Overview of the Metam Sodium Risk Assessments

June 2, 2004

Introduction

This document summarizes EPA's preliminary human health and ecological risk findings for the pesticide metam sodium, as presented fully in the documents "Metam sodium/metam potassium: The HED Chapter of the Reregistration Eligibility Decision Document (RED).", dated May 21, 2004 and, "Revised Reregistration Environmental Risk Assessment for Metam-Sodium and Metam Potassium.", dated May 18, 2004. The purpose of this summary is to assist the reader by identifying the key features and conclusions reached in the assessments. References to relevant sections in the complete documents are given to allow the reader to find the place in these assessments where a more detailed explanation is provided. This summary was developed in response to comments and requests from the public which indicated that the risk assessments were difficult to understand, that they were too lengthy, and that it was not easy to compare the assessments for different chemicals due to the use of different formats.

These metam sodium risk assessments and additional supporting documents can be viewed on the EPA's Internet website www.epa.gov/pesticides/reregistration/ (listed under methyldithiocarbamate salts), and public comments may be submitted to the OPP electronic docket at www.epa.gov.edockets under OPP-2004-0159. These documents also can be viewed in hard copy form in the OPP docket, located in Room 119, Crystal Mall #2, 1921 Jefferson Davis Highway, Arlington, VA. Public comments also can be submitted at this location to docket number OPP-2004-0159.

The preliminary risk assessments available for comment assess the agricultural, turf/ornamental and antimicrobial uses of metam sodium, and the risks associated with its toxic degradate, methyl isothiocyanate, or MITC. Although the soil fumigants metam potassium and dazomet also degrade to MITC, the agricultural use of metam sodium greatly exceeds that of these other two soil fumigants. Consequently, the assessments of the risks associated with metam-produced MITC are considered to be protective of any potential aggregate bystander and environmental risks associated with metam potassium and dazomet-produced MITC. Occupational exposure to dazomet and to the antimicrobial uses of metam potassium will be addressed at a later date. Although MITC itself is a registered fumigant, its only use is for the antimicrobial treatment of wood poles and pilings.

The Agency cautions that these risk assessments are preliminary and that further refinements may be appropriate. Risk assessments reflect only the work and analysis conducted as of the time they were produced and it is appropriate that, as new information becomes available and/or additional analyses are performed, the risk estimates they contain may change.

Use Profile

- **Non-selective soil fumigant or sterilant:** metam sodium (sodium N-methyldithiocarbamate) is a dithiocarbamate salt with fungicidal, herbicidal, insecticidal, and nematicidal properties. It quickly breaks down in the environment to the primary toxic degradate methyl isothiocyanate, or MITC. MITC is highly volatile and is responsible for the fumigant properties of metam sodium. In agriculture, metam sodium is typically used to sterilize the soil prior to planting, but it can also be used to fumigate the soil post-harvest. Metam sodium is also registered as an antimicrobial agent.

- **Use sites:** Metam sodium is registered as an agricultural soil fumigant for use on all food, feed, and fiber crops, including turf and ornamentals. Major agricultural use sites for metam sodium include potatoes, tomatoes, cotton, and carrots. Metam sodium is also registered for use on golf course turf, and for application to small areas of turf and soil. In addition, metam sodium is used as a root-control agent in drains and sewers, for vegetation control along drained ponds and lakes in California (through a Special Local Need registration), and as an antimicrobial agent for the following use sites: cane and beet sugar processing mills, wood poles and pilings, hides and skins (leather manufacturing), and sewage/organic sludge and animal waste.

- **Use classification:** Most metam sodium products are registered for general use. Only the metam sodium products registered specifically for use on golf courses, for use on small areas of turf and soil, and for antimicrobial uses including sewer root control, are registered as "restricted use". No metam sodium products are intended for use by homeowners.

- **Formulations:** Soluble concentrate, and ready-to-use aqueous solution.

- **Methods of application:** In agricultural settings, metam sodium is applied through chemigation or with tractor-drawn equipment. Chemigation methods include sprinkler irrigation (which accounts for 90% of irrigation applications), flood, furrow, and drip/trickle irrigation. Tractor-drawn applications are carried out with various types of shank soil injection and rotary tiller injection equipment. Applications to smaller areas can be made with handheld equipment, including sprinkler cans, hose proportioners (hose-end sprayers), power sprayers (handgun sprayers), or foam injectors. Metam sodium applications to potting soil may be made by adding the chemical to soil in a cement mixer, or by spraying it onto a soil stream as soil is ejected from a shredder. The antimicrobial uses of metam sodium have their own associated application methods, including use of a hand-held, pressurized pump or injector for making applications to wood poles and pilings, open pouring or applying through a metering pump for treating hides/skins in leather manufacture, and applying through a metering pump in sugar processing mills or for the treatment of sewage sludge.

- **Use rates:** The maximum application rate listed on most product labels for application to ornamentals, turf, food, feed, and fiber crops is 320 pounds of active ingredient per acre (lbs ai/A). Tobacco plant beds have a maximum application rate of 387 lbs ai/A on most product labels, but at least one product lists a rate as high as 412 lbs ai/A. For small areas of ornamentals, food and fiber crops, seed beds, plant beds, and lawns, the maximum application rate is 12 lbs ai/1000 square feet. For sewers and drains, the maximum application rate is 0.212 lbs ai/gallon of solution.

- **Annual pounds used in the United States:** Based on pounds of active ingredient used, metam sodium is the third most widely used agricultural pesticide in the United States. In 2002, 51-55 million pounds of metam sodium were used in U.S. agriculture. Since metam sodium is considered to be a potential methyl bromide (MeBr) replacement, its use is expected to increase as use of MeBr decreases.

- **Regional use:** Of the total U.S. agricultural use of metam sodium, use in the Pacific Northwest (ID, OR, WA) accounts for 50%, followed by CA at 36%, and the Midwest (mainly MI, WI) at 9%; FL accounts for just over 1% of use.

- **Tolerances:** There are no tolerances currently established for metam sodium on agricultural food or feed crops, or on livestock commodities. No residues in plants or livestock are expected from the use of metam sodium as a soil fumigant or antimicrobial agent.

- **Technical registrants (metam sodium):** Amvac Chemical Corporation, Buckman Laboratories International, Inc., Loveland Products, Inc., (formerly Platte Chemical Company), Taminco N.V., and Tessenderlo Kerley, Inc. Of these, only Taminco and Tessenderlo-Kerley are members of the Metam-Sodium Task Force.

Human Health Risk Assessment

Hazard Profile

(For a complete discussion, see section 3.1 of the “HED Chapter of the Reregistration Eligibility Decision Document,” dated May 21, 2004, sections 2.0 and 5.0 of the “2nd Revised Toxicology Disciplinary Chapter,” dated May 19, 2004, and the memo, “Quantification of Carcinogenic Potential for MITC,” dated May 13, 2004.)

Toxicological endpoints were selected for metam sodium and MITC. Metam sodium and dazomet are metabolized to MITC *in vivo*. Although the toxicological database for MITC is not complete, the toxicological databases for metam sodium and dazomet are complete. Because of *in vivo* metabolism and remarkable similarity in toxic effects, metam sodium and dazomet studies are currently used to characterize hazard when MITC data are missing or inadequate.

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.

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 (blood chemistry) 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 subchronic inhalation toxicity studies with metam sodium and MITC, histopathology (tissue damage) 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.

Occupational exposure to metam sodium can occur via the dermal and inhalation routes only; exposure is not expected via the oral route. Occupational and bystander exposure to MITC is anticipated via the inhalation route only. The endpoint selected is used to assess all durations of inhalation exposure. See the table, below, for a description of the metam sodium and MITC endpoints selected for risk assessment.

Metam sodium is classified as a probable human carcinogen, based on the total incidence of malignant angiosarcomas in both sexes of the mouse, and supported by a similar tumor type in male rats. The upper-bound Q_1* (cancer slope factor) for metam sodium is 1.98×10^{-1}.

There are insufficient data to characterize the cancer risk of MITC, due to limitations in the rat and mouse MITC oral carcinogenicity studies, and lack of chronic testing via the inhalation route. The Agency has determined that it would not be appropriate to quantify the carcinogenic potential of MITC using the oral cancer slope factor (Q_1*) for metam sodium, due to the following evidence:

- negative results in dazomet cancer studies in both rats and mice;
- a lack of tumor response with MITC at doses similar to and greater than those resulting in angiosarcomas with metam sodium;
- an indication of port-of-entry effects in a 28-day MITC inhalation study, suggesting that oral carcinogenicity studies may not be predictive of carcinogenic potential following inhalation exposure.

Although the carcinogenic potential of MITC cannot be determined from available data, based on the current use profile, chronic oral exposure to MITC is not expected.

The following table summarizes the endpoints selected and used in the human health risk assessment for metam sodium/potassium and MITC.

Toxicological Endpoints Selected for Human Health Risk Assessment

Exposure Scenario	Metam Sodium		MITC	
	Dose Used in Risk Assessment	Study and Toxicologial Effects	Dose Used in Risk Assessment	Study and Toxicologial Effects
Acute Dietary	Acute dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.			
Chronic Dietary	Chronic dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.			
Incidental Oral Residential only	Short- and intermediate-term incidental oral endpoints were not selected since the use-pattern does not indicate potential for residential incidental oral exposure.			
Dermal Short-Term (1 - 30 days) Occupational only	Maternal NOAEL[a,b]= 4.2 mg/kg/day	**Developmental toxicity in rat (MRID 41577101)** LOAEL[c] = 16.9 mg/kg/day based on reduced body weight gain and decreased food efficiency in maternal rats	No dermal hazard via typical dermal contact with MITC is expected.	
Dermal Intermediate- (1 - 6 Months) and Long-Term (> 6 Months) Occupational only	Oral NOAEL[a] = 0.1 mg/kg/day	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on increased alanine aminotransferase and microscopic changes in the liver in females.	No dermal hazard via typical dermal contact with MITC is expected.	

Exposure Scenario	Metam Sodium		MITC	
	Dose Used in Risk Assessment	Study and Toxicologial Effects	Dose Used in Risk Assessment	Study and Toxicologial Effects
Inhalation Short- (1 - 30 days), Intermediate- (1-6 Months), and Long-Term (> 6 Months) Occupational (Metam Sodium and MITC) and Bystander (MITC only)	Inhalation NOAEL= 6.5 mg/m^3 (1.1 mg/kg/day)	**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.	Inhalation NOAEL = 5.4 mg/kg/day	**Subchronic inhalation toxicity- rat with MITC (MRID 45314802)** LOAEL = 27 mg/kg/day based on persistent clinical signs, body weight changes, and gross and histopathological lesions
Cancer Occupational only	**Classification:** Probable human carcinogen (B2) **Q1* =** 1.98×10^{-1} in human equivalents converted from animals		Insufficient data to characterize the cancer risk.	

a No data were available to measure systemic effects following dermal exposure to metam sodium; the existing dermal study did not take adequate precautions for the volatilization of MITC. As a result, oral studies were used to select endpoints for dermal exposure to metam sodium, and a dermal absorption factor of 2.5% was used for route-to-route extrapolation;
b NOAEL = no observed adverse effect level;
c LOAEL = lowest observed adverse effect level.

Acute, Chronic, and Cancer Dietary Risk (Food)

(For a complete discussion, see section 4.2 of the "HED Chapter of the Reregistration Eligibility Decision Document," dated May 21, 2004, and the memo, "Metam Sodium Dietary Risk Assessment of Antimicrobial Uses," dated April 16, 2004.)

