791
80	3,938	4,155	3,593	5,116	4,101
100	4,455	4,701	4,066	5,789	4,640

Acreage	Distance (m) (24-hr 40.4 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	406	428	372	525	423
5	977	1,029	893	1,261	1,016
10	1,433	1,510	1,311	1,850	1,491
20	2,107	2,220	1,928	2,721	2,192
40	3,083	3,249	2,820	3,981	3,208
80	4,531	4,774	4,145	5,852	4,714
100	5,127	5,402	4,690	6,624	5,334

Table 24: Sprinkler irrigation, Intermittent Seal, MOE=100

Acreage	Distance (m) (2-hr 240 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	247	223	166	247	247
5	642	579	430	642	642
10	986	884	660	986	986
20	1,601	1,436	1,043	1,601	1,601
40	2,570	2,317	1,719	2,570	2,570
80	4,187	3,780	2,828	4,187	4,187
100	4,897	4,428	3,330	4,897	4,897

Acreage	Distance (m) (16-hr 59.1 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	157	169	139	219	166
5	379	406	334	527	399
10	556	597	491	774	587
20	819	879	723	1,139	865
40	1,200	1,288	1,060	1,667	1,266
80	1,766	1,894	1,559	2,451	1,863
100	1,998	2,144	1,765	2,773	2,108

Acreage	Distance (m) (24-hr 40.4 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	172	185	153	238	182
5	416	445	369	571	438
10	610	653	542	839	643
20	899	962	798	1,234	946
40	1,316	1,408	1,169	1,806	1,385
80	1,936	2,070	1,720	2,655	2,037
100	2,191	2,343	1,947	3,005	2,305

Tables 25 and 26 indicate that for 2-, 16- and 24-hr time frames, shank injection applications resulted in lengthy distances from the treated area until the concentrations of concern were achieved.

Table 25: Shank Injection, Standard Seal, MOE=100

Acreage	Distance (m) (2-hr 240 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	321	292	226	321	321
5	828	757	588	828	828
10	1,307	1,183	897	1,307	1,307
20	2,097	1,905	1,458	2,097	2,097
40	3,352	3,046	2,351	3,352	3,352
80	5,427	4,946	3,836	5,427	5,427
100	6,330	5,774	4,492	6,330	6,330

Acreage	Distance (m) (16-hr 59.1 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	209	222	187	282	219
5	503	535	451	677	527
10	738	786	662	993	774
20	1,086	1,156	975	1,461	1,139
40	1,590	1,692	1,427	2,138	1,667
80	2,338	2,488	2,098	3,142	2,451
100	2,645	2,815	2,375	3,555	2,773

Acreage	Distance (m) (24-hr 40.4 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	209	223	188	282	219
5	503	536	451	678	528
10	739	787	663	995	775
20	1,088	1,158	976	1,463	1,141
40	1,593	1,695	1,430	2,141	1,670
80	2,342	2,492	2,102	3,147	2,455
100	2,650	2,819	2,379	3,561	2,778

Table 26: Shank Injection, Intermittent Seal, MOE=100

Acreage	Distance (m) (2-hr 240 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	119	101	67	119	119
5	307	262	170	307	307
10	476	408	262	476	476
20	739	636	412	739	739
40	1,219	1,025	644	1,219	1,219
80	2,062	1,765	1,085	2,062	2,062
100	2,433	2,093	1,305	2,433	2,433

Acreage	Distance (m) (16-hr 59.1 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	80	89	67	127	87
5	193	215	161	307	209
10	285	316	237	452	309
20	422	467	350	667	456
40	620	686	516	977	670
80	915	1,012	762	1,438	988
100	1,036	1,146	864	1,628	1,119

Acreage	Distance (m) (24-hr 40.4 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	96	106	81	147	104
5	234	257	197	356	251
10	345	378	291	523	370
20	509	558	431	771	546
40	747	819	633	1,130	801
80	1,101	1,207	934	1,662	1,181
100	1,247	1,366	1,057	1,881	1,337

Tables 27 and 28 indicate that drip irrigation methods result in much lower distances to achieve the concentrations of concern than either sprinkler irrigation or shank injection applications. All distance (where MOEs of at least 100) are less than 800 meters for all field sizes up to 100 acres.

