UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

May 21, 2004

MEMORANDUM

SUBJECT: METAM SODIUM/METAM POTASSIUM: The HED Chapter of the Reregistration Eligibility Decision Document (RED). PC Codes 039003 and 039002. Case 2390. DP Barcode: D293343

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The attached human health risk assessment for the methyl dithiocarbamate salts metam sodium (sodium N-methyldithiocarbamate) and metam potassium (potassium N-methyldithiocarbamate) is generated as part of Phase III of the public participation process. The Health Effect Division's (HED's) chapter reflects the Office of Pesticide Programs (OPP) current policies and guidelines concerning risk assessment. There are no residues expected in or on food upon use of metam sodium and metam potassium ("non-food use chemicals") as a soil fumigants; therefore, OPP is not required to evaluate the chemicals' risks under the rubric established by the Food Quality Protection Act (FQPA) of 1996. However, metam sodium and metam potassium are subject to evaluation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This chapter includes a product chemistry review by Ken Dockter, residue chemistry review by Sherrie Kinard, toxicology review by Anna Lowit and Judy Facey, incident review by Jerry Blondell and Monica Hawkins, and an occupational and residential exposure and risk assessment by Steven Weiss. Information concerning the environmental fate and drinking water exposure potential of metam sodium/potassium was prepared by Faruque Khan, Environmental Fate and Effects Division.

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1.0 Executive Summary

The methyl dithiocarbamate salts metam sodium (sodium N-methyldithiocarbamate) and metam potassium (potassium N-methyldithiocarbamate) are non-selective pre-plant or post-harvest soil fumigants with fungicidal, herbicidal, insecticidal, and nematicidal properties. Metam sodium and potassium end-use products are registered for many crops including: root and tuber vegetables; bulb vegetables; leafy vegetables; Brassica (cole) leafy vegetables; legume vegetables; fruiting vegetables; cucurbit vegetables; citrus fruits; pome fruits; stone fruits; berries; tree nuts; cereal grains; nongrass livestock feeds; and herbs and spices. Metam sodium/potassium may be applied to field or row crops via chemigation, soil broadcast treatment, soil band treatment, soil-incorporated treatment, and soil-injection treatment. The mode of pesticidal action is inactivation of sulfhydryl groups in amino acids. Based upon the results of acceptable plant metabolism studies, there is currently no expectation of residues on foods from the use of metam sodium/potassium as soil fumigants. Metam sodium/potassium are considered together in risk assessment as well as for re-registration purposes given virtually identical physicochemical properties (both are salts of N-methyldithiocarbamate) and a similar use profile. The maximum application rate is 320 lb active ingredient per acre for most agricultural food crops. In the U.S., total annual use of metam sodium is 51 million pounds and total annual use of metam potassium is 1-2 million pounds.

Metam sodium and metam potassium quickly break down into methyl isothiocyanate (MITC) in the environment. MITC is highly volatile and is the primary toxic degradate of concern in this risk assessment. The fumigant dazomet also produces MITC in the environment. HED is not currently assessing exposure to dazomet *per se*, however dazomet's contribution of MITC in the environment is considered in this assessment. The Health Effects Division (HED) notes there is a current registration for the use of MITC *per se* for wood preservation. There is also a current registration for the use of metam potassium as an antimicrobial agent (fungicide/slimicide) in sugar cane processing plants. The potential for human exposure and risk from use of metam potassium as an antimicrobial agent in sugarcane processing plants and use of MITC as a wood preservative is assessed by the Office of Pesticide Program's (OPP) Antimicrobial Division.

MITC is acutely toxic via the oral, inhalation (category II) and the dermal (category I) route of exposure. MITC also causes skin and eye irritation and is a skin sensitizer. Metam sodium is less toxic than MITC (category III) and is not a skin or eye irritant nor is it a skin sensitizer. Metam sodium and dazomet are efficiently metabolized to MITC *in vivo*. Although the toxicological database for MITC is not complete; the toxicological database for metam sodium and dazomet are complete. Because of *in vivo* metabolism and remarkable similarity in toxic effects observed at similar molar equivalents, metam sodium and dazomet studies are currently used to characterize hazard when data are missing or inadequate. From the available data, it is known that MITC is primarily an irritating compound that produces non-specific, systemic effects in oral toxicity studies such as changes in body weight, food consumption, and hematological parameters. The mode of toxic action for MITC is not known at this time. At similarly low doses, metam sodium and MITC produce effects on the liver in studies with dogs.

Reduced motor activity has been noted at all dose levels in oral acute neurotoxicity studies with metam sodium and dazomet. In the subchronic inhalation toxicity studies with metam sodium and MITC, histopathology of the nasal cavity and lung indicative of inhalation irritation were observed. Inhalation toxicity testing with MITC resulted in persistent clinical signs and gross and histopathological lesions. Increased incidence of resorptions were noted at a dose that resulted in maternal body weight gain decreases in an oral developmental study.

Metam sodium is currently classified as a probable human carcinogen, based on statistically significant increases in malignant angiosarcoma in both sexes of the mouse, supported by a similar tumor type (malignant hemangiosarcoma) in male rats. Carcinogenicity studies for MITC *per se* are insufficient to characterize cancer risk, therefore, the carcinogenic potential of MITC cannot be determined at this time.

Toxicological endpoints were selected for both metam sodium/potassium and MITC. HED has previously accepted toxicity data for metam sodium for the registration of metam potassium; endpoints selected for metam sodium apply to metam potassium. As mentioned above, there is currently no expectation of residues in/on foods from the use of metam sodium/potassium as soil fumigants. Therefore, acute and chronic dietary reference doses are not needed at this time. Similarly, there is no expectation that oral exposure to children in the residential environment will occur. Toxicological endpoints were selected for dermal and inhalation exposure to metam sodium and for inhalation exposure to MITC. Systemic effects following dermal exposure to metam sodium at this time are not known; the existing dermal study does not take adequate precautions for the volatilization of MITC. HED has elected to use oral studies and route to route extrapolation using a dermal absorption factor (2.5%) for risk assessment. The short-term dermal endpoint is based on reduced body weight gain and decreased food efficiency in maternal rats seen in a developmental toxicity study with metam sodium [No Observable Adverse Effect Level (NOAEL) =4.2 mg/kg/day]. The intermediate-term dermal endpoint is an oral NOAEL of 0.1 mg/kg/day based on microscopic changes in the liver in females seen in a chronic toxicity study in the dog. A NOAEL of 6.5 mg/m^3 is selected for inhalation exposure to metam sodium and is used to assess all durations of inhalation exposure. The dose selected is based upon histopathological changes in the nasal passages and changes in clinical chemistry seen at the Lowest Observable Adverse Effect Level (LOAEL) in females following inhalation exposure. The short- and intermediate-term inhalation endpoint for MITC is based on persistent clinical signs, body weight changes, and gross and histopathological lesions [NOAEL of 20 mg/m^3]. The default 10X factors for inter- and intra-species extrapolation are applied.

HED does not anticipate exposure through the drinking water pathway. Environmental fate data suggest that there is a low potential for the parent compound metam sodium or MITC to be present in drinking water due to the rapid degradation of metam sodium to MITC in the environment. Therefore, neither acute nor chronic dietary exposure and risk assessment was performed.

There are no residential (homeowner applied) uses of metam sodium registered; however, based on available MITC air concentration data, HED has concerns about non-occupational (residential) persons located near – but outside of – a metam sodium-treated field. These may be adults or children who live and/or work near a treated field. Metam sodium quickly forms MITC in the environment; this conversion is influenced greatly by parameters of the physical environment such as soil temperature, pH, and moisture. As a result, MITC air concentration can vary greatly. Postapplication exposure to MITC may result from use of metam sodium as an agricultural fumigant on many different agricultural crops, as a root control agent in sewer systems, and, as a vegetation control agent for shorelines and drained bodies of water. HED assumes the exposure and risk to MITC from metam potassium uses is similar to that estimated in the assessment for MITC from metam sodium uses. Postapplication exposure data are available for the use of metam sodium as an agricultural fumigant in large-scale agricultural settings. Measured MITC air concentration data from (11) field volatility studies in which metam sodium is applied by shank injection or chemigation form the basis of the postapplication exposure and risk assessment. HED expects exposure to MITC to be of both a short- and intermediate-term duration. HED's target Margin of Exposure (MOE) is 100 for non-occupational bystander risk assessment. Risks estimates are less than the target MOE of 100 and are of concern for many of the postapplication exposure scenarios for residential bystanders. 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 for the non-occupational bystanders. As a result, HED utilized the Industrial Sources Complex (ISC) air dispersion model to predict distances from the treated field necessary to achieve the target MOE.

The Agency has determined that there are potential occupational exposures to mixers, loaders, and applicators during the usual use-patterns associated with metam sodium. HED is also concerned about postapplication worker exposure to MITC. Metam sodium is applied in large agricultural settings, small- to medium-agricultural operations, and in commercial applications. The anticipated use patterns and current labeling indicate several occupational exposure scenarios based on the types of equipment and techniques that are used to make metam sodium applications. Twenty-eight (28) major occupational handler exposure scenarios were identified and are expected to be of short (1-30 days) and intermediate-term (30 days to several months) duration. HED is also concerned about the cancer risk associated with the application of metam sodium by both non-commercial applicators and commercial applicators. 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. HED's level of concern for occupational cancer risk to metam sodium are cancer risks greater than 1×10^{-4}. For many of the agricultural scenarios assessed occupational exposure and risks exceed the level of concern for most cancer and non-cancer assessments for exposures to metam sodium and for most assessments for exposures to MITC. For example, cancer risks exceed HED's level of concern for all loader/applicator scenarios even with maximum risk mitigation for metam sodium exposures to both noncommercial and commercial handlers. 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 risks to occupational handlers exposed to MITC from application of metam sodium in small agricultural and commercial settings.

HED is also concerned about postapplication worker exposure to MITC. Worker exposure can occur for those persons re-entering a metam sodium treated field to perform certain activities and those who are working near a metam sodium treated field. MITC postapplication exposure estimates for workers performing tasks near metam sodium treated areas are based on data from eleven metam sodium field volatility studies measuring air concentration of MITC. Because air concentration values were not collected inside the treated field, HED was unable to use these data directly to determine the risk to the occupational worker who may re-enter a treated field. HED's target for occupational non-cancer risk to MITC is an MOE of less than 100. Postapplication risks to workers performing duties near a treated field exceed HED's level of concern for many postapplication exposure scenarios assessed.

HED used the Industrial Source Complex (ISC) dispersion model to predict MITC air concentrations in and near treated fields at locations that were not measured directly in field volatility studies. In this way, HED was able to estimate what distances were necessary to achieve postapplication risks levels that were not of concern to either non-occupational (residential) bystander or the occupational agricultural workers when metam sodium is applied (based upon available data). Model results show that distances up to a 1 mile are sometimes required to achieve risk levels that are not of concern to non-occupational bystanders for certain field sizes and application methods assessed. 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. Similarly, for the postapplication exposure to the occupationally exposed worker similar distances are also required for some of the exposure scenarios assessed. HED used the Industrial Source Complex (ISC) dispersion model to estimate MITC air concentrations in the treated field to measure risk to re-entering occupational handlers after the entry prohibition period of 48 hours. The results of ISC modeling indicate that MOE's of less than 100 are likely to occur for individuals performing tasks in treated fields even after 48 hours.

Case studies based upon incidents of metam sodium exposure confirm that metam sodium poses a hazard to bystanders exposed from off-site drift and that the chemical can cause health effects at distances above one-quarter mile to one mile from the treated field and many hours after the initial application. For example, application of metam sodium using an overhead sprinkler resulted in complaints from a shop 1-mile away, and on subsequent days of application complaints of odor and sickness were reported by the nearby elementary school.

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

Data gaps are noted in the toxicological database as well. Specifically, an acute neurotoxicity study in rat via inhalation with pathological evaluation of the complete respiratory tract a two generation reproduction study in rat via inhalation with pathological evaluation of the complete respiratory tract are required at this time. In addition, an *in vivo* cytogenetic assay and, a repeat of the unscheduled DNA synthesis assay are required.

2.0 Physical and Chemical Properties Characterization

The methyl dithiocarbamate salts metam sodium and metam potassium are considered together in this risk assessment because they are both salts of N-methyldithiocarbamate and virtually identical in use profile, toxicity and exposure scenarios. Metam sodium and metam potassium are non-selective soil sterilants with fungicidal, herbicidal, insecticidal, and nematicidal properties. Metam sodium and metam potassium are presently registered as soil fumigants on a wide variety of crops including: root and tuber vegetables; bulb vegetables; leafy vegetables; Brassica (cole) leafy vegetables; legumes; fruiting vegetables; cucurbits vegetables; citrus fruits; pome fruits; stone fruits; berries; tree nuts; cereal grains; nongrass animal feeds; and herbs and spices. HED assumes the exposure and risk to MITC from metam potassium use as a soil fumigant is similar to that estimated in the assessment for MITC from metam sodium uses.