When used as an agricultural soil fumigant, metam sodium is considered to be a non-food use. Based upon the results of appropriate plant metabolism studies, residues of metam sodium and MITC are not expected to occur in plant or livestock commodities. Therefore, no dietary risk assessment was performed for the agricultural uses of metam sodium and potassium. Similarly, no residues in food or food products are anticipated from the antimicrobial use of metam sodium in sugar cane processing plants due to the elevated temperatures and liming processes used in the processing of raw sugar cane.

Drinking Water Dietary Risk

(For a complete discussion, see section 4.3 of the "HED Chapter of the Reregistration Eligibility Decision Document," dated May 19, 2004, and the memo, "Estimated Drinking Water Concentrations for Metam Sodium and Its Metabolite Methyl Isothiocyanate for Application on Florida Tomatoes," dated September 16, 2004.)

Exposure to metam sodium and MITC in drinking water is not expected. The environmental fate properties of these chemicals suggest that there is a low potential for them to be present in either surface water or ground water. In the environment, metam sodium rapidly degrades to MITC. Consequently, it is unlikely that metam sodium will reach surface or ground water, or be present in drinking water.

Although MITC is volatile, it is also soluble in water, and has low soil adsorption. Based on these properties, MITC potentially could reach surface water in runoff, if a metam sodium application were immediately followed by an intense rainfall or by continuous heavy irrigation. However, any MITC that reaches surface water is likely to volatilize rapidly. Similarly, MITC could leach into ground water under "worst case" field conditions, but it is unlikely to do so, because it rapidly degrades and volatilizes in soil.

Residential Risk

(For a complete discussion, see section 4.4 of the "HED Chapter of the Reregistration Eligibility Decision Document," dated May 21, 2004, and sections 2.2 and 3.0 of the "Occupational and Residential Exposure Assessment," dated May 21, 2004.)

There are no registered homeowner-applied uses of metam sodium or MITC in the U.S. Nevertheless, non-occupational (residential) bystanders (adults or children living or working near a site where metam sodium has been applied) could experience post-application exposure to MITC. There is the potential for post-application MITC exposure to residential bystanders from the use of metam sodium as a soil fumigant on agricultural crops, turf (including golf courses), and ornamentals, as a vegetation control agent along shorelines and in drained water bodies (CA SLN), as a fumigant on small and medium-sized areas of turf (lawns) and soil, and for application to potting soil. Applications could take place in an enclosed or semi-enclosed greenhouse. Residential bystanders could also be exposed to MITC following metam sodium applications as a root-control agent in drains and sewer pipes.

Due to a lack of exposure data for other application methods, the only post-application exposure scenarios evaluated for residential bystanders were from the use of metam sodium as a soil fumigant applied using shank injection or chemigation equipment in large-scale agricultural settings. No data were available to assess post-application exposure resulting from the use of metam sodium as a vegetation control agent, on small- or medium-scale areas of turf and soil, on potting soil, as or as a root-control agent in sewers.

Risk to residential bystanders was calculated using two methods: point estimates and estimates derived from modeling. Point estimates of risk (Margins of Exposure, or MOEs) at specific distances from a treated field were based on measured MITC concentrations from field volatility studies. and estimates of distances from treated fields needed to achieve a target MOE of 100, derived from MITC concentrations estimated using EPA's Industrial Source Complex (ISC) dispersion model. Each method is described in turn, below.

Calculation of bystander risk: point estimates

The risks to residential bystanders were calculated based on MITC air concentrations measured at specific distances from treated fields in eleven field volatility studies. The eleven studies were performed using a variety of application methods including shank injection, sprinkler irrigation, and drip irrigation. In some of the studies, the metam sodium was watered into the soil immediately following application ("standard seal"), in other studies, the application was followed by intermittent watering-in, over consecutive days ("intermittent water-seal"), and in still other studies, application was not followed by any watering-in (no "seal"). For drip irrigation, some studies were performed on tarped fields, others on untarped fields. No data were available to assess the risks to bystanders following rotary tiller applications, or following applications using handheld/stationary equipment.

Because metam sodium label instructions recommend soil "sealing" immediately following application (either with a tarpaulin or by watering-in with irrigation water), MITC air concentration levels could spike when the soil "seal" is removed (e.g. by removing a tarpaulin, or by cultivating the soil surface to aerate the soil). However, there were no data available to assess this scenario.

Assumptions for point-estimate calculations

- Post-application inhalation 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. However, at this time, the inhalation endpoint of concern for MITC is the same for short-, intermediate-, and long-term MITC exposures, therefore, only one post-application non-cancer risk calculation was performed.

- For MITC, the target MOE for non-cancer risks to bystanders is 100 (based on a 10X uncertainty factor for intraspecies extrapolation and a 10X uncertainty factor for interspecies variation). MOEs less than 100 represent risks that are above the Agency's level of concern.

- Key variables in these studies were the method of application, the type of soil "seal" (*i.e.*, tarpaulin covering treated soil), and the distance from the treated field at which measurements were taken.

- Different application rates were used in the studies. These rates were proportionately scaled to equal the maximum label application rate of 320 lbs ai/A for assessment purposes.

- The MITC air concentration levels were measured at various time periods following application (*e.g.*, 2 hours, 8 hours, 24 hours), at various distances from the edge of the treated field (*e.g.*, 15 meters, 150 meters, 300 meters) and in various directions from the treated field (*e.g.*, north, south, east, west).

- The assessment assumed an exposure duration of 16.4 hours per day for indoor exposure, and an exposure duration of 2 hours per day for outdoor exposure. For adults, a minute volume (inhalation rate) of 8.3 liters per minute (representing sedentary activities) was used for the 16.4-hour indoor exposure period. For children, a minute volume of 6.7 liters per minute (representing a mixture of rest and sedentary activities) was used for indoor exposure. For both adults and children, a minute volume of 16.7 liters per minute (representing light activities) was used for the 2-hour outdoor exposure period.

- A study measuring indoor and outdoor ambient air concentrations of MITC following applications of metam sodium indicated that over a given exposure period, indoor and outdoor MITC air concentrations are approximately equal. Based on the results from this study, calculated risks were assumed to apply equally to bystanders indoors and outdoors near treated fields.

- All post-application risk estimates were based on a single treated field. The risk to bystanders in the vicinity of multiple treated fields was not assessed.

<u>Results of point-estimate calculations of bystander risk</u>

Based on the MITC air concentrations measured in the available field-volatility studies, the risks to residential bystanders (adults and children) were above the Agency's level of concern for many different exposure scenarios and distances from metam sodium treated fields (see tables, below, for ranges of MOEs). With respect to application equipment, the data indicated that drip irrigation applications are the most effective in inhibiting release of MITC, shank injection applications are moderately effective in inhibiting release of MITC, and sprinkler irrigation applications are the least effective in inhibiting release of MITC. With respect to soil "sealing" methods, 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 (but they evaporate unless reapplied), and rolling and dragging to compact the soil, if done correctly, is moderately effective in inhibiting release of MITC. Without any soil "sealing" method following application, MITC tends to be released from soils to which metam sodium has been applied.

The point-estimates of bystander risks to adults resulted in the ranges of MOEs shown in the tables below. The residential exposure assessment also presents MOEs estimated for child bystanders; these were somewhat lower than those for adults, due to differences in breathing rate. For simplicity of presentation in this overview, MOEs have been grouped across different studies by application method, exposure duration, sealing method, and distance from edge of treated field. However, these different studies may have been conducted in different geographical regions and/or under differing environmental conditions.

Adult Bystander: **Sprinkler Irrigation**

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Total Number of MOEs	Number of MOEs < 100	Minimum MOE	Maximum MOE
2-Hour MITC Exposure					
None	5	**13**	**5**	**19**	910
	25	**13**	**5**	**23**	780
	125	**13**	**3**	**29**	2300
	500	13	0	150	12000
Standard	5	**38**	**17**	**3**	9900
	71	10	0	160	9200
	75	11	0	160	8600
	77	9	0	120	9000
	82	**11**	**4**	**3.4**	8800
	150	**92**	**11**	**5.5**	430000
Intermittent	137	96	0	110	160000
	150	**75**	**4**	**39**	80000
	274	216	0	110	160000
	411	24	0	620	160000
	530	24	0	320	160000
	549	24	0	630	160000
16.4-Hour MITC Exposure					
None	5	**2**	**2**	**11**	65
	25	**2**	**2**	**10**	50
	125	**2**	**2**	**17**	95
	500	**2**	**1**	**86**	390
Standard	5	**12**	**6**	**2.1**	2300
	71	**3**	**1**	**97**	2100
	75	**3**	**1**	**67**	2900
	77	3	0	140	2000
	82	**3**	**2**	**3.3**	220
	150	**17**	**5**	**4.9**	3300

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Total Number of MOEs	Number of MOEs < 100	Minimum MOE	Maximum MOE
Intermittent	137	**16**	**2**	**93**	15000
	150	**12**	**4**	**41**	57000
	274	**36**	**1**	**55**	28000
	411	4	0	400	870
	530	4	0	360	1100
	549	4	0	570	1200

Adult Bystander: **Shank Injection**

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Total Number of MOEs	Number of MOEs < 100	Minimum MOE	Maximum MOE
2-Hour MITC Exposure					
None	11.0	**6**	**1**	**58**	2600
	11.9	**16**	**2**	**50**	19000
	13.7	**21**	**7**	**18**	84000
	18.3	**30**	**8**	**14**	14000
	36.6	**8**	**1**	**59**	8300
Intermittent	150	**159**	**4**	**66**	140000
	300	187	0	120	73000
	500	24	0	440	59000
	700	48	0	600	60000
16.4-Hour MITC Exposure					
None	11.0	**3**	**1**	**24**	390
	11.9	**9**	**2**	**18**	2600
	13.7	**3**	**1**	**11**	270
	18.3	**12**	**8**	**4.5**	1400
	36.6	**3**	**2**	**16**	870
Intermittent	150	**28**	**3**	**44**	15000
	300	**32**	**1**	**98**	15000
	500	4	0	560	14000
	700	8	0	550	14000

Adult Bystander: Drip Irrigation

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Total Number of MOEs	Number of MOEs < 100	Minimum MOE	Maximum MOE
2 Hour MITC Exposure Summary					
Untarped	3	20	0	530	14000
	6.1	10	0	270	2200
	15.2	10	0	270	2300
	45.7	10	0	430	3400
Tarped	3	20	0	420	480000
	6.1	10	0	1100	480000
	15.2	10	0	530	480000
	45.7	10	0	510	9200
16.4 Hour MITC Exposure Summary					
Untarped	3	8	0	200	1500
	6.1	**4**	**1**	**95**	430
	15.2	4	0	110	520
	45.7	4	0	130	720
Tarped	3	8	0	170	2000
	6.1	4	0	420	120000
	15.2	4	0	240	12000
	45.7	4	0	180	1100

Calculation of bystander risk: ISC modeling

Based solely on the above point estimates, it was not possible to calculate the distance from a treated field at which risks to bystanders would fall below the Agency's level of concern, for each application type and "soil sealing" method. To refine the above assessment, EPA's Industrial Source Complex (ISC) dispersion model was used to estimate ambient MITC air concentrations near treated fields. Key inputs to the ISC model included hourly meteorological data (wind speed, wind direction, and air stability category) and flux rates. Modeled concentrations then were used to calculate the distances from treated fields at which MITC inhalation risks to bystanders would fall below the Agency's level of concern.