Table 27: Drip Irrigation, Tarped Field, MOE=100

Acreage	Distance (m) (2-hr 240 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	40	33	22	40	40
5	101	83	47	101	101
10	155	127	72	155	155
20	241	197	113	241	241
40	380	311	176	380	380
80	607	495	283	607	607
100	713	579	330	713	713

Acreage	Distance (m) (16-hr 59.1 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	24	25	22	46	25
5	54	64	42	112	62
10	81	95	62	166	92
20	121	142	92	246	136
40	180	210	137	363	202
80	269	313	206	538	302
100	306	356	234	610	343

Acreage	Distance (m) (24-hr 40.4 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	28	34	24	56	33
5	70	80	53	136	77
10	103	119	79	201	115
20	153	177	119	298	171
40	227	263	176	440	254
80	339	390	264	651	377
100	385	443	300	738	428

Table 28: Drip Irrigation, Untarped Field, MOE=100

Acreage	Distance (m) (2-hr 240 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	22	19	12	22	22
5	47	38	21	47	47
10	72	57	27	72	72
20	113	89	44	113	113
40	176	139	69	176	176
80	283	223	112	283	283
100	330	260	131	330	330

Acreage	Distance (m) (16-hr 59.1 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	16	18	13	24	18
5	24	27	21	56	25
10	35	42	24	83	41
20	50	63	37	123	60
40	76	93	53	183	89
80	116	141	82	274	134
100	132	160	94	312	153

Acreage	Distance (m) (24-hr 40.4 ug/m3)				
	Region 3	Region 4	Region 5	Region 9	Region 10
1	20	22	18	34	21
5	37	44	25	79	42
10	53	64	40	118	61
20	80	95	59	175	92
40	120	142	88	260	136
80	179	213	132	387	204
100	205	242	151	440	233

3.4 Non-cancer MITC Inhalation Risks to Occupational Workers Performing Tasks Near Treated Areas

HED ran ISC for each of the various application and sealing methods, treated-area sizes, and regions to estimate the downwind distance to the concentration of concern for occupational workers. Using a target inhalation MOE of 100 and a minute volume inhalation rate of 16.7 L/min for an 8-hour time period, HED calculated a concentration of concern of 60 ug/m3. Tables 29, 30, and 31 depict the distance ranges for the various applications methods, sealing methods, and EPA Regions. A maximum distance of 12,000 meters was used for the various treated-area sizes.

Table 29 shows that shank injection applications generated lengthy distances (thousands of meters for fields greater than 5 acres in size) from the edge of the treated area until the concentration of concern was achieved.

Table 29: Distances for Occupational Workers–Shank Injection (8 hours, Concentration of Concern = 60 $\mu g/m^3$)

Acreage	Region 3	Region 4	Region 5	Region 9	Region 10
Shank Injection, Standard Seal - Distance (m)					
1	780	725	599	780	780
5	2,160	1,993	1,617	2,160	2,160
10	3,418	3,153	2,557	3,418	3,418
20	5,473	5,049	4,088	5,473	5,473
40	8,712	8,036	6,516	8,712	8,712
80	> 12,000	> 12,000	10,466	> 12,000	> 12,000
100	> 12,000	> 12,000	> 12,000	> 12,000	> 12,000
Shank Injection, Intermittent Seal - Distance (m)					
1	424	391	311	424	424
5	1,109	1,013	804	1,109	1,109
10	1,764	1,614	1,266	1,764	1,764
20	2,810	2,574	2,034	2,810	2,810
40	4,498	4,119	3,251	4,498	4,498
80	7,237	6,636	5,267	7,237	7,237
100	8,426	7,733	6,145	8,426	8,426

Table 30 shows that sprinkler irrigation applications also generated lengthy distances (thousands of meters for fields greater than 5 acres in size) from the edge of the treated area until the concentration of concern was achieved.

