Attachment 6

Measured Air Quality Data for Cooler Weather Studies (Relative to Summertime Conditions in Kern County, California): Evaluation of Differences Between the Upper-End Metam Sodium Task Force Studies in California and Cooler Climates

Table 1 provides a summary of the GLP and non-GLP metam-sodium field studies, including studies already submitted to EPA, as well as seven new studies (6 USDA field studies and a study conducted by TKI in the Pacific Northwest). The GLP studies conducted by the Metam Sodium Task Force (MSTF) depict worst-case emission rates in hot, dry climates represented by Kern County, California. The non-GLP studies that were conducted in cooler conditions and/or heavier soils show much lower off-gassing results than the GLP standard sealing studies for shank injection and chemigation conducted in Kern County, California.

Table1
Listing of Metam-Sodium Field Studies (1 of 3)

Name of Field Study	Reference	Year	Time of Application	Application Method	Sealing Method
Firebaugh	Rosenheck, 1993a	1992	Nighttime	Chemigation	Line flushed for 15 minutes
Grant	Rosenheck, 1993b	1992	Unknown	Center Pivot Chem.	No sealing
Grant	Rosenheck, 1993b	1992	Unknown	Rotary Tiller	No sealing
Yuma	Rosenheck, 1993c	1992	Unknown	Chemigation	Standard Water
Yuma	Rosenheck, 1993c	1992	Unknown	*Shank Injection*	No sealing
Contra Costa	Air Resources Board, 1993	1993	Daytime	*Shank Injection*	No sealing
Kern	Air Resources Board, 1994	1993	Daytime	*Shank Injection*	No sealing
Wofford	Wofford, 1994	1993	Nighttime	Chemigation	Standard Water
Kern	Air Resources Board, 1995	1995	Daytime-Nighttime	*Shank Injection*	No sealing
Orange County	Sullivan, 2001a	1997	Evening	Drip Irrigation	No sealing
Orange County	Sullivan, 2001a	1997	Evening	Drip Irrigation	Tarp
Kern 1999 (GLP)	Merricks, 2002b	1999	Daytime	Chemigation	Standard Water
Kern 1999 (GLP)	Merricks, 2002b	1999	Daytime	*Shank Injection*	Standard Water
Lancaster	Sullivan, 2001b	2000	Daytime	Chemigation	Pseudo Intermittent Water
Lost Hills (GLP)	Merricks, 2001	2000	Daytime	*Shank Injection*	Intermittent Water
Santa Barbara	Sullivan, 2001c	2000	Daytime	*Shank Injection*	Pseudo Intermittent Water
Kern 2001 (GLP)	Merricks, 2002a	2001	Daytime	Chemigation	Intermittent Water
Panama Lane	Sullivan, 2001d	2001	Daytime	Chemigation	Both Intermittent & Standard
USDA 2002 Bakersfield, CA	Nelson, 2003a	2002	Daytime	*Shank Injection*	Intermittent Water
USDA 2002 Bakersfield, CA	Nelson, 2003a	2002	Daytime	Chemigation	Intermittent Water
Pacific Northwest	Sullivan, 2004	2003	Daytime	*Shank Injection*	None, soil rototilled
USDA 2003 Citra, FL	Nelson, 2003b	2003	Daytime	Incorporation	Tarp
USDA 2003 Citra, FL	Nelson, 2003b	2003	Daytime	Drip Irrigation	Tarp
USDA 2004 Salinas, CA	Nelson, 2004	2004	Daytime	*Shank Injection*	Tarp
USDA 2004 Salinas, CA	Nelson, 2004	2004	Daytime	Drip Irrigation	Tarp

Table 1
Listing of Metam-Sodium Field Studies (2 of 3)