This assessment will review three major uses of metam sodium: as an agricultural fumigant; as a root control agent for use in sewers and drains; and, as a vegetation control agent for shorelines and drained bodies of water. Metam sodium is quickly converted to MITC gas when applied (accelerated under certain environmental conditions). It is MITC that holds the pesticidal, fumigating properties sought by users. Due to the vapor pressure/volatility of MITC, there is a likelihood of postapplication inhalation exposure to the non-occupational bystander and occupational worker as a result of the use of metam sodium. MITC *per se* is also registered as an active ingredient and used as a wood preservative, *e.g.*, telephone poles. Metam potassium is also used as a fungicide/slimicide in sugarcane processing plants. The use of MITC as a wood preservative and the use of metam potassium in sugarcane processing plants will be assessed by OPP's Antimicrobial Division (AD).

A listing of the physical and chemical properties of the three ingredients included in this assessment follows the presentation of their chemical structures.

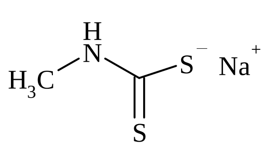
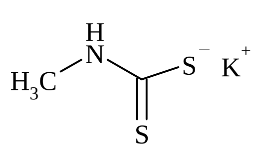
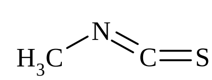
Metam Sodium Structure	Metam Potassium Structure	MITC Structure
		

Table 1: Physical and Chemical Properties of Metam Sodium/Potassium and MITC

Properties	**Metam Sodium**	**Metam Potassium**	**MITC**
PC Code	039003	039002	068103
Chemical Group	dithiocarbamate	dithiocarbamate	isothiocyanate
Chemical Type	fumigant	fumigant	fumigant
CAS No.	137-42-8	137-41-7	556-61-6
Common Name	metam sodium	metam potassium	methyl isothiocyanate
Mode of Pesticidal Action	not available	not available	Inactivation of sulhydryl groups in amino acids
Empirical Formula	$C_2H_4NS_2Na$	$C_2H_4NS_2K$	C_2H_3NS
Molecular Weight	129.18	114.2	73.12
Appearance	white crystalline solid	yellow to light yellow-green (aqueous formulation (54%)[1])	colorless crystalline solid
Melting Point	86.5-90.5° C	N/A	35-36° C
VP	5.75×10^{-2} Pa at 25° C	24mm of Hg at 25° C (aqueous formulation (54%)[1])	2×10^{4} Pa
Partition Coefficient	(Log P) ≤-2.91	N/A	1.05 at 20° C
Solubility in Water	578.29 g/L at 20° C	yes, insoluble in mineral oil	8.94 g/L at 20° C
Toxic Impurities	none[2]	none[2]	none[2]

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

[2] There are no major toxic impurities; however, there are several toxic degradate compounds.

There are significant product chemistry data requirements listed in the Product Chemistry Chapter supporting this document, particularly for the metam potassium products included in this reregistration eligibility document. These requirements are listed in Section 9.0 Data Requirements of this document. (Product Chemistry Chapter for Methyldithiocarbamate salts, Metam Sodium, Metam Potassium and MITC (Revised). DP Barcode D293330. Ken Dockter. May 20, 2004.)

3.0 Hazard Characterization

3.1 Hazard Profile

The Hazard Identification and Review Committee (HIARC) reviewed metam sodium, metam potassium, dazomet and MITC concurrently because the toxicological and exposure profiles are intricately related. Metam sodium, metam potassium, and dazomet are agricultural fumigants and all convert in the environment to MITC, the significant pesticide agent and a toxicologically significant degradate of concern. Postapplication inhalation exposure to MITC is a significant pathway of concern in this assessment. Occupational handlers may also be exposed to metam sodium parent compound through the dermal and inhalation routes upon mixing, loading and applying metam sodium/potassium products. Exposure is not anticipated through the oral route. The hazard characterization presented in this section is extracted from the Revised Toxicology Chapter for: Metam Sodium (039003) and Methyl isothiocyanate (MITC, PC Code 068103) (Lowit and Facey. TXR No. 0050166, May 19, 2004).

In acute toxicity testing, MITC is Acute Toxicity Category II for the oral and inhalation routes and Category I for the dermal route. MITC also causes skin and eye irritation (Acute Toxicity Category I) and is a sensitizer in guinea pigs. Eye irritation and odor threshold for MITC has been determined in humans. Metam sodium and dazomet are relatively less acutely toxic compared to MITC. Metam sodium is of low toxicity (Acute Toxicity Category III) in acute toxicity studies by the oral, dermal, and inhalation routes. Metam sodium is not a skin and eye irritant (Category III and IV, respectively) and is negative for skin sensitization in guinea pigs. Acute toxicity test results for metam sodium and MITC are presented in Tables 2 and 3.

Table 2: Acute Toxicity of Metam Sodium (P. C. Code 039003)

Guideline No.	Study Type	MRIDs #	Results	Toxicity Category
81-1	Acute Oral-Rat	41277002	LD_{50} =7 80 mg/kg (male rats) 845 mg/kg (female rats)	III
81-2	Acute Dermal-Rat	41277003	LD_{50} = >2020 mg/kg	III
81-3	Acute Inhalation-Rat	41277004	LC_{50} = 2.27 mg/L	III
81-4	Primary Eye Irritation	41277005	No corneal/iris involvement; all irritation was absent by 7 days	III
81-5	Primary Skin Irritation-Rabbit	41277006	non-irritating to the skin of male rabbits	IV
81-6	Dermal Sensitization	41277007	Negative in guinea pigs	
81-8	Acute Neurotoxicity-Rat	42977801 and 42977802	The LOAEL of 22 mg/kg is based on reduced ambulatory and total motor activity observed in male & female rats. The NOAEL < 22 mg/kg and was not achieved in this study.	

Table 3: Acute Toxicity of Methyl Isothiocyanate (PC Code 068103)

Guideline No.	Study Type	MRID #(S).	Results	Toxicity Category
81-1	Acute Oral-Rat	00162331	LD_{50} = 82 mg/kg ♂ 55 mg/kg ♀	II
81-2	Acute Dermal-Rat	00162330 42443501	LD_{50} = 136-436 mg/kg ♂ 181 mg/kg ♀	I
81-3	Acute Inhalation-Rat	45919410	LC_{50} = 0.54 mg/L	II
81-4	Primary Eye Irritation	00162328	corrosion of the cornea and conjuctivae	I
81-5	Primary Skin Irritation	00162329	all animals died within one hour	I
81-6	Dermal Sensitization	459194101	positive for sensitization in guinea pig	

Metam sodium, metam potassium, and dazomet are converted to MITC in the environment, particularly soil after application. It is MITC that performs the fumigating activity. Metam sodium, metam potassium, and dazomet are efficiently converted to MITC *in vivo*. MITC is primarily an irritating compound that produces non-specific systemic effects in oral toxicity studies such as changes in body weight, food consumption, and hematological parameters. The mode of toxic action for MITC is not known at this time. Although toxicological databases for metam sodium and dazomet are complete for risk assessment purposes, the toxicological database for MITC is not complete (See Toxicological Profile Table 4). Many toxicological studies via the oral route with MITC do not meet the guideline requirements, primarily due to problems surrounding the volatility of MITC and inadequate characterization of exposure concentrations or doses. Some of the data gaps are being filled through bridging with the toxicology databases of metam sodium and dazomet. There are insufficient data to characterize the cancer risk of MITC due to the limitations in the rat and mouse MITC oral carcinogenicity studies, and lack of chronic testing via the inhalation route.

Pharmacokinetic and metabolism studies in rats for dazomet, metam sodium, and MITC were submitted to support metabolism for metam sodium. Each compound was tested at two dose levels. It was shown that all three were excreted mainly in urine with urinary recoveries over 168 hours of 63-65% for dazomet, 37-58% for metam sodium, and 84-87% for MITC. Excretion via the feces was low–usually ranging from 1.5% to 3.3%. Three different compounds (MITC, CO_2, COS/CS_2) were found to be excreted via the lungs. Total excretion of the 3 products of the lungs over a 73 hour collection period were about 35% and 50% for metam sodium, 22% and 28% for dazomet, and 22% and 9% for MITC at low and high doses, respectively. There were no differences between males and females in amounts excreted via the three excretion routes. Tissue retention at 168 hours was about 2% for all 3 compounds at both dose levels. Total recoveries, including the percentage of the doses excreted and that remaining in the tissues combined after 168 hours, ranged from 92.6% to 106%, indicating virtually complete absorption from the GI tract. By the first 24 hours, 85% or more of each of the 3 compounds at both dose levels had been excreted. All three compounds were also rapidly absorbed from the GI tract. However, plasma half-lives after 24 hours were long, ranging from around 60 to 74 hours for all three compounds. Tissue and plasma levels at all time periods, and plasma AUCs were consistently higher in females than in males by a substantial amount. The tissue with the highest uptake for all three compounds was the thyroid gland. High uptake were also seen by the liver, kidneys, and lung, with the lowest level in testes, brain and eyes. Metabolic profiles detected in urine, liver, and kidneys were basically similar for the three compounds but there were some differences, mainly quantitative in nature.

There is remarkable similarity in the oral doses causing similar toxic effects for metam sodium, dazomet, and MITC, particularly at low to moderate doses. Specifically, reduced body weight gain and food consumption in addition to changes in hematological parameters were observed at low doses in oral toxicity studies with rats, mice, rabbits, and dogs. Effects on the liver have been noted in dogs at doses with similar molar levels. Reduced motor activity has been noted at all dose levels in oral acute neurotoxicity testing in studies with metam sodium and dazomet. In oral developmental toxicity studies with MITC, dazomet, and metam sodium, effects such as fetal weight decrements, reduced ossification of various skeletal structures, and increased incidence of resorptions have been noted at similar molar dose levels. At higher doses levels of metam sodium, the neurotoxic effects from the *in vivo* production of CS_2 begin to manifest. Specifically, incidence of meningocele has been noted following oral administration of metam sodium in two developmental studies in rat and one developmental study in rabbits. There were no neuropathological changes noted in the oral acute and subchronic neurotoxicity studies with metam sodium and dazomet, however, the doses used in the metam sodium subchronic toxicity study may not be sufficiently high to detect these effects. There is some limited evidence that MITC may cause immunotoxicity at high doses (Kiel et al., 1996 as summarized by Lowit and Facey (TXR. 0050166), May 19, 2004). There is no evidence of endocrine disruption in the database. The systemic effects following dermal exposure to metam sodium at this time are not known; the existing dermal study does not take adequate precautions for the volatilization of MITC. Therefore, HED has elected to use oral studies and route to route extrapolation using a dermal absorption factor in its risk assessment.

Relating to the inhalation toxicity with these pesticides, two subchronic inhalation studies in MITC, one subchronic inhalation studies in metam sodium, and no inhalation studies in dazomet are available at this time. There is existing uncertainty related to the adverse effects following exposure to MITC via the inhalation route, particularly for acute or single day exposures. Histological changes consistent with a highly irritating compound were observed in the 28-day study with MITC and also the 90-day study with metam sodium. In the 90-day inhalation study with MITC, negative histopathological findings are questionable because of several reasons such as lack of nasal pathology and poor analytical data. As suggested by results of the human eye irritation study with MITC and oral acute neurotoxicity studies with metam sodium and dazomet, single inhalation exposures may potentially result in adverse effects. An acute inhalation neurotoxicity study in MITC with additional measurements to characterize the complete respiratory tract is required at this time. There are no studies available for evaluating the route specific effects of MITC in the young, therefore an inhalation reproductive toxicity study is required at this time. Additional justification for this study come from inhalation developmental studies with MIC, a photolysis degradate of MITC, (Schwetz et al, 1987; Shilohi et al, 1986; Varma, 1987; Varma et al., 1987 reported by Lowit and Facey (TXR. 0050166), May 19, 2004) which report effects such as pup death and survivability.

There are several toxicologically notable metabolites/degradates of metam sodium, metam potassium, MITC, and dazomet. Methyl isocyanate (MIC) is a photolysis degradate of the MITC. MIC is a toxic and irritating compound which has been detected in ambient air in parts of California. Following soil application of metam sodium, both CS_2 and 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 CS_2. CS_2 is a neurotoxic agent known to cause a variety of effects such as neuropathology and changes in sensory conduction velocity and peroneal motor conduction velocity. Exposure to H_2S at low levels in humans can result in eye injury, headaches, nausea, and insomnia. Comprehensive reviews of the toxicological profiles of CS_2 and H_2S are available on EPA's IRIS website and are briefly summarized in the Revised Toxicological Chapter for Metam Sodium and MITC (TXR no. 0050166).

Metam sodium was negative in several mutagenicity assays (including the chromosomal aberration, clastogenicity, Salmonella assay, an unscheduled DNA synthesis). Carcinogenic potential was evidenced by statistically significant increases in malignant angiosarcomas in both sexes of the CD-1 mouse and also supported by a similar tumor type (malignant hemangiosarcomas) in male Wistar rats. Metam sodium is classified as a 'probable human carcinogen.' For the purpose of risk characterization, a low dose extrapolation model be applied to the animal data for the quantification of human risk (Q,*) , based on the total incidence of angiosarcomas in male mice, at all sites combined.

