

Staff Report

**USE INFORMATION AND AIR MONITORING
RECOMMENDATIONS FOR THE PESTICIDE ACTIVE
INGREDIENTS SULFURYL FLUORIDE AND CHLOROPICRIN**

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By
Shifang Fan,
Johanna Walters,
And
Pam Wofford



ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

STATE OF CALIFORNIA
Environmental Protection Agency
Department of Pesticide Regulation
Environmental Monitoring Branch
1001 I Street
Sacramento, California, 95814

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USE INFORMATION AND AIR MONITORING RECOMMENDATION FOR APPLICATIONS OF THE PESTICIDE ACTIVE INGREDIENTS SULFURYL FLUORIDE AND CHLOROPICRIN

A. BACKGROUND

This recommendation contains general information regarding the physical-chemical properties and the historical uses of sulfuryl fluoride and chloropicrin in structural fumigations and field application uses of chloropicrin. The Department of Pesticide Regulation (DPR) provides this information to assist the Air Resources Board (ARB) in their selection of appropriate locations for conducting pesticide air monitoring operations.

Sulfuryl Fluoride

Table 1 describes some of the physical-chemical properties of sulfuryl fluoride and figure 1 depicts its chemical structure.

Table 1. Some Physical-Chemical Properties of Sulfuryl Fluoride¹

Chemical name	Sulfuryl fluoride
Common name	Sulfuryl fluoride
Some tradenames [†]	Vikane
CAS number	2699-79-8
Molecular formula	F ₂ O ₂ S
Molecular weight	102.1
Form	Colorless, odorless gas
Solubility	Water: 0.75 g/L at 25 °C (EXTOXNET, 2001)
Vapor pressure	>760 mm Hg at 20 °C (Matheson Tri-Gas, 2001)
Soil adsorption Coefficient (K _{oc})	6.124 (Dow AgroSciences, 2000)

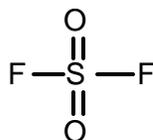
¹Data from DPR, 2001a.

Environmental effects of sulfuryl fluoride are expected to be negligible because it is only registered for applications indoors or in sealed structures (US EPA, 1993). Sulfuryl fluoride is a gas with low water solubility. It is sustainable to diffuse out of water into atmosphere, but not leach to contaminate groundwater (EXTOXNET, 2001). Under neutral conditions, sulfuryl fluoride hydrolyzes very slowly in water to chlorosulfonic acid and hydrogen fluoride, and

[†]Disclaimer: The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

ultimately to sulfuric acid and hydrogen fluoride. Hydrolysis under alkaline conditions occurs rapidly and forms fluorosulfonic acid and hydrofluoride (Tomlin, 1997; US EPA, 1993). Hydrolysis half-life is estimated to be 18 minutes to three days (Dow AgroSciences, 2000).

Figure 1. The Chemical Structure of Sulfuryl Fluoride



Sulfuryl Fluoride

Because use of sulfuryl fluoride is permitted only indoors, exposure to aquatic organisms and wildlife is unlikely, and data regarding these scenarios were not required for registration by the US EPA. Bioconcentration potential is low with a BCF < 100 (Dow AgroSciences, 2000). Exposure to birds is considered to be minimal. Inhalation LC₅₀ (4 hour) for male and female rats is 1,122 and 991 ppm, respectively.

Chloropicrin

Table 2 describes some of the physical-chemical properties of chloropicrin and figure 2 depicts its chemical structure.

Table 2. Some Physical-Chemical Properties of Chloropicrin¹

Chemical name	trichloronitromethane
Common name	Chloropicrin
Some tradenames	Chlor-O-Pic, Metapicrin, Chloropicrin-100
CAS number	76-06-2
Molecular formula	CCl ₃ NO ₂
Molecular weight	164.4
Form	Colorless liquid with a lachrymatory action (Tomlin, 1997).
Solubility	Water: 2.00 g/L at 25°C
Vapor pressure	23.8 mmHg at 25°C
Henry's Law Constant (K _H)	2.51 x 10 ⁻³ at 25°C
Soil adsorption Coefficient (K _d)	0.139- 0.311
Aerobic soil metabolism half-life	0.374- 5.13 days

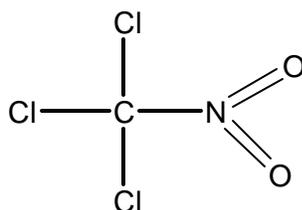
¹Data from DPR, 2001a.