Assumptions for ISC modeling calculations

- As for the point-estimate calculations, the ISC modeling assessment used an exposure duration of 16.4 hours per day for indoor exposure, and an exposure duration of 2 hours per day for outdoor exposure. In addition, a 24-hour indoor exposure duration was modeled. A minute volume (inhalation rate) of 8.3 liters per minute (representing sedentary activities) was used for the 16.4-hour and 24-hour indoor exposure periods, and a minute volume of 16.7 liters per minute (representing light activities) was used for the 2-hour outdoor exposure period. Risks to child bystanders were not modeled.

- Flux rates were estimated or calculated directly from the data from the eleven field studies measuring MITC air concentration levels following applications.

- Concentrations and associated distances were calculated for the five major metam-sodium use regions (California, the Pacific Northwest, the Midwest, the Southeast, and the Northeast). Regional wind speed data for input to the ISC model were taken from five years of data from the Solar and Meteorological Surface Observation Network, except wind speeds for California which were developed by the California Department of Pesticide Regulation using data collected for the California Irrigation Management Information System.

- Wind speed and direction, and the air stability category, were all assumed to be constant for the time periods modeled. Distances were calculated downwind from the treated field, only.

- Concentrations were modeled based on treated field sizes of 1, 5, 10, 20, 40, 80, and 100 acres.

Results of bystander risk calculations based on modeled MITC concentrations

Based on modeled estimates of MITC concentrations for a range of application and "sealing" methods, field sizes, exposure durations, and geographical regions, the distances from treated fields that would be required to achieve the target MOE of 100 for residential bystanders are shown in the tables, below. The greatest distances are required for sprinkler irrigation applications with a standard seal, and shortest for tarped drip irrigation applications. In general, the shortest distances were estimated for the midwest (EPA region 5), and the greatest distances for California (EPA region 9). For simplicity of presentation, the range of distances presented in the tables does not distinguish among geographical regions (the total range across all regions is shown).

Adult Bystander: Sprinkler Irrigation

Type of "Seal"	Acres treated	2-hr MITC exposure		16-hr MITC exposure		24-hr MITC exposure	
		Distance from treated field (in meters)					
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Standard	1	508	666	322	459	372	525
	5	1,350	1,818	774	1,103	893	1,261
	10	2,139	2,869	1,136	1,618	1,311	1,850
	20	3,411	4,599	1,671	2,379	1,928	2,721
	40	5,450	7,323	2,445	3,481	2,820	3,981
	80	8,746	11,785	3,593	5,116	4,145	5,852
	100	10,190	13,767	4,066	5,789	4,690	6,624
Intermittent	1	166	247	139	219	153	238
	5	430	642	334	527	369	571
	10	660	986	491	774	542	839
	20	1,043	1,601	723	1,139	798	1,234
	40	1,719	2,570	1,060	1,667	1,169	1,806
	80	2,828	4,187	1,559	2,451	1,720	2,655
	100	3,330	4,897	1,765	2,773	1,947	3,005

Adult Bystander: Shank Injection

Type of "Seal"	Acres treated	2-hr MITC exposure		16-hr MITC exposure		24-hr MITC exposure	
		Distance from treated field (in meters)					
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Standard	1	226	321	187	282	188	282
	5	588	828	451	677	451	678
	10	897	1,307	662	993	663	995
	20	1,458	2,097	975	1,461	976	1,463
	40	2,351	3,352	1,427	2,138	1,430	2,141
	80	3,836	5,427	2,098	3,142	2,102	3,147
	100	4,492	6,330	2,375	3,555	2,379	3,561
Intermittent	1	67	119	67	127	81	147
	5	170	307	161	307	197	356
	10	262	476	237	452	291	523
	20	412	739	350	667	431	771
	40	644	1,219	516	977	633	1,130
	80	1,085	2,062	762	1,438	934	1,662
	100	1,305	2,433	864	1,628	1,057	1,881

Adult Bystander: **Drip Irrigation**

Type of "Seal"	Acres treated	2-hr MITC exposure		16-hr MITC exposure		24-hr MITC exposure	
		Distance from treated field (in meters)					
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Untarped	1	12	22	13	24	18	34
	5	21	47	21	56	25	79
	10	27	72	24	83	40	118
	20	44	113	37	123	59	175
	40	69	176	53	183	88	260
	80	112	283	82	274	132	387
	100	131	330	94	312	151	440
Tarped	1	22	40	22	46	24	56
	5	47	101	42	112	53	136
	10	72	155	62	166	79	201
	20	113	241	92	246	119	298
	40	176	380	137	363	176	440
	80	283	607	206	538	264	651
	100	330	713	234	610	300	738

Estimating bystander risks: next steps for refining the assessment

In some instances, the risk estimates 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 (point estimates, described above). The point estimate risks were calculated using actual off-site measured air concentrations from field volatility studies. The time period over which concentrations were measured ranged from 4 to 24 hours. During these measurement time periods, the wind speed, wind direction, wind stability, mixing height, and flux rate were not constant. In contrast, with the current modeling approach, the off-site air concentrations were calculated using a constant flux rate (derived or reported from field volatility studies), constant wind speed (based on average 10th percentile of wind speed measured in growing regions in the U.S.), constant wind direction, and a constant wind stability class (based on conservative assumptions used by California's Department of Pesticide Regulation, CDPR). Although use of the ISC model allowed EPA to estimate MITC concentrations at distances not measured in the field volatility studies, the modeling results are more conservative than the point estimates.

______Further refinements to the bystander risk assessment are anticipated for future revisions of the metam sodium risk assesment. The EPA Office of Pesticide Programs is in the process of working with the EPA Office of Air, the California Department of Pesticide Regulation (Cal DPR), EPA's Science Advisory Panel (SAP), registrants, and other stakeholders to further refine risk assessment approaches used for metam sodium and other soil fumigants. Such refinements could include the use of a probabilistic and/or distributional modeling approach, to incorporate variability in wind and other meteorological parameters. Other refinements could include the incorporation of additional toxicity and exposure data, and a consideration of different toxic effects. See the last section of this overview for additional discussion of potential refinements.

Occupational Risk

(For a compete discussion, see section 5.0 of the "HED Chapter of the Reregistration Eligibility Decision Document," dated May 21, 2004, sections 2.1, 2.2 and 3.0 of the "Occupational and Residential Exposure Assessment," dated May 21, 2004, and the memo, "Occupational and Residential Exposure Assessment of Antimicrobial Uses," dated April 13, 2004.)

Workers have the potential to be exposed to metam sodium and MITC when handling metam sodium products during the application process (i.e., mixing/loading, applying, and mixing/loading/applying). Workers also can be exposed to MITC when entering fields previously treated with metam sodium, or when working near metam sodium-treated fields. Workers using antimicrobial products also have the potential to be exposed to metam sodium and MITC during application, and to MITC following application.

The risks to handlers and post-application workers were assessed for the following uses of metam sodium:

- As a fumigant in large-scale agricultural settings applied with shank injection, rotary tiller, or chemigation equipment;
- As a vegetation control agent for shorelines and drained water bodies (CA SLN);
- As a fumigant/soil sterilant in small- or medium-scale settings, applied with a sprinkler can, hose proportioner, cement mixer, shredder, or open-pour equipment;
- As a root control agent in sewers and drains, applied with a foam applicator;
- As an antimicrobial agent for the treatment of wood poles/pilings, in cane and beet sugar processing, for the treatment of hides/skins in leather manufacture, and for the treatment of sewage and animal wastes.

Occupational Handler Risk

<u>Occupational handler risk: agricultural, small-scale, and sewer uses</u>

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 to handlers are above the Agency's level of concern even with maximum feasible personal protective equipment (PPE or engineering controls), 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 the Agency's level of concern at maximum application rates for all loader/applicator scenarios even with maximum PPE, for metam sodium exposures to both noncommercial and commercial handlers. Industry sources indicate that approximately 90% of handlers who apply metam sodium with a tractor also do their own mixing and loading.

For applications to sewer systems and in small scale agricultural settings (i.e., sprinkling can, hose proportioner, potting soil, and tree replant scenarios), the non-cancer and cancer risks for metam sodium are below the Agency'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 scenarios.

Due to their length, tables showing the risk estimates for occupation handlers are presented in Appendices A-C. Appendix A presents the short and intermediate-term dermal and inhalation non-cancer risk estimates for handlers exposed to metam sodium. Appendix B presents the cancer risk estimates for handlers exposed to metam sodium. Appendix C presents the inhalation risk estimates for non-commercial and commercial handlers exposed to MITC.

Assumptions for handler calculations

- Workers who mix, load, and apply metam sodium products in agricultural settings can be exposed to metam sodium dermally or through inhalation, over short (1 to 30 days) or intermediate (1 to 6 months) exposure durations. In addition, they can be exposed to MITC through inhalation over the short and intermediate term.

- For both metam sodium and MITC, the target MOE for non-cancer risks to occupational handlers is 100 (based on a 10X uncertainty factor for intraspecies extrapolation and a 10X uncertainty factor for interspecies variation). MOEs less than 100 represent risks that are above the Agency's level of concern.

- Metam sodium is classified as a probable (B2) human carcinogen. For occupational handlers, cancer risks above 1×10^{-4} exceed the Agency's level of concern, but the Agency attempts to mitigate cancer risks to below 1×10^{-6}. There are insufficient data to characterize the cancer risk for MITC.

- For metam sodium, occupational handler exposure estimates were based on surrogate data from: (1) the Pesticide Handlers Exposure Database (PHED); (2) Outdoor Residential Exposure Task Force (ORETF); and (3) California DPR's review of a sodium tetrathiocarbonate handler study.

- For MITC, handler exposure estimates were based on four chemical-specific handler studies that examined MITC exposures to handlers involved in metam sodium applications.

- Non-cancer risks for commercial handlers (i.e. for hire applicators, large-scale private growers, cooperatives, etc.) who support metam sodium applications for ornamentals, food, and fiber crops and sewer treatment applications were calculated for short-term (1-30 days) and intermediate-term (1-6 months) exposure durations. Non-cancer risks for non-commercial handlers were calculated for short-term exposure durations, only.

- Cancer risks for commercial handlers who support metam sodium applications for ornamentals, food and fiber crops, and for sewer treatment applications, were calculated assuming 20 days of exposure per year (based on average values). All other handlers were assumed to be exposed for 5 days per year (based on average values). All handlers were assumed to have a 35-year career and a 70-year lifespan.

- The maximum application rates listed on product labels were used to calculate non-cancer risks for metam sodium and MITC. Where available, average/typical application rates were used to calculate cancer risks for metam sodium.

Occupational handler risk: antimicrobial uses

For the antimicrobial uses of metam sodium, non-cancer dermal and inhalation risks are below the Agency's level of concern. Cancer risks for handlers are in the range of 1.1×10^{-4} to 6.6×10^{-6}. Because of the short loading and/or application durations (minutes), handlers are not expected to be exposed to MITC.

Occupational Post-application Risk

Agricultural workers could be exposed to MITC when working near fields that recently have been treated with metam sodium, or when re-entering metam sodium-treated fields following an application. There is the potential for post-application occupational exposure to MITC from the use of metam sodium as a soil fumigant on agricultural crops, turf (including golf courses), and ornamentals, as a vegetation control agent along shorelines and in drained water bodies (CA SLN), as a fumigant on small and medium-sized areas of turf (lawns) and soil, and for application to potting soil. Worker exposure to MITC could also occur following applications in an enclosed or semi-enclosed greenhouse. Workers could also be exposed to MITC following metam sodium applications as a root-control agent in drains and sewer pipes.

Due to a lack of exposure data for other application methods, the only post-application exposure scenarios evaluated for workers were from the use of metam sodium as a soil fumigant applied using shank injection or chemigation equipment in large-scale agricultural settings. No data were available to assess post-application exposure resulting from the use of metam sodium as a vegetation control agent, on small- or medium-scale areas of turf and soil, on potting soil, as or as a root-control agent in sewers.