In *in vitro* studies, dazomet is not mutagenic in the Ames test (bacteria, unacceptable studies), non mutagenic in the Rec assay (bacteria) and negative for inducing DNA damage/repair, and does not cause unscheduled DNA damage in primary rat hepatocytes. It was negative in *in vivo* bone marrow cytogenetic assay, micronucleus assay and in *in vitro* cytogenetic assay with human lymphocytes. It was positive in mammalian cells in culture gene mutation in Chinese hamster ovary (CHO) cells. Carcinogenicity and chronic feeding studies in Wistar rats appeared to be negative for carcinogenicity at doses up to 16.36 mg/kg/day in males and 21.54 mg/kg/day in females. There was lack of tumors in male B6C3F1 mice at doses up to 69.9 mg/kg/day and equivocal evidence for hepatocellular tumors in females at doses up to 21.54 mg/kg/day. Dazomet is currently classified as Group D-not classifiable as to human carcinogenicity.

Several of the MITC mutagenicity studies are considered unacceptable. MITC was positive in the structural chromosomal aberration assay in V79 lung cells. There are insufficient data to characterize the cancer risk of MITC, due to the limitations in the rat and mouse MITC oral carcinogenicity studies, and lack of chronic testing via the inhalation route. Negative cancer studies in rats and mice with dazomet, as well as lack of a tumor response at doses similar or greater than those resulting in angiosarcomas with metam sodium, contributes to the weight of evidence that it is not appropriate to quantify MITC cancer potential using the metam sodium cancer slope factor.

3.2 Discussion of Uncertainty Factors

A discussion of uncertainty factors appropriate for use in quantitative risk assessment of metam sodium and MITC occurred at the January 23, 2003, June 5, 2003, and March 16, 2004 meetings of the HIARC. The default 10x factors for inter- and intra-species extrapolation should be applied to the toxicological endpoints selected from studies with laboratory animals (total = 100x). No other uncertainty factors are needed for metam sodium and MITC at this time.

3.3 Dose-Response Assessment

Toxicological endpoints were selected for both metam sodium and MITC. HED has previously accepted toxicity data for metam sodium for the registration of metam potassium; endpoints selected for metam sodium apply to metam potassium. Exposure to metam sodium and MITC is not expected through the oral route. Exposure to metam sodium and potassium is expected via the dermal and inhalation routes only. Systemic effects following dermal exposure to metam sodium at this time are not known; the existing dermal study does not take adequate precautions for the volatilization of MITC. HED has elected to use oral studies and route-to-route extrapolation using a dermal absorption factor for risk assessment. The short-term dermal endpoint is derived from a developmental toxicity study with metam sodium in which the endpoint identified is reduced body weight gain and decreased food efficiency in maternal animals [NOAEL=4.22 mg/kg/day; LOAEL=16.88 mg/kg/day]. The intermediate-term and long-term dermal endpoint is derived from a chronic toxicity study in the dog with metam sodium in which the endpoint identified is increased alanine aminotransferase (ALT) and microscopic changes in the liver in females [NOAEL=0.1 mg/kg/day; LOAEL=1 mg/kg/day]. A dermal absorption factor of 2.5% for route to route extrapolation from oral to dermal route is used in risk assessment. Inhalation endpoints for metam sodium are taken from a 90-day inhalation study with metam sodium. The endpoint identified is histopathological changes in the nasal passages and changes in clinical chemistry [NOAEL=6.5 mg/m^3; LOAEL=45 mg/m^3] . This endpoint is used for all durations of inhalation exposure to metam sodium in the occupational environment. Because the selected study examines toxicity via the inhalation route, no inhalation absorption factor is needed.

Exposure to MITC is anticipated via the inhalation route only. The endpoint selected is used to assess all durations of inhalation exposure. The endpoint is taken from a subchronic inhalation study in the rat with MITC. The endpoint is based on persistent clinical signs, body weight changes and gross and histopathological lesions [NOAEL=5.4 mg/kg/day; LOAEL= 27 mg/kg/day]. Unprotected skin could be exposed to MITC vapor, however at this time dermal exposure to MITC vapor cannot be quantified.

Metam sodium is classified as a probable human carcinogen, based on statistically significant increases in malignant angiosarcoma in both sexes of the mouse, supported by a similar tumor type (malignant hemangiosarcoma) in male rats. The HED Carcinogenicity Peer Review Committee (CPRC) recommended that for the purpose of risk assessment, a low dose extrapolation model be applied to the animal data for the quantification of human risk, based on the total incidence of angiosarcomas in male mice, at all sites combined. The upper-bound unit risk (Q_1*) is 1.98×10^{-1} in human equivalents converted from animals to humans using the 3/4's scaling factor. Carcinogenicity studies for MITC *per se* are classified as unacceptable, therefore, there are insufficient data to characterize cancer risk of MITC.

The Toxicological Profile Table, the Summary of Toxicology Endpoint Selection Table, and the Target MOE Summary Chart for both metam sodium and MITC are presented below.

Table 4: Toxicological Profile Table				
Guideline No./ Study Type	**Metam Sodium**		**MITC**	
	MRID No. (year)/ Classification /Doses	**Results**	**MRID No. (year)/ Classification /Doses**	**Results**
870.3100 90-Day oral toxicity rodents (rat)	42117302 (1991) Unacceptable/guideline 0, 0.018, 0.089, 0.443 mg/mL M: 0, 1.7, 8.1, 26.9 mg/kg/day F: 0, 2.5, 9.3, 30.6 mg/kg/day	NOAEL = 1.7M/ 2.5F mg/kg/day LOAEL = 8.1M/9.3 F mg/kg/day based on hematology and decrease absolute body weight.	Not available	
870.3100 90-Day oral toxicity rodents (mouse)	42117301 (1991) Unacceptable/guideline 0, 0.018, 0.088, 0.35, and 0.62 mg/ml M: 0, 2.7, 11.7, 52.4, and 78.7 mg/kg/day F: 0, 3.6, 15.2, 55.4, and 83.8 mg/kg/day	NOAEL = 0.018 mg/mL; 2.7M/3.6 F mg/kg/day LOAEL = 0.088 mg/mL; 11.7 M/15.2 F mg/kg/day based on urinary bladder lesions (eosinophilic granules, cystitits and mucosal hyperplasia) in both sexes and decrease in hematological parameters (hemoglobin, RBC, hematocrit) in female	Not available	
870.3150 90-Day oral toxicity in nonrodents (dog)	42600001 (1992) Unacceptable/guideline 0, 1, 5, and 10 mg/kg/day	NOAEL = < 1 mg/kg/day LOAEL = 1 mg/kg/day based on increase in plasma ALT, AST, and alkaline phosphatase, as well as increase incidence of biliary duct proliferation with inflammatory cell infiltration.	Not available	
870.3200 21/28/30-Day dermal toxicity	41106204 (1979) Unacceptable/guideline	Methods unacceptable	00132815 (1983) Unacceptable/guideline 0, 0, 120, 240, or 480 mg/kg/day	NOAEL < 120 mg/kg/day LOAEL = 120 mg/kg/day based on decreased body weight gain and food intake. Severe necrosis and corrosion of the skin.
870.3200 21/28/30-Day dermal toxicity			41221406 (1986) Unacceptable/guideline 0, 1.0, 10.0, and 100 mg/kg/day	NOAEL = 1 mg/kg/day LOAEL = 10 mg/kg/day based on decreased serum albumin and increased globulin values in addition to increased liver weights. Irritation at all doses
870.3250 90-Day dermal toxicity	Not available		Not available	

Table 4: Toxicological Profile Table				
Guideline No./ Study Type	**Metam Sodium**		**MITC**	
	MRID No. (year)/ Classification /Doses	**Results**	**MRID No. (year)/ Classification /Doses**	**Results**
870.3465 28-Day inhalation toxicity	Not available		45314802 (1987) Acceptable/guideline 0, 5.1, 19.9, 100 ug/L	NOAEL = 19.9 ug/L LOAEL = 100 ug/L based on clinical signs, body weight changes, and gross and histopathological lesions
870.3465 90-Day inhalation toxicity	00162041 (1983) Acceptable/guideline 0, 6.5, 45 and 160 mg/m^3	NOAEL = 6.5 mg/m^3 ; 1.11 mg/kg/day LOAEL = 45 mg/m^3 ; 7.71 mg/kg/day based on histopathological changes in the naval passages (ie, mucigenic hyperplasia) and changes in clinical chemistry.	41221407 (1978) Acceptable/guideline 0, 3.16, 30.67, and 137.13 ug/L for 4 hours/day 0, 2.1, 20.6, and 91.9 ug/L extrapolated to 6 hour exposure	NOAEL = 3.16 ug/L LOAEL = 30.67 ug/L based on decreased body weight, food efficiency and blood protein values accompanied by increased water intake.
870.3700a Prenatal developmental in rodents	42983701 (1993) Acceptable/guideline 0, 5, 20, or 60 mg/kg bw/day	**Maternal** NOAEL = 5 mg/kg/day LOAEL = 20 mg/kg/day based on reduced body weight gain and decreased food consumption. **Developmental** NOAEL =5 mg/kg/day LOAEL = 20 mg/kg/day based on the increased incidence of skeletal observations and the increase in total resorptions and resorptions/dam.	44733602 (1998) Acceptable/guideline 0, 3, 10, or 30 mg/kg/day	**Maternal** NOAEL = 3 mg/kg/day LOAEL = 10 mg/kg/day based on salivation and decreased body weight gain. **Developmental** NOAEL =10 mg/kg/day LOAEL = 30 mg/kg/day based on reduced fetal weight and an increased incidence of the skeletal variation of unossified sternebra(e).
	41577101 (1987) Acceptable/guideline 0, 4.22, 16.88, and 50.64 mg/kg/day	**Maternal** NOAEL = 4.22 mg/kg/day LOAEL = 16.88 mg/kg/day based on reduced body weight gain and decreased food efficiency. **Developmental** NOAEL = 4.22 mg/kg/day LOAEL = 16.88 mg/kg/day based on the increased incidence in postimplantation loss and decrease in the % of live fetuses/dam.	45919417 (1987) Unacceptable/guideline 0, 3, 10, or 30 mg/kg/day	**Maternal** NOAEL = 10 mg/kg/day LOAEL = 30 mg/kg/day based on decreased body weight gain and food consumption. **Developmental** NOAEL =10 mg/kg/day LOAEL = 30 mg/kg/day based on higher number of runts and reduced placental weights.

Table 4: Toxicological Profile Table

Guideline No./ Study Type	Metam Sodium		MITC	
	MRID No. (year)/ Classification /Doses	**Results**	**MRID No. (year)/ Classification /Doses**	**Results**
870.3700b Prenatal developmental in nonrodents (rabbit)	42963101 (1991) Acceptable/guideline 0, 5, 20, or 60 mg/kg/day	**Maternal** NOAEL = 5 mg/kg/day LOAEL = 20mg/kg/day based on the red uced body weight gain, reduced food consumption and food efficiency. **Developmental** NOAEL = 5 mg/kg/day LOAEL = 20mg/kg/day based on the increased incidence of skeletal observations.	45919418 (1986) Unacceptable/guideline 0, 1, 3 or 10 mg/kg/day	**Maternal** tentative NOAEL = 3 mg/kg/day Tentative LOAEL = 10 mg/kg/day based on reduced body weight gain and food consumption. **Developmental** NOAEL =10 mg/kg/day LOAEL > 10 mg/kg/day
	40330901 (1987) Unacceptable/guideline 0, 4.22, 12.66, 42.2 mg/kg/day	Numerous defiencies		
870.3800 Reproduction and fertility effects	43136101 (1993) Acceptable/ guideline 0, 0.01, 0.03, 0.1 mg/mL M: 0, 1.2, 3.2, or 11.5 mg/kg/day F: 0, 1.8, 3.9, or 13.5 mg/kg/day	**Parental/Systemic** NOAEL = 3.2 M/ 3.9 F mg/kg/day LOAEL = 11.5M/ 13.5F mg/kg/day based on pathology of Bowman's gland duct and olfactory epithelium. **Reproductive** NOAEL = 11.5M/13.5F mg/kg/day LOAEL =11.5M/13.5F mg/kg/day (HDT). **Offspring** NOAEL = 3.2M/ 3.9 F mg/kg/day LOAEL = 11.5M/ 13.5F mg/kg/day based on decrease pup weight.	40974601 (1987) Unacceptable/guideline 0, 2, 10, and 50 ppm M P: 0, 0.16, 0.76 and 3.58 mg/kg/day F P: 0, 0.21, 1.01, and 4.76 mg/kg/day M F1 0, 0.15, 0.71, 3.4 mg/kg/day F F1: 0, 0.19, 0.87, 4.22 mg/kg/day	**Parental/Systemic** NOAEL = 10 ppm, 0.71 mg/kg/day LOAEL = 50 ppm, 3.4 mg/kg/day based on decreased body weight gain in F1 males. **Reproductive** NOAEL = 50 ppm, 3.4M/ 4.22F mg/kg/day LOAEL > 50 ppm, 3.4M/ 4.22F mg/kg/day **Offspring** NOAEL = 50 ppm, 3.4M/ 4.22F mg/kg/day LOAEL > 50 ppm, 3.4M/ 4.22F mg/kg/day
870.4100a Chronic toxicity rodents	See combined chronic/carcinogencity		See combined chronic/carcinogencity	
870.4100b Chronic toxicity dogs	43275801 (1994) Acceptable/guideline 0, 0.05, 0.1, and 1.0 mg/kg/day	NOAEL =1M/ 0.1F mg/kg/day LOAEL >1 M/ 1 F mg/kg/day based on increased ALT and microscopic changes in the liver in females.	41240701 (1988) Unacceptable/guideline 0, 0.04, 0.4, 2.0 mg/kg/day	NOAEL = 0.4 mg/kg/day LOAEL = 2.0 mg/kg/day based on excessive salivation, RBC measures, and increased liver weights.

