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MEMORANDUM

TO: Thomas Thongsinthusak, Staff Toxicologist **HSM-98003**

FROM: David Haskell, Associate Environmental Research Scientist
[original signed by David Haskell]

DATE: May 11, 1998

SUBJECT: METHYL BROMIDE FUMIGATION OF VARIOUS
COMMODITIES

The occupational exposure to methyl bromide (MeBr) is dictated by the seasonal nature of most applications. In California, MeBr is primarily used to fumigate soil for planting agronomic crops and to fumigate commodities in storage or for export. This memo is concerned with estimating the duration of the workday exposure (hours per day) for workers applying MeBr or working with fumigated commodities and the annual frequency these workday exposures occur. This information is needed to derive estimates of the acute, subchronic and chronic exposure. The duration of the workday exposure and the annual frequency it occurs were estimated from several sources of information. The various sources of information and the derived values are discussed in the following appendices.

Appendix A: Frequency of Workday Exposure for Fumigated Commodities Including Potting Soil

Appendix B: Frequency of Workday Exposure for Nurseryman

Appendix C: Duration of Workday Exposure to Methyl Bromide for Applicators and Workers Handling Fumigated Commodities

Appendix D: Duration of Workday Exposure for Applicators Treating Soil with Methyl Bromide or Workers Pulling Fumigation Tarps

References

Appendix A: Frequency of Workday Exposure for Fumigated Commodities Including Potting Soil

Companies that store and apply MeBr are required by California regulations to have a “restricted materials” permit. These permit holders must report any MeBr treatments to the County Agricultural Commissioner’s office. California regulations allow “restricted materials” permit holders to report treatments to commodities as a monthly summary. The monthly summaries of permit holders located in Fresno, San Joaquin, Sacramento, Sutter, Tulare and Yolo Counties were reviewed for 1997 use season. The information generated from this review is summarized in Table I according to the fumigated commodity including potting soil. The table lists the names of the permit holders, county location, and the pounds of MeBr applied per month.

The assumption was made that exposure to applicators and workers handling fumigated commodities is related to the amount of MeBr used by a particular company. MeBr treatments are designed to bring the atmosphere inside a chamber, truck trailer or the area under a tarp to a required concentration of MeBr (lb. 1,000/ft³) for a designated period of time (hours) at a set temperature. This concentration and time period is usually independent of the amount of material (bins of prunes, sacs of rice, etc.) that is present in the chamber or under the tarp. The applicator may use the same amount of MeBr to treat different amounts of the same commodity. When the monthly amount of MeBr use increases for a permit holder, it is usually an indication of an increase in fumigation activity. This increase can be accomplished by making more treatments with the existing chamber or using greater application rates per fumigation. Or multiple chambers may be used to handle the increased work load. With either condition, the handler is handling more MeBr compared to the slow season with a greater potential for exposure. Or other workers can be hired to handle the increased work load.

Most companies fumigate with MeBr to control pests in commodities that are received directly from the grower or to control pests that result from extended storage. Commodities are also fumigated before export to guarantee a pest-free product and to satisfy the import requirements for various countries. Companies that are handling cotton, fresh fruits and packaged rice are fumigating once prior to export. Companies handling almonds, dry beans, figs, prunes and walnuts are fumigating commodities received from growers, commodities that have been held for extended storage and for export.

Fumigations of commodities that will continue to be kept in storage are generally at lower rates 1-2 lbs. per 1,000 ft³ than commodities that are being exported to a foreign country. Some countries like Japan, require higher rates of 3-3.5 lbs./1,000 ft³ to permit importation (Hosoda, 1998). The same number of treatments may be made by the applicator, but the increase in use may be the result of storage fumigations changing to export fumigations. The use reported on the monthly summary for the permit holders does not indicate the destination of the fumigated commodity.

Table I generates a series of estimates of the number of workdays MeBr was applied by workers for each permit holder. These estimates were derived from the amount of MeBr applied each month and the following assumptions. Workers were assumed to be applying MeBr 4-5 days per week (17-21 days per month) when the amount they handled was similar to the monthly average for the year. The three consecutive months (≈90 days) with the highest reported MeBr use were considered the peak use season for each permit holder. A few companies may have skipped a month at this time or consolidated the

reported use for two months into one report. During this peak period, workers were assumed to be working at least 6 days per week (25 days per month) if the use during this period was approximately 2X or more times greater than the monthly average. If there was a sharp increase of use per month during this peak period, the assumption was made that applications of MeBr were taking place seven days per week (30 days per month). For some companies (example-Enoch Packing Co. INC), MeBr use was relatively constant for the whole year. The assumption was made that workers handled MeBr 4-5 days per week year round.

When the monthly summary indicated the MeBr use for a particular month was approximately 50% or less than the monthly average for the permit holder, the assumption was made that applications were taking place less than 3 days per week. Because this use was less than 30% of the time or 30 days or less during a 90 day period, this use rate was not considered for chronic exposure (memo to Gary Patterson dated March 10, 1998). The exposure days for these months were not included in estimating the number of annual workdays methyl bromide was handled. An exception to this was made for packers fumigating commodities that are known to retain MeBr residues for an extended period of time after a fumigation. Data from studies observed half-lives for MeBr residues of up to 132 hours in walnuts and 139 hours in raisins. Because of these long half lives for MeBr residues, exposure to workers handling the fumigated commodity or working in proximity of stored fumigated commodities could continue to occur for several days after a fumigation. For these permit holders, the exposure days were estimated at 10 per month (\approx 30% of possible work time).