Chloropicrin is metabolized in soils by sequential reductive dechlorination. The end products are thought to be nitromethane and small amounts of carbon dioxide (Montgomery, 1997).

Chloropicrin moves rapidly in soils within twelve inches of injection, but may diffuse to maximum of four feet in sandy soil (EXTOXNET, 2001). Chloropicrin will not move rapidly

into aquatic environments since it is only slightly soluble in water. Chloropicrin has a higher density than water and will tend to sink to the bottom of surface water. Chloropicrin photodegrades in surface water to carbon dioxide, bicarbonate, chloride, nitrate, and nitrite with a half-life of 31.1 hours (EXTOXNET, 2001). Chloropicrin vapor is heavier than air and spreads along the ground (Howard, 1991). It efficiently photolyzes in atmosphere to phosgene, nitric oxide, chlorine, nitrogen dioxide, and dinitrogen tetroxide (EXTOXNET, 2001; Montgomery, 1997). When chloropicrin is heated to decomposition, toxic fumes of nitrogen oxides and chlorine are released (Montgomery, 1997).

Figure 2. The Chemical Structure of Chloropicrin



Chloropicrin

Chloropicrin is toxic to fish with an LC₅₀ (96 hours) of 0.0765 mg/L for rainbow trout and 0.105 mg/L for bluegill sunfish. It is nontoxic to bees when used as label recommended (Tomlin, 1997). Inhalation LC₅₀ (15 minutes) for rabbits is 150 ppm (Meister, 1996).

B. CHEMICAL USES

Sulfuryl Fluoride

As of March 2004, one product containing sulfuryl fluoride was registered for use in California. Sulfuryl fluoride is an inorganic gas fumigant used in structures, vehicles, furnishings (household effects) and wood products for control of existing infestations of drywood termites, wood infesting beetles, roaches, moths, and rodents. There are no registered uses of sulfuryl fluoride on food or feed crops.

For determination of fumigant rates, the Fumiguide calculator(s) is to be used with soil or slab temperature, exposure period, and fumigant loss rate measured as half-loss-time (HLT) according to the label and structural fumigation manual for Vikane® (99.8% active ingredient). The Fumiguide calculator determines the dosage for the drywood termite. Fumigation rates for other pests are listed on the label as multiple factors of the drywood termite dosage. No applications for fumigating insects are to occur if the temperature measured at the coolest part of the structure is below 40 °F. However, this restriction does not apply to fumigation of rodents. When fumigating a single unit of a multiple unit complex, all units must be vacated during fumigation and aeration. In preparation for fumigation, the label guides all persons, domestic animals, pets, fish, and growing plants be removed from the structure. Mattresses (except waterbeds) and pillows that are

completely enveloped in waterproof cover must be removed. Food (including those items in refrigerators and freezers) and medicines not adequately sealed must be removed from fumigation sites or double bagged in Nylofume bags. The label and manual for Vikane® give additional instructions on preparations for tarpaulin and taped fumigations.

The Vikane® product label requires that chloropicrin be used as a warning agent and be released into the structure at least five to ten minutes prior to introduction of the fumigant. Vikane® is released into large open spaces in the fumigation site via a leak-proof tube with a minimum burst pressure of 500 pounds per square inch (psi). The fumigant should be directed into the blast of a fan with a minimum capacity of 1,000 cubic feet per minute for each pound of Vikane® released per minute. The label gives two options for aeration procedures based on the rate used. Structures may be reoccupied when concentrations of Vikane® are 5 ppm or less. Only an approved detection device, such as the INTERSCAN or MIRAN, may be used to confirm concentrations. Vikane® is a restricted use pesticide due to its inhalation toxicity and includes the Signal Word “Danger” on the label.