Table 4: Toxicological Profile Table

Guideline No./ Study Type	Metam Sodium		MITC	
	MRID No. (year)/ Classification /Doses	Results	MRID No. (year)/ Classification /Doses	Results
870.4300 Combined Chronic/ Carcinogenicity rats	43275802 (1994) Acceptable/guideline 0, 0.019, 0.056, and 0.19 mg/mL M: 0, 1.3, 3.9, and 12.0 mg/kg/day F: 0, 2.3, 6.2, and 16.2 mg/kg/day	NOAEL = 0.056 mg/mL LOAEL =0.19 mg/mL based on the changes in body weight gain, food efficiency, hematologic and clinical chemistry alterations, and macro- and microscopic abnormalities observed at this dose in both sexes.	00150078 (1984) Unacceptable/guideline 0, 2, 10, and 50 ppm 0, 0.2, 1.0 and 5 mg/kg/day	NOAEL = 50 ppm LOAEL = > 50 ppm
870.4300 Chronic/Carcinogenicity mice	43233501 (1994) Acceptable/guideline 0, 0.019, 0.074, and 0.23 mg/mL M: 0, 1.6, 6.5, and 27.7 mg/kg/day F: 0, 2.3, 8.7 and 29.9 mg/kg/day	NOAEL = 1.6 M/ 2.3 F mg/kg/day LOAEL = 6.5 M/ 8.7F mg/kg/day based on significant increase in liver weight, and decrease body weight gain, food and water consumption in male and female mice. Evidence of carcinogenicity	00150075 (1980) Unacceptable/guideline 0, 5, 20, 80, and 200 ppm M: 0, 0.82, 3.30, 11.83, and 25.71 mg/kg/day F: 0, 0.91, 3.66, 13.03, 29.03 mg/kg/day	NOAEL = 20 ppm; 0.82 M/0.91 F mg/kg/day LOAEL = 80 ppm, 3.30 M/ 3.66 F mg/kg/day based on decreased body weight gain throughout the majority of the study and reduced water consumption.
870.6200a Acute neurotoxicity screening battery	42977802 (1993) Acceptable/guideline 0, 22, 324, and 647 mg/kg	NOAEL = < 22 mg/kg LOAEL = 22 mg/kg based on reduced ambulatory and total motor activity observed in male and female rats on day 0, 45 minutes post-dosing.	Not available	
870.6200b Subchronic neurotoxicity screening battery	43248801 (1994) Acceptable/guideline 0, 0.02, 0.06,and 0.20 mg/mL M: 0, 1.4, 5.0, and 12.8 mg/kg/day F: 0, 2.3,7.0 and 15.5 mg/kg/day	NOAEL = 1.4 M/ 2.3F mg/kg/day LOAEL = 5.0 M/ 7.0 F mg/kg/day based on decreased body weight gain for male and female rats.	Not available	
870.6300 Developmental neurotoxicity	Not available		Not available	
870.7600 Dermal penetration	42670301 (1992) Acceptable/guideline 0.1, 1, 10 mg/rat	Mean absorbed at 10 hours = 2.52%	Not available	

Table 5: Summary of Toxicology Endpoint Selection for
Metam Sodium (PC Code 39003)* and *Metam Potassium (PC Code 39002)

Exposure Scenario	Dose Used in Risk Assessment	Uncertainty Factors and Level of Concern for Risk Assessment	Study and Toxicologial Effects
Acute Dietary general population including infants and children	Acute dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.		
Chronic Dietary all populations	Chronic dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.		
Incidental Oral Short- and Intermediate-Term (1 - 30 Days; 1-6 Months) Residential Only	Short- and intermediate term incidental oral endpoints were not selected since the use-pattern does not indicate potential for this exposure scenario.		
Dermal Short-Term (1 - 30 days) Residential and Occupational	Maternal NOAEL[a,d]= 4.22 mg/kg/day Dermal absorption factor = 2.5%	**Residential** LOC for MOE[b] = N/A[e] **Occupational** = LOC[c] for MOE = 100	**Developmental toxicity in rat (MRID 41577101)** LOAEL[f] = 16.88 mg/kg/day based on reduced body weight gain and decreased food efficiency in maternal rats
Dermal Intermediate-Term (1 - 6 Months) Residential and Occupational	Oral NOAEL[a]= 0.1 mg/kg/day Dermal absorption factor = 2.5%	**Residential** LOC for MOE = N/A **Occupational** = LOC for MOE = 100	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on increased ALT and microscopic changes in the liver in females.
Dermal Long-Term (> 6 Months) Residential and Occupational	Oral NOAEL[a]= 0.1 mg/kg/day Dermal absorption factor = 2.5%	**Residential** LOC for MOE = N/A **Occupational** = LOC for MOE = 100	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on based on increased ALT and microscopic changes in the liver in females.
Inhalation Short-, Intermediate, and Long-Term (1 - 30 days, 1-6 Months, and > 6 Months) Residential and Occupational	Inhalation NOAEL= 6.5 mg/m^3 (1.11 mg/kg/day)	**Residential** LOC for MOE = N/A **Occupational** = LOC for MOE = 100	**90-day inhalation study (MRID 00162041)** LOAEL =45 mg/m^3 (7.71 mg/kg/day) in females based on histopathological changes in the naval passages (ie, mucigenic hyperplasia) and changes in clinical chemistry.
Cancer	**Classification:** Probable human carcinogen (B2) **Q1* =**$1.98x10^{-1}$ in human equivalents converted from animals		

a Since an oral NOAEL was selected, a dermal absorption factor of 2.5% should be used in route-to-route extrapolation.; b Margin of Exposure (MOE) = 100 [10x for interspecies extrapolation and 10x for intraspecies variations.]; c LOC = level of concern; d NOAEL = no observed adverse effect level; e NA = Not Applicable; f LOAEL = lowest observed adverse effect level.

Table 6: Summary of Toxicology Endpoint Selection for Methyl isothiocyanate MITC (PC Code 068103)

Exposure Scenario	Dose Used in Risk Assessment	Uncertainty Factors and Level of Concern for Risk Assessment	Study and Toxicological Effects
Acute Dietary General population including infants and children	Dietary exposure is not expected for MITC at present time.		
Chronic Dietary (All populations)	Dietary exposure is not expected for MITC at present time.		
Incidental Oral Short-Term (1 - 30 Days)	Incidental oral exposure is not expected for MITC		
Incidental Oral Intermediate-Term (1 - 6 Months)	Incidental oral exposure is not expected for MITC		
Dermal Short-Term (1 - 30 days), Intermediate-Term (1 - 6 Months) Long-Term (> 6 Months)	No dermal hazard via typical dermal contact with MITC is expected. Unprotected skin could exposed to MITC vapor; however this exposure can not, at this time, be quantified.		
Inhalation Short-Term (1 - 30 days) Intermediate-Term (1 - 6 Months) Long-Term (>6 Months)	Inhalation NOAEL[c]= 5.4 mg/kg/day	**Residential** LOC for MOE = 100[a] **Occupational** LOC[b] for MOE = 100[a]	**Subchronic inhalation toxicity- rat with *MITC* (MRID 45314802)** LOAEL[d] = 27 mg/kg/day based on persistent clinical signs, body weight changes, and gross and histopathological lesions
Cancer	**Classification:** Insufficient data to characterize cancer risk.		

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

The following is a summary of Target Margins of Exposure (MOEs) for Risk Assessment for metam sodium.

Table 7: Target MOE Summary Chart Metam Sodium

Target Margins of Exposure for Risk Assessment of Metam Sodium			
Route / Duration	**Short-Term (1-30 Days)**	**Intermediate-Term (1 - 6 Months)**	**Long-Term (> 6 Months)**
Occupational (Worker) Exposure			
Dermal	100	100	100
Inhalation	100	100	100
Residential (Non-Dietary) Exposure			
Oral	N/A	N/A	N/A
Dermal	N/A	N/A	N/A
Inhalation	N/A	N/A	N/A

For Occupational exposure: Target MOEs are based on the conventional uncertainty factor of 100X (**10X** for intraspecies extrapolation and **10X** for interspecies variation).

For Residential exposure: No residential exposure to metam sodium *per se* is expected.

The following is a summary of the target MOEs for risk assessment of MITC.

Table 8: Target MOE Summary Table MITC

Target Margins of Exposure for Risk Assessment of MITC			
Route / Duration	**Short-Term (1-30 Days)**	**Intermediate-Term (1 - 6 Months)**	**Long-Term (> 6 Months)**
Occupational (Worker) Exposure			
Dermal	NA	NA	NA
Inhalation	100	100	100
Residential (Non-Dietary) Exposure			
Oral	NA	NA	NA
Dermal	NA	NA	NA
Inhalation	100	100	100

For Non-Occupational (Residential Bystander) and Occupational Exposure: For the inhalation route, the target MOE of 100 is based on the conventional uncertainty factor of 100X (**10X** for intraspecies extrapolation and 10X for interspecies variation).

4.0 Exposure Assessment and Characterization

4.1 Summary of Registered Uses

The dithiocarbamate salts metam sodium and metam potassium are included in this risk assessment. These chemicals are non-selective soil sterilants or fumigants with fungicidal, herbicidal, insecticidal, and nematicidal properties. The mode of action is inactivation of sulfhydryl groups in amino acids. Metam sodium and potassium are active against all living matter in the soil. Typical applications are made prior to planting to sterilize the soil but applications can also be made post-harvest. The concentrations of MITC in soil must drop to non-phytotoxic levels prior to planting or else desirable crops may be damaged. The results of the residue chemistry studies show that there are no residues detected in treated material. These two salts are considered together in risk assessment as well as for re-registration purposes. Metam sodium and potassium hold virtually identical physicochemical properties and identical use profile; HED assumes exposure and risk from the two salts are similar. Metam sodium is the third most widely used agricultural pesticide in the U.S. There are a total of 51 active end-use products currently registered. (*Metam Sodium. Residue Chemistry Chapter for the Metam Sodium Reregistration Eligibility Decision (RED) Document. Sherrie Kinard, September 30, 2003*.)

There is also the use of metam potassium as an antimicrobial agent in sugarcane processing plants and the use of methyl isothiocyanate (MITC) as an active ingredient in wood preservation. These uses are reviewed by the Office of Pesticide Program's Antimicrobial Division.

Metam sodium end-use products are registered for use on many crops including: root and tuber vegetables; bulb vegetables; leafy vegetables; Brassica (cole) leafy vegetables; legume vegetables; fruiting vegetables; cucurbit vegetables; citrus fruits; pome fruits; stone fruits; berries; tree nuts; cereal grains; nongrass livestock feeds; and herbs and spices. Metam sodium may be applied to plant beds as a soil drench treatment, *e.g.*, tobacco plant beds. It may also be applied to field or row crops during pre-plant and post-harvest stages via chemigation, soil broadcast treatment, soil band treatment, soil-incorporated treatment, and soil-injection treatment. Chemigation is the most common method of application. Metam sodium is sold in the United States under the trade names Vapam, A7Vapam, Basamid-Fluid, Karbation, Maposol, Metam fluid BASF, N-869, Sistan, and Solasan 500. Metam potassium is sold in the U.S. under the trade names Busan 1180 or K-Pam.

The range of percent of active ingredient in the end-use products is 24-48% for metam sodium and 5-54% for metam potassium for uses on food, fiber and ornamental crops. The maximum application rate is 320 lbs. a.i./A for food and fiber crops; agricultural crops such as tobacco have higher rates. Application equipment used includes drencher, drip irrigation, gravity irrigation, soil incorporation equipment, soil injector equipment, and sprinkler irrigation. The current entry prohibition period is 48 hours. Homeowner uses have been cancelled by the registrants and agricultural labels are general use except small-area uses which are classified as restricted use pesticides.

Available information from EPA's Biological and Economic Analysis Division (BEAD) using different EPA databases indicates usage for the year 2002 is in the range of 51-55 million pounds per year for metam sodium and 1-2 million pounds per year for metam potassium. (Alsadek, J. *Internal Communication*). Most of the acreage is treated with 190 pounds or less of a.i. per application, the highest use rate is 412 lb a.i./A. Metam sodium's largest markets in terms of total pounds of active ingredient is allocated to potatoes (49%) followed by tomatoes (21%) and cotton (5.5%). The remaining usage is applied over all agricultural sectors but usage in terms of pounds active ingredient used per crop site ranges from less than 1 % to 5%. In terms of percent crop treated, metam sodium's usage is allocated to tomatoes (17%), potatoes (10%) and carrots (5%) (Quantitative Usage Analysis. February 11, 1999).