Table 30: Distances for Occupational Workers–Sprinkler Irrigation (8 hours, Concentration of Concern = 60 µg/m^3)

Acreage	Region 3	Region 4	Region 5	Region 9	Region 10
Sprinkler irrigation, Standard Seal - Distance (m)					
1	1,236	1,145	939	1,236	1,236
5	3,502	3,237	2,647	3,502	3,502
10	5,582	5,159	4,212	5,582	5,582
20	8,923	8,252	6,734	8,923	8,923
40	> 12,000	> 12,000	10,730	> 12,000	> 12,000
80	> 12,000	> 12,000	> 12,000	> 12,000	> 12,000
100	> 12,000	> 12,000	> 12,000	> 12,000	> 12,000
Sprinkler irrigation, Intermittent Seal - Distance (m)					
1	520	481	390	520	520
5	1,385	1,271	1,009	1,385	1,385
10	2,194	2,015	1,608	2,194	2,194
20	3,499	3,213	2,565	3,499	3,499
40	5,590	5,134	4,105	5,590	5,590
80	8,965	8,250	6,613	8,965	8,965
100	10,453	9,604	7,706	10,453	10,453

Drip irrigation (see Table 31) generated much shorter distances to achieve the concentrations of concern than either sprinkler irrigation or shank injection applications. However, even these distances (the highest being around 4,250 meters for a 100 acre field) may be too lengthy for to protect occupational workers, especially for larger field acreage sizes.

Table 31: Distances for Occupational Workers–Drip Irrigation (8 hours, Concentration of Concern = 60 : g/m^3)

Acreage	Region 3	Region 4	Region 5	Region 9	Region 10
Drip Irrigation, Tarped Field - Distance (m)					
1	214	191	137	214	214
5	555	496	356	555	555
10	846	758	549	846	846
20	1,370	1,216	853	1,370	1,370
40	2,217	1,981	1,419	2,217	2,217
80	3,621	3,244	2,367	3,621	3,621
100	4,243	3,810	2,787	4,243	4,243
Drip Irrigation, Untarped Field - Distance (m)					
1	123	106	70	123	123
5	321	274	179	321	321
10	497	426	275	497	497
20	770	664	433	770	770
40	1,275	1,078	677	1,275	1,275
80	2,147	1,847	1,151	2,147	2,147
100	2,531	2,187	1,382	2,531	2,531

From Tables 29 and 30 it can be seen that the sprinkler irrigation and shank injection applications generated lengthy distances (thousands of meters for fields greater than 5 acres in size) from the edge of the treated area until the concentration of concern was achieved. Drip irrigation generated much shorter distances to achieve the concentrations of concern than either sprinkler irrigation or shank injection applications. However, even these distances may be too lengthy for to protect occupational workers.

3.5 Entry Prohibition Intervals for Occupational Workers Reentering Treated Areas

According to the *ISC User's Guide, Volume II - Description of Model Algorithms, Section 1.2.3, The Short-term Area Source Model*, ISCST can estimate air concentrations for receptors located in an area source, – in this case in a field treated with metam sodium – provided the fields are more than a few meters across. Therefore, HED attempted to estimate the flux rates from the various treated-area sizes that would be necessary to generate ambient MITC air concentrations at or below the maximum permissible MITC air concentrations for occupational worker reentry into the treated area. HED then used this estimate to quantify the entry prohibition interval for occupational workers.

3.5.1 Entry Prohibition Interval Model Calculations for Occupational Workers Reentering Treated Areas

HED examined entry prohibition intervals using 1-hour and 8-hour exposures. HED calculated 1-hour and 8-hour ambient MITC air concentrations of concern at 481 and 121 : g/m3, respectively.

Using ISCST, HED estimated the ambient air concentrations in the treated fields using a flux rate of 100 : g/m^2-s. Because the wind speed and stability category at the treated area have the largest impacts on determining the ambient air concentrations inside the treated field boundaries, HED used wind speeds and stability categories that would provide a range for the entry prohibition interval. For the minimum entry prohibition time, HED estimated the average wind speed (approximately 5 m/s) for the various regions where metam sodium is or will be used during the months of March and April and assumed the wind stability category was C. For the maximum entry prohibition time, HED assumed that the wind speed was 1 m/s (the minimum wind speed used in ISCST) and that the stability category was D. In both cases, the wind was assumed to be moving in a southerly direction. For all treated-area sizes and meteorological conditions, the maximum concentration typically occurred at the midpoint of the southern-most edge of the field.