As for bystander risk, risk to occupational bystanders (those working *in the vicinity of* metam sodium-treated fields) was calculated using two methods: point estimates of risk (Margins of Exposure, or MOEs) at specific distances from a treated field, based on measured MITC concentrations from field volatility studies, and estimates of distances from treated fields needed to achieve a target MOE of 100, derived from MITC concentrations estimated using EPA's Industrial Source Complex (ISC) dispersion model.

In addition, the ISC model was used to estimate concentrations of MITC *within* metam sodium treated fields, in order to calculate the number of hours after application at which risk to workers re-entering treated fields would fall below the Agency's level of concern.

Calculation of post-application worker risk: point estimates

As for non-occupational bystanders, the risks to post-application workers performing tasks near treated fields were calculated based on MITC air concentrations measured at specific distances from treated fields in eleven field volatility studies. The eleven studies were performed using a variety of application methods including shank injection, sprinkler irrigation, and drip irrigation. In some of the studies, the metam sodium was watered into the soil immediately following application ("standard seal"), in other studies, the application was followed by intermittent watering-in, over consecutive days ("intermittent water-seal"), and in still other studies, application was not followed by any watering-in (no "seal"). For drip irrigation, some studies were performed on tarped fields, others on untarped fields. No data were available to assess the risks to workers following rotary tiller applications, or following applications using handheld/stationary equipment.

Because metam sodium label instructions recommend soil "sealing" immediately following application (either with a tarpaulin or by watering-in with irrigation water), MITC air concentration levels could spike when the soil "seal" is removed (e.g. by removing a tarpaulin, or by cultivating the soil surface to aerate the soil). However, there were no data available to assess this scenario.

Assumptions for point-estimate calculations

- The assessment assumed an exposure duration of 8 hours for agricultural workers performing activities near a metam-sodium treated field. A minute volume (inhalation rate) of 16.7 liters per minute was used (representing light to moderate work activities).

- All other assumptions are the same as those listed in the section of this overview describing risk calculations for non-occupational bystanders.

Results of point-estimate calculations of post-application worker risk

Based on the MITC air concentrations measured in the available field-volatility studies, the risks to post-application workers performing tasks near treated fields were above the Agency's level of concern for many different exposure scenarios and distances from metam sodium treated fields (see tables, below, for ranges of Margins of Exposure (MOEs)). With respect to application equipment, the data indicated that drip irrigation applications are the most effective in inhibiting release of MITC, shank injection applications are moderately effective in inhibiting release of MITC, and sprinkler irrigation applications are the least effective in inhibiting release of MITC. With respect to soil "sealing" methods, 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 (but they evaporate unless reapplied), and rolling and dragging to compact the soil, if done correctly, is moderately effective in inhibiting release of MITC. Without any soil "sealing" method following application, MITC tends to be released from soils to which metam sodium has been applied.

The point-estimates of post-application worker risks resulted in the ranges of MOEs shown in the tables below. For simplicity of presentation in this overview, MOEs have been grouped across different studies by application method, exposure duration, sealing method, and distance from edge of treated field. However, these different studies may have been conducted in different geographical regions and/or under differing environmental conditions. All estimates assumed an eight-hour exposure duration.

Post-application Worker: **Sprinkler Irrigation**

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Number of MOEs ≥ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
None	5	**4**	**13**	**4.8**	230
	25	**5**	**13**	**5.8**	200
	125	**5**	**13**	**7.4**	570
	500	**11**	**13**	**37**	3100
Standard	5	**17**	**38**	**0.74**	2500
	71	**6**	**11**	**0.85**	2200
	75	**8**	**11**	**40**	2100
	77	**7**	**9**	**30**	2300
	82	**8**	**10**	**39**	2300
	150	**71**	**92**	**1.4**	22000
Intermittent	137	**81**	**96**	**27**	39000
	150	**56**	**75**	**9.6**	20000
	274	**199**	**216**	**26**	41000
	411	24	24	160	39000
	530	**22**	**24**	**80**	39000
	549	24	24	160	39000

Post-application Worker: Shank Injection

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Number of MOEs ≥ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
None	11	**4**	**6**	**14**	640
	11.9	**14**	**16**	**12**	4800
	13.7	**9**	**21**	**4.5**	21000
	18.3	**17**	**30**	**3.4**	3600
	36.6	**5**	**8**	**15**	2100
Intermittent	150	**149**	**159**	**17**	34000
	300	**180**	**187**	**30**	18000
	500	24	24	110	15000
	700	48	48	150	15000

Post-application Worker: **Drip Irrigation**

Type of "Seal"	Sampler Distance from Edge of Field (meters)	Number of MOEs ≥ 100	Total Number of MOEs	Minimum MOE	Maximum MOE
Untarped	3	20	20	130	3400
	6.1	**9**	**10**	**68**	550
	15.2	**9**	**10**	**68**	580
	45.7	10	10	110	850
Tarped	3	20	20	110	120000
	6.1	10	10	270	120000
	15.2	10	10	130	120000
	45.7	10	10	130	2300

Calculation of occupational bystander risk: ISC modeling

Based solely on the above point estimates, it was not possible to calculate the distances from treated fields at which MITC inhalation risks to workers would fall below the Agency's level of concern. To refine the above assessment, EPA's Industrial Source Complex (ISC) dispersion model was used to estimate ambient MITC air concentrations near treated fields. Key inputs to the ISC model included hourly meteorological data (wind speed, wind direction, and air stability category) and flux rates. Modeled concentrations were then were used to calculate the distances from treated fields at which MITC inhalation risks would fall below the Agency's level of concern.

Assumptions for ISC modeling calculations: distances from treated fields

- As for the point-estimate calculations, the ISC modeling assessment used an exposure duration of 8 hours and a minute volume (inhalation rate) of 16.7 liters per minute (representing light work activities) for agricultural workers performing activities near a metam-sodium treated field. For occupational workers reentering treated areas, exposure durations of 8 hours and 1 hour were used, with minute volumes of 8.3 liters per minute (representing sedentary activities) and 16.7 liters minute (representing light work activities), respectively.

- Flux rates were estimated or calculated directly from the data from the eleven field studies measuring MITC air concentration levels following applications.

- Risks were calculated for the five major metam-sodium use regions (California, the Pacific Northwest, the Midwest, the Southeast, and the Northeast). Regional wind speed data for input to the ISC model were taken from five years of data from the Solar and Meteorological Surface Observation Network, except wind speeds for California which were developed by the California Department of Pesticide Regulation using data collected for the California Irrigation Management Information System.

- Wind speed and direction, and the air stability category, were all assumed to be constant for the time periods modeled.

- Risks were modeled based on treated field sizes of 1, 5, 10, 20, 40, 80, and 100 acres.

Results of ISC modeling calculations: distances from treated fields

Based on modeled estimates of MITC concentrations for a range of application and "sealing" methods, field sizes, exposure durations, and geographical regions, the distances from treated fields that would be required to achieve the target MOE of 100 for residential bystanders are shown in the tables, below. The greatest distances are required for sprinkler irrigation applications with a standard seal, and shortest for tarped drip irrigation applications. In general, the shortest distances were estimated for the midwest (EPA region 5), and the greatest distances for California (EPA region 9). For simplicity of presentation, the range of distances presented in the tables does not distinguish among geographical regions (the total range across all regions is shown). All estimates assumed an eight-hour exposure duration.

Post-application Workers: Sprinkler Irrigation

Type of "Seal"	Acres Treated	Distance from treated field (in meters)	
		Minimum	Maximum
Standard	1	939	1,236
	5	2,647	3,502
	10	4,212	5,582
	20	6,734	8,923
	40	10,730	> 12,000
	80	> 12,000	> 12,000
	100	> 12,000	> 12,000
Intermittent	1	390	520
	5	1,009	1,385
	10	1,608	2,194
	20	2,565	3,499
	40	4,105	5,590
	80	6,613	8,965
	100	7,706	10,453

Post-application Workers: Shank Injection

Type of "Seal"	Acres Treated	Distance from treated field (in meters)	
		Minimum	Maximum
Standard	1	599	780
	5	1,617	2,160
	10	2,557	3,418
	20	4,088	5,473
	40	6,516	8,712
	80	10,466	> 12,000
	100	> 12,000	> 12,000
Intermittent	1	311	424
	5	804	1,109
	10	1,266	1,764
	20	2,034	2,810
	40	3,251	4,498
	80	5,267	7,237
	100	6,145	8,426

Post-application Workers: Drip Irrigation

Type of "Seal"	Acres Treated	Distance from treated field (in meters) Minimum	Maximum
Untarped	1	70	123
	5	179	321
	10	275	497
	20	433	770
	40	677	1,275
	80	1,151	2,147
	100	1,382	2,531
Tarped	1	137	214
	5	356	555
	10	549	846
	20	853	1,370
	40	1,419	2,217
	80	2,367	3,621
	100	2,787	4,243

<u>Calculation of post-application risk to workers re-entering treated fields: ISC modeling</u>

The available field volatility studies did not measure MITC concentrations within treated fields following application of metam sodium. As a result, it was not possible to use the data from these studies to calculate the number of hours after application at which workers could re-enter treated fields without experiencing MITC inhalation risks above the Agency's level of concern. EPA's Industrial Source Complex (ISC) dispersion model was used to estimate ambient MITC air concentrations within treated fields, immediately following and for several days after applications of metam sodium. Key inputs to the ISC model included hourly meteorological data (wind speed, wind direction, and air stability category) and flux rates. Modeled concentrations were then were used to calculate the number of hours after application at which MITC inhalation risks would fall below the Agency's level of concern for workers re-entering metam sodium-treated fields.

<u>Assumptions for ISC modeling calculations: number of hours following application</u>

- The ISC modeling assessment used exposure durations of 1 hour and 8 hours per day for post-application re-entry workers.
- Minimum and maximum flux rates were estimated. (See pp. 129-131 in the Occupational and Residential Assessment for details.)

- Minimum concentrations (corresponding to the minimum number of hours needed to achieve an MOE of 100) were estimated using the average wind speed (approximately 5 m/s) for March and April across all metam sodium use regions and assuming a wind stability category of "C". Maximum concentrations (corresponding to the maximum number of hours needed to achieve an MOE of 100) were estimated assuming a wind speed of 1 m/s (the minimum wind speed allowable as an input to the ISC model) and a wind stability category of "D".

- Concentrations were modeled based on treated field sizes of 1, 5, 10, 20, 40, 80, and 100 acres.

<u>Results of ISC modeling calculations: number of hours following application</u>

The post-application restricted entry interval (REI) on current metam sodium agricultural product labels is 48 hours. The number of hours following application that would be required to achieve the target MOE of 100 for re-entry workers are shown in the tables, below. These calculations are based on modeled estimates of MITC concentrations in treated fields following application of metam sodium for a range of application methods, "sealing" methods, and field sizes, and using 1-hour and 8-hour exposure durations. The results of ISC modeling indicate that risks are likely to exceed the Agency's level of concern for workers re-entering treated fields even after 48 hours.

