Mary-Ann Warmerdam
Director

Department of Pesticide Regulation

MEMORANDUM

Arnold Schwarzenegger
Governor

TO: Joseph P. Frank, Ph.D.
Senior Toxicologist
Worker Health and Safety Branch

FROM: Bruce Johnson, Ph.D. *Original signed by*
Research Scientist III
Environmental Monitoring Branch
916-324-4106

DATE: December 2, 2009

SUBJECT: CALCULATION OF SCREENING CONCENTRATIONS FOR 1,3-DICHLOROPROPENE

BACKGROUND

The Worker Health and Safety (WHS) requested screening concentrations for 1,3-dichloropropene(1,3-d) acute exposure appraisal (Linda Hall, Ph.D. and Joseph P. Frank, Ph.D., personal communication 2008). They requested concentrations associated with maximum daylight 8 hour flux and maximum 24 hour flux. In addition, they requested that the associated concentrations should reflect the maximum acreage and application rates. The general methodology has been outlined and utilized for iodomethane and chloropicrin (Barry 2008).

METHODS

Flux studies

Seven flux studies were identified as relevant to this project. Two studies (contained in a single citation) provided shallow shank flux (Gillis and Dowling 1999). Three studies provided flux for deep shank applications (Knuteson et al. 1992ab, Knuteson et al. 1995). And two studies measured flux from drip applications (Knuteson and Dolder 2000, Wesenbeeck and Phillips 2000).

For each study, the period by period flux was entered into Excel worksheets. The 24 hour rolling average fluxes were calculated and the maximum 24 hour flux identified. For eight hour fluxes, maximum flux periods were identified. These studies typically used measurement periods of 5 to 12 hours and WHS determined (Frank 2008abc) that no peak-to-mean adjustments, such as outlined in Barry (2008), were required. The requested time period of 8 h was generally longer than the measurement periods which were mostly 5 to 6 h. Multiplicative peak-to-mean adjustment factors going from shorter periods to longer periods would generally be less than 1 (Barry 2000).

Maximum acreage

Maximum acreages were determined based on phone calls to enforcement personnel and various field personnel, who were familiar with the shank and drip application methodologies for 1,3-d. The consensus of these individuals was that the maximum shank acreage was probably 40 acres per day per rig and the maximum drip acreage was 40 acres per day, if there was sufficient water pressure and everything went perfectly. The 40 acre drip limitation has also been determined for other drip-applied fumigants (Barry personal communication). It is likely that upon occasion, two rigs would be used for shank applications and therefore, I believe, a maximum daily acreage for shank applications is 80 acres.

Table 1. Summary of acreage distributions for 1,3-d applications based on CDMS data from 1999-2003 and 2005 PUR data. Acres are abbreviated ac.

	CDMS 1999-2003 Statewide			PUR 2005	
	Telone II		InLine	Telone II	InLine
	Shallow Shank	Deep Shank	Drip	Shallow+Deep Shank	Drip
90th percentile	60-80 ac	60-80 ac	40-60 ac	40-60 ac	60-80 ac
95th percentile	80-100 ac	80 ac	60-80 ac	60-80 ac	80-100 ac
Maximum	186 ac	390 ac	251 ac	306 ac	192.2 ac
Total Number Apps	2141	5178	719	1533	381

The Pesticide Use Report (PUR) for 2005 and the Crop Data Management Systems (CDMS) reports from 1999-2003 list apparent single shank applications which exceed 300 acres (Table 1). However, it is well known that applicators will report multiple applications on a single use report in order to save paperwork. CDMS data from 1999-2003 provided field size distributions that were more or less consistent with those from the 2005 PUR data. The high single-application acreages for drip applications in these use reports must reflect multiple applications because field personnel that I spoke with indicated the physical impossibility of single drip applications exceeding 40 acres.