4.2 Dietary Exposure/Risk Pathway

4.2.1 Residue Profile

There are no tolerances currently established for the use of metam sodium or metam potassium on agricultural food or feed crops. When mixed with water, metam sodium as well as metam potassium hydrolyze to MITC and carbon disulfide. The results of an acceptable turnip metabolism study, show that ultimate breakdown products consist of natural plant biochemicals. Neither metam sodium, MITC nor any related thioureas or methylated ureas were detected in the extractable radioactivity or the post-extraction solids in the reviewed turnip metabolism study. The observed radioactivity was shown to be distributed over a variety of natural products indicating complete incorporation of metam sodium into the carbon pool. The results of the turnip study, MITC's volatility in the environment and phytotoxity to desirable crops confirm that there is no reasonable expectation of finite residues to be incurred in/on any raw agricultural commodity when the soil sterilant is applied according to label directions. The use of metam sodium/potassium as a soil sterilant is considered to be a non-food use. Because there are no metam sodium residues of concern detected in plants, the requirement for a livestock metabolism study is waived for metam sodium and metam potassium. There are no new tolerances proposed in this assessment.

Dazomet is another soil fumigant that produces MITC in the environment. There are currently no tolerances established for the use of dazomet as a soil fumigant. At this time, HED does not anticipated dietary exposure to MITC from use of dazomet as a soil fumigant.

HED has noted that there is a current registration for the use of metam potassium as an antimicrobial in sugar cane processing plants; however, at this time HED does not anticipate that residues of metam potassium or MITC would be present in sugar or sugarcane products as a result of this use. Metam potassium is added to the sugarcane slurry. There are numerous processing steps that occur after the addition of metam potassium involving boilers, evaporators, a clarification step involving lime and/or phosphoric acid, vacuum pans, crystalizers, additional dryers, and bulk storage.

Because there is no expectation of residues to be incurred in/on food crops when metam sodium and potassium are used as soil sterilants, all metam sodium and metam potassium residue chemistry requirements are waived at this time. There is no requirement for the development of enforcement analytical methods for plant or livestock commodities, for multiresidue methods, and storage stability data. The magnitude of residue in plants and animals are waived as are processing studies, ruminant and poultry feeding studies. The requirement for confined and field rotational crop studies are also waived. There are no existing residue chemistry data requirements for either metam sodium or metam potassium.

No Codex MRLs (Maximum Residue Limits) are in effect for metam sodium residues; therefore, issues of compatibility between Codex MRLs and U.S. tolerances do not exist. There are also no Canadian or Mexican MRLs established for metam sodium residues.

4.2.2 Acute Dietary

Metam sodium/potassium, when used as a soil sterilants are considered to be non-food uses. Based upon the results of appropriate metabolism studies, residues of metam sodium and MITC are not expected to occur in plants. It is not possible to establish with certainty whether finite residues will be incurred, but there is no reasonable expectation of finite residues.

4.2.3. Chronic Dietary

See Section 4.2.2.

4.2.4. Cancer Dietary

See Section 4.2.2.

4.3 Water Exposure/Risk Pathway

There are no food uses for metam sodium or metam potassium. Therefore, a drinking water exposure assessment is not presented. However, information concerning the environmental fate properties and drinking water exposure potential is discussed here. There is a low probability of exposure through drinking water.

Environmental fate data suggest that metam sodium photolyzes in surface water with a half-life of 28 minutes and metabolizes aerobically in soil with a 23 min half-life. The major routes of degradation based on the use pattern are volatilization/dissipation and aerobic soil metabolism. Metam sodium rapidly degrades in soil and water bodies generating 60 to 83% of MITC under prevalent environmental conditions. Environmental fate data suggest that there is a low potential for the parent compound metam sodium or MITC to be present in drinking water due to the rapid degradation of metam sodium to MITC in the environment. Although MITC is volatile, it is also soluble in water and its low adsorption in soil suggest that leaching to ground water may be possible under worst-case conditions. In most field conditions, the potential for ground water contamination of MITC is unlikely due to its volatilization and fast degradation in soil. Based on available non-targeted monitoring data, MITC was not detected in the ground water samples within the USA. MITC can also potentially move to surface water through runoff under an intense rainfall and/or if continuous irrigation occurs right after metam sodium application. However, the Henry's Law Constant of 1.79 x 10-4 atm-m3/mol for MITC suggests that it will be volatilized quickly from surface water. (*Estimated Drinking Water Concentration for Metam Sodium and its Metabolites Methyl Isothiocyanate for Application on Florida Tomato. Faruque Khan, Ph.D. September 16, 2003.*)

4.4 Residential Bystander Exposure and Risk Assessment

There are no registered homeowner applied uses of metam sodium/metam potassium or MITC in the U.S. However, based on available MITC air concentration data, HED has concerns about non-occupational (residential) bystanders located near but outside of treated fields. Residential bystanders may be adults or children living or working near a metam sodium treated field or area. The non-occupational bystander exposure and risk assessment for MITC is completely detailed in the document "Metam Sodium: Occupational and Residential Exposure (ORE) Assessment for the Reregistration Eligibility Decision Document" (DP Barcode D293331. Steven Weiss, May 21, 2004).

Metam sodium is registered as an agricultural fumigant, root control agent for use in sewers, and vegetation control agent for shorelines and drained bodies of water. Once mixed with water or added to soil, metam sodium breaks down into MITC. There is the potential for postapplication inhalation exposure to the non-occupational (residential) bystander from each of these major use sites. However, the postapplication exposure scenario evaluated is residential bystander exposure and risk to use of metam sodium as a soil fumigant in large-scale agricultural settings using shank injection and chemigation application equipment. Postapplication exposure data for use of metam sodium in small- or medium-scale agricultural settings, as a vegetation control agent or in commercial settings as a root control agent in sewers are not available.

The purpose of the non-occupational postapplication assessment is to determine the risk to the bystander living or working near a metam sodium treated field or area. 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. Therefore, both short- and intermediate-term exposure durations were assessed. Using available postapplication exposure data measuring air concentration of MITC following metam sodium applications using either shank injection or chemigation equipment and comparing exposure to appropriate non-cancer endpoints, HED is unable to determine an appropriate distance from the treated field at which risk do not exceed HED's level of concern using available MITC air concentration data. 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. Many of the calculated risks at each of the MITC air concentration data points collected in the available field volatility studies exceed HED's level of concern. As a result of this assessment, HED also performed air dispersion modeling using data from these same 11 field volatility studies, exposure assumptions and meteorological information to predict the distances from a treated field at which the calculated risks do not exceed HED's level of concern. Results of the air dispersion modeling are discussed in Section 6.0 of this document.

There are other sources of postapplication exposure to MITC. This risk assessment evaluates the use of both metam sodium and metam potassium as agricultural fumigants. However, no data were submitted to HED for MITC exposure from metam potassium use as a soil fumigant. Upon comparison of use patterns and exposure scenarios for metam sodium and metam potassium, HED assumes the exposure and risk to MITC from metam potassium uses is similar to that estimated in the assessment for MITC from metam sodium uses. Dazomet is a another soil fumigant that produces MITC as its primary degradate. No data were submitted to HED for MITC exposure from dazomet uses, therefore quantitative exposure and risk assessment of MITC exposure from dazomet uses is not possible. Until further data is provided, HED assumes the inhalation exposure and risk to MITC from dazomet uses is similar to that estimated in this assessment for MITC from metam sodium uses. Finally, as noted above MITC is registered as an active ingredient as a sterilization agent in treated wood products. At this time, HED does not anticipate postapplication exposure to MITC will occur from this use. It should also be noted that this assessment is based only on the risk associated with metam sodium and its major breakdown product MITC. However, application of metam sodium may also result in exposure to other breakdown products that are volatile and with known toxicity including methyl isocyanate (MIC), hydrogen sulfide, and carbon disulfide.

4.4.1 Data, Assumptions and Limitations

Data from several studies measuring MITC air concentration levels following applications of metam sodium formed the basis of the postapplication non-occupational bystander exposure and risk assessment. Key variables in these studies are the type of application equipment, type of soil seal (*i.e.*, tarpaulin covering treated soil), distance from treated field at which measurements were taken, and time of application, night versus day, and atmospheric conditions. The MITC 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.). Different application rates were used in the studies. The eleven studies were performed utilizing a variety of application methods including shank injection, sprinkler irrigation, and, drip irrigation. 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 other studies, no soil seal was applied. The studies are considered adequate for estimating postapplication exposure to MITC by calculating Margin of Exposure (MOE) values for each individual air sample concentration collected in the 11 field volatility studies. Risk results listed below present a range of MOE's based upon the lowest and highest air concentration sample taken at each sampling site within each study. These studies are summarized and HED Study review citations are provided in "Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision Document" (DP Barcode D293331. Steven Weiss, May 21, 2004).

HED notes the following limitations with the above mentioned MITC air concentration studies. All of these studies were conducted in California. Currently, California's Department of Pesticide Regulation (DPR) has a technical information bulletin (TIB) for metam sodium application that identifies certain application practices (*e.g.,* regarding water sealing, air temperature, wind speed, time of application, etc.). These practices were not followed in all of the 11 MITC air concentration studies included in this assessment. However, the California's

DPR's TIB does not apply to other states where metam sodium is used. Also, three of the 11 studies are pilot studies and may not reflect currently practiced intermittent-sealing methods. In one of the 11 studies used in the postapplication exposure and risk assessment, 'Air Monitoring for Methyl Isothiocyanate During a Sprinkler Application of Metam-sodium,' a nocturnal inversion occurred. Study researchers also report that the application was conducted with air temperatures that exceeded 90^{o} F, an application practice currently prohibited. 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 assessment for comparative historical purposes.

Parameters of the physical environment such as pH, moisture level and temperature of the soil influence the rate at which MITC is formed during the degradation of metam sodium. Therefore, air concentration levels are expected to vary based on the conditions of the physical environment. Extended discussion of the parameters which influence the air concentration levels of MITC, the rate at which MITC is formed during the degradation of metam sodium, and the rate at which MITC is released from treated soul into the atmosphere is presented in "Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision" (DP Barcode D293331. Steven Weiss, May 21, 2004).

A number of exposure assumptions are included in the residential bystander exposure and risk assessment. These assumptions were applied in conjunction with the MITC air concentration data described above to complete the residential bystander exposure and risk assessment. Although the MITC air concentration studies described above were completed using different application rate, HED proportionally scaled the rates to equal 320 lbs a.i./A for all study data. Daily exposure duration is an important factor in the risk estimates. HED assumed residential bystanders were exposed 16.4 hours and 2 hours per day representing time spent indoors and outdoors, respectively. HED assumed that when indoors, an adult inhalation rate is 8.3 liters per minute (l/min) and for children 6.71 l/min. When outdoors, adults and children are assumed to have an inhalation rate of 16.7 l/min. Assumptions regarding inhalation rates were taken from the 1997 EPA Exposure Factors Handbook Volume III. One of the MITC-specific exposure studies conducted following applications of metam sodium indicated that MITC indoor and outdoor air concentrations levels are approximately equal over an exposure period. Therefore, HED is able to use the MITC air concentration data from the 11 field volatility studies to estimate residential bystander exposure for both the indoor exposure duration of 16.4 hours and the outdoor exposure duration of 2 hours per day. Also, 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 into risk calculations.

There are a number of limitations in the residential bystander exposure and risk assessment. The residential bystander is exposed to MITC via the inhalation route. The majority of MITC-specific studies used in the residential bystander risk assessments measured MITC air concentration levels for only the first few days following application; they did not continue to monitor until the limit of detection was achieved. Therefore, HED has limited data to indicate how many days following metam sodium applications that MITC air concentration levels are a concern to residential bystanders near treated fields. Also, because metam sodium label instructions recommend soil sealing immediately following application (either with a tarpaulin or irrigation water), HED believes that MITC air concentration levels may spike when the soil seal is removed. However, there are no data to properly assess this scenario. Metam sodium may be applied to potting soil and where application is likely to take place in an enclosed or semi-enclosed area. Commercial application of metam sodium may also be applied to sewer systems. HED believes that exposure to non-occupational bystanders may occur if there are cracks in the sewer system. HED currently has no data about MITC air concentration levels following either the potting soil use, application in an enclosed or semi-enclosed space or the use of metam sodium in sewer system application.

4.4.2 Non-Occupational Bystander Exposure and Risk Assessment

Based upon 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. HED assessed postapplication exposure to MITC following application of metam sodium by chemigation or shank injection methods in large-scale agricultural operations. Postapplication data are not available for other metam sodium postapplication scenarios including use of metam sodium as a root control agent in sewers and as a vegetation control agent in beach area and drained water bodies. When performing this assessment, it is assumed that residential bystanders are not wearing respirators or other personal protective equipment. Measured MITC air concentration data were used in conjunction with exposure assumptions to determine the exposure to the residential bystander. Exposure estimates were then compared to relevant toxicological endpoints of concern to calculate a non-cancer margin of exposure (MOE). This was done for each of the air concentration data points in the 11 field volatility studies and presented as a range of MOE's. The result of this analysis illustrate that there are some exposure scenarios, *i.e.*, data points, for which the target MOE is not achieved.

4.4.3 Non-Occupational Bystander Postapplication Risks to MITC

HED believes that postapplication residential bystander exposure can occur over several days following a single metam sodium application and may occur over several weeks if several fields near a residential environment are treated consecutively within a short time span. Since it is not possible to know with certainty at this time the probability of an individual's exposure to multiple metam sodium treated fields over a number of days and weeks, HED has considered both short-term (1-7 days) and intermediate-term (30 days to several weeks) inhalation exposure and risks to the residential bystander. However, because the toxicological endpoint for exposure to MITC via inhalation is the same for all durations of exposure (short- and intermediate-term), only one set of risk estimates is provided for each method of application for which data are available.