Post-application Re-entry Workers: Sprinkler Irrigation

Type of "Seal"	Acres treated	1-hr MITC exposure		8-hr MITC exposure	
		Number of Hours After Application Needed to Reach MOE ≥ 100			
		Minimum	Maximum	Minimum	Maximum
Standard	1	28	44	44	> 48
	5	32	44	44	> 48
	10	44	44	44	> 48
	≥ 20	44	> 48	44	> 48
Intermittent	1	0	40	36	44
	5	4	40	36	44
	10	12	40	40	44
	20	12	40	44	44
	40	12	40	44	> 48
	≥ 80	12	44	44	> 48

Post-application Re-entry Workers: Shank Injection

Type of "Seal"	Acres treated	1-hr MITC exposure		8-hr MITC exposure	
		Number of Hours After Application Needed to Reach MOE ≥ 100			
		Minimum	Maximum	Minimum	Maximum
Standard	1	40	> 48	> 48	> 48
	≥ 5	> 48	> 48	> 48	> 48
Intermittent	1	0	24	12	> 48
	5	0	24	16	> 48
	10	0	24	16	> 48
	20	0	36	16	> 48
	40	0	36	16	> 48
	80	0	36	24	> 48
	100	0	36	24	> 48

Post-application Re-entry Workers: Drip Irrigation

Type of "Seal"	Acres treated	1-hr MITC exposure		8-hr MITC exposure	
		Number of Hours After Application Needed to Reach MOE ≥ 100			
		Minimum	Maximum	Minimum	Maximum
Untarped	1	0	> 28	0	> 36
	5	0	> 28	0	> 36
	10	0	> 28	0	> 36
	20	0	> 28	0	> 36
	40	0	> 28	0	> 36
	80	0	> 28	> 28	> 36
	100	0	> 28	> 28	> 36
Tarped	1	0	8	0	> 40
	5	0	8	4	> 40
	10	0	8	4	> 40
	20	0	12	4	> 40
	40	0	12	4	> 40
	80	0	12	8	> 40
	100	0	12	8	> 40

Post-application worker risk: anti-microbial uses

For the antimicrobial pole-treatment use of metam sodium, occupational post-application exposure to MITC is expected to be negligible, because the metam sodium is injected into pre-drilled holes which are immediately capped. Any migration of MITC through the wooden cap would result in negligible ambient air concentrations. There is the potential for post-application inhalation exposure to MITC for the remaining metam sodium antimicrobial use patterns: applications in sugar processing, leather manufacture, and sewage sludge treatement. However, no data are available to estimate MITC concentrations in air at these types of facilities. Monitoring data measuring air concentrations of MITC in sugar cane/beet processing facilities, in leather processing facilities, and in the vicinity of sewage sludge treatments are needed to assess post-application worker risks from these uses of metam sodium.

Human Incidents

(For a complete discussion, see section 7.0 of the "HED Chapter of the Reregistration Eligibility Decision Document," dated May 21, 2004, and the memo, "Review of Metam Sodium Incident Reports," dated September 24, 2003.)

Based on incident reports, metam sodium poses a risk to both handlers and non-occupational bystanders when used as a soil fumigant in large-scale agricultural settings and as a root-control agent in sewers and drains. The reported effects of MITC drift include irritant effects to eyes, throat, and skin, headache, nausea, and shortness of breath. A more severe health effect reported in the literature is the development and exacerbation of asthma, which was observed in adults exposed to the fumes from the 1991 accidental spill of metam sodium into the Sacramento River in California. The potential for metam sodium to drift and cause health effects at distances above one-quarter mile and for many hours after application is well documented. Direct contact of metam sodium to skin surfaces is well documented to cause skin irritation. The potential for health effects to large numbers of persons in communities and schools adjacent to fields where metam sodium has been applied, either by sprinkler irrigation or by poorly "sealed" soil injection, is also well documented.

The state of California collected detailed descriptions of 902 cases involving exposure to metam sodium from 1982-1994. Metam sodium is in the top forty in the list of pesticides that caused systemic poisoning in California during this time period. According to these data, changes in wind direction and temperature inversions can contribute to MITC exposure and subsequent exposure-related 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.

Ecological Risk

(For a complete discussion, see the "Reregistration Environmental Risk Assessment for Metam-Sodium," dated May 18, 2004, and the memo, "Ecological Risk from Antimicrobial Uses of Metam-Sodium," dated April 14, 2004.)

To estimate potential ecological risk, EPA integrates the results of exposure and ecotoxicity studies using the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic, for various wildlife species. RQ s are then compared to levels of concern (LOCs). Generally, the higher the RQ, the greater the potential risk. Risk characterization provides further information on the likelihood of adverse effects by considering the fate of the chemical in the environment, species and ecological communities potentially at risk, their spatial and temporal distributions, and the nature of the effects observed in studies.

In the environment, metam-sodium is rapidly transformed to MITC, which is highly volatile and can off-gas from treated fields. Consequently, the ecological effects assessment for agricultural applications of metam sodium focused on the risks to terrestrial and aquatic organisms associated with exposure to MITC in air and in water.

Environmental Fate and Transport
(For a complete discussion, see sections III and IV of the "Reregistration Environmental Risk Assessment for Metam-Sodium," dated May 18, 2004.)

Studies of aerobic soil metabolism, hydrolysis, and photodegradation in water suggest that metam sodium is very unstable and degrades rapidly to MITC and other minor degradates. Environmental fate data and measurements of residual concentrations in soils suggest that metam sodium is highly unlikely to reach or cause adverse ecological effects in surface water or ground water. However, MITC, the major metabolite of metam sodium degradation in soil and water, appears to be dependent on hydrolysis and microbially-mediated degradation, and to persist longer than metam sodium in the environment. The dissipation of MITC in aquatic and terrestrial environments appears to be predominantly dependent on volatilization and to a lesser extent on leaching and degradation. Photolytic degradation is the major dissipation route of MITC in atmosphere. Since MITC is also highly soluble in water and has low adsorption in soil, it could potentially leach into surface water through runoff under flooded conditions, or into ground water through leaching.

Although MITC is volatile, it is also very soluble in water. This, together with its low adsorption in soil suggest that MITC may have the potential to leach into ground water under flooded conditions. However, under most field conditions, the potential for ground water contamination of MITC is unlikely, due to its rapid volatilization and degradation in soil (aerobic soil half-live is ≤10 days). Based on available non-targeted monitoring data in the U.S., no MITC was detected in the ground water samples. MITC can also potentially move to surface water through runoff under an intense rainfall, or if continuous irrigation occurs right after metam sodium application. However, it is likely to volatilize quickly from surface water.

Risks to Non-Target Terrestrial Organisms (Mammals and Birds)
(For a complete discussion, see sections III and VII of the "Registration Environmental Risk Assessment for Metam-Sodium," dated May 18, 2004.)

A screening-level LD_{50}/ft^2 method was used to assess the risks of MITC exposure to birds and mammals. Previously, this method has most frequently been applied to pesticide application scenarios involving granular formulations, seed treatments, and baits. This method has not been generally been used to assess the ecological risks associated with highly volatile compounds, but it was considered the Agency's most appropriate available index for MITC assessment. This LD_{50}/ft^2 method is an index that does not systematically account for risks from each potential route of exposure. Instead, it estimates the overall potential for adverse effects given a bioavailable amount of a pesticide, conservatively related to the pounds applied per unit area at the treatment site.

Mammals of three body weights were assessed: 15 g, 35 g, and 1000 g. The resulting risk quotients for these three sizes of mammals were 1897, 813, and 28, respectively. These far exceed the acute risk LOC of 0.5, as well as the acute restricted use LOC of 0.2 and the acute endangered species LOC of 0.1. Thus, this screen indicates a clear potential for risk to wild mammals exposed to MITC off-gassing from metam sodium-treated fields.

Owing to the limitations of the the LD_{50}/ft^2 method for highly volatile compounds, such as MITC, the risks to mammals and birds from inhalation exposure to MITC were also assessed using monitoring data from a California study (Wofford et al., 1993). This study indicates that the highest MITC concentrations occur primarily during pesticide applications and immediately following watering-in ("soil sealing"). Concentrations during applications ranged from 78.3 to 2450 ppb (0.002342 to 0.007327 mg/L) at 5 meters from the field edge, and 11.7 to 1320 ppb (0.000035 to 0.003948 mg/L) at 150 meters from the field edge. The following table shows a comparison of these air concentrations with available mammalian acute inhalation toxicity data:

Comparison of Air Concentrations with Acute Mammalian Inhalation Toxicity Endpoint

Air concentration (mg/L)	Acute Mammal LC50 (mg/L)	Ratio Exposure/Effects (RQ)
5 meters from treated field		
0.0023	0.54	0.004
0.0073	0.54	0.014
150 meters from treated field		
0.000035	0.54	0.00006
0.0039	0.54	0.007

The Agency has not established level of concern (LOC) thresholds expressly for the interpretation of RQs calculated for inhalation exposure risks. However, if the existing LOC values for acute mammalian wildlife risk were used to evaluated such RQs, the above analysis would suggest that LOCs would not be exceeded.

However, it should be noted that the air samples from this California study were collected at 1.2 to 1.8 meters above the ground. This sampling height likely exceeds the height at which most exposure to ground-dwelling mammals and ground-feeding birds would normally occur. It is reasonable to assume that MITC concentrations would follow a gradient, with higher concentrations of MITC occurring closer to the ground. The Agency does not have a model that accounts for this potential gradient. However, a conservative upper-bound concentration at the soil surface could be approximated as being equivalent to the theoretical concentration at saturation. Using this assumption, the theoretical maximum concentration at saturation would be 25,000 ppm (74.7 mg/L), which exceeds the acute inhalation dose for mammals (LC50 = 0.54 mg/L) by a factor of 138. This soil-surface estimate suggests that inhalation of MITC could pose a risk to terrestrial wildlife.

The above assessment is limited to acute exposures and effects. Given that the rat 28-day inhalation NOAEL for MITC is 0.02 mg/L, lower than the acute inhalation endpoint of 0.54 mg/L, the potential exists for subchronic risk to wild mammals.

Wofford et al., 1993 reported that air samples were below a detection limit of 2 ppb (0.000006 mg/L) by 72 hours after application, suggesting that long-term air concentrations would be well below the chronic inhalation NOAEL for mammals, based on the treatment of a single field. However, multiple fields may be treated in an area over a number of days. Wild mammals may have home ranges in the treatment area, and may experience single or repeated exposures as a result of metam sodium use on multiple fields over multiple days in a given geographic area. Therefore, there is a potential for chronic MITC exposure and risk to mammals in an area where multiple fields have been treated with metam sodium.

The above analysis was based on mammalian toxicity data for the inhalation route. Although a similar analysis could be performed for birds if the necessary data were available, no inhalation toxicity data for MITC are available for birds. Assuming that birds and mammals are equivalently sensitive to MITC exposure, then the risks calculated for mammals in the above analysis would suggest potential risks for birds, as well.

In fact, birds have the potential to be more sensitive than mammals to MITC inhalation exposure. Birds have higher respiration rates than mammals, and physiological characteristics of the avian lung would suggest that MITC diffusion rates across the lung membrane would be higher for birds than for mammals. As a result, birds may be at greater risk from MITC inhalation exposure than mammals.

Although birds are mobile, and some may only experience a very brief exposure to MITC when flying over or near metam sodium treated fields, others may have territories or nests in the vicinity of metam sodium-treated fields and may experience more substantial exposure. Since metam-sodium can be applied to different fields in a given geographic area on different days, repeated exposures could also occur. The uncertainty associated with this screening-level analysis would be reduced by submission of avian inhalation toxicity data.

Risks to Non-target Aquatic Organisms
(For a complete discussion, see sections III and VI of the "Registration Environmental Risk Assessment for Metam-Sodium," dated May 18, 2004.)