Name of Field Study	Application Rate lbs a.i../acre	% A.I.	Application Rate/Acre (gallons/acre)	Acreage	Season	Violation?
Firebaugh	327	32.7%	99.9	6.7	Spring	Unknown
Grant	330	32.7%	100.8	31	Winter	Unknown
Grant	329	32.7%	100.5	19	Winter	Unknown
Yuma	289	32.7%	88.3	40	Fall	Not following cultural practice
Yuma	274	32.7%	83.7	19	Fall	Unknown
Contra Costa	59	32.7%	18.0	95	Spring	No, breakthrough problems
Kern	165	33.0%	50.0	85	Summer	No, sample problems
Wofford	330	33.0%	100.0	19	Summer	Label Violation
Kern	165	33.0%	50.0	80	Summer	No
Orange County	318	42.5%	74.8	12	Winter	No
Orange County	318	42.5%	74.8	4	Winter	No
Kern 1999 (GLP)	315	42.0%	75.0	80	Summer	No
Kern 1999 (GLP)	158	42.0%	37.5	80	Summer	No
Lancater	315	42.0%	75.0	16	Winter	No
Lost Hills (GLP)	158	42.0%	37.5	40	Summer	No
Santa Barbara	158	42.0%	37.5	10	Summer	No
Kern 2001 (GLP)	315	42.0%	75.0	20	Summer	No
Panama Lane	315	42.0%	75.0	12	Summer	No
USDA 2002 Bakersfield, CA	158	42.0%	37.5	15	Summer	No
USDA 2002 Bakersfield, CA	315	42.0%	75.0	15	Summer	No
Pacific Northwest	319	42.0%	76.0	20	Summer	No
USDA 2003 Citra, FL	315	42.0%	75.0	1.3	Winter	No
USDA 2003 Citra, FL	378	42.0%	90.0	1.3	Spring	Yes, application > 75 gallons/acre
USDA 2004 Salinas, CA	315	42.0%	75.0	1	Winter	No
USDA 2004 Salinas, CA	315	42.0%	75.0	1	Winter	No

Table 1
Listing of Metam-Sodium Field Studies (3 of 3)

Name of Field Study	Soil Type	% Sand	% Silt	% Clay	pH	% Moisture at Field Capacity	% Organic Matter
Firebaugh	Loamy sand	82.7%	13.3%	4.0%	7.9%	17.7%	6.5%
Grant	Timmerman Coarse Sandy Loam and Quincy Loamy Fine Sand						
Grant	Quincy Loamy Fine Sand						
Yuma	Indio Silt Loam						
Yuma	Hotville Clay						
Contra Costa	Clay Loam						
Kern	Sandy Loam						
Wofford	Loam	45%	28%	27%	7.8		1.18%
Kern	Unknown						
Orange County	Unknown						
Orange County	Unknown						
Kern 1999 (GLP)	Sandy Loam	69.0%	24.0%	7.0%		13.0%	
Kern 1999 (GLP)	Sandy Loam	75.0%	16.0%	9.0%		10.1%	
Lancater	Sandy Loam	72.0%	18.0%	10.0%		10.9%	0.5%
Lost Hills (GLP)	Clay Loam	30.0%	36.0%	34.0%	7.8	12.2%	0.8%
Santa Barbara	Sandy Loam	73.0%	22.0%	5.0%		10.2%	
Kern 2001 (GLP)	Silt Loam						
Panama Lane	Sandy Loam	63.0%	26.0%	11.0%		24.0%	
USDA 2002 Bakersfield, CA	Wasco sandy loam	73.0%	20.0%	7.0%			
USDA 2002 Bakersfield, CA	Wasco sandy loam	76.0%	18.0%	6.0%			
Pacific Northwest	Clay Loam	20.0%	48.6%	31.4%			5.2%
USDA 2003 Citra, FL	Sand	92.0%	7.0%	1.0%		13.5%	
USDA 2003 Citra, FL	Sand	92.0%	7.0%	1.0%		13.5%	
USDA 2004 Salinas, CA	Chualar loam	51.0%	32.0%	17.0%			0.7%
USDA 2004 Salinas, CA	Chualar loam	51.0%	34.0%	15.0%			0.7%

The emissions of MITC from metam-sodium applications are complex terms that are a function of soil type, soil temperature, percent field capacity, percent organic matter, application method, and sealing method (among other factors). A large matrix of conditions can be envisioned to empirically cover the wide range of possibilities. The general approach this is followed is to start with worst case soil conditions to compute the upper end concentrations. This approach produces a tractable set of studies, which can be used to estimate (conservatively) off-gassing rates and exposures throughout the United States. The intent is to reduce the conservatism as the data base improves in time.