The non-cancer residential bystander exposure and risk estimates were calculated using the “Route-Specific Inhalation Margin of Exposure (MOE) Method.” This equation accounts for the differences in the duration of daily exposure for animals and humans, and the increased respiration and exposure that results from the increased activity. The short-, intermediate-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 for non-occupational, non-cancer postapplication risks is a margin of exposure of less than 100. The range of MOEs presented for each study are derived from the range of individual air concentration samples taken in each of the 11 field volatility studies discussed in section 4.4.1. Many of the risk values calculated for each of the exposure study samples taken exceed HEDs level of concern for both chemigation and shank injection methods of application and for both adults and children for at least one of the 2-hour (outdoor) and 16.4-hour (indoor) residential bystander exposure scenarios, *i.e.*, MOEs are less than 100 for many study data points. Studies varied in use of application equipment, use of soil seal and the distance from treated field at which the air concentration measurement is taken. Four tables are presented summarizing the range of residential bystander risks calculated. They are presented by method of application (2) and for both adults and children.

Table 9: 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
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.

Table 10: Chemigation Adult Bystander MITC Risk Summary							
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	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

Table 10: Chemigation Adult Bystander MITC Risk Summary							
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**
		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.

Table 11: 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.

Table 12: 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
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

Table 12: 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**
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.

4.4.4 Non-Occupational Bystander Risk Summary

The results of the 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.

5.0 Occupational Exposure

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. Metam sodium has four major uses: an agricultural fumigant, a root control agent for use in drains and sewers, as a vegetation control agent for shorelines and drained bodies of water (California special local needs label) and as a wood preservative. This assessment is concerned with its use as an agricultural fumigants and as a root control agent. The wood preservative exposure and risk assessment is being completed separately by another OPP Division. Risk assessments have been completed for occupational handler scenarios as well as postapplication occupational scenarios for the above major uses. The handler and postapplication risk assessment for metam sodium and MITC indicates risk exceeds HED level of concern for many exposure scenarios. The occupational handler and postapplication exposure and risk assessment results presented in this section are fully discussed in “Metam Sodium: Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision Document” (Steven Weiss, May 21, 2004 (D293331)).

This section examines the occupational exposure and risk for the use of metam sodium and its primary degradate MITC. The occupational handler assessment considers persons involved in mixing and loading and/or applying pesticide products containing metam sodium as well as persons who may work as chemigation monitors or irrigators. HED believes that occupational metam sodium and MITC exposure can occur for both short-term (up to 30 days) and intermediate-term (30-days to several months) durations of exposure. Long-term (continuous) handler exposures are not anticipated based on the use patterns identified.

Once mixed with water or added to soil, metam sodium rapidly breaks down into MITC. Therefore, HED is concerned about postapplication inhalation exposure to MITC to occupational workers in or near treated areas. HED does not anticipate that postapplication dermal exposures to metam sodium will occur.

This assessment evaluates occupational handler and postapplication worker exposure and risk to metam sodium and MITC. Handler exposure may occur to metam sodium via the dermal and inhalation routes and to MITC via the inhalation route. Short- and Intermediate-term dermal exposure to metam sodium have separate toxicological endpoints of concern. 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 both the short- and intermediate-term inhalation exposure to metam sodium, therefore the risk results for all durations of inhalation exposure to metam sodium are identical. Similarly, one toxicological endpoint of concern was selected for all exposure durations in the assessment of MITC risk; results of the MITC risk assessment are the same for all durations of exposure. Occupational handler cancer risk assessment from exposure to metam sodium considered both private and commercial applicators separately because the respective exposure profiles differ considerably.

HED has risk concerns for many of the occupational handler exposure scenarios as well as the postapplication worker exposure scenarios. It should be noted, this assessment is based only on the risk associated with metam sodium and its major breakdown product MITC. However, application of metam sodium may also result in exposure to other breakdown products that are volatile and with known toxicity including methyl isocyanate (MIC), hydrogen sulfide, and carbon disulfide.

5.1 Occupational Handler

The occupational handler exposure and risk assessment reflects the use of metam sodium as an agricultural fumigant to control weeds, nematodes, and fungi on a wide variety of crops; 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. In addition, 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 application equipment. Therefore, exposure to pesticide handlers is likely 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 exposure scenarios.

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)

Current metam sodium labels require maximum PPE for most handler scenarios including the following: 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; face sealing goggles, if no full-face respirator worn; and a respirator with either an organic vapor removing cartridge with a pre-filter approved for pesticides or a canister approved for pesticides.

Section 2.1.1 'Data and Assumption for Handler Exposure Scenarios' of the Occupational and Residential Exposure Assessment (DP Barcode D293331, Steven Weiss, May 21, 2004) summarizes the parameters used for the handler scenarios and the corresponding exposure and risk assessments. These include the source of the data and an assessment of the overall quality of the data. Key assumptions include: use of surrogate exposure data; use of a 60 kg body weight for an adult female for the non-cancer risks from metam sodium; and, use of certain estimates for acres treated per day by a metam sodium handler. The later assumption could be refined from input by affected parties. Maximum application rates were used to calculate non-cancer exposure and risks while typical or average application rates were used in the cancer risk assessments for the occupational handler.

For the metam sodium occupational handler exposure assessment, all analyses were completed using data that were deemed to be a source of acceptable surrogate exposure data for the scenario in questions. These sources are listed below:

Pesticide Handler Exposure Database (PHED) Version 1.1 (August 1998)

ORETF Handler Studies (MRID 449722-01): Submitted by the Outdoor Residential Exposure Task Force, the report presents data in which the application of various products used on turf by homeowners and lawncare operators was monitored. A study using a low pressure, high volumes handgun and a study examining homeowner exposures while using a hose-end sprayer was used in the assessment.

Sodium Tetrathiocarbonate Surrogate Data: HED used surrogate data for sodium tetrathiocarbonate to estimate metam sodium handler exposure via the dermal route in the assessment. Sodium tetrathiocarbonate is a soil fumigant applied by shank injection and chemigation. The sodium tetrathiocarbonate study focused solely on dermal exposures pertaining to chemigation and is used in this assessment.

For MITC, all handler exposure analyses were completed using MITC-specific inhalation exposure data taken from four metam sodium handler studies submitted to the Agency. These studies have been reviewed by the Agency and are considered adequate for this use. The studies were conducted using the maximum application rate (320 lbs a.i./A), performed in three different states (CA(2), WA, AZ), measured MITC, and, two studies used a soil seal and two studies did not use a soil seal. The studies examined the exposure to mixers, loader, applicators, monitors, and irrigators and using both chemigation and shank injection methods of application. Several limitations are noted in the supporting document Occupational and Residential Exposure assessment (DP Barcode D293331, Steven Weiss, May 21, 2004).

Calculations for the handler risk assessment were completed for a range of maximum application rates for specific crops recommended by the best available metam sodium labels, the LUIS/BEAD report of current label uses, and through correspondence with the registrants through the Special Review and Reregistration Division (SRRD). A summary of the maximum application rates for registered metam sodium uses utilized in the occupational exposure and risk assessment is presented in the following table.

Table 13: 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.

5.1.1 Non-cancer Exposure and Risk Estimates

Non-cancer handler exposure assessments were completed using a baseline exposure scenario followed by increasing levels of risk mitigation (PPE and engineering controls) in an attempt to achieve the target margin of exposure. In this risk assessment, for many exposure scenarios the calculated MOEs exceed HED's level of concern even using engineering controls. The baseline scenario generally represents a handler wearing long pants, a long-sleeved shirt, no respirator, and no chemical-resistant gloves. Short- and intermediate-term exposures and risks were calculated for dermal and inhalation exposure to metam sodium. Inhalation exposure and risk to MITC from the occupational use of metam sodium by pesticide handlers is also assessed.

Separate toxicological endpoints were selected for the metam sodium and the MITC risk assessments. The short-term dermal endpoint for metam sodium is an oral NOAEL of 4.22 mg/kg/day based on a LOAEL for 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 an oral NOAEL of 0.1 mg/kg/day based on a study that 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 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 showing histopathological changes in the nasal passages and changes in clinical chemistry. 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, 60 kg, was used to estimate dose in the exposure assessments for adults.

The short-, intermediate-term inhalation risk assessment for MITC is based on an NOAEL of 20 $mg/m^{3.}$ 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. Estimated dermal and inhalation exposure was compared to the dose and endpoint for the appropriate duration of exposure to calculate a Margin of Exposure (MOE) for each scenario. A total MOE was not calculated because common toxicity endpoints were not used in calculate dermal and inhalation risk for each exposure duration.

Due to their length, the summary of occupational exposure and risk to handlers of metam sodium for both the dermal and inhalation routes of exposure and for both short- and intermediate-term durations of exposure are presented in Appendices A and B. Occupational exposure and risk to handlers who are also exposed to MITC via inhalation when performing mixing, loading, and applicator activities were also assessed and are presented in Appendix C.

<u>Appendix A</u>: Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary
<u>Appendix B</u>: Non-cancer Intermediate-term Metam Sodium Occupational Handler Risk Summary

Appendix C: Non-cancer Short- and Intermediate-term MITC Handler Risk Summary

It is important to note, for the applications in commercial and small scale agricultural settings, HED currently has no data with regards to exposure to MITC when using handheld equipment. Therefore, the risks to occupational handlers in these exposure settings are not assessed at this time.

5.1.2 Cancer Exposure and Risk Estimates for Handler

Occupational handler cancer risk assessment considers identical exposure scenarios as those assessed in the non-cancer handler assessment. To assess cancer risk, a total daily dose, a lifetime daily dose and a total cancer risk are calculated. The total daily dose is calculated to include both dermal and inhalation exposure; a dermal absorption factor is used since an oral cancer endpoint was used. The Q_1* for metam sodium is 1.98 x 10^{-1} $(mg/kg/day)^{-1}$.

The occupational handler cancer risk assessment assumed that the average lifetime is 70 years, exposure duration is 35 years. Commercial, large-scale private growers or professional applicators, and non-commercial, private applicators, were separated for the cancer exposure and risk assessment because the frequency and duration of exposure to the two populations are different. For cancer risk estimates, it was assumed that noncommercial and commercial applicators are exposed for 5 and 20 days per year, respectively. Typical application rates were used in both the non-commercial and commercial handler cancer assessment (except for wheat and barely). Typical application rates are listed in 2.1.1.1 of the ORE chapter (D293331, May 21, 2004). Appendices D and E summarize the cancer risks associated with the handling of metam sodium for the baseline, maximum PPE and engineering control level of mitigation. In general, the Agency is concerned when occupational cancer risk estimates exceed $1x10^{-4}$. The Agency will seek ways to mitigate the risks, to the extent that it is practical and feasible, to lower the risk to 1 x 10^{-6} or less. The metam sodium cancer risks for noncommercial applicators and commercial applicators are summarized in this section. Due to their length, the risk summary tables are presented in the appendices to this document.

Appendix D: Summary of Noncommercial Applicator Cancer Risks to Handlers for Metam Sodium
Appendix E: Summary of Commercial Applicator Cancer Risks to Handlers for Metam Sodium

5.1.3 Summary of Occupational Handler Risks and Data Gaps

The handler risk assessment for metam sodium indicates risk that exceed HED's level of concern 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, *i.e.*, use of personal protection equipment (PPE), for most cancer and non-cancer assessments for exposures to metam sodium and for most 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 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 risks to MITC for these application techniques.

Many occupational handler scenarios for metam sodium and MITC have data gaps. There are a number of data gaps for both the metam sodium and the MITC occupational handler risk assessment. To refine this assessment, the following recommendations are made. 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 a review of the quality of the data used in this assessment and needed to refine the assessment. In addition, 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.

5.2 Occupational Postapplication Exposures

Once mixed with water, metam sodium rapidly breaks down into several degradates, the key degradate is MITC. 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. Therefore, HED is concerned about postapplication inhalation exposure to MITC for the occupational worker in or near metam sodium treated fields or areas. HED is concerned about postapplication occupational exposure and risk from the use of metam sodium 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. Among the three major use sites for metam sodium - as a fumigant for large agricultural areas, vegetation control for shorelines, and as a root control agent in sewer lines - postapplication exposure data is only available for use of metam sodium as a fumigant in large agricultural settings using chemigation or shank injection application methods. HED does not anticipate postapplication dermal exposures to metam sodium applied in agricultural settings or in commercial settings as a foam treatment to sewer lines.

This risk assessment evaluates the use of both metam sodium and metam potassium as agricultural fumigants. However, no data were submitted to HED for MITC exposure from metam potassium use as a soil fumigant. Upon comparison of use patterns and exposure scenarios for metam sodium and metam potassium, HED assumes the exposure and risk to MITC from metam potassium uses is similar to that estimated in the assessment for MITC from metam sodium uses.