Loaded truck trailers or containers are often fumigated with MeBr just before shipment. Most of the time the fumigated commodity is aerated on site and then shipped directly without being unloaded (Lawsten, 1998). However, occasionally the fumigated commodity is unloaded from the container and put into a warehouse or reloaded into another container for shipment. Because of their small size (1600-3500 ft³), each treatment may require applying only 5-6 lbs. of MeBr per trailer or container. One applicator can fumigate and aerate several containers during one full workday. For some permit holders (example-Valley View Packing) fumigating truck trailers or containers required only a few days per month to complete the fumigations. However, the survey observed that companies fumigating packaged rice ready for shipping (American Rice, Inc) treated an average of 50 trailers per month or 2-3 trailers per workday (Joost, 1992). A rate of five lbs. of MeBr per trailer was used in Table I to estimate the number of fumigations per workday with the exception of the packaged rice fumigations (Radian, 1992).

Most of the packers reporting MeBr use on their monthly summaries did not indicate the actual dates the applications took place. Although a notice of intent (NOI) is required to be filed with the County Agricultural Commissioner before a methyl bromide treatment is made, some counties permit a blanket NOI to be filed when the fumigations are handled on a regular schedule. Most counties do not file the NOIs with the monthly summaries of pesticide use. However, a few packers did include their NOIs with each monthly summary. A review of the actual dates the fumigations took place indicate the total application days per month during the peak season and for the year were less than the values derived from the total pounds of MeBr applied. This observation indicates the values in Table I probably overestimate the actual number of days the fumigations are made. However, since most companies did not file their NOIs with their monthly summaries, the values in Table I are based on the amount of MeBr used. The values estimated from the NOIs are noted with an asterisk.

Table I. Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (county)	Treatment Month	Lbs. of MeBr Applied	Peak Season Weekdays per Week	Peak 90-Day Work Season + No. of Workdays	Number of Annual Workdays
Dried Figs (chamber)	Kalashian Land & Farm (Fresno)	May	81	4-5	Oct.-December 60	135
		June	74			
		July	34			
		August	110			
		September	55			
		October	134			
		November	81			
		December	109			
		Monthly Ave.	85			
		Producers Packing Co. (Fresno)				
March	125					
April	125					
June	200					
July	430					
August	282					
September	208					
October	100					
November	107					
December	264					
Monthly Ave.	242					
San Joaquin Figs Inc (Fresno)		February	319	5	July-September 60	210
		March	445			
		April	379			
		May	512			
		June	386			
		July	533			
		August	672			
		September	729			
		October	464			
		November	696			
December	607					
Monthly Ave.	522					

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Est. Peak 90-day Work Season + No. of workdays	Number of Annual Workdays
Dried figs (chamber)	Valley Fig Growers (Fresno)	January	394	5-6	August-October 65	120
		February	424			
		March	208			
		April	248			
		May	248			
		Aug-Sept.?	840			
		October	1016			
		November	512			
	Monthly Ave.	486				
Raisins (chamber)	Lamanuzzi & Pantaleo (Fresno)	April	350	3-4	April-May 30	30
		May	175			
	National Raisin Co (Fresno)	March	320	5	May-June 50	90
		April	300			
		May	750			
		June	800			
		December	800			
		Monthly Ave.	594			
	Enoch Packing Co. INC. (Fresno)	January	4200	4-5	Nov.- January 60	220
		February	3150			
		April	2975			
		May	3675			
		June	3150			
		July	3325			
		August	3325			
September		3325				
October		2975				
November		3150				
December		3150				
Monthly Ave.		3309				
Caruthers Raisin Packing Co. INC (Fresno)	January	576	5	March-May 65	200	
	February	504				
	March	972				
	April	1368				
	May	828				
	June	936				
	July	612				
	August	540				
	October	1440				
	November	288				
	December	720				
	Monthly Ave.	799				

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. MeBr Applied	Peak Season Workdays per Week	Peak 90-day Work Season + No. of workdays	Number of Annual Workdays					
Raisins (chamber)	Chooljian Bros. Packing (Fresno)	April	450	4-5	April 20	20					
	Boghosian Raisin Packing Co. (Fresno)	May	940	4-5	May 20	20					
Dried Fruit (chamber)	Yorkshire Dried Fruit & Nut Co.	January	645	5	Sept.-November 65	215					
		February	1119								
		March	1251								
		April	540								
		May	770								
		June	1174								
		July	643								
		August	1555								
		September	1419								
		October	1634								
		November	1962								
		December	1317								
	Monthly Ave.	1169									
Walnuts (chamber/silos)	Diamond Walnut (San Joaquin)	January	3703	5-7	Oct.-December 75	180					
		February	6682								
		March	1612								
		April	1140								
		May	791								
		June	1350								
		July	992								
		September	3230								
		October	19,179								
		November	9162								
		December	5783								
			Monthly Ave.				4875				
		(chamber)	Linden Nut Co (San Joaquin)				September	434	5-7	Sept.-October 50	80
							October	1149			
							November	180			
January	18										
February	54										
	Monthly Ave.			331							
	Danamark- Stockton (San Joaquin)	October	420	3*	Oct.-November 12*	21*					
		November	210								
		December	?								
		March	90								

* Values indicated with an asterisk were derived from NOIs that indicated the application dates.