Chloropicrin

As of March 2004, fifty products containing chloropicrin were registered for use in California. Chloropicrin is primarily used as a preplant soil fungicide to control root-attacking pathogens, nematodes, insects and weed seeds. It is also used to treat wood poles and timber for internal decay and space, and for vault fumigations to control mites, cockroaches, silverfish, and fungi. Chloropicrin is used as a warning agent for odorless structural and soil fumigants.

According to the label for Chlor-O-Pic®, chloropicrin can be used as a warning agent and is applied to structures five to ten minutes prior to fumigation with methyl bromide or sulfuryl fluoride. When used in this manner, the chloropicrin at use rate of one ounce per 10,000 cubic feet of space to be fumigated is dispensed into a shallow plastic or non-aluminum metal pan with a “wicking agent” (usually cotton). The container is placed in the direct air stream of a fan to hasten evaporation. Additional fans may be used to distribute the chloropicrin throughout the structure. Chloropicrin is a restricted use pesticide due to its acute toxicity and includes the Signal Word “Danger” on the label.

In California’s agricultural setting, chloropicrin is mainly used on strawberries, preplant soil application, tomatoes, and outdoor grown transplants. According to the label for Chlor-O-Pic® (which contains 99% of active ingredient), chloropicrin’s primary use is for control or suppression of plant parasitic causing organisms including nematodes, the bacterial pathogen *Pseudomonas solanacearum*, fungi in the genera *Cylindrocladium*, *Fusarium*, *Phytophthora*, *Pyrenochaeta*, *Ptythium*, *Rhizoctonia*, *Sclerotium*, and *Verticillium*, the clubroot organism *Plasmodiophora*, and the soil pox organism *Actinomyces ipomoea*. Control of certain soil-infesting insects such as cutworms, grubs, and wireworms may also be obtained as well as suppression of weeds if used with a tarpaulin. The label gives soil fumigation rates of 148.5 to 495 pounds AI per acre depending on soil and crop; dosage is reduced by 33% if area is covered by a plastic tarp immediately after application. Fumigations should take place at least 14 days prior to planting whenever soil conditions are suitable. Soil should be tilled to a fine, loose condition with a temperature between 60°F and 85°F for best results

The chloropicrin product label offers several methods for application including: overall field treatment using a chisel type applicator, row or bed treatment, and probe type point injection for small areas or volumes. The label recommends sealing the field with a plastic tarp or by the use of drag, cultipacker, roller, or float to firm the soil surface immediately behind chisels. Chloropicrin may also be applied through drip lines to bed furrows. Chloropicrin is a restricted use pesticide due to its acute toxicity and includes the Signal Word “Danger” on the label.

Pesticide Use Summary

With DPR’s implementation of full pesticide use reporting in 1990, all users must report the agricultural use of any pesticide to their county agricultural commissioner, who subsequently forwards this information to DPR. DPR compiles and publishes the use information in the annual Pesticide Use Report (PUR). DPR data for structural fumigations include pesticide applications used for structural pest control, public health pest control, vertebrate pest control, regulatory pest control, and other non-cropland fumigations not included in the above categories. The information included in this monitoring recommendation reflects applications of sulfuryl fluoride and chloropicrin in the DPR’s broad structural fumigations.

According to the PUR, the annual use for structural fumigations in California from 1999 to 2002 ranged approximately 1,117,000 to 3,900,000 pounds of sulfuryl fluoride (Table 3) and 15 to 18,400 pounds of chloropicrin (Table 5) in the top 15 counties of use. The majority use of sulfuryl fluoride occurred in three counties - Los Angeles, Orange, and San Diego.

The total amount of agricultural chloropicrin used in California from 1999 to 2002 has ranged annually between approximately 3,650,000 to 4,325,000 pounds (Table 5). The majority of California’s total use of these chemicals occurred in five counties - Monterey, Ventura, Santa Cruz, Santa Barbara and Orange. On average the total use for the 15 counties with the highest use accounted for 93% of the total use in California. Table 6 displays agricultural chloropicrin use for each county for the years 1999 - 2000. Chloropicrin is generally used on strawberries, preplant soil applications, tomatoes, and outdoor grown transplant/ propagative material, and tomatoes (Table 7).