The purpose of this occupational postapplication exposure and risk assessment is to determine the risk associated with re-entering metam sodium treated fields or areas and with working near treated field sites or areas. Currently, there is a 48 hour entry prohibition period. Using the results of the 11 field volatility studies measuring air concentration of MITC as a basis for the postapplication assessment, HED is unable to determine an appropriate distance from the treated field at which risk to the occupational worker are below HED's level of concern using available MITC air concentration data. 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. Many of the calculated risks at each of the MITC air concentration data points collected in the 11 field volatility studies exceed HED's level of concern for the occupational worker. In addition, available data did not measure the air concentration levels inside the treated field nor did the studies continue to monitor air concentration over time until the limit of detection was achieved. Therefore, HED has no data to indicate the risk to the re-entering occupational worker, the number of days following metam sodium applications that MITC air concentration levels are a concern to workers. HED is unable to calculate the distance needed from the treated field at which MOEs are at least 100.

5.2.1 Data, Assumptions and Limitations

Data and assumptions for the postapplication occupational exposure and risk assessment are similar to those detailed for the residential postapplication exposure and risk assessment and are included in section 4.4.1 of this risk assessment. The results of 11 field volatility studies measuring air concentration of MITC form the basis of this assessment. These studies measured MITC air concentrations using different application methods, application rates, soil sealing techniques (including none) and measurements were taken at different distances from the field. Parameters such as the pH, moisture level and temperature of the soil influence the rate at which MITC is formed during the degradation of metam sodium. Therefore, air concentration levels are expected to vary based on condition of the physical environment.

HED notes the following limitations with the above MITC air concentration studies. All of these studies were conducted in California. Currently, California's Department of Pesticide Regulation (DPR) has a technical information bulletin (TIB) for metam sodium application that identifies certain application practices (*e.g.*, regarding water sealing, air temperature, wind speed, time of application, etc.). These practices were not followed in all of the 11 MITC air concentration studies included in this assessment. However, the DPR's TIB does not apply to other states where metam sodium is used. Also, three of the 11 studies are pilot studies and may not reflect currently practiced intermittent-sealing methods. In one of the 11 studies used in the postapplication exposure and risk assessment, 'Air Monitoring for Methyl Isothiocyanate During a Sprinkler Application of Metam-sodium,' a nocturnal inversion occurred. They also report that the application was conducted with air temperatures that exceeded 90^{o} F, an application practice currently prohibited. 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 assessment for comparative historical purposes.

Assumptions incorporated into the occupational postapplication exposure assessment differ from the non-occupational postapplication exposure assessment. The exposure duration for the occupational worker is 8 hours per day. For occupational postapplication estimates of MITC exposure, a minute volume of 16.7 liters per minute was used– representing light to moderate work activities. The level of concern for occupational risks is an MOE of 100.

There are a number of occupational postapplication exposure scenarios for which HED has no data to assess. HED believes MITC air concentration may spike when the soil seal is removed and there are no data to assess this situation. Also, HED believes that application to potting soil, one of the uses on the metam sodium label, may occur in a sheltered setting where air circulation is somewhat restricted, however, there are no data about MITC air concentration levels following applications to potting soils. There is no data submitted to evaluate applications in small areas such as greenhouses (with open sides) or lawns (professionally applied). As stated earlier, postapplication exposure is anticipated following all major uses of metam sodium - as an agricultural fumigant, vegetation control agent, and root control in sewer lines. However, data are only available for postapplication exposure to MITC from use of metam sodium in large scale agricultural practice.

5.2.2 Postapplication Exposure and Risk Estimates

HED is primarily concerned about inhalation exposures to MITC to occupational workers who perform tasks in treated areas and near treated areas. These tasks are defined as:

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 area 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.

EPA has determined that there are potential postapplication exposures to individuals entering treated fields. The current metam sodium labels have an entry prohibition of 48 hours and during this time, only trained and PPE-equipped pesticide handlers are permitted to enter the treated area and only a few specific handling tasks are allowed to be performed according to the current labels. These activities include such things as 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. The following PPE is required upon re-entry: coveralls over long-sleeved shirt and long pants; chemical resistant gloves; and, chemical resistant footwear plus socks. In cases in which a pungent odor is also detected workers re-entering treated fields must also wear: face sealing goggles and a respirator. However, there are no data available that monitors MITC air concentration levels inside a metam sodium treated field. Therefore, HED was not able to calculate risks for the re-entering occupational worker with available data. Section 6.0 discusses HED's use of an air dispersion model to predict MITC air concentration levels inside the treated field to estimate appropriate entry prohibition periods for the re-entering worker.

The occupational postapplication exposure and risk assessment was performed using the same methodology as the non-occupational (residential) bystander exposure and risk assessment presented in Section 4.4.1 of this document. The results of the 11 field volatility measuring air concentration levels of MITC following application of metam sodium by either shank injection or chemigation were used in conjunction with certain exposure assumptions (application rate, inhalation rate, exposure duration) to determine exposure values for use in risk assessment. These values were compared to the appropriate endpoints to determine risk to the occupational postapplication worker near the metam sodium treated field. All postapplication exposure and risk estimates in this assessment are based on a single treated field; assessment of an occupational worker's exposure to MITC from exposure to multiple treated fields in one area is not possible at this time.

5.2.2.1 Occupational Postapplication Exposure and Risk Assessment

The non-cancer occupational 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 from 11 MITC-specific studies. HED believes that use patterns indicate both short-term and intermediate-term exposure potential. However, at this time the inhalation endpoint of concern for MITC is the same for short- and intermediate-term MITC exposure, therefore only one postapplication non-cancer risk calculation is performed. The short-, intermediate-term 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. The target MOE is 100.

A range of MOEs are presented reflecting the range of air concentration data points collected in each of the field volatility studies utilized in the assessment. Risk results are presented for each method of application for which postapplication data are available. Risk values of concern, MOEs less than 100, were calculated during at least one or more 8-hour periods for many of the occupational postapplication worker scenarios assessed. Within each study for the respective method of application, MOEs are generally greater the greater distance from the treated field edge. The following is a risk summary of the postapplication inhalation risk to the occupational worker.

Table 14: 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 15: 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.

5.2.2 Summary of Risks and Uncertainties

The results of the occupational 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.

6.0 Bystander Exposure and Risk Based on Dispersion Modeling

HED used the Industrial Source Complex (ISC) dispersion model to estimate MITC air concentrations in and near treated fields at locations that were not measured directly in field volatility studies. HED used a computer-based dispersion model entitled "Industrial Source Complex (ISC)" to estimate MITC postapplication exposure and risks at varying distances from the treated field. The Industrial Source Complex model (ISC) is a PC-based, straight line, steady-state Gaussian plume equation model developed by EPA's Office of Air Quality Planning and Standards division. The model assumes that a chemical, released from an emission source, will disperse in the horizontal and vertical directions in the form of a normal bell-shaped curve, with the maximum concentration occurring along the center of the plume. ISC is comprised of a short- and long-term model and will estimate emission concentrations from point, area, volume, and open pit sources. The ISC model characteristics, inputs and results are discussed in "Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision Document" (Steven Weiss, D293331, May 21, 2004).

Use of this tool enabled HED to address some of the uncertainties in the MITC postapplication exposure and risk assessment including, wind speed, wind direction, air temperature, and size of treated area. Data from both the MITC air concentration studies (*i.e.*, flux rates or the emission rate of MITC from the treated area divided by the size of the treated area), exposure assumptions (*e.g.*, exposure duration, application rate, inhalation rate) and meteorological data (*e.g.*, wind speed and direction) were used in the ISC model to predict MITC air concentration levels at varying distances from the perimeter of metam sodium treated fields. This permitted HED to estimate what distances were necessary to achieve risk levels that were not of concern to either non-occupational bystanders or occupational agricultural workers living or working near a treated field or area. The tool was also used to determine the length of time that must pass before occupational handlers may perform allowable re-entry activities inside the treated area.

HED ran the ISC model for various application and soil sealing methods, treated area sizes, and regions to estimate the distance from the treated field at which non-occupational bystander and occupational worker postapplication risks would not be a concern to the Agency. Using a target MOE of 100 and exposure assumptions appropriate for the non-occupational bystander, 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.

Similarly, for occupational agricultural worker the ISC model was used to determine distances from the treated areas at which calculated MOE's were below HED's level of concern. Using slightly different assumptions appropriate for the occupational populations and a target MOE of 100, the ISC model estimated distances from the treated field required to achieve risk levels that did not exceed HED's level of concern. Shank injection and sprinkler irrigation applications, primarily due to the high flux rates, resulted in greater distances from the edge of the metam sodium treated field than drip irrigation to achieve the target MOE. Drip irrigation generated much shorter distances from the edge of the treated field to achieve the target MOE than either shank injection or sprinkler irrigation. However, these distances may not be feasible to protect occupational workers in some cases.

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.

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 that these concentrations were measured the wind speed, wind direction, atmospheric stability, mixing height, and flux rate were not fixed. With the current modeling approach, the off-site air concentrations were calculated by using a constant flux rate (derived or reported from field volatility studies), constant wind speed (based on the average 10th percentile of wind speed measured in growing regions in the U.S.), constant wind direction, constant mixing height, and a constant atmospheric 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 approaches).

The short-term area source part of the ISC model can estimate air concentrations for persons located in a field treated with metam sodium. HED attempted to estimate the flux rates from the various treated-area sizes that would be necessary to generate 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. 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.

HED believes that the estimates made here 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. However, several data gaps and uncertainties remain and if fulfilled, may prove to enhance the assessment using dispersion modeling. These include improved information concerning 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; use of tarp as a soil seal; size of treated area; dissipation time of MITC; indoor versus outdoor exposure; and, various application equipment and application techniques.

The state of California Air Resources Board performed ambient air monitoring for metam sodium and certain breakdown products during 2001. Their report can be found at: http://www.cdpr.ca.gov/docs/dprdocs/methbrom/recent_pubs.htm. It is important to note that this program was not designed to determine air concentration at the field edge, but rather represent ambient concentrations of metam sodium and its breakdown products. Ambient air concentrations of MITC were detected in these studies. These results were not incorporated into the HED Chapter of the Reregistration Eligibility Document.

7.0 Summary of Incident Data

A review of metam sodium exposure incidents is detailed in a memorandum by Blondell and Hawkins (Review of Metam Sodium Incident Reports. D293158, September 24, 2003) in support of the HED chapter of the metam sodium RED. These reviewers conclude that based on the incident data, metam sodium poses a hazard to bystanders exposed to relatively low levels from off-site drift, *i.e*., bystander exposure. The effects of drift are usually minor to moderate leading primarily to irritant effects to eyes, throat, and skin, headache, nausea and shortness of breath. A serious threat to bystander health reported in the literature is the development and exacerbation of asthma seen in adults exposed to the fumes from an accidental spill in the Sacramento River in California. The potential for metam sodium to drift and cause health effects at distances above one-quarter mile and many hours after application is well documented. Direct contact of metam sodium to skin surfaces is well documented to cause irritative dermatitis. The potential for health effects to large numbers of persons in communities and schools adjacent to metam sodium applications, either by a sprinkler system or poorly sealed soil fumigation is also well documented. These incident profiles will be considered as HED assesses the exposure and risk to the fumigation use of metam sodium in agriculture. Key aspects of the incident data report are highlighted below.

There are a number of different datasets with which HED compiled a human exposure incident report for metam sodium and its degradate. The OPP Incident Data system items are anecdotal or represent allegations only. Information in this system comes from registrants, other federal and state health and environmental agencies and individual consumers. Among many incidents reported, these data revealed one incident relating to use of the chemical in a greenhouse and another incident in which application of 3,750 gallons of the chemical was applied 60 feet from an elementary school. Another OPP source of incident information is Poison Control Center (PCC) data from 1993-1998 that are obtained from about 65-70 centers at hospitals and universities. Dermal symptoms were most commonly reported among Poison Control Center cases, including skin irritation or pain. Other symptoms included erythema, rash, severe burn, eye irritation, nausea, and difficulty breathing.

The state of California collected detailed descriptions of 902 cases involving metam sodium from 1982-1994. Metam sodium is in the top 40 list of pesticides that caused systemic poisoning in the state for this time period. According to these data, changes in wind direction and weather inversions can readily contribute to significant illness. Metam sodium accounted for nine percent of the nearly 1,000 drift-related (*i.e.*, bystander) cases reported in California from 1994 through 1997 and 22% of the incidents involving clusters of 10 or more people during the same time period.

Between 2001 and 2002, the number of potential cases of pesticide illness in California more than doubled, 979 cases in 2001 and 1,859 cases in 2002. The state attributes this increase to two factors: increased surveillance and a significant number of cases based on two incidents involving metam sodium drift from agricultural fields. In one incident, applicators injected metam sodium into the soil as irrigators ran clean water through sprinklers to minimize off-gassing. However, the application tractors moved faster that irrigators could supply water. That night, a shift in wind blew gasses into the adjacent neighborhood and a carrot processing plant. Residents called emergency crews, and one woman was hospitalized with serious respiratory problems. Illness reports were collected from 72 workers at the carrot processing plant and 178 residents and visitors in the residential area. In the other major metam sodium drift incident in 2002 in California, 138 vineyard workers arrived on the job just as a metam sodium application was ending in an adjacent field. While only one worker sought medical care, DPR determined that 123 of the workers developed exposure symptoms such as eye and respiratory irritation, and headaches. The state of California summarized the 2002 pesticide incident data at www.cdpr.ca.gov/doc/whs/2002pisp.htm. Bystander exposure to metam sodium application is a major public health problem in California, as these data indicate.