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Peak 90-day Work Season + No. of workdays	Number of Annual Workdays					
Walnuts (chamber)	Poindexter Nut Co. (Fresno)	March	250	7	Sept.-October 60	110					
		April	150								
		August	200								
		September	1700								
		October	1700								
		November	275								
		December	107								
		Monthly Ave.	626								
Walnuts (chamber)	A&A Dasso Stockton (San Joaquin) Wilbur Packing Co. (Sutter)	September	12	4-5	Oct.-November 45	70					
		October	16								
		October 96	119								
		November 96	52								
		February	45								
		March	15								
		Monthly Ave.	58								
Almonds (chamber)	Treehouse Farms, INC. (Tulare)	January	243	6-7	July-September 55	95					
		February	141								
		March	41								
		June	88								
		July	1599								
		August	419								
		September	3954								
		October	716								
		November	999								
		December	229								
							Monthly Ave.	843			
		(containers)	Blue Diamond Growers (Sacramento)				March	10	1	April-June 9	15
							April	5			
May	20										
June	18										
August	5										
September	5										
December	15										
Prunes (chamber)	Howard Dryer Co. (Sutter)	February	75		May-July (60)	120					
		March	24								
		April	30								
		May	71								
		June	132								
		July	132								
		August	36								
		September	72								
		November	108								
							Monthly Ave.	76			

* Values indicated with an asterisk were derived from NOIs that indicated the application dates.

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Peak 90-day Work Season + No. of workdays	Number of Annual Workdays					
Almonds/Walnuts/ Dried Tomatoes (chamber)	Mariani Nut (Yolo)	January	954	5-7	Sept.-November 70	185					
		February	593								
		March	409								
		April	296								
		May	296								
		June	548								
		July	293								
		August	885								
		September	3080								
		October	5307								
		November	1818								
		December	606								
			Monthly Ave.				1257				
Prunes (truck trailers/ containers) (chamber)	Valley View Packing Co.	September 96	8	1-3	Dec.-February 25	45					
		October 96	11								
		November 96	22								
		December 96	28								
		January	30								
		February	54								
		March	18								
		May	18								
		June	25								
			Monthly Ave.				600				
		(chamber)	Calif. Prune Packing Co. (Sutter)				October	400	4-5	Oct. November 40	60
							November	1000			
							December	200			
May	800										
Monthly Ave.	600										
(chamber)	Wilbur Packing Co. (Sutter)	October 96	315	4-6	April-June 65	110					
		November 96	68								
		December 96	425								
		January	60								
		February	30								
		March	70								
		April	490								
		May	247								
		June	154								
			Monthly Ave.				207				
		Dry Beans (chamber)	Valley Seed Growers				February	26	6-7	March-April 55	55
							March	193			
							April	300			
May	33										
June	42										
July	33										
August	42										
	Monthly Ave.			96							

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Est. Peak 90 day Work Season (no. of workdays)	Est. Number of Annual Workdays
Prunes (chamber)	SunSweet Growers (Sutter)	December	96 300	4-7	August-October 70	130
		January	75			
		February	150			
		March	75			
		April	300			
		May	150			
		June	75			
		July	450			
		August	300			
		September	450			
		October	900			
		November	225			
	Monthly Ave.	288				
Dry Beans (chamber)	Cal-Bean & Grain Coop (Tulare)	December	1100	5-6	August- October 65	175
		November	690			
		October	1470			
		September	1860			
		August	1020			
		July	900			
		June	870			
		May	1170			
		April	600			
		March	60			
		Monthly Ave.	974			
	Kerman warehouse (Fresno)	February	155	5	March-May 65	130
		March	330			
		April	530			
		May	420			
June		95				
July		665				
August	180					
October	560					
November	25					
	Monthly Ave.	296				
Helm Bean & Seed Warehouse (Fresno)	February	129	5-6	April- June 45	45	
	April	535				
	June	1085				
	August	210				
	October	70				
	Monthly Ave.	406				
Cherries (chamber)	A&A Dasso Stockton (San Joaquin)	May	313	2-5*	May-June 19*	19*
		June	37			

* Values indicated with an asterisk were derived from NOIs that indicated the application dates.

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Peak 90-day Work Season + No. of workdays	Number of Annual Workdays
Cherries (chamber)	O&G Packing Stockton (San Joaquin)	April	51	4-6	May-June	45
		May	770		45	
		June	373			
	Lodi Export Corp (San Joaquin)	May	4419	7*	May 31*	31*
Fresh apricots, Nectarines, Peaches (chamber)	Blue Anchor INC. (Tulare)	May	135	4-6	May-July	60
		June	174			
		July	413			
		August	80			
		Monthly Ave.	200			
	Mountain View Cold Storage (Tulare)	April	14	4-6	June-July	45
		June	240			
		July	444			
	Nash de Camp Exerter (Tulare)	May	124	4-6	May-July	65
		June	304			
		July	290			
		August	46			
		September	43			
	Monthly Ave.	161				
	Jody Cold Storage, Dinuba (Tulare)	April	13	5	May-July	85
May		156				
June		122				
July		126				
August		109				
Monthly Ave.	105					
Spencer Fruit Co. (Fresno)	June	155	4-5	June-August	55	
	July	100				
	August	90				
Gerawan Farming (Fresno)	June	59	4-6	July-September	65	
	July	502				
	August	133				
	September	333				
	Monthly Ave.	257				
Simonian Fruit (Fresno)	June	120		June-July	45	
	July	368				
	August	27				
	October	43				
	Monthly Ave.	140				

* Values indicated with an asterisk were derived from NOIs that indicated the application dates.