When considering the degree of conservatism in the measured data collected in California relative to the cooler weather studies, it is very important to keep in mind that most of the applications in the United States and Europe are not conducted in locations such as Kern County, California, which can be characterized as hot, sandy, and very dry. How different would the emissions be for applications in locations with cooler temperatures and/or heavier soils? At the very least, it can be demonstrated that off-gassing rates are much lower under such circumstances, even if there is not as extensive data to support regression-based emission assessment.

This attachment documents the studies involving off-gassing that can be viewed as supplemental information to augment the U.S. GLP and pilot studies already submitted to the U.S. EPA. It is subdivided into two major sections

1. U.S. Studies

- **Pacific Northwest Study**

  A recent U.S. Study (Pacific Northwest Study of shank injection / rototilling, following by compaction) – conducted July 2003

- **USDA Field Studies**

  Six field studies supported by the U.S. Department of Agriculture, conducted in three sets of paired studies -- conducted September 2002 through February 2004.

Figure 1 shows the Mount Vernon, WA and Salinas, CA shank injection emission rates compared with other shank injection studies emission rates. Figure 2 shows the Salinas, CA drip irrigation, the Citra, Florida drip irrigation emission rates compared with earlier studies.

Figure 1
Shank Injection Studies

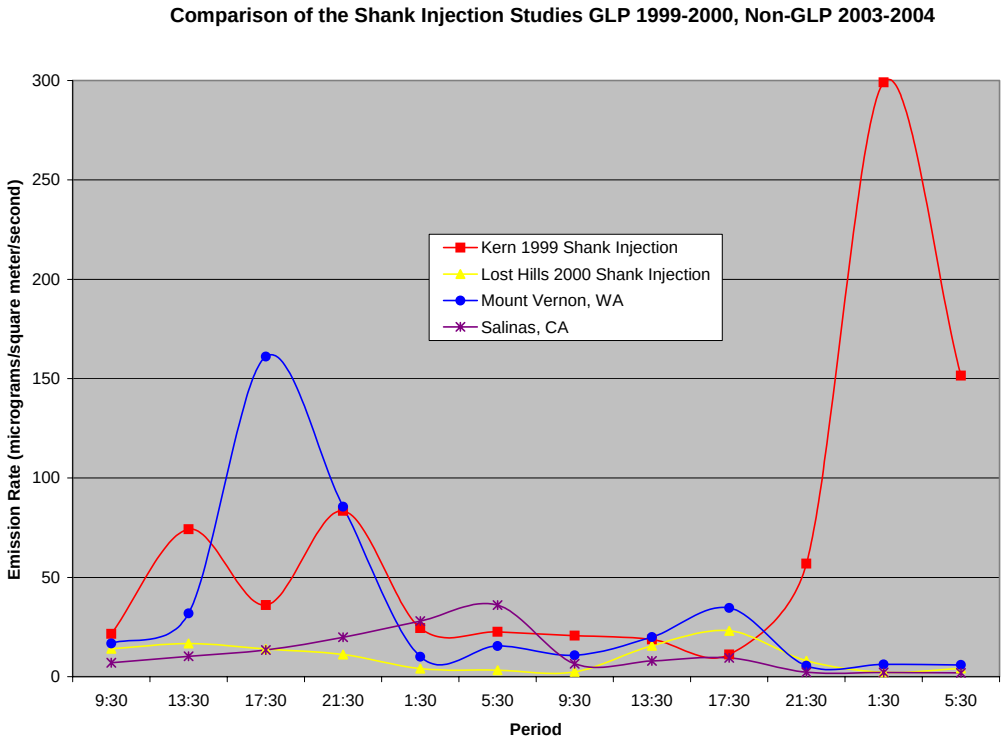
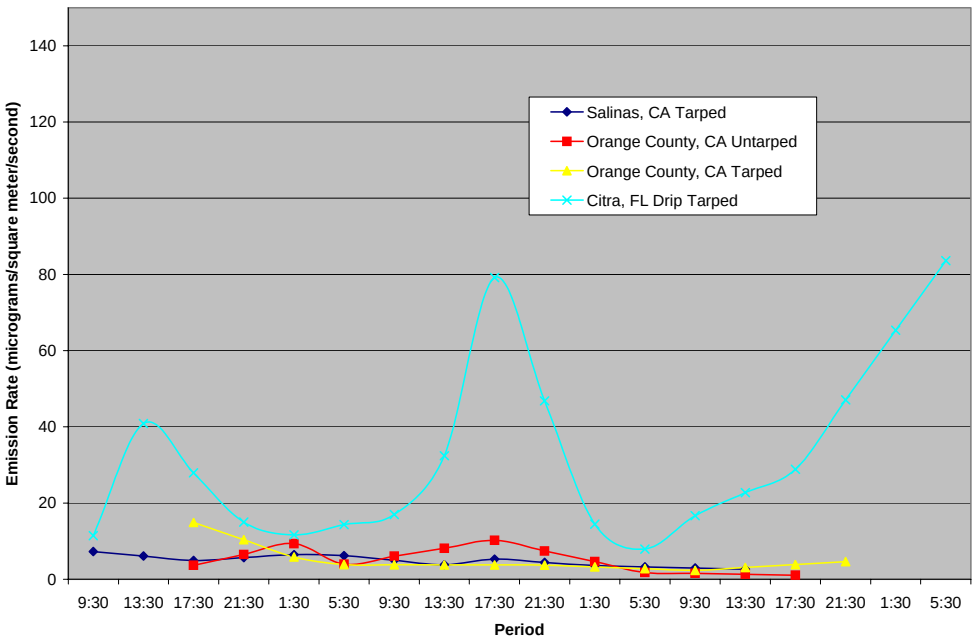