Maximum application rate

I reviewed the labels and permit conditions for 1,3-d use in California in order to determine a maximum application rate. For shank applications, permit conditions impose a maximum 332 lb active ingredient (a.i.)/acre limitation. This limitation appears to be lower than label limitations. The 2005 PUR indicated a 95th percentile of 334 lbs a.i./acre. I used 332 lbs a.i./acre as the maximum rate for shank applications. For drip applications, the InLine label recommends up to 38.4 gallons/acre for strawberries. At 6.57 lbs a.i./gallon, the application of InLine at 38.4 gallons/acre is equivalent to 252 lbs a.i./acre. The 2005 PUR shows maximum application rates for InLine of 204 lbs a.i./acre. For InLine I used 252 lbs a.i. /acre as the maximum application rate.

Generic downwind concentrations

As outlined in Barry (2008), there are two generic screening scenarios relevant to the 8 h daytime and 24 h exposure periods requested by WHS. The 8 h daytime corresponds to overcast

Table 2. Generic downwind concentrations (ug/m^3) for screening scenarios for 40 and 80 acre fields using fixed 100 ug/m^2s flux.

		Column headers are downwind distance (m)					
		3.04	**15.2**	**30.4**	**91.2**	**152**	**760**
40 acres	**C, 1.4m/s, 24 h**	2589	2351	2019	1374	1083	377
	D, 1.0m/s, 8 h day	5181	4838	4445	3179	2560	1045
80 acres	**C, 1.4m/s, 24 h**	2878	2645	2308	1634	1319	516
	D, 1.0m/s, 8 h day	5879	5517	5154	3830	3160	1408

(neutral) meteorological conditions (D stability) with a 1 m/s wind speed. The 24 h scenario corresponds to C stability with a wind speed of 1.4 m/s. Given that there are two acreages, 40 and 80, this results in 4 generic air concentration scenarios (Table 2). Barry (2008) provided 20 and 40 acre scenarios. The 80 acre scenario was generated in a fashion similar to Barry (2008): running Industrial Source Complex Short Term version 3 (ISCST3) model (U.S. Enivornmental Protection Agency 1995) using 100 ug/m^2s as the flux with the meteorological conditions in Table 2 and 80 acre (568.99 m x 568.99 m) source. Downwind distances were those previously requested by WHS (Barry 2008).

Computations

The computations consisted of utilizing two factors to proportionately adjust the generic screening concentrations (Barry 2008). The two factors are (1) the identified or computed flux from the monitoring studies in relation to the nominative 100ug/m^2s modeled flux, and (2) the study application rates in relation to the maximum application rate.

<u>Results</u>

Study summaries

Study application rates ranged from 67.4 to 128 lbs a.i./acre. Maximum 24 h flux ranged from 4.72 to 30.9 ug/m^2s for the shank studies and 8.1 to 8.18 ug/m^2s for the two drip studies (Table 3). The two drip studies, however, differed by a factor of 2 in the application rates. The 8 hour fluxes were approximated by flux measurement periods ranging from 5 h to 12 h. For shank applications, the maximum 8 h fluxes ranged from 3.78 to 37 ug/m^2s. For the drip studies, the maximum 8 hour fluxes were 14.4 and 20.1 ug/m^2s.

Table 3. Key flux and application rate values associated with 1,3-dichloropropene studies for WHS acute exposure assessment. The 'intended' columns reflect WHS request. Rows shaded for easier reading.

Study	Location	Application Method	Study Application Rate (lbs a.i./acre)	Intended Period Length (h)	Intended Night or Day	Measured Flux (ug/m^{2}s)	Actual Period Length (h)	Actual Night or Day	Maximum Rate (lbs a.i./acre)
Gillis & Dowling (1999)	Salinas Valley	Shank row 12" depth	68.3	24	-	21.9	24	-	332
				8	D	32	5	D	
Gillis & Dowling (1999)	Salinas Valley	Shank broadcast 14"	122	24	-	30.9	24	-	332
				8	D	37	5.5	D	
Knuteson et al. (1992a)	Salinas Valley	Shank 18"	122	24	-	7.92	24	-	332
				8	D	6.81	6	D	
Knuteson et al. (1995)	Firebaugh (Fresno)	Shank 18"	120	24	-	10.13	24	-	332
				8	D	17.53	6	D	
Knuteson et al. (1992b)	Imperial County	Shank 18"	121	24	-	4.72	24	-	332
				8	D	3.78	12	D	
Knuteson & Dolder (2000)	Salinas	Drip	128	24	-	8.1	24	-	252
				8	D	14.42	6	D	
Wesenbeeck & Phillips (2000)	Douglas, GA	Drip	67.4	24	-	8.18	24	-	252
				8	D	20.1	5	D	