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Peak 90-day Work Season + No. of workdays	Number of Annual Workdays
Rice (truck trailers/ containers)	Fume Tech, Inc (Yolo)	January	367	3-5*	August-October 45*	180*
		February	404			
		March	382			
		April	346			
		May	308			
		June	342			
		July	332			
		August	332			
		September	625			
		October	497			
		November	316			
		December	346			
Miscellaneous - turf furniture, tree holes (tarp)	Orchard Supply (Sacramento)	January	91	2*	Sept.-November 10*	14*
		March	0.3			
		May	1.5			
		August	0.2			
		September	73			
		October	223.4			
		November	50.3			
Residential structures (tarp)	Tanner Fumigation Specialists, Inc (Fresno)	April 96	one house	1	June-July 4	15
		August 96	one house			
		October 96	two houses			
		January	two houses			
		April	two houses			
		June	two houses			
		July	two houses			
		September	two houses			
		October	one house			
		March 96	one house			
	April 96	two houses				
	July 96	one house				
	January	two houses				
	May	two houses				
June	four houses					
August	one house					

* Values indicated with an asterisk were derived from NOIs that indicated the application dates.

Table I (cont.). Estimated Number of Workdays Commodity Workers Apply Methyl Bromide

Treated Commodity (application method)	Name of Permit Holder (County)	Treatment Month	Lbs. of MeBr Applied	Peak Season Workdays per Week	Peak 90-day Work Season + No. of workdays	Number of Annual Workdays
Potting Soil (tarp)	Monrovia Nursery (Tulare)	February	200	1	June-August	27
		March	400		9	
		April	500			
		May	400			
		June	600			
		July	600			
		August	500			
		September	200			
		October	400			
		November	600			
		December	400			

Appendix B: Frequency of Workday Exposure for Nurseryman

MeBr application information for nurseries that fumigate greenhouse soil and field soil was generated from the DPR pesticide use report database for 1995. This database was queried to generate a report that itemized methyl bromide use in greenhouses according to county, grower ID number, month of application, total pounds applied and number of applications. Because nursery production is considered an agricultural commodity, growers have to report their MeBr use as individual treatments and not as a monthly summary. The “number of applications” per month field generated by the report indicates individual treatments of MeBr. This value can be used to estimate the number of peak season and annual workdays when MeBr was applied in 1995 by nursery workers. The distinction between MeBr applications made by the grower and pest control operators was determined by including a field in the report that identified the company who filed the report. An “A” indicated the application was made by a commercial pest control operator and a “B” indicated the application was made by the permit holder (grower). Almost all the applications reported for greenhouse soil were made by the grower. Most of the 77 permit holders reporting MeBr use on greenhouse soil made only a few applications per year. Only the companies (14) that reported making applications for three or more consecutive months in 1995 are listed in Table I.

Table I. Estimated Number of Workdays Nursery Workers Apply Methyl Bromide to Greenhouse Soil

Number of Permit Holder (County)	Treatment Month	Number of Applications	Lbs. of Methyl Bromide Applied	Est. Peak 90 day Work Season (no. of workdays)	Est. Number of Annual Workdays
279527PGN16 (Monterey)	January	2	49	May-July (13)	34
	February	5	167		
	March	1	59		
	April	3	78		
	May	3	74		
	June	5	123		
	July	5	123		
	August	2	49		
	September	3	74		
	October	3	74		
	November	1	25		
	December	1	25		
(County) 379537P0614 (San Diego)			Applied	(no. of workdays)	Workdays
	January	4	119	June-August (7)	24
	February	4	142		
	March	2	159		
	April	3	149		
	May	3	73		
	June	3	259		
	July	3	264		
	August	1	90		
	September	1	30		
379537P0702 (San Diego)	February	4	458		
	March	5	512		
	April	8	587		
	May	5	279		
	June	1	50		
	September	1	25		
	October	4	647		
	November	3	149		
	December	3	105		
379537P0708 (San Diego)	January	5	313	May-July (16)	34
	February	4	184		
	March	3	214		
	April	3	114		
	May	6	502		
	June	8	428		
	July	2	149		
	August	3	248		

Table I (cont.). Estimated Number of Workdays Nursery Workers Apply Methyl Bromide to Greenhouse Soil

Number of Permit Holder (County)	Treatment Month	Number of Applications	Lbs. of Methyl Bromide Applied	Est. Peak 90 day Work Season + no. of workdays	Est. Number of Annual Workdays
379537P7530 (San Diego)	February	2	174	May-July 13	27
	March	4	657		
	April	5	582		
	May	3	463		
	June	4	697		
	July	6	728		
	August	3	264		
40954010015 (San Luis Obispo)	June	8	420	July-September 18	26
	July	6	334		
	August	4	295		
	September	8	575		
42954205012 (Santa Barbara)	March	2	235	October-December 8	10
	October	1	245		
	November	3	451		
	December	4	539		
424205032 (Santa Barbara)	January	1	147	January-March 3	3
	February	1	196		
	March	1	196		
42954205009 (Santa Barbara)	January	1	78	June-August (3)	7
	June	1	147		
	July	1	196		
	August	1	176		
	September	1	39		
	November	1	78		
	December	1	196		
42954205012 (Santa Barbara)	January	9	235	Sept.-November (16)	64
	March	11	437		
	May	9	470		
	June	7	377		
	July	12	926		
	September	5	882		
	October	9	1250		
	November	2	392		