Figure 2
Drip Irrigation Studies



■ Wisconsin Field Study

This study was conducted in Wisconsin by the University of Wisconsin (Madison) under the direction of Dr. Abrahim Saeed (Saeed, 2000). Application methods involved chemigation/center pivot and also by shank injection. The shank injection application was done with a 50 percent metam-sodium 50 percent water mix, using a shank spacing of 15 cm, and injecting at three depths: 5, 15, and 25 cm. For the center pivot application, a total volume of 169 m^3/hectare of irrigation water was used (0.67 inches of water). Air quality samples were taken at the three heights above the ground (0.2 to 2 meters), directly over the applied fields. Most samples were taken during the daylight hours, but some were collected at night, and these showed similar quantities of MITC. Nighttime periods were characterized by low wind speeds, 1 to 2 m/sec. Table 2 provides a summary of this field study.

Table 2
Summary of Study of Center Pivot and Shank Injection Conducted In Wisconsin

Factor	Study 1	Study 2
Application Method	Center Pivot	Shank
Sealing Method	none	Roller
Application Rate (Liters/Hectare)	480	480
Soil Type	Plainfield Loamy Sand	Plainfield Loamy Sand
Soil % Field Capacity At time of application		
Soil Temp (°C) at Application Time[1]	<0	<0
Range of Soil Temp. (°C)	<0 to 10	<0 to 10
Daytime or Nighttime Application	Nighttime	Nighttime
Tarped	NA	No
Maximum concentrations Measured 10 cm over the treated Field (μg/m^3)	11	7
Maximum worker concentration (μg/m^3)	Not Applicable	Not Applicable

The cooler conditions and heavier soils in the Pacific Northwest study (Sullivan, 2004c), the USDA Salinas studies (Nelson, 2004), and the Wisconsin study (Saeed, 2000)

[1] Not specified, but applications took place in late September (1987) and early October (1986). Soil temperatures during this season would be expected to be similar to the preceeding table, *i.e.* approximately 10 °C. This estimate can be refined as more data become available.

showed substantially lower off-gassing rates than in the standard GLP studies conducted in Kern County, California during hot and dry summertime conditions.[2]

2. European Studies to Qualitatively Augment U.S. Studies -- Cooler Conditions and Heavier soils

Research has been conducted in Europe to evaluate off-gassing rates. Applications in the studies that are listed below were done in cooler, autumn applications, often with soil temperatures in the range of 5 – 15 °C. These studies involved application of metam-sodium via shank injection (often followed by a roller for compaction). According to the documentation in these study reports, no water sealing was used in these studies.