The PRZM/EXAMS model was used to calculate the estimated environmental concentrations (EECs) used to determine the acute and chronic risk to aquatic organisms from MITC exposure. Selected scenarios (onions, turf, tomatoes, and potatoes) were used to represent the numerous crops on which metam sodium is registered for use. Although the same application rate of 320 lbs of metam sodium per acre was used for all four crop scenarios, exposure estimates resulted in different risk potentials. Tomatoes had higher estimated residues than the other three use sites, and RQs slightly exceeded the acute endangered species, acute restricted use, and acute risk LOCs (RQ = 0.64 for invertebrates and 0.69 for fish). Onions (RQ = 0.19 for invertebrates and 0.20 for fish) and turf (RQ = 0.15 for invertebrates and 0.16 for fish) slightly exceeded the acute endangered species and acute restricted use LOCs. The potato exposure scenario did not exceed any LOC. Chronic aquatic LOCs were not exceeded for aquatic invertebrates at any modeled site, but the analysis was based on supplemental data. Chronic fish data on MITC are needed to evaluate chronic risk to fish.

Risks to Non-target Terrestrial and Aquatic Plants
(For a complete discussion, see sections III, VI, and VII of the "Registration Environmental Risk Assessment for Metam-Sodium," dated May 18, 2004.)

Based on the labeled phytotoxicity of MITC, it is expected that non-target plants may be at risk from off-gassed MITC. Terrestrial plant toxicity data are needed to evaluate this risk. LOCs for aquatic plants are not exceeded based on available data, but additional toxicity data are needed to complete this assessment.

Risks to Endangered Species
(For a complete discussion, see sections III, VI and VII of the "Registration Environmental Risk Assessment for Metam-Sodium.")

The Agency's Levels of Concern (LOC) for endangered and threatened fish and aquatic invertebrates are exceeded for three of four modeled use patterns, based on MITC concentrations. Similar risks may also be associated with the many additional, non-modeled use sites. The preliminary analysis indicates that there is a potential risk to endangered birds and mammals from inhalation, based on the maximum expected air residues of MITC. Additional data are required to refine this analysis. It is also expected that any insects or other terrestrial invertebrates exposed to MITC would be adversely affected. Although endangered species LOCs are exceeded using freshwater invertebrate data, the oyster (marine/estuarine) is very likely to be more representative of endangered/threatened freshwater molluscs than is the freshwater daphnid. This is a data gap for MITC.

Ecological Incidents
(For a complete discussion, see sections III, VI and VII of the "Registration Environmental Risk Assessment," dated May 18, 2004.)

Although not representative of agricultural applications, a major tank car spill in California in 1991 clearly demonstrated that metam-sodium has the ability to kill large numbers of aquatic organisms if the chemical gets into water in large quantities. Also, fish farm incidents show the potential for off-gassed MITC from agricultural applications of metam-sodium to be inadvertently drawn into mechanical aeration systems, potentially resulting in fish kills.

A limited number of metam sodium-related incidents (1 probable, 2 possible) involving terrestrial plants have also been reported.

Ecological Risks Associated with Antimicrobial Uses of Metam Sodium

With the possible exception of deep well injection of leather processing fluid wastes, no appreciable risk to non-target organisms is expected from the antimicrobial uses of metam sodium (treatment of wood poles, cane/beet sugar processing, treatment of hides/skins in leather manufacture, and treatment of sewage/organic sludge and animal wastes). Additional information is needed to determine whether deep well injection of leather processing fluid wastes could result in metam sodium or MITC leaching into ground water. In the absence of minimum holding period of 21 days for sewage/sludge/animal waste treatment products, the potential exists for environmental exposure to metam sodium or MITC from this use.

Summary of Pending Data

Human Health Data Requirements

Toxicology

The toxicology database for MITC is incomplete and additional data requirements may be imposed, including the following:

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

- *In vivo* cytogenetic assay
- Repeat of the unscheduled DNA synthesis assay

There are no outstanding metam sodium toxicological data requirements.

Product Chemistry

See the product chemistry memorandum dated May 20, 2004 for a list of all outstanding product chemistry data requirements for metam sodium, metam potassium, and MITC.

Residue chemistry

There are no outstanding residue chemistry requirements for metam sodium or MITC.

Occupational and Residential Exposure

For handlers, metam sodium and MITC exposure data (875.1100 Dermal exposure-outdoor, and 875.1300 Inhalation exposure-outdoor) are required for the following scenarios:

- applying to potting soil
- 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

For post-application workers, MITC exposure data (875.2400 Dermal exposure, 875.2500 Inhalation exposure, Series 840 Spray Drift Test Guidelines, and Subdivision N, 163-3 Field Volatility) are required for the following scenarios:

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

Ecological and Environmental Fate Data Requirements

See the Registration Environmental Risk Assessment, dated May 18, 2004, for a complete description of all outstanding ecological effects data requirements for MITC. There are no outstanding ecological effects data requirements for metam sodium.

The following ecological effects data requirements are outstanding for MITC:

- avian acute oral toxicity
- avian acute inhalation toxicity
- avian sub-chronic/chronic inhalation toxicity
- acute marine/estuarine fish toxicity , acute marine/estuarine mollusk
- acute marine/estuarine shrimp
- early life-stage fish
- life-cycle aquatic invertebrate
- seed germination/seedling emergence – tier II
- vegetative vigor – tier II
- aquatic plant growth – tier II

The following ecological effects data requirements for MITC are reserved:

- early life-stage fish – marine/estuarine
- life-cycle fish

Antimicrobial Data Requirements

<u>Residue chemistry</u>

A sugar processing study is required. This study can be performed using either sugar cane or sugar beets. Analyses for MITC and other residues of concern should be conducted on sugar, syrup, and molasses.

<u>Occupational and Residential Exposure</u>

Post-application MITC exposure data (875.2500 Inhalation exposure) are required for the following scenarios:

- application of metam sodium to sewage sludge
- use of metam sodium in sugar processing
- use of metam sodium in leather processing

Ecological and Environmental Fate

There are no outstanding ecological effects data requirements for the antimicrobial uses of metam sodium. A groundwater monitoring study could help to resolve concern regarding the deep-well injection of leather processing fluids, but this study is not required at this time.

Next Steps

The human health and ecological risk assessments for metam sodium are preliminary and will be revised as part of the reregistration process. For example, a number of issues are currently being considered by the Agency with respect to the human health risk assessment. Several of these issues are described, below.

Harmonization with the California Department of Pesticide Regulation (Cal DPR)

The California Department of Pesticide Regulation (DPR) has performed risk assessments for both MITC and metam sodium. While there are many similarities between the EPA's assessment and that of Cal DPR, there are also some differences, particularly concerning the hazard characterization of MITC. The non-cancer endpoints used by California DPR are lower than EPA's (3X-66X lower). These differences arise primarily from two sources: 1) Cal DPR's utilization of a human acute eye irritation study for quantitative risk assessment, and 2) differences in interpretation of the effects observed in the 28-day inhalation rat study for the 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.*, Cal DPR's use of 1- to 8-hour acute exposure durations. EPA has begun a dialogue with Cal DPR regarding the harmonization of the hazard and exposure characterization of metam sodium and MITC.

Modeling risk from MITC exposure to occupational and residential bystanders

EPA is considering the 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 provided to EPA also would be considered. All such models would need to go through FIFRA SAP evaluation prior to being considered for use in risk assessment.

Appendix A: Occupational Handler Risk Summary for Exposure to Metam Sodium: Non-Cancer

The tables below present the occupational handler scenarios for exposure to metam sodium that are above the Agency's level of concern for non-cancer risk, even with maximum feasible PPE or engineering controls. For simplicity of presentation, only the exposure scenarios using maximum rates that appear on most product labels are shown (outlier labels with higher rates are omitted).

Short-term Non-Cancer

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Loader							
Transferring Liquids from Tank Delivery Truck to **Shank Injection** Equipment (mechanical transfer system)	tobacco plant beds	387	40	38	76	36	52
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	128	15	29	14	20
			80	23	46	22	31
	turf (golf course)	320	40	47	92	43	63
	peanuts (CBR susceptible cultivars)	63.3	128	74	**150**	68	99
Transferring Liquids from Tank Delivery Truck to **Rotary Tiller** Equipment (mechanical transfer system)	ornamentals, food and fiber crops, turf (sod farm)	320	128	15	29	14	20
			80	23	46	22	31
	turf (golf course)	320	40	47	92	43	63
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to **Sprinkler irrigation** Nurse Tank (mechanical transfer system)	tobacco plant beds	387	40	38	76	36	52
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	350	5	11	5	7
	peanuts (CBR susceptible cultivars)	63.3	350	27	53	25	36
	peanuts (CBR resistant cultivars)	32	350	53	**110**	50	72
	wheat, barley	31.7	350	54	**110**	50	72
Loading Liquids to support **Sprinkler Irrigation** Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)	tobacco plant beds	387	40	ND	**410**	ND	ND
			20	ND	**830**	ND	ND
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	350	ND	57	ND	ND
	peanuts (CBR susceptible cultivars)	63.3	350	ND	**290**	ND	ND

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
	wheat, barley	31.7	350	ND	**570**	ND	ND
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to **Drip Irrigation** Nurse Tank (mechanical transfer system)	ornamentals, food and fiber crops, turf (sod farm)	239	100	25	49	23	34
Loading Liquids to support **Drip Irrigation** Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)	ornamentals, food and fiber crops, turf (sod farm)	239	100	ND	**270**	ND	ND
	cotton, soybeans, sugar beets	38	100	ND	**1700**	ND	ND
Applicator							
Applying Liquids via **Shank Injection** Equipment (using PHED groundboom data)	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	128	22	49	22	38
			80	36	79	35	61
Applying Water Soluble Liquids via **Rotary Tiller** Equipment (using PHED groundboom data)	ornamentals, food and fiber crops, turf (sod farm)	320	128	22	49	22	38
			80	36	79	35	61
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)[d]	tobacco plant beds	387	40	18	NA	33	NA
			20	36	NA	66	NA
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	128	7	NA	13	NA
			80	11	NA	20	NA
	turf (golf course)	320	40	22	NA	40	NA
			20	44	NA	80	NA
	peanuts (CBR susceptible cultivars)	63.3	128	35	NA	63	NA
			80	56	NA	**100**	NA
	cotton, soybeans, sugar beets	38	128	58	NA	**110**	NA
			80	93	NA	**170**	NA
	peanuts (CBR resistant cultivars)	32	128	69	NA	**130**	NA
	wheat, barley	31.7	128	69	NA	**130**	NA

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) **and** then **applying** them via **Shank Injection** Equipment (using PHED groundboom MLA with **closed cab**)[d]	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523	5	NA	44	NA	73
	tobacco plant beds	387	40	NA	7	NA	12
	tobacco plant beds	387	20	NA	15	NA	25
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	128	NA	3	NA	5
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm)	320	80	NA	4	NA	7
	turf (golf course)	320	40	NA	9	NA	15
			20	NA	18	NA	30
	peanuts (CBR susceptible cultivars)	63.3	128	NA	14	NA	23
			80	NA	22	NA	38
	cotton, soybeans, sugar beets	38	128	NA	23	NA	39
			80	NA	37	NA	63
	peanuts (CBR resistant cultivars)	32	128	NA	28	NA	46
			80	NA	44	NA	74
	wheat, barley	31.7	128	NA	28	NA	47
			80	NA	45	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**)[d]	ornamentals, food and fiber crops, turf (sod farm)	320	128	7	NA	13	NA
			80	11	NA	20	NA
	turf (golf course)	320	40	22	NA	40	NA
			20	44	NA	80	NA
Transferring Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) **and** then **applying** them via **Rotary Tiller** Equipment (using PHED groundboom MLA with **closed cab**)[d]	ornamentals, food and fiber crops, turf (sod farm)	320	128	NA	3	NA	5
			80	NA	4	NA	7
	turf (golf course)	320	40	NA	9	NA	15
			20	NA	18	NA	30

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Chemigation Monitor							
Monitoring Chemigation Applications Using Liquid Formulation	No Metam Sodium data is available for this scenario.						
Soil Seal Irrigator							
Sealing Soil with Irrigation Water Following Shank Injection Applications Using Liquid Formulations	No Metam Sodium data is available for this scenario.						
Mixer/Loader/Applicator							
Mixing/Loading/Applying Water Soluble Liquids via power sprayer (using ORETF LCO hand-gun data - occupational)	drained water bodies and shorelines	350	5	23	NF	**250**	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, square feet, or cubic feet treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Treated in Agriculture," industry sources, and HED estimates.
d	May over-estimate exposure, PHED data is based on open pour mixing/loading.