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

Blondell and Hawkins (2003) also summarized work by other researchers who reported on adults experiencing persistent respiratory disorders including irritant-induced asthma after this spill occurred, among those who lived and worked near the spill cite. Data collected from the medical records, history, physical examination, spirometry, and methacholine challenge testing and revealed 20 cases of persistent irritant induced asthma and 10 cases of persistent exacerbation of asthma. The 20 cases with new onset of asthma due to exposure to metam sodium included 17 cases that met the criteria for RADS (reactive airway dysfunction syndrome). For these cases, symptoms persisted from 3 to 14 months. Of the 10 patients with persistent aggravation of existing asthma, all patients still had the problems even 3-15 months after the spill as compared to baseline prior to exposure to metam sodium. The study authors concluded that both exposure concentration and duration of exposure were factors in the development of long-term respiratory health effects. The same study authors note that the Bhopal, India release of methyl isocyanate (MIC), a photolysis degradate of MITC, has resulted in acute irritative effects followed by other long-term respiratory effects. These effects included increased cough and phlegm, difficulty breathing, and evidence of reduced lung function. MIC represents 4-7% of the MITC in the air so it is possible that MIC may also contribute to the long term respiratory effects seen in the population surrounding the Sacramento River spill site. Industrial hygiene data show that isocyanates were the most frequently reports asthma-causing agents found through surveillance from 1988-1992 (Blondell and Hawkins, 2003).

Another major metam sodium exposure incident is reported in the literature involving the evacuation of a school in California. The California Department of Health summarized an incident involving an overhead sprinkler application of metam sodium in 1999 in which two fields were sprayed over a 6-day period. On day-4, complaints were received from a shop 1-mile away, and on day-6 complaints of odor and sickness were reported by the nearby elementary school. After the school was evacuated, trace levels of MITC were detected in 8 air monitoring samples inside the school 36 hours after that last application of the fumigant. Symptoms reported are similar to other exposed persons discussed in this section.

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

8.0 Risk Characterization

Metam sodium/potassium quickly convert into the toxic and volatile degradate MITC in the environment. Metam sodium is among the top agricultural pesticides used in the U.S.; total annual use of metam sodium and metam potassium combined is 51-55 million pounds. There is no dietary exposure to metam sodium or MITC expected at this time. However, the exposure potential to non-occupational bystanders is significant. Risk calculations based upon air concentration data (point estimates) indicate risks are of concern to the residential bystander even at the maximum distances from the treated field measured in the field volatility studies, approximately 500-700 feet. Using currently available emission rate data and modeling tools, the result of air dispersion modeling illustrate that distances over 1 mile from the treated field are required to achieve risks that are not of concern to residential bystander when 20 acres are treated with metam sodium, at the maximum label rate using certain application and soil sealing methods.

Case studies based upon reports of metam sodium exposure illustrate that metam sodium poses a hazard to bystanders exposed to relatively low levels from off-site drift and that the chemical can cause health effects at distances above one-quarter mile to one mile from the treated field and many hours after the initial application. Incident data in the human population show similar types of health effects as seen in the toxicological animal data. Specifically, effects such as irritation to eyes, throat and shortness of breath; irritant induced asthma and exacerbation of asthma; and, evidence of neurotoxic impairment such as increased neurological, memory and concentration problems.

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

HED is considering use of probabilistic models for exposure assessment. One such model will be presented to the FIFRA Scientific Advisory Panel (SAP) in the summer of 2004. Other models which are non-proprietary and are presented to HED will be considered also. All such models will go through the FIFRA SAP.

9.0 Data Needs

a) Hazard Identification: The database MITC is incomplete for pesticidal uses of MITC *per se*, and additional data requirements may be imposed. The HIARC has identified following studies on MITC as the data gaps:

1. Acute neurotoxicity study in rat via inhalation with pathological evaluation of the complete respiratory tract
2. Two generation reproduction study in rat via inhalation with pathological evaluation of the complete respiratory tract. This study should also include a subchronic neurotoxicity component with functional battery and motor activity measurements using the F0 animals. If the F1 animals exhibit developmental neurotoxicity then the F2 generation should be evaluated for the standard developmental neurotoxicity parameters.
3. *In vivo* cytogenetic assay
4. Repeat of the unscheduled DNA synthesis assay

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

b) Residue and Product Chemistry:

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

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

Product	EPA Reg. No.	Registrant	OPPTS Guideline Requirements
54% FI	5481-484	Amvac Chemical Corporation	830.6313 (stability), 7050 (UV/visible absorption), 7220 (boiling point), 7370 (dissociation constant), 7550 (partition coefficient), 7840 (water solubility), and 7950(vapor pressure)
MITC (068103)			
97% EP	69850-1	MLPC International	830.1620 (description of product/process) and 7050 (UV/visible absorption)

c) Occupational and Residential Exposure:

For handlers, metam sodium and MITC exposure data are required for the following major tasks:

- potting soil applications;
- applying with hand-held equipment;
- 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;
- aerating or loosening the soil several days following an application.
- greenhouse applications
- weed control in beach front or drained water bodies

Series 875 Occupational and Residential Exposure Test Guidelines
875.1100 Dermal exposure-outdoor
875.1300 Inhalation exposure-outdoor

To assess postapplication exposure to MITC, the following data are needed:

- small area uses;
- greenhouses (with open sides);
- lawns and/or other residential sites;
- beach fronts/drained water bodies;
- potting soil

Series 875 Occupational and Residential Exposure Test Guidelines
875.2400 Dermal exposure
875.2500 Inhalation exposure
Series 840 Spray Drift Test Guidelines
Subdivision N, 163-3 Field Volatility

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APPENDICES

Appendix A: 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**
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

Appendix A: 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
	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
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**

Appendix A: 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
	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
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

Appendix A: Non-cancer Short-term Metam Sodium Occupational Handler Risk Summary										
Exposure Scenario	Crop or Target [a]	Application Rate [b]	Area Treated Daily [c]	Dermal MOEs				Inhalation MOEs		
				Baseline	PPE-G	PPE-G,DL	Eng Cont	Baseline	OV Respirator 90% PF	Eng Cont
	wheat, barley	31.7 lb ai/acre	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
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

Appendix A: 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

Appendix A: 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.

Appendix B: 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

Appendix B: 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
Loader/Applicator										

Appendix B: 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 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
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

Appendix B: 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
	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.									
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.

Appendix C: 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
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
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

Appendix C: 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
	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**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	tobacco plant beds	412 lb ai/acre	3	8.3	17	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	tobacco plant beds	387 lb ai/acre	3	8.3	18	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	7.7	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	8.1	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	41	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	68	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	81	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (enclosed cab with cellulose filter): MRID# 42968402 (2b)	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**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	tobacco plant beds	412 lb ai/acre	3	8.3	35	**350**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	tobacco plant beds	387 lb ai/acre	3	8.3	37	**370**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	16	**160**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	17	**170**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	85	**850**
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	**140**	1400
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**170**	1700
Applying Water Soluble Liquids via Shank Injection Equipment- Personal Sampler Pumps (open cab): MRID# 42968402 (2c)	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
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	tobacco plant beds	412 lb ai/acre	3	8.3	28	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	tobacco plant beds	387 lb ai/acre	3	8.3	29	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	ornamentals, food and fiber crops, turf (sod farm/golf course)	338 lb ai/acre	8	8.3	13	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320 lb ai/acre	8	8.3	13	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	peanuts (CBR susceptible cultivators)	63.3 lb ai/acre	8	8.3	67	**NA**
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	cotton, soybeans, sugar beets	38 lb ai/acre	8	8.3	**110**	NA
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	peanuts (CBR resistant cultivators)	32 lb ai/acre	8	8.3	**130**	NA
Applying Water Soluble Liquids via Shank Injection Equipment- In-cab Sampler Pumps (enclosed cab with charcoal filter): MRID# 45123902 and 45703703 (2d)	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**
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)	320 lb ai/acre	8	8.3	21	**NA**

Appendix C: 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
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						
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
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	No MITC specific exposure data is available for this			

Appendix C: 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
		ft	scenario			
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			
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:

5. 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.
6. 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.
7. 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.

Appendix D: Summary of Noncommercial Handlers Cancer Risks to Metam Sodium

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

Appendix D: Summary of Noncommercial Handlers Cancer Risks to Metam Sodium									
Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Noncommercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Applicator									
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	small areas of seed beds, plant beds	523 lb ai/acre	5 acres	5.5E-05	5.5E-05	5.1e-05	2.1E-05	1.8E-05	8.5E-06
	tobacco plant beds	387 lb ai/acre	20 acres	3.4E-04	3.4E-04	3.2e-04	1.3E-04	1.1E-04	5.3E-05
	orchard replant/transplant sites	320 lb ai/acre	100 acres	6.8E-04	6.8E-04	6.3e-04	2.6E-04	2.2E-04	1.0E-04
	turf (sod farms)	252 lb ai/acre	100 acres	5.3E-04	5.3E-04	5.0e-04	2.1E-04	1.7E-04	8.2E-05
	turf (golf courses)	252 lb ai/acre	20 acres	1.1E-04	1.1E-04	9.9e-05	4.1E-05	3.4E-05	1.6E-05
	wheat, barley [d]	162 lb ai/acre	100 acres	3.4E-04	3.4E-04	3.2e-04	1.36E-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
	peanuts	27.5 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.4E-04

Appendix D: Summary of Noncommercial Handlers Cancer Risks to Metam Sodium

Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Noncommercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [e]	turf (sod farms)	252 lb ai/acre	100 acres	1.1E-02	1.3E-03	1.1e-03	7.6E-04	5.0E-04	NA
	turf (golf courses)	252 lb ai/acre	20 acres	2.3E-03	2.7E-04	2.1e-04	1.5E-04	1.0E-04	NA
	ornamentals and food crops	108 lb ai/acre	100 acres	4.9E-03	5.7E-04	4.6e-04	3.3E-04	2.2E-04	NA
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	2.0E-03	2.3E-04	1.9e-04	1.3E-04	8.9E-05	NA
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with closed cab) (5b) [e]	turf (sod farms)	252 lb ai/acre	100 acres	NA	NA	NA	NA	NA	1.3E-03
	turf (golf courses)	252 lb ai/acre	20 acres	NA	NA	NA	NA	NA	2.5E-04
	ornamentals and food crops	108 lb ai/acre	100 acres	NA	NA	NA	NA	NA	5.4E-04
	cotton, soybeans, sugar beets	44.4 lb ai/acre	100 acres	NA	NA	NA	NA	NA	2.2E-04
Chemigation Monitor									
Monitoring Chemigation Applications Using Liquid Formulation (6)	No Metam Sodium data is available for this scenario.								
Soil Seal Irrigator									
Sealing Soil with Irrigation Water Following Shank Injection Applications Using Liquid Formulations (7)	No Metam Sodium data is available for this scenario.								
Mixer/Loader/Applicator									
Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data - occupational) (8)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	12 lb ai/1000 sq ft	1000 sq ft	3.6E-05	ND	ND	ND	ND	NF
	potting soil	4 lb ai/1000 sq ft	1000 sq ft	1.2E-05	ND	ND	ND	ND	NF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF hand-gun data - occupational) (9)	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	5 acres	6.4E-04	4.6E-04	2.6e-04	4.1E-04	2.2E-04	NF
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350 lb ai/acre	0.5 acres	6.4E-05	4.6E-05	2.6e-05	4.1E-05	2.2E-05	NF
Mixing/Loading/Applying Water Soluble Liquids via power sprayer (using ORETF LCO hand-gun data - occupational) (10)	drained water bodies and shorelines	350 lb ai/acre	5 acres	6.4E-04	4.6E-04	2.6e-04	4.1E-04	2.2E-04	NF

Appendix D: Summary of Noncommercial Handlers Cancer Risks to Metam Sodium

Exposure Scenario	Crop Type [a]	Typical Application Rate [b]	Area Treated [c]	Noncommercial Handler Cancer Risks					
				Baseline	PPE-G	PPE-G, DL	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
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.

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

Appendix E: 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
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
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

Appendix E: 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 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									
Mixing/Loading/Applying Liquids via Sprinkling Can (using ORETF hose-end data - occupational) (8)	small areas of ornamentals, food, fiber crops	12 lb ai/1000 sq ft	1000 sq ft	1.5E-04	ND	ND	ND	ND	NF
Mixing/Loading/Applying Water Soluble Liquids via hose-proportioner (using ORETF hand-gun data - occupational) (9)	small areas of ornamentals, food, fiber crops	350 lb ai/acre	5 acres	2.5E-03	1.8E-03	1.1E-03	1.6E-03	8.7E-04	NF
	small areas of ornamentals, food, fiber crops	350 lb ai/acre	0.5 acres	2.5E-04	1.8E-04	1.1E-04	1.6E-04	8.7E-05	NF
Mixing/Loading/Applying Water Soluble Liquids via Power Sprayer (using ORETF hand-gun data - occupational) (10)	No commercial cancer risks were calculated for this scenario.								
Mixing/Loading/Applying	No commercial cancer risks were calculated for this scenario.								

Appendix E: 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
Liquid via Cement Mixer (using PHED Mixer/Loader data for Open-pour Liquids) (11)									
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.