The following table provides a concise summary of the available studies that were reviewed at this time.

Table 3
Van den Berg, 1999

Factor	Field 85-I	Field 85-II	Field 85-III	Field 85-IV	Field 85-V	Field 85-VI	Field 85-VII	Field 86-1	Field 86-II	Field 87-I	Field 87-II
Application Method	Shank	shank	shank	shank	shank	shank	shank	shank	shank	shank	shank
Sealing Method	Roller	roller	roller	roller	roller	roller	roller	roller	roller	roller	Roller
Application Rate (Liters / Hectare)	300	300	300	300	300	300	300	300	300	300	300
Soil pH								4.9	4.3	5.2	4.9
Soil % Organic Matter								19.5	13.8	6.2	17.8
Soil Temp (°C) at Application Time											
Range of Soil Temp. (°C)	5-15	5-15	5-15	5-5	5-5	5-5	5-5	5-5	5-5	5-15	5-5
Daytime or Nighttime Application	Day	Day	Day	Day	Day	Day	Day	Day	Day		
Tarped?	No	No	No	No	No	No	No	No	No		
Maximum concentrations Measured at Distance 1 (μg/m^3)	323 (on-field)	<5 (on-field)	<5 (on-field)	9	<5 (on-field)	<5 (on-field)	9 (on-field)	6.9 (on-field)	12 (on-field)	30 (edge of field)	5 (edge of field)
Maximum concentrations for Distance 2 (μg/m^3)	12 (60m)	<5	<5	<5	<5	<5	<5	6 (75m)	4 (30)	221 (~5m)	112 (8m)

[2] The Pan Ag Grant County study (Rosenheck, 1993a) is another example of a cool weather study. Air temperatures were generally in the range of 40 to 50 °F. Although this study was limited to worker exposures (no bystander samples were taken), it is another indication of relatively low off-gassing potential during cooler weather periods. The Pan Ag Yuma study (Rosenheck, 1993b), on the other hand, was conducted with air temperatures in the range of 58 to 83 °F (for shank injection) and 50 to 81 °F (for chemigation).

Table 4
Van den Berg, 1999

Factor	Field A	Field B
Application Method	Shank	Shank
Sealing Method	Roller	Roller
Application Rate (Liters / Hectare)	300	300
Soil Type		
Soil pH	4.3	5.2
% organic matter	13.8	6.2
Range of Soil Temp. (°C)	11-12	11-12
Computed Loss (%)	10	10
Tarped?	No	No
Maximum concentrations Measured for by-standers at Distance 1 ($\mu g/m^3$)	3 (180m)	3 (50m)
Maximum concentrations Measured for by-standers at Distance 2 ($\mu g/m^3$)		1 (90m)
Maximum worker concentration ($\mu g/m^3$)	NA	NA

The common thread through all of these studies is that off-gassing rates are much lower than shown in the Kern County, California, studies. Based on all of the information available through the U.S. studies and these European studies, it can be anticipated, especially for applications outside of the summer period, that the summertime, worst case standard sealing chemigation and shank injection studies substantially overstate typical exposures.

As shown in the preceding tables, the measured MITC concentrations during the cool weather studies, even without enhanced water sealing practices, are much lower than the standard seal applications in California. The MITC concentrations at comparable downwind distances are generally 50 to 100 times lower than the worst case studies in California. The high summertime temperatures appear to the most significant factor. On this basis, it is apparent that the exposures based on summertime conditions are directly applicable only to summertime applications, as an indication of worst case conditions. For all other seasons, substantially lower concentrations would be expected downwind of treated fields, based on all of the information shown in this section. Less restrictive regulatory requirements, relative to standard sealing applications, would be appropriate for applications made in seasons other than summertime. Distances to endpoint would be expected to be conservatively addressed by using a 10-fold reduction in downwind concentrations for applications with soil temperatures less than approximately 15 ^{o}C.