Table I (cont.). Estimated Number of Workdays Nursery Workers Apply Methyl Bromide to Greenhouse Soil

Number of Permit Holder (County)	Treatment Month	Number of Applications	Lbs. of Methyl Bromide Applied	Est. Peak 90 day Work Season + no. of workdays	Est. Number of Annual Workdays
42954205104 (Santa Barbara)	January	1	53	August-October (9)	25
	February	5	617		
	March	1	59		
	April	3	180		
	May	2	161		
	July	2	49		
	August	2	417		
	September	5	1092		
	October	2	154		
	November	1	25		
	December	1	20		
	42954205008 (Santa Barbara)	July	1		
August		3	1725		
September		2	1068		
October		2	1318		
November		1	559		
4495440317A (Santa Cruz)	May	1	196	May-July 3	3
	June	1	149		
	July	1	441		
4495440325A (Santa Cruz)	June	1	196	June-August 3	3
	July	1	196		
	August	1	172		

Most of the field soil fumigations for nursery stock production were made by pest control operators in 1995. Only 24 of the 90 permit holders reported making their own MeBr applications. The majority of these nurserymen were located in San Diego County. The permit holders that reported making their own MeBr applications for three or more consecutive months in 1995 are listed in Table II. The annual number of workdays methyl bromide was applied by pest control operators like Tri/Cal, is discussed in Appendix D.

Table II. Estimated Number of Workdays Nursery Workers Apply Methyl Bromide to Field Soil Used for Propagating Nursery Stock

Number of Permit Holder (County)	Treatment Month	Number of Applications	Lbs. of Methyl Bromide Applied	Est. Peak 90 day Work Season + No. of Workdays	Est. Number of Annual Workdays
379537P0205 (San Diego)	March	1	183	April-June 6	10
	April	4	3286		
	May	1	275		
	June	1	2941		
	July	1	2332		
	September	2	7491		
379537P0503 (San Diego)	February	2	20	March-May 9	20
	March	4	39		
	April	2	20		
	May	3	29		
	June	2	20		
	July	2	39		
	August	3	29		
	November	2	39		
379537P0527 (San Diego)	March	1	30	May-July 4	6
	April	1	60		
	May	2	119		
	June	1	60		
	July	1	60		
379537P0702 (San Diego)	April	1	75	August-October 8	16
	May	1	30		
	June	1	1646		
	July	3	199		
	August	2	1741		
	September	4	1085		
	October	2	1493		
	November	2	219		
379537P0708 (San Diego)	January	2	358	May-July 6	15
	February	3	582		
	March	1	184		
	April	3	408		
	May	1	911		
	June	3	2481		
	July	2	1455		

Appendix C: Duration of Workday Exposure to Methyl Bromide for Applicators and Workers Handling Fumigated Commodities

The duration of the workday exposure to MeBr from a commodity fumigation was estimated from various sources of information. One of these sources was the submissions made by various commodity groups in response to a 1992 DPR request for information on the use of MeBr and work tasks where exposure may occur. As many of these submissions are now 5-6 years old, the author has contacted some of the persons responsible for the submission, for updates and more information.

Siemer and Associates (1992) monitored the exposure to workers performing various work tasks related to the application of MeBr. Observations were made during commodity and soil fumigations and when the tarps were removed. Some workers whose work task entailed working with a fumigated commodity (fork lift driver, etc.) were also monitored for exposure. As part of this study, the researchers sometimes noted the length of the workday when exposure could occur or the length of the monitoring period.

A study by Radian (1992) monitored the levels of MeBr present during the fumigation of prunes, raisins and walnuts. MeBr levels present during chamber and truck trailer fumigations were monitored for workers performing the work tasks related to fumigation. As part of the study, worker exposure times were sometimes noted.

Jim Lawsten at American Rice, Inc. was contacted regarding a submission by Comet Rice, Inc. that estimated the number of truck trailers or containers fumigated with MeBr prior to shipping (Lawsten, 1998). The submission indicated that applications take place year-round with an average of 44 treatments per month. Mr. Lawsten indicated that 0-8 trailers/containers can be treated during any particular workday. Aeration occurs on site and then the trailers are loaded on a truck and taken to a port. On occasion, the packaged rice is unloaded and put in a warehouse or into another container for shipment. Work time to treat and aerate an individual container was 10 minutes to apply and ten minutes to aerate.

The duration of the workday exposure is related to the amount of MeBr applied and the number of treatments made per workday. The application rate per treatment is proportional to the size of the fumigation chamber the applicator is operating. Several companies responding to the 1992 Commodity Fumigation Questionnaire by DPR indicated the size of the chambers they are using. The average size of fumigation chambers operated by companies fumigating almonds, cherries, dry beans and walnuts was approximately 10,000 ft³ (N=14). Table Nine in the exposure assessment document for MeBr lists the application rates for various commodity treatments. Assuming any one treatment could range from 1-3.5 lbs. of MeBr per 1,000 ft³ of chamber volume, the application rate for a 10,000 ft³ chamber could range from 10-35 lbs. of MeBr per treatment. A treatment of 22.5 lbs. (10 + 35/2 lbs.) of MeBr can be derived as an average treatment. For truck trailer/container fumigations, a rate of 5 lbs. MeBr per treatment was used to make the calculation (Radian, 1992).