Table 3. Annual Sulfuryl Fluoride Use for Structural Fumigation by Top Fifteen Counties (Pounds Active Ingredient)

COUNTY	1999	2000	2001	2002	TOTAL
LOS ANGELES	921,228	806,172	970,514	1,178,144	3,876,057
ORANGE	466,664	401,696	424,410	460,257	1,753,027
SAN DIEGO	385,589	369,391	368,295	441,987	1,565,263
SANTA CLARA	345,199	163,346	149,792	172,909	831,246
VENTURA	106,681	112,202	91,279	100,452	410,613
SAN BERNARDINO	65,623	71,249	94,850	94,336	326,059
SANTA BARBARA	75,176	101,492	68,461	67,879	313,008
RIVERSIDE	59,352	65,823	68,205	84,920	278,300
ALAMEDA	70,501	15,586	44,273	54,582	184,942

MONTEREY	36,952	41,112	43,046	47,604	168,714
SAN MATEO	33,489	36,804	38,235	49,994	158,523
SAN LUIS OBISPO	41,241	40,653	37,989	35,898	155,782
KERN	38,831	34,386	23,208	55,628	152,053
SANTA CRUZ	31,902	22,769	29,617	37,176	121,464
FRESNO	28,810	25,733	25,399	37,449	117,391
Total for Top 15 Counties	2,707,238	2,308,416	2,477,574	2,919,214	10,412,441
Percent of CA Total	97	96	96	96	96
Total Statewide Use	2,777,723	2,406,133	2,585,841	3,045,084	10,814,781



Table 4. Monthly Sulfuryl Fluoride Use for Structural Fumigation by County for Years 1999-2002
(Pounds Active Ingredient)

COUNTY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
ALPINE												
ALAMEDA	12,160	7,236	8,727	15,130	13,532	9,823	15,567	14,899	16,515	17,375	13,641	9,103
AMADOR	23		94	50	23		37	92	81		39	
BUTTE	72	155	83		105	53	61	359	280	265	317	48
CALAVERAS		281	35	123	204	14	47	83	175	74		437
COLUSA				237					165		14	
CONTRA COSTA	2,119	2,204	2,314	2,963	3,156	3,120	2,947	2,857	2,970	3,368	3,349	2,441
DEL NORTE												
EL DORADO	162		101	103	130	139	76	126	286	292	101	
FRESNO	10,430	9,150	12,342	11,838	12,082	10,709	8,097	9,680	7,268	10,652	7,641	7,931
GLENN				28	17				60			
HUMBOLDT	21			356				234	180			
IMPERIAL	45	113	33						30			
INYO		155	85		60	68	58	96	22	154	75	30
KERN	11,978	10,915	13,766	11,685	14,037	15,543	16,141	13,606	11,128	10,503	13,885	8,866
KINGS	1,513	1,366	2,542	1,962	1,831	2,187	1,414	1,851	1,275	1,872	1,682	2,183
LAKE	15	134	124	78	60	67	12	110	15	196	180	
LASSEN												
LOS ANGELES	264,735	235,695	279,266	325,635	349,612	356,810	329,694	383,591	295,682	348,630	381,310	328,753
MADERA	279	488	266	713	442	348	357	355	387	232	278	275
MARIN	1,896	2,030	2,247	2,080	3,606	2,701	2,294	2,310	3,447	3,296	2,359	1,623
MARIPOSA				23				30				
MENDOCINO	797	552	738	674	720	899	1,423	909	765	1,719	1,565	1,249
MERCED	698	1,108	696	831	552	703	1,353	738	619	766	493	947
MODOC								25				
MONO												
MONTEREY	11,160	10,914	14,046	11,878	13,407	16,127	17,449	13,666	15,928	16,969	15,235	11,934
NAPA	46	149	139	182	193	262	56	301	258	461	391	246
NEVADA					173	403	266	134	155	283	398	
ORANGE	120,792	119,918	162,273	160,108	157,181	159,832	155,739	165,077	136,536	158,029	151,765	105,817
PLACER	317	299	60	866	647	1,099	560	426	519	828	1,106	214
PLUMAS					1	43			45	6		14
RIVERSIDE	17,281	19,493	21,914	23,335	25,353	26,003	29,236	24,208	21,908	25,912	22,666	22,526