Since there is a direct proportionality between the flux rate and the ambient concentrations estimated in ISC, HED estimated the flux rates that would generate the necessary ambient concentration by using the following equation

$$Flux_{req} = Flux_{model} \times \frac{COC}{C_{model}}$$

where

$Flux_{req}$	required flux rate (: g/m^2-s)
$Flux_{model}$	modeled flux rate (100 : g/m^2-s)
COC	concentration of concern (: g/m^3)
C_{model}	concentration from model (: g/m^3)

Table 32 depicts the maximum and minimum flux rates for the 1-hour and 8-hour concentrations of concern. It should be noted that the maximum flux rates will occur sooner in the course of a field volatility study, and therefore will provide the minimum time required for reentry. Conversely, the minimum flux rates will take longer to achieve and will provide the maximum reentry time. HED then compared the estimated maximum and minimum flux rates to the flux rates developed in the field volatility studies that were used to determine distances where MOEs were at least 100 and identified when the estimated flux rate would be achieved for the different application and sealing methods.

Table 32: Required Concentrations and Associated Flux Rates Modeled for Re-Entry Determination						
Acreage	**Maximum Flux Rates**			**Minimum Flux Rates**		
	Modeled Concentration (μg/m3)	**1-hour Flux Rate ($\mu g/m^2$-s)**	**8-hour Flux Rate ($\mu g/m^2$-s)**	**Modeled Concentration (μg/m3)**	**1-hour Flux Rate ($\mu g/m^2$-s)**	**8-hour Flux Rate ($\mu g/m^2$-s)**
1	722	67	17	5,193	9	2
5	893	54	14	6,554	7	2
10	973	49	12	7,207	7	2
20	1,051	46	12	7,864	6	2
40	1,136	42	11	8,575	6	1
80	1,218	40	10	9,312	5	1
100	1,245	39	10	9,567	5	1

Minimum values were determined using the 5 m/s, stability category C meteorological conditions, while the maximum values were determined using the 1 m/s, stability category D meteorological conditions.

3.5.2 Summary of Entry Prohibition Intervals for Occupational Workers Reentering Treated Areas

A summary of the entry prohibition intervals for occupational workers reentering areas after applications of metam sodium are presented below in Tables 33 and 34. Where ">" symbols are used, the applicable field volatility study did not provide flux rates beyond the time reported in the table. Where values are reported, the value represents the time the reported flux rate remained at or below the required flux rate.

Table 33: Minimum and Maximum Entry Prohibition Times for Various Application and Sealing Types for 1-Hour Exposure												
Acreage	**Entry Prohibition, Hours After Application, for 1-hour Exposure**											
	Sprinkler irrigation				**Shank Injection**				**Drip Irrigation**			
	Standard		**Intermittent**		**Standard**		**Intermittent**		**Tarped**		**Untarped**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
1	28	44	0	40	40	> 48	0	24	0	8	0	> 28
5	32	44	4	40	> 48	> 48	0	24	0	8	0	> 28
10	44	44	12	40	> 48	> 48	0	24	0	8	0	> 28
20	44	> 48	12	40	> 48	> 48	0	36	0	12	0	> 28
40	44	> 48	12	40	> 48	> 48	0	36	0	12	0	> 28
80	44	> 48	12	44	> 48	> 48	0	36	0	12	0	> 28
100	44	> 48	12	44	> 48	> 48	0	36	0	12	0	> 28

Studies used for comparison were the same ones used to develop the flux rates used in the regional analysis (see Table 22).

Table 34: Minimum and Maximum Entry Prohibition Times for Various Application and Sealing Types for 8-Hour Exposure												
Acreage	Entry Prohibition, Hours After Application, for 8-hour Exposure											
	Sprinkler irrigation				Shank Injection				Drip Irrigation			
	Standard		Intermittent		Standard		Intermittent		Tarped		Untarped	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	44	> 48	36	44	> 48	> 48	12	> 48	0	> 40	0	> 36
5	44	> 48	36	44	> 48	> 48	16	> 48	4	> 40	0	> 36
10	44	> 48	40	44	> 48	> 48	16	> 48	4	> 40	0	> 36
20	44	> 48	44	44	> 48	> 48	16	> 48	4	> 40	0	> 36
40	44	> 48	44	> 48	> 48	> 48	16	> 48	4	> 40	0	> 36
80	44	> 48	44	> 48	> 48	> 48	24	> 48	8	> 40	> 28	> 36
100	44	> 48	44	> 48	> 48	> 48	24	> 48	8	> 40	> 28	> 36

Studies used for comparison were the same ones used to develop the flux rates used in the regional analysis (see Table 22).