Computation of adjustment factors

The adjustment factors were multiplied by the generic screening concentrations (Table 2) to obtain the final screening concentrations. The calculation of adjustment factors is outlined in Table 4. All of the studies were conducted at application rates less than the maximum allowable. Flux adjustment factors in Table 4 are shown to 3 decimal places so that computations based on the tabulated values will agree with net adjustment factors calculated in Excel under full precision.

Screening concentrations

Applying the net adjustment factors in Table 4 to the corresponding generic concentrations from Table 2 results in the screening concentrations shown in Table 5. Rows in Table 5 correspond to rows in Tables 3 and 4. Shallow shank studies were Gillis and Dowling (1999). Deep shank studies were Knuteson et al. (1992ab, 1995). Drip studies were Knuteson and Dolder (2000) and Weesenbeeck and Phillips (2000). Shank concentrations based on 80 acre simulation while drip concentrations were based on 40 acre simulation. Concentrations have been rounded to two significant figures, as recommended in Barry (2008). The highest screening concentrations resulted from the shallow shank studies. The 24 h drip and deep shank screening concentrations were similar in magnitude.

Table 4. Flux and application rate adjustments for modifying the generic screening concentration values. Note that C and D in the Meteorological Scenario column refer to C and D atmospheric stability. Rows shaded for easier reading.

Study	Application Method	Study Application Rate (lbs a.i./acre)	Maximum Rate (lbs a.i./acre)	Application Rate Factor	Maximum Measured Flux (ug/m^{2}s)	Flux Adjustment Factor	Net Adjustment Factor	Period Duration and Meteorological Scenario	Maximum Acreage
Gillis & Dowling (1999)	Shank row 12" depth	68.3	332	4.86	21.9	0.219	1.06	24 h, C, 1.4 m/s	80
		68.3	332	4.86	32.0	0.320	1.56	8 h, D, 1.0 m/s	80
Gillis & Dowling (1999)	Shank broadcast	122.0	332	2.72	30.9	0.309	0.84	24 h, C, 1.4 m/s	80
		122.0	332	2.72	37.0	0.370	1.01	8 h, D, 1.0 m/s	80
Knuteson et al. (1992a)	Shank 18"	122.0	332	2.72	7.92	0.079	0.22	24 h, C, 1.4 m/s	80
		122.0	332	2.72	6.81	0.068	0.19	8 h, D, 1.0 m/s	80
Knuteson et al. (1995)	Shank 18"	120.0	332	2.77	10.13	0.101	0.28	24 h, C, 1.4 m/s	80
		120.0	332	2.77	17.53	0.175	0.48	8 h, D, 1.0 m/s	80
Knuteson et al. (1992b)	Shank 18"	121.0	332	2.74	4.72	0.047	0.13	24 h, C, 1.4 m/s	80
		121.0	332	2.74	3.78	0.038	0.10	8 h, D, 1.0 m/s	80
Knuteson & Dolder (2000)	Drip	128.0	252	1.97	8.1	0.081	0.16	24 h, C, 1.4 m/s	40
		128.0	252	1.97	14.42	0.144	0.28	8 h, D, 1.0 m/s	40
Wesenbeeck & Phillips (2000)	Drip	67.4	252	3.74	8.18	0.082	0.31	24 h, C, 1.4 m/s	40
		67.4	252	3.74	20.1	0.201	0.75	8 h, D, 1.0 m/s	40

Table 5. Downwind screening concentrations (ug/m^3) for shank and drip 1,3-d application scenarios. Column headers are distance downwind (m). Row headers refer to 24 h or 8 h concentrations. Concentrations were rounded to two significant figures. Rows correspond to rows in Tables 3 and 4. Shank concentrations were based on 80 acres and drip concentrations were based on 40 acres.