PPE-G,DL: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves
Eng Controls (dermal): Closed mixing/loading system or enclosed cab
OV Respirator: NIOSH/MSHA-approved cartridge or cannister respirator with an organic-vapor removing filter and dust/mist prefilter.

Intermediate-term Non-cancer

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Loader							
Transferring Liquids from Tank Delivery Truck to **Shank Injection** Equipment (mechanical transfer system)	small areas of ornamentals, food, fiber crops	523	5	5	11	**330**	480
	ornamentals, food and fiber crops, orchard (replant/transplant)	320	128	< 0.1	1	21	31
			80	1	1	34	49
	peanuts (CBR susceptible cultivars)	63.3	128	2	3	**110**	160
			80	3	6	**170**	250
	cotton, soybeans, sugar beets	38	128	3	6	**180**	260
			80	5	9	**290**	420
	peanuts (CBR resistant cultivars)	32	128	3	7	**210**	310
			80	6	11	**340**	490
	wheat, barley	31.7	128	4	7	**220**	310
			80	6	11	**350**	500
Transferring Liquids from Tank Delivery Truck to **Rotary Tiller** Equipment (mechanical transfer system)	ornamentals, food and fiber crops, orchard (replant/transplant)	320	128	< 0.1	1	21	31
			80	1	1	34	49
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to **Sprinkler irrigation** Nurse Tank (mechanical transfer system)	ornamentals, food and fiber crops	320	350	< 0.1	< 0.1	8	11
	peanuts (CBR susceptible cultivars)	63.3	350	1	1	39	57
	peanuts (CBR resistant cultivars)	32	350	1	3	78	**110**
	wheat, barley	31.7	350	1	3	79	**110**
Loading Liquids to support **Sprinkler Irrigation** Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)	ornamentals, food and fiber crops, orchard (replant/transplant)	320	350	ND	1	ND	ND
	peanuts (CBR susceptible cultivars)	63.3	350	ND	7	ND	ND
	peanuts (CBR resistant cultivars)	32	350	ND	14	ND	ND
	wheat, barley	31.7	350	ND	14	ND	ND

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Transferring Liquids from Tank Delivery Truck to Pick-up Truck and subsequent transfer to **Drip Irrigation** Nurse Tank (mechanical transfer system)	ornamentals, food and fiber crops	239	100	1	1	37	53
	cotton, soybeans, sugar beets	38	100	4	7	**230**	330
Loading Liquids to support **Drip Irrigation** Applications (Sodium tetrathiocarbonate study used as surrogate data Study # 770AA11)	ornamentals, food and fiber crops	239	100	ND	6	ND	ND
	cotton, soybeans, sugar beets	38	100	ND	40	ND	ND

Applicator

Applying Liquids via **Shank Injection** Equipment (using PHED groundboom data)	small areas of ornamentals, food, fiber crops	523	5	8	18	**540**	930
	ornamentals, food and fiber crops, orchard (replant/transplant)	320	128	1	1	35	60
			80	1	2	55	95
	peanuts (CBR susceptible cultivars)	63.3	128	3	6	**180**	300
			80	4	10	**280**	480
	cotton, soybeans, sugar beets	38	128	5	10	**290**	500
			80	7	16	**470**	800
	peanuts (CBR resistant cultivars)	32	128	5	12	**350**	600
			80	9	19	**550**	950
	wheat, barley	31.7	128	5	12	**350**	600
			80	9	19	**560**	960
Applying Water Soluble Liquids via **Rotary Tiller** Equipment (using PHED groundboom data)	ornamentals, food and fiber crops	320	128	1	1	35	60
			80	1	2	55	95

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Loader/Applicator							
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) **and** then **applying** them via **Shank Injection** Equipment (using PHED groundboom MLA **open cab** data)[d]	small areas of ornamentals, food, fiber crops	523	5	3	NA	**310**	NA
			0.5	25	NA	3,100	NA
	ornamentals, food and fiber crops, orchard (replant/transplant)	320	128	< 0.1	NA	20	NA
			80	< 0.1	NA	32	NA
	peanuts (CBR susceptible cultivars)	63.3	128	1	NA	**100**	NA
			80	1	NA	**160**	NA
	cotton, soybeans, sugar beets	38	128	1	NA	**170**	NA
			80	2	NA	**270**	NA
	peanuts (CBR resistant cultivars)	32	128	2	NA	**200**	NA
			80	3	NA	**320**	NA
	wheat, barley	31.7	128	2	NA	**200**	NA
			80	3	NA	**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**)[d]	small areas of ornamentals, food, fiber crops	523	5	NA	1	NA	**110**
			0.5	NA	10	NA	**1,100**
	ornamentals, food and fiber crops, orchard (replant/transplant)	320	128	NA	< 0.1	NA	7
			80	NA	< 0.1	NA	12
	peanuts (CBR susceptible cultivars)	63.3	128	NA	< 0.1	NA	37
			80	NA	1	NA	59
	cotton, soybeans, sugar beets	38	128	NA	1	NA	62
			80	NA	1	NA	99
	peanuts (CBR resistant cultivars)	32	128	NA	1	NA	73
			80	NA	1	NA	120
	wheat, barley	31.7	128	NA	1	NA	74
			80	NA	1	NA	**120**

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
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**)[d]	ornamentals, food and fiber crops	320	128	< 0.1	NA	20	NA
			80	< 0.1	NA	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**)[d]	ornamentals, food and fiber crops	320	128	NA	< 0.1	NA	7
			80	NA	< 0.1	NA	12
Chemigation Monitor							
Monitoring Chemigation Applications Using Liquid	No Metam Sodium specific data is available for this scenario.						
Irrigator							
Irrigating Following Shank Injection	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)	small areas of ornamentals, food, fiber crops	12 lb ai/1000 sq ft	1000 sq ft	ND	NF	No Data	NF
Mixing/Loading/Applying Water Soluble Liquids via **hose-proportioner** (using ORETF LCO hand-gun data - occupational)	small areas of ornamentals, food, fiber crops	350	5	1	NF	**400**	NF
			0.5	6	NF	**4,000**	NF

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Area Treated Daily [c] (acres)	Dermal MOEs		Inhalation MOEs	
				PPE-G,DL	Eng Cont	OV Respirator 90% PF	Eng Cont
Mixing/Loading/Applying Water Soluble Liquids via **power sprayer** (using ORETF LCO hand-gun data - occupational)	drained water bodies and shorelines	350	5	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)	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	49	NF	**3,100**	NF
	sewer roots	0.212 lb ai/gal	675 gallons	99	NF	**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, square feet, or cubic feet treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily Treated in Agriculture," industry sources, and HED estimates.

d May over estimate exposure, PHED data is based on open pour mixing/loading.

PPE-G,DL: Coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves

Dermal Eng Controls: Closed mixing/loading system or enclosed cab

OV Respirator: NIOSH/MSHA-approved cartridge or cannister respirator with an organic-vapor removing filter and dust/mist prefilter.

Appendix B: Occupational Handler Risk Summary for Exposure to Metam Sodium: Cancer

The tables below present the occupational handler scenarios for exposure to metam sodium that exceed the Agency's level of concern for cancer risk, even with maximum feasible PPE or engineering controls. For simplicity of presentation, only the exposure scenarios using maximum rates that appear on most product labels are shown (outlier labels with higher rates have been omitted).

Non-Commercial Handler Cancer Risks

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lb ai/acre)	Area Treated [c] (acres)	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	5	3.5E-05	2.8E-05	1.5E-05
	tobacco plant beds	387	20	1.0E-04	8.2E-05	4.5E-05
	orchard replant/transplant sites	320	100	4.3E-04	3.4E-04	1.8E-04
	turf (sod farms)	252	100	3.4E-04	2.7E-04	1.5E-04
	turf (golf courses)	252	20	6.8E-05	5.3E-05	2.9E-05
	wheat, barley [d]	162	100	3.5E-05	2.8E-05	1.5E-05
	ornamentals and food crops	108	100	1.5E-04	1.1E-04	6.2E-05
	cotton, soybeans, sugar beets	44	100	6.0E-05	4.7E-05	2.6E-05
	peanuts	28	100	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	100	3.4E-04	2.7E-04	1.5E-04
	turf (golf courses)	252	20	6.8E-05	5.3E-05	2.9E-05
	ornamentals and food crops	108	100	1.5E-04	1.1E-04	6.2E-05
	cotton, soybeans, sugar beets	44	100	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	20	1.0E-04	8.2E-05	4.5E-05
	orchard replant/transplant sites	320	350	1.5E-03	1.2E-03	6.5E-04
	turf (sod farms)	252	350	1.2E-03	9.3E-04	5.1E-04
	wheat, barley [d]	162	350	7.6E-04	6.0E-04	3.3E-04
	ornamentals and food crops	108	350	5.1E-04	4.0E-04	2.2E-04
	cotton, soybeans, sugar beets	44	350	2.1E-04	1.6E-04	9.0E-05
	peanuts	28	350	1.3E-04	1.0E-04	5.6E-05

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lb ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
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	100	3.4E-04	2.7E-04	1.5E-04
	ornamentals and food crops	108	100	1.5E-04	1.1E-04	6.2E-05
	cotton, soybeans, sugar beets	44	100	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	20	ND	ND	5.9E-06
	orchard replant/transplant sites	320	350	ND	ND	8.6E-05
	turf (sod farms)	252	350	ND	ND	6.8E-05
	wheat, barley [d]	162	350	ND	ND	1.0E-04
	ornamentals and food crops	108	350	ND	ND	2.9E-05
	cotton, soybeans, sugar beets	44	350	ND	ND	1.7E-05
	peanuts	28	350	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	100	ND	ND	1.9E-04
	ornamentals and food crops	108	100	ND	ND	2.7E-05
	cotton, soybeans, sugar beets	44	100	ND	ND	1.2E-05
Applicator						
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	small areas of seed beds, plant beds	523	5	2.1E-05	1.8E-05	8.5E-06
	tobacco plant beds	387	20	1.3E-04	1.1E-04	5.3E-05
	orchard replant/transplant sites	320	100	2.6E-04	2.2E-04	1.0E-04
	turf (sod farms)	252	100	2.1E-04	1.7E-04	8.2E-05
	turf (golf courses)	252	20	4.1E-05	3.4E-05	1.6E-05
	wheat, barley [d]	162	100	1.36E-04	1.1E-04	5.3E-05
	ornamentals and food crops	108	100	8.9E-05	7.3E-05	3.5E-05
	cotton, soybeans, sugar beets	44	100	3.6E-05	3.0E-05	1.4E-05
	peanuts	28	100	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	100	2.1E-04	1.7E-04	8.2E-05
	turf (golf courses)	252	20	4.1E-05	3.4E-05	1.6E-05
	ornamentals and food crops	108	100	8.9E-05	7.3E-05	3.5E-05
	cotton, soybeans, sugar beets	44	100	3.6E-05	3.0E-05	1.4E-05