According to the current product labels for metam sodium, "Entry (including early entry that would otherwise be permitted under the WPS) any person - other than a correctly trained and equipped handler who is performing a handling task permitted on this label - is PROHIBITED from the start of application until 48 hours after the application." The results of ISC modeling indicate that MOEs of less than 100 are likely to occur for individuals performing tasks in treated fields even after 48 hours. Entry exposure and risk estimates may be further refined with air monitoring data collected inside treated fields.

3.6 Summary of Risk Concerns for Dispersion Modeling

Several studies were submitted to EPA that measured MITC air concentration levels following applications of metam sodium with tractor-drawn or chemigation equipment. The air concentration levels were measured at various time periods following application (e.g., 2 hours, 8 hours, 24 hours, etc.), at various distances from the edge of the treated field (e.g., 15 meters, 150 meters, 300 meters, etc.) and in various directions from the treated field (e.g., north, south, east, west, etc.). In some of the studies, the application was sealed into the soil with water immediately following application, in other studies the application was intermittently (i.e., thin seal of water applied on consecutive days) sealed into the soil with water, and in still other studies, no soil seal was applied. HED had several QA/QC issues with the studies and concerns about some methodologies and inconsistencies.

In several of the studies, the reported flux rates were somewhat sinusoidal. For instance, as shown in Table 19, the flux rate for the Study 457037-07 decreased to 15.85 : g/m^2-s during Day 1, Period 20-24, but then rose to 31.29 : g/m^2-s during Day 2, Period 4-8. In such cases, if the reported flux rate was at or below the required flux rate for a particular period, but then rose above the required flux rate at a later period, the entry prohibition time would be selected when the reported flux rate decreased below the required flux rate and remained below it.

Data uncertainties, include insufficient information on the influence of the following on MITC air concentration levels immediately following metam sodium applications:

- wind speed and direction,
- air and soil temperature,
- application rate,
- tarpaulins as a soil seal,
- size of treated area,
- dissipation time of MITC
- indoor versus outdoor exposures, and
- various application equipment and application techniques.

3.7 Risk Characterization for Dispersion Modeling

HED believes that the air concentrations estimated in this report and the corresponding distances to those concentrations represent the highest quality results that could be produced given the application, meteorological, and toxicology data collected from the various available field volatility studies. HED believes that the distances represent reasonable worse-case estimates because maximum flux rates are coupled with medium- to high-end estimates of treated area acreage and low-end wind speeds to generate estimates that likely will fall in the upper percentiles of actual distance distributions.

4.0 References

5/13/04 HED memo from A. Lowit to M. Stasikowski. Quantification of carcinogenic potential for MITC with metam sodium cancer slope factor (DP293345)

4/2/04 HED memo from Anna Lowit. Metam Sodium (039003), Metam Potassium (039002), Dazomet (035602), and MITC (068103) Report of the Hazard Identification Assessment Review Committee.

August 2002 California EPA DPR report: Evaluation of MITC as a Toxic Contaminant

Johnson, B., Barry, T., Wofford, P. (1999). Workbook for Gaussian Modeling Analysis of Air Concentration Measurements. California Department of Pesticide Regulation. September 1999. EH99-03.

6/24/02 California EPA DPR report: Metam Sodium, Risk Characterization Document

8/17/94 HED memo from A. Mehta, Comments on CA Risk Assessment on MITC

9/30/02 HED Memo from S. Recore. Review of Mixer/Loader/Applicator Inhalation Monitoring Study Using Personal Sampling Pumps. (DP Barcode D285487, MRID 42958401)

9/30/02 HED Memo from S. Recore. Review of Mixer/Loader/Applicator Inhalation Monitoring Study Using Personal Sampling Pumps (DP Barcode D285486, MRID 42968402)

5/30/03 HED Memo from S. Recore. Review of Determination of Methyl Isothiocyanate Inhalation Exposure to Workers as They Apply Metam-Sodium through Shank Injection and Sprinkler Irrigation. (DP Barcode D273316, MRID 42968402)

5/13/04 HED Memo from S. Recore. Review of Determination of Methyl Isothiocyanate Inhalation Exposure to Workers During Application Metam-Sodium through Shank Injection. (DP Barcode D290873, MRID 45703703)

MRID 42440501, Rosenheck, L. (1992) Worker Mixer/Loader and Applicator Exposure from Field Applications of Metam-Sodium: Lab Project Number: EF-91-360. Unpublished study prepared by Morse Laboratories and Pan-Agricultural Laboratories Inc.