The assumption has previously been made that the worker making the MeBr application will also conduct the aeration process. A conversation with Ed Hosoda (1998) and information provided by various commodity fumigators indicate the length of time to do these two work tasks is about 15-30 minutes each or one hour maximum to do one treatment (Radian, 1992). However, with a long

fumigation (eight hours +) or aeration period, one worker may start the fumigation and another may complete the aeration process.

The monthly summaries of MeBr use reported by various commodity fumigators listed in Table I. of Appendix A were used to estimate the number of treatments made per workday. The information from the permit holder with the greatest total annual use of MeBr was used to represent a particular commodity group. The values for the highest monthly use, the average monthly use during the 90-day peak season, and the total use for the 1997 season were used in the following equations to estimate the hours of exposure per workday in Table I. The values have been rounded-off to the nearest 0.5 day.

1. Maximum Exposure Hours per Workday at Peak Season-Lbs. of MeBr used (highest monthly use) ÷ (max. no. of workdays per month at peak season) ÷ 22.5 lbs. of MeBr = no. of treatments per day x one hour exposure per treatment = maximum hours of exposure per workday.

2. Average Exposure Hours per Workday During Peak 90 Day Season- (total lbs. of MeBr used in peak 90 day use season) ÷ (no. of workdays at peak season) ÷ 22.5 lbs. of MeBr = no. of treatments per day x one hour exposure per treatment = average hours of exposure per workday.

3. Average Annual Exposure Hours per Workday- (total lbs. of MeBr used in 1997) ÷ (no. of annual workdays) ÷ 22.5 lbs. of MeBr = no. of treatments per day x one hour exposure per treatment = average hours of exposure per workday.

Example for Dry Beans (Cal-Bean & Grain Coop):

1860 lbs. ÷ 23.5 days ÷ 22.5 lbs./treatment = 3.5 treatments per day X One hour of exposure per treatment = 3.5 hours of exposure per workday at maximum use season.

4350 lbs. ÷ 70 days ÷ 22.5 lbs./treatment = 3 treatments per day x one hour of exposure per treatment = 3 hours of exposure per workday at 90 day use season.

9740 lbs. ÷ 180 days ÷ 22.5 lbs. = 2.5 treatments per day x one hour of exposure per treatment = 2.5 hours of exposure per annual workday.

This method of deriving exposure time per workday at different times of the season makes two conservative assumptions. To calculate the values, the use information from the permit holder with the greatest MeBr use was used to calculate the values in Table I. Most of the fumigators are using less MeBr and making fewer treatments with the reduced potential for exposure. For most fumigations, it was assumed that only one worker will perform the MeBr treatment and the aeration each workday. In reality, especially with permit holders who do a lot of fumigation, more than one worker will perform the treatments. At Mariani Nut, three workers routinely perform the treatments and at Diamond Walnut, five workers are certified to perform the treatments (Mattes, 1998). For companies that are using large quantities (>10,000 lbs. per year) of MeBr per year, the assumption was that a minimum of three workers were making the fumigations if company specific data was not available. For rice trailer fumigations, the assumption was made that each fumigation used five lbs. of MeBr and one worker performed all the fumigations.

Permit conditions can reduce the potential for exposure applicators and workers by limiting the time they can be in a greenhouse. For greenhouse soil fumigations, there is a minimum period of three days for tarps to remain over fumigated soil (Vadari, 1998). The tarps are then sliced to start the aeration process which is a minimum of two additional days. Un-protected workers cannot enter greenhouses with MeBr treated soil for a minimum of five days after the treatment. These conditions can limit the amount of greenhouse that can be fumigated at any particular time since work inside the greenhouse has to stop for a minimum of five days.

Table I. Estimated Daily Exposure Duration for Workers That Apply Methyl Bromide or Work with Fumigated Commodities.

Commodity/ Application Method	Work Task	Maximum Hours of Exposure per Workday	Average Hours of Exposure per Workday at peak season	Average Annual Hours of Exposure per Workday	References
Dried Figs (chamber)	applicator/ aerator	1.5	1.5	1	see equations
	forklift driver	1	1	0.4	June, 1992
Raisins (chamber)	applicator/ aerator	3.0	2.5	2.5	Radian, 1992 see equations
	applicator/ assistant	3.5	2.5	2.5	Radian, 1992 see equations
	forklift driver	2.5	2	2	Churchill, 1993
	cathall operator	8	8	8	Radian, 1992
	hopper operator	8	8	8	“ “
	capper dumpers	8	8	8	“ “
	inspectors	8	8	8	“ “
	moisture checkers	8	8	8	“ “
	stem pickers packers	8 8	8 8	8 8	“ “ “ “
Walnuts (chamber/silo)	applicator/ aerator	5.5	4	2.5	see equations see equations
	sorting line	8	8	N/A	Radian, 1992/ Winegar, 1994
	meats pool	8	8	N/A	“ “
	warehouse worker	8	8	8	“ “
Dried prunes (truck trailers)	applicator/ aerator	1	1	N/A	Radian, 1992
Dried prunes (chamber)	applicator/ aerator	1.5	1	1	see equations
	forklift driver	1.0	1	1	Radian, 1992
Dry beans (chamber)	applicator/ aerator	3.5	3	2.5	see equations
	forklift driver	2.5	2.5	2	Churchill, 1993
Packaged rice (truck trailers)	applicator/ aerator	6.0	6.5	5	see equations
	forklift driver	1	0.5	0.5	Lawsten/ Tibbitts, 1998
	rice processing workers	N/A	N/A	N/A	
Nursery Potting Soil (tarp)	applicator/ aerator	1	N/A	N/A	Siemer & Associates, 1992
	tractor drivers	1	N/A	N/A	Wilemius, 1998
	truck drivers	1	N/A	N/A	“ “
	potterers	3	N/A	N/A	“ “
Nursery Greenhouse Soil (tarp)	applicator	2	N/A	N/A	Vadari, 1998
	tarp venter	1	N/A	N/A	Siemer & Associates, 1992
	tarp remover	1	N/A	N/A	

Table I (cont.). Estimated Daily Exposure Duration for Workers That Apply Methyl Bromide or Work with Fumigated Commodities.