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lb ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
Loader/Applicator						
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) and then applying them via Shank Injection Equipment (using PHED groundboom MLA open cab data) (4a) [e]	small areas of seed beds, plant beds	523	5	7.9E-05	5.2E-05	NA
	tobacco plant beds	387	20	2.3E-04	1.5E-04	NA
	orchard replant/transplant sites	320	100	9.6E-04	6.4E-04	NA
	turf (sod farms)	252	100	7.6E-04	5.0E-04	NA
	turf (golf courses)	252	20	1.5E-04	1.0E-04	NA
	wheat, barley [d]	162	100	4.9E-04	3.2E-04	NA
	ornamentals and food crops	108	100	3.3E-04	2.2E-04	NA
	cotton, soybeans, sugar beets	44	100	1.3E-04	8.9E-05	NA
	peanuts	28	100	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	5	NA	NA	1.3E-04
	tobacco plant beds	387	20	NA	NA	3.9E-03
	orchard replant/transplant sites	320	100	NA	NA	1.6E-03
	turf (sod farms)	252	100	NA	NA	1.3E-03
	turf (golf courses)	252	20	NA	NA	2.5E-04
	wheat, barley [d]	162	100	NA	NA	8.1E-04
	ornamentals and food crops	108	100	NA	NA	5.4E-04
	cotton, soybeans, sugar beets	44	100	NA	NA	2.2E-04
	peanuts	28	100	NA	NA	1.4E-04
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [e]	turf (sod farms)	252	100	7.6E-04	5.0E-04	NA
	turf (golf courses)	252	20	1.5E-04	1.0E-04	NA
	ornamentals and food crops	108	100	3.3E-04	2.2E-04	NA
	cotton, soybeans, sugar beets	44	100	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	100	NA	NA	1.3E-03
	turf (golf courses)	252	20	NA	NA	2.5E-04
	ornamentals and food crops	108	100	NA	NA	5.4E-04
	cotton, soybeans, sugar beets	44	100	NA	NA	2.2E-04

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lb ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Control
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	ND	ND	NF
	potting soil	4 lb ai/1000 sq ft	1000 sq ft	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	5	4.1E-04	2.2E-04	NF
	small areas of ornamentals, food, fiber crops, seed beds, plant beds, tobacco plant beds, lawns	350	0.5	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	5	4.1E-04	2.2E-04	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	3.9E-06	3.0E-06	NF
	sewer roots	0.212 lb ai/gal	675 gallons	1.9E-06	1.5E-06	NF

Footnotes

– **Noncommercial handler** exposure was considered to be 5 days per year for 35 years over a 70 year lifetime.

NA Not Applicable

ND No Data

NF Not Feasible

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

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

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

Commercial Handler Cancer Risks

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lbs ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Controls
		Mixer/Loader				
Transferring Liquids from Tank Delivery Truck to Shank Injection Equipment (mechanical transfer system) (1a)	wheat, barley [d]	162	100	8.7E-04	6.8E-04	3.7E-04
	ornamentals and food crops	108	100	5.8E-04	4.6E-04	2.5E-04
	cotton, soybeans, sugar beets	44.4	100	2.4E-04	1.9E-04	1.0E-04
	peanuts	27.5	100	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	100	5.8E-04	4.6E-04	2.5E-04
	cotton, soybeans, sugar beets	44.4	100	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	350	3.1E-03	2.4E-03	1.3E-03
	ornamentals and food crops	108	350	2.0E-03	1.6E-03	8.7E-04
	cotton, soybeans, sugar beets	44.4	350	8.4E-04	6.6E-04	3.6E-04
	peanuts	27.5	350	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	100	5.8E-04	4.6E-04	2.5E-04
	cotton, soybeans, sugar beets	44.4	100	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	350	ND	ND	4.0E-04
	ornamentals and food crops	108	350	ND	ND	1.2E-04
	cotton, soybeans, sugar beets n)	44.4	350	ND	ND	6.9E-05
	peanuts	27.5	350	ND	ND	5.6E-05

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lbs ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Controls
Loading Liquids to Support Drip Irrigation Applications (Sodium tetrathiocarbonate study used as surrogate data, Study # 770AA11) (1f)	ornamentals and food crops	108	100	ND	ND	1.1E-04
	cotton, soybeans, sugar beets	44.4	100	ND	ND	5.0E-05
Applicator						
Applying Liquids via Shank Injection Equipment (using PHED groundboom data) (2)	wheat, barley [d]	162	100	5.3E-04	4.4E-04	2.1E-04
	ornamentals and food crops	108	100	3.5E-04	2.9E-04	1.4E-04
	cotton, soybeans, sugar beets	44.4	100	1.5E-04	1.2E-04	5.8E-05
	peanuts	27.5	100	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	100	3.5E-04	2.9E-04	1.4E-04
	cotton, soybeans, sugar beets	44.4	100	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	100	2.0E-03	1.3E-03	NA
	ornamentals and food crops	108	100	1.3E-03	8.6E-04	NA
	cotton, soybeans, sugar beets	44.4	100	5.4E-04	3.5E-04	NA
	peanuts	27.5	100	3.3E-04	2.2E-04	NA

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lbs ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Controls
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	100	NA	NA	3.2E-03
	ornamentals and food crops	108	100	NA	NA	2.2E-03
	cotton, soybeans, sugar beets	44.4	100	NA	NA	8.9E-04
	peanuts	27.5	100	NA	NA	5.5E-04
Transferring Water Soluble Liquids from Tank Delivery Truck to Rotary Tiller Equipment (mechanical transfer system) and then applying them via Rotary Tiller Equipment (using PHED groundboom MLA with open cab) (5a) [e]	ornamentals and food crops	108	100	1.3E-03	8.6E-04	NA
	cotton, soybeans, sugar beets	44.4	100	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	100	NA	NA	2.2E-03
	cotton, soybeans, sugar beets	44.4	100	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.					

Exposure Scenario	Crop Type [a]	Typical Application Rate [b] (lbs ai/acre)	Area Treated [c] (acres)	PPE-G-OV Respirator 90% PF	PPE-G, DL-OV Respirator 90% PF	Eng Controls
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	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	5	1.6E-03	8.7E-04	NF
	small areas of ornamentals, food, fiber crops	350	0.5	1.6E-04	8.7E-05	NF
Mixing/Loading/Applying Water Soluble Liquids via Power Sprayer (using ORETF hand-gun data - occupational) (10)	No commercial cancer risks were calculated for this scenario.					
Mixing/Loading/Applying Liquid via Cement Mixer (using PHED Mixer/Loader data for Open-pour Liquids) (11)	No commercial cancer risks were calculated for this scenario.					
Mixing/Loading/Applying Liquid via Shredder (using PHED Mixer/Loader data for Open-pour Liquids) (12)	No commercial cancer risks were calculated for this scenario.					
Mixing/Loading/Applying Liquid with Foaming Equipment (using PHED Mixer/Loader data for Open-pour Liquids) (13)	sewer roots	0.212 lb ai/gal	1350 gallons	1.5E-05	1.2E-05	NF
	sewer roots	0.212 lb ai/gal	675 gallons	7.7E-06	6.0E-06	NF
Mixing/Loading/Applying Liquid via Open Pour (using PHED Mixer/Loader data for Open-pour Liquids) (14)	No commercial cancer risks were calculated for this scenario.					

Footnotes

–	**Commercial handler** exposure was considered to be 20 days per year for 35 years over a 70 year lifetime.
NA	Not Applicable
ND	No Data
NF	Not Feasible

a	Target for all crops is the soil except for turf, which may be applied to the foliar surface.
b	Application rates are the typical application rates provided by USDA (2001) for metam sodium where possible. If typical rates were not available, the maximum label rates were used in place of typical rates.
c	Amount handled per day values are HED estimates of acreage treated or gallons applied based on Exposure SAC SOP #9 "Standard Values for Daily 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
Dermal 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: Occupational Handler Risk Summary for Exposure to MITC

The tables below present the occupational handler scenarios for exposure to MITC that are above the Agency's level of concern, even with maximum feasible PPE or engineering controls. For simplicity of presentation, only the exposure scenarios using maximum rates that appear on most product labels are shown (outlier labels with higher rates have been omitted).

Short- and Intermediate-Term Risk

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs: Baseline	Inhalation MOEs: OV Respirator 90% PF
Applicator: Personal Pump Samplers						
Applying Water Soluble Liquids via **Shank Injection** Equipment-Personal Sampler Pumps (**enclosed cab with charcoal filter**): MRID# 42968402	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320	8	8.3	55	**NA**
Applying Water Soluble Liquids via **Shank Injection** Equipment-Personal Sampler Pumps (**enclosed cab with cellulose filter**): MRID# 42968402	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523	1	8.3	40	**NA**
	tobacco plant beds	387	3	8.3	18	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320	8	8.3	8.1	**NA**
	peanuts (CBR susceptible cultivars)	63.3	8	8.3	41	**NA**
	cotton, soybeans, sugar beets	38	8	8.3	68	**NA**
	peanuts (CBR resistant cultivars)	32	8	8.3	81	**NA**
	wheat, barley	31.7	8	8.3	82	**NA**

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	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 **Shank Injection** Equipment-In-cab Sampler Pumps (**enclosed cab with charcoal filter**): MRID# 45123902 and 45703703	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523	1	8.3	65	NA
	tobacco plant beds	387	3	8.3	29	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320	8	8.3	13	**NA**
	peanuts (CBR susceptible cultivars)	63.3	8	8.3	67	**NA**
Applying Water Soluble Liquids via **Rotary Tiller** Equipment-Personal Sampler Pumps (**enclosed cab with charcoal filter**): MRID# 42958401	ornamentals, food and fiber crops, turf (sod farm/golf course)	320	8	8.3	21	**NA**
Applying Water Soluble Liquids via **Rotary Tiller** Equipment (**enclosed cab with cellulose filter**): 42958401	ornamentals, food and fiber crops, turf (sod farm/golf course)	320	8	8.3	20	**NA**

Exposure Scenario	Crop or Target [a]	Application Rate [b] (lbs ai/acre)	Time Exposed per Day for Scenario (hrs/day) [c]	MV_{ACTUAL} - Minute Volume Exposure for Scenario (L/min)	Inhalation MOEs Baseline	Inhalation MOEs OV Respirator 90% PF
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	small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns	523	1	8.3	52	**NA**
	tobacco plant beds	387	3	8.3	24	**NA**
	ornamentals, food and fiber crops, orchard (replant/transplant), turf (sod farm/golf course)	320	8	8.3	11	**NA**
	peanuts (CBR susceptible cultivars)	63.3	8	8.3	54	**NA**
	cotton, soybeans, sugar beets	38	8	8.3	90	**NA**

Footnotes

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

NA Not Applicable

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

b Application rates are the maximum application rates determined from EPA registered labels for metam sodium.

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

- All agricultural crops are expected to be treated for 8 hours per day based on 80 to 128 acres (shank injection), 350 acres (sprinkler irrigation), 100 acres (drip irrigation) being treated per day. This also includes golf course turf based on a telone field volatility study (MRID 45 1207), 9 holes irregular shaped fairways (20.4 acres) were treated in 11 hours using tractor-drawn shank injection.
- Tobacco plant beds are expected to be treated for no more than 3 hours per day based on 20 to 40 acres being treated per day.
- Small areas of ornamentals, food, fiber crops, seed beds, plant beds, lawns are expected to be treated for 1 hour per day based on 0.5 to 5 acres treated per day.