MRID 42968402, Rosenheck, L. (1993) Worker Mixer/Loader and Applicator Exposure From Field Applications of Metam-Sodium: Lab Project Number: EF-91-360. Unpublished study prepared by Morse Labs; Pan-Agricultural Labs, Inc.

8/7/02 HED memo from S. Weiss. (DP Barcode D281774), Study Review of Ambient Air Monitoring in Contra Costa County During March 1993 After an Application of Metam-Sodium to a Field. (Test Report No. C92-070A)

8/702 HED memo from S. Weiss (DP Barcode D281777), Study Review of Ambient Air Monitoring For MITC in Kern County During Summer 1993 (Test Report No. C92-070)

8/7/02 HED memo from S. Weiss (DP Barcode D281778), Study Review of Ambient Air Monitoring for MITC in Kern County During Summer 1993 After a Ground Injection Application of Metam-Sodium to a Field (Test Report No. C92-070B)

8/7/02 HED memo from S. Weiss (DP Barcode D281787), Study Review of Field Volatility of Metam-Sodium During and After Applications (MRID 42659901)

8/7/02HED memo from S. Weiss (DP Barcode D281790), Study Review of Ambient Air Monitoring for MIC and MITC After a Soil Injection Application of Metam-Sodium in Kern County During August 1995 (Test Report No. C94-046A)

8/7/02 HED memo from S. Weiss (DP Barcode D281791), Study Review of Determination of Methyl Isothiocyanate Offsite Air Movement From the Application of Metam-Sodium Through Shank Injection and Sprinkler Irrigation (MRID 451239-01)

8/7/02 HED memo from S. Weiss. Post-application Bystander Risk Estimates for Allante Granular Herbicide (DP Barcode D281430)

6/13/03 HED memo from S. Weiss. Study Review of Determination of Methyl Isothiocyanate Offsite Air Movement from the Chemigation of Metam Sodium Through Sprinkler Irrigation (DP Barcode D290245, MRID 45703702)

6/13/03 HED memo from S. Weiss. Study Review of Determination of Methyl Isothiocyanate Offsite Air Movement from the Chemigation of Metam Sodium Through Shank Injection (DP Barcode D290246, MRID 45703704)

6/13/03 HED memo from S. Weiss. Study Review of Santa Barbara County Pilot Study of Intermittent Sealing for a Shank Injection Application (DP Barcode D290247, MRID 45703705)

6/13/03 HED memo from S. Weiss. Study Review of Lancaster County Pilot Study of Intermittent Sealing for a Sprinkler Irrigation Application (DP Barcode D290249, MRID 45703706)

6/13/03 HED memo from S. Weiss. Study Review of Panama Lane Pilot Study of Intermittent Sealing for a Chemigation Application (DP Barcode D290251, MRID 45703707)

6/13/03 HED memo from S. Weiss. Study Review of Orange County Drip Application Study Modeling Results Prepared for the Metam Sodium Task force (DP Barcode D290252, MRID 45703708)

6/13/03 HED memo from S. Weiss. Study Review of Determination of Ambient MITC Residues in Indoor and Outdoor Air in Townships near Fields with Metam Sodium (Sieber, 1999) (DP Barcode D290253)

6/13/03 HED memo from S. Weiss. Study Review of Ambient Air Monitoring for Pesticides in Lompoc, California Volume 2: Fumigants (Wofford, 2003) (DP Barcode D290255)

6/13/03 HED memo from S. Weiss. Study Review of Air Monitoring for Methyl Isothiocyanate During a Sprinkler Application of Metam Sodium (Wofford, 1999) (DP Barcode D290254)

5/13/94 CDPR memo from D. Haskell. Estimation of Occupational and Nonoccupational Exposure to Sodium Tetrathiocarbonate and Carbon Disulfide from Proposed Registration of Enzoneon Grapes and Citrus. Worker Health and Safety Branch, DPR. HSM-94003.

12/7/93 Unocal Corporation Report by R Pilling. Worker Exposure to Sodium Tetrathiocarbonate and Carbon Disulfide During Normal Application of GY-81. (Unocal Study 770AA11)

6/7/94 CDPR memo from D. Haskell. Worker Exposure to Sodium Tetrathiocarbonate and Carbon Disulfide During Normal Application of GY-81. Worker Health and Safety Branch, DPR. HSM-94004.