Commodity/ Application Method	Work Task	Maximum Hours of Exposure per Workday	Average Hours of Exposure per Workday at peak season	Average Annual Hours of Exposure per Workday	References
Fresh Cherries (chamber)	applicator/ aerator	1	N/A	N/A	see equations
	forklift driver	0.75	N/A	N/A	Radian, 1992
	Sorters	8	N/A	N/A	
Warehouse Fumigation	applicator/ aerator	8	no information	no information	

*Numerical value refers to DPR, Pesticide Registration Branch methyl bromide data submission number.

Appendix D: Duration of Workday Exposure for Applicators Treating Soil with Methyl Bromide or Workers Pulling Fumigation Tarps

Information specific to soil applications was obtained from a letter (8/28/92) from Kirk Fowler (1998) submitted in response to DPR's request for information regarding the use of MeBr. The following information characterizes the maximum workday and application capacity for workers at TRI/CAL.

Maximum workday

a. driving to and from the job	1.5 hrs.
b. job set-up and take down	1.0 hrs.
c. fumigation activity	6.5 hrs.
d. lunch/breaks	<u>0.5 hrs.</u>
total	9.5 hrs.

Application capacity

<u>Application Method</u>	<u>Acres Fumigated per Hour</u>
tarp, shallow shank	2.5
tarp, deep shank	1.75
no tarp, shallow shank	5.5
no tarp, deep shank	4.0

In addition, the annual work records for eight applicators (drivers) were summarized outlining the average hours worked per day and the acres treated per month. Included with each monthly summary was the application rate (lbs. MeBr per acre) and the application method used. The records for two drivers were selected from each territory (4) on the basis they have applied the most MeBr. The information was summarized in Table I according to the application method. The following methods were used to derive the values in Table I. These values have been rounded off to the nearest half hour.

1. Maximum Hours of Exposure per Workday = 6.5 hours for all application methods.
2. Average Hours of Exposure per Workday at Peak 90 Day Season for each application method
 - a. Determine average exposure time per driver = (sum of the average hours worked per month for three busiest months/3).
 - b. (sum the average exposure time for each driver) ÷ (number of drivers).
3. Average Annual Hours of Exposure per Workday for each application method
 - a. Determine average annual exposure time per driver = (sum of the average hours worked per month/number of months). Did not include months with less than 2% of the total acres treated annually.
 - b. (sum the average annual exposure time for each driver) ÷ (number of drivers).

In a recent phone conversation, Mr. Fowler (1998) outlined the work tasks for the various application methods and the source of the workers needed. The driver of the tractor and the co-pilot are Tri/Cal workers. The workers shoveling dirt on the edges of the tarps are provided by the grower. The grower can also provide a second tractor and driver when the top of the beds need to be packed or disced after a MeBr treatment. Tarp removal is done by the grower or by private contractors that haul the tarps to the dump after removal. In general, removing the tarp is much faster than laying the tarp during fumigation. Private contractors can pull and load 40

acres of tarp in a few hours with specialized equipment. Data from the Seimer & Associates study (1993) indicated that 10 acres of tarp was removed in 1-2 hours. The estimated time to remove 40 acres of tarp is about six hours. Tarp removal is a part-time business that focuses primarily on removing tarps from strawberry fumigations along the coast. Assuming tarp removal closely follows the application season, the MeBr application information from Kirk Fowler's letter indicated the removal season was from July-October or August-November. If one removal crew pulled all the tarp laid by TRICAL drivers # 74 and # 72 working on the north coast at 40 acres per day, they would work approximately 50 days during the season.

Table I. Estimated Daily Exposure Duration for Work Tasks Related to Soil Applications of Methyl Bromide

Application Method/Removal (lbs. of mebr/acre)	Work Task	Maximum Hours of Exposure per Workday	Average Hours of Exposure per Workday at Peak 90 day season	Average Annual Hours of Exposure per Workday
Shallow shank with tarp (300)	Applicator	6.5	3.5	2.5
	Co-pilot	6.5	3.5	2.5
	Shoveler	6.5	N/A	N/A
	Drip tape layer	6.5	N/A	N/A
Deep shank with tarp (360)	Applicator	6.5	3.0	2.0
	Co-pilot	6.5	3.0	2.0
	Shoveler	6.5	N/A	N/A
Shallow shank with no tarp (140)	Applicator	6.5	2.5	2.5
	Co-pilot	6.5	2.5	2.5
	tractor driver for disc/cultipacker	6.5	N/A	N/A
Deep shank with no tarp (375)	Applicator	6.5	3.0	2.5
	Co-pilot	6.5	3.0	2.5
	tractor driver for disc/cultipacker	6.5	N/A	N/A
Tarped bed fumigation (400)				
Tarp cutter	Grower	2	N/A	N/A
Tarp cutter	Commercial	6	6	N/A
Tarp cutter/remover	Commercial	6	6	N/A

Table II estimates the number of workdays season for custom applicators that apply MeBr to soil. To derive estimates for the number of workdays during the busiest month, the 90 day peak season and the annual number of workdays, the following methods were used. The values have been rounded off to the nearest whole day.