		3.04	15.2	30.4	91.2	152	760
Shallow Shank	24 h	3100	2800	2500	1700	1400	550
	8 h	9100	8600	8000	6000	4900	2200
	24 h	2400	2200	1900	1400	1100	430
	8 h	5900	5600	5200	3900	3200	1400
Deep Shank	24 h	620	570	500	350	280	110
	8 h	1100	1000	960	710	590	260
	24 h	810	740	650	460	370	140
	8 h	2900	2700	2500	1900	1500	680
	24 h	370	340	300	210	170	67
	8 h	610	570	530	400	330	150
Drip	24 h	410	370	320	220	170	60
	8 h	1500	1400	1300	900	730	300
	24 h	790	720	620	420	330	120
	8 h	3900	3600	3300	2400	1900	790

Combining concentrations from similar studies
You asked me for my recommendation on how to combine screening concentrations from similar studies. I would recommend taking a simple average since these studies represent the natural variability in application conditions and the application and flux rates have all been normalized. In addition, these concentrations were based on maximum fluxes, maximum application rates and maximum acreages and, thus, embody significant conservatism.

bcc: Johnson Surname File

REFERENCES

Barry, Terrell. 2000. Memorandum to Kean Goh on Peak-to-mean air concentration estimation for fumigants dated November 6, 2000.

Barry, Terrell. 2008. SCREENING LEVEL AIR CONCENTRATION ESTIMATES FOR WORKER HEALTH AND SAFETY EXPOSURE APPRAISALS. Memorandum to Randy Segawa dated August 21, 2008. Available at: <http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/2071_segawa.pdf>.

Frank, Joseph. 2008abc. Emails to Bruce Johnson on meeting summary. Dated Feburary 4, 2008.

Gillis, Matthew J. and Kathryn C. Dowling. 1999. Effect of broadcast and row application methods on 1,3-dichloropropene emissions. Dow AgroSciences LLC, 9330 Zionsville Rd., 308/2E. Indianapolis, IN. Bolsa Research Project #:BR730, Dow AgroSciences Study ID #: HEA95177.

Knuteson, James A., David G. Petty, and Bradley A. Shurdet. 1992a. Field volatility of 1,3- dichloropropene in Salinas Valley California. DowElanco, Midland, MI.

Knuteson, James A., David G. Petty and Bradley A. Shurdut. 1992b. Field volatility of 1,3- dichloropropene in the Imperial Valley of Southern California. DowElanco, Midland, MI. (ENV91001).

Knuteson, J.A., H.E. Dixon-White and D.G. Petty. 1995. Field volatility of 1,3-dichlororopropene in San Joaquin Valley California. DowElanco ENV93063.

Knuteson, J.A. and S.C. Dolder. 2000. Field volatility of 1,3- dichloropropene and chloropicrin from shallow drip irrigation application of Telone C-35 (InLine) to strawberry beds with VIF tarp. April 27, 2000. Global Environmental Chemistry Laboratory - Indianapolis Lab, Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, Indiana. 46268-1054. Laboratory Study ID 980070.01.

U.S. EPA. 1995. User’s guide for the industrial source complex (ISC3) disperson models. Volume 1 - User Instructions. EPA-454/B-95-003a. U.S. Environmental P rotection Agency. Office of Air Quality Planning and Standards Emissions, Monitoring and Analysis Division Research Triangle Park, North Carolina 27711. September 1995.

Wesenbeeck, I. Van and A. M. Phillips. 2000. Field volatility of 1,3-dichloropropene and chloropicrin from surface drip irrigation application of In-Line to vegetable beds under

polyethylene tarp. Global Environmental Chemistry Laboratory – Indianapolis Lab, Dow AgroSciences LLC, 9330 Zionsville Rd., Indianapolis, Indiana 46268-1054. Study ID 990072.