1. Maximum Acres Treated per Workday = (6.5 hours) X (Acres Fumigated per Hour/method).

2. Typical Acres Treated per Workday = (Acres Fumigated per Hour/method) X (Average Hours of Exposure at Peak 90 Day Season in Table I).

When a driver applied the MeBr using two methods, both sets of values were presented in the table.

3. Peak Season Workdays per Week = (Acres Treated per Month-highest) ÷ (Maximum Acres Treated per Workday).

When two methods were used to apply MeBr, the average value for the “Maximum Acres Treated per Workday” for each application method was used to divide the “Acres Treated per Month” for the month with the greatest number of acres.

4. Number of Workdays at Peak 90 Day Season = (Sum of acres for three busiest consecutive months) ÷ (“Maximum Acres Treated per Workday” + “Typical Acres Treated per Workday”)/2. When two methods were used to apply MeBr, the values for the “Maximum Acres Treated per Workday” and “Typical Acres Treated per Workday” were added together and divided by four. This value was used to divide the sum of acres for three busiest consecutive months.

5. Number of Annual Workdays = (Annual Number of Acres Treated) ÷ (Typical Acres Treated per Workday). When two methods were used to apply MeBr, the average value for the “Typical Acres Treated per Workday” was used to divide the “Annual Number of Acres Treated”.

Table II. Estimated Number of Annual Workdays TRI/CAL Workers Apply MeBr with Various Application Methods

Driver # Location in State	Application Method	Acres Treated per Month*	Acres Treated per Workday Max.	Typical	Peak Season Workdays per Week	No. of Workdays at Peak 90 day season	Number of Annual Workdays	
083 South coast	Shallow shank with tarp	March	33	16	9	5	50	105
		April	71					
		June	40					
		July	40					
		August	312					
		Sept.	146					
		Oct.	140					
		Nov	101					
		Annual	965					
		971 South coast	Shallow shank with tarp	June	57	16		
July	79							
August	156							
Sept.	262							
Oct.	259							
Nov.	160							
Annual	997							

* Months with 2% or less than the total acres treated for the year were not included.

Table II (cont.). Estimated Number of Annual Workdays TRI/CAL Workers Apply MeBr with Various Application Methods

Driver # Location in State	Application Method	Acres Treated per Month*	Acres Treated per Workday Max. Typical	Peak Season Workdays per Week	No. of Workdays at Peak 90 day season	Number of Annual Workdays**
74* North coast	Deep shank with tarp and deep shank without tarp	March 47	11 5	7	60	200
		April 558	26 12			
		May 192				
		June 66				
		July 59				
		August 222				
		Sept. 181				
		Oct. 204				
		Nov. 116				
		Annual 1715				
72* North coast	Deep shank with tarp and deep shank without tarp	April 581	11 5	7	65	215
		May 212	26 12			
		June 53				
		July 101				
		August 210				
		Sept. 171				
		Oct. 251				
		Nov. 105				
		Dec. 118				
		Annual 1830				
027* South valley	Deep shank without tarp and deep shank with tarp	March 138	11 5	6	70	250
		April 264	26 12			
		May 66				
		July 182				
		August 498				
		Sept. 170				
		Oct. 297				
		Nov. 207				
		Dec. 248				
		Annual 2123				

* Months with 2% or less than the total acres treated for the year were not included.

** Indicates driver performed fumigations using two application methods (example-deep shank with tarp and deep shank with no tarp). Work season in table indicates combined workdays for both methods.

Table II (cont.). Estimated Number of Annual Workdays TRI/CAL Workers
Apply MeBr with Various Application Methods

Driver # Location in State	Application Method	Acres Treated per Month*	Acres Treated per Workday Max. Typical	Peak Season Workdays per Week	No. of Workdays at Peak 90 day season	Number of Annual Workdays**
921* South valley	Non tarp, shallow or deep shank	Feb. 88	26 12	5	40	170
		March 102	36 14			
		April 381				
		July 399				
		August 662				
		Sept. 209				
		Oct. 79				
		Nov. 96				
		Dec. 162				
		Annual 2178				
939* South Valley	Non tarp, shallow or deep shank	Feb. 101	26 12	5	55	215
		March 59	36 14			
		April 380				
		July 393				
		August 654				
		Sept. 168				
		Oct. 434				
		Nov. 239				
		Dec. 251				
		Annual 2800				
018* North valley	Deep shank with tarp and deep shank without tarp	January 142	11 5	5	50	155
		March 59	26 12			
		April 175				
		July 47				
		August 208				
		Sept. 91				
		Oct. 397				
		Nov. 65				
		Dec. 99				
		Annual 1300				

* Months with 2% or less than the total acres treated for the year were not included.

** Indicates driver performed fumigations using two application methods (example-deep shank with tarp and deep shank with no tarp). Work season in table indicates combined workdays for both methods.

Mr. Fowler estimates the current permit conditions for making soil applications of MeBr will reduce the workday capacity by 30%. This is due to the reduction in acres treated per workday needed to provide adequate buffer zones for occupied dwellings adjacent to treated fields. However, since the values in Table I and II were derived from information before these new permit conditions were in effect, they have not been corrected.

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