COUNTY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
SACRAMENTO	3,985	3,513	5,042	4,608	3,613	5,564	3,715	6,400	6,021	4,715	4,223	4,799
SAN BENITO	1,085	914	1,009	1,065	869	1,288	1,186	1,557	792	1,587	704	892
SAN BERNARDINO	22,249	26,711	23,596	29,670	31,045	31,590	27,574	27,347	22,903	31,515	28,834	23,897
SAN DIEGO	113,483	107,172	136,935	136,019	130,194	112,208	120,828	147,018	139,313	143,738	134,042	146,664
SAN FRANCISCO	171	419	237	28	1,040	140	472	128		282	69	508
SAN JOAQUIN	1,793	1,281	2,362	2,531	1,753	2,084	1,513	1,840	1,902	1,877	2,784	1,919
SAN LUIS OBISPO	10,325	9,603	11,775	14,823	13,680	14,125	14,531	14,220	14,857	13,822	11,166	12,856
SAN MATEO	11,634	10,297	15,583	13,114	11,709	16,675	10,029	16,193	12,075	16,150	13,747	11,330
SANTA BARBARA	16,489	20,562	25,327	30,666	30,370	26,386	26,449	42,246	23,969	24,518	24,007	22,697
SANTA CLARA	50,256	48,402	51,406	55,454	58,271	63,774	62,635	78,042	209,812	49,674	59,139	44,437
SANTA CRUZ	7,092	7,213	4,914	12,744	8,826	12,077	10,615	13,601	9,879	14,413	10,714	8,644
SHASTA	76		36	155	27	39	1		14	21	54	15
SIERRA												
SISKIYOU				71		16	13	80	48			
SOLANO	1,068	523	607	545	976	686	777	957	968	996	394	391
SONOMA	4,766	3,652	4,467	64,805	4,270	5,673	6,350	6,310	5,467	7,888	5,602	4,238
STANISLAUS	1,310	1,302	1,554	2,202	1,940	1,433	1,061	961	1,679	1,674	1,245	1,229
SUTTER	132			111	202	73		90	103	87	46	115
TEHAMA			48	39		15	110	27	191	39		
TRINITY												
TULARE	3,194	3,748	3,732	5,386	5,037	3,609	3,965	3,794	3,890	4,724	4,382	4,353
TUOLUMNE			30		102		16	88	160		46	
VENTURA	27,055	34,918	39,697	34,516	40,232	41,354	32,336	35,343	36,759	36,373	39,515	24,914
YOLO	209	185	132	199	412	87	729	306	145	477	212	115
YUBA			242	362	235	244	78	78	20	27		

Table 5. Annual Agricultural Chloropicrin Use by Top Fifteen Counties
(Pounds Active Ingredient)

COUNTY	1999	2000	2001	2002	TOTAL
MONTEREY	1,108,556	1,143,038	1,191,073	1,183,541	4,626,208
VENTURA	670,298	752,940	1,002,241	901,732	3,327,212
SANTA CRUZ	413,409	434,273	470,604	452,785	1,771,072
SANTA BARBARA	326,366	239,776	356,783	325,415	1,248,339
ORANGE	193,951	180,906	218,517	280,908	874,281
SAN DIEGO	135,504	151,663	174,741	200,104	662,013
SISKIYOU	63,868	63,192	133,945	148,368	409,373
RIVERSIDE	78,112	63,590	87,155	98,588	327,444
KERN	46,199	93,068	40,033	126,311	305,611
SAN LUIS OBISPO	62,180	89,819	77,073	72,627	301,699
MERCED	61,257	70,072	60,735	70,799	262,863
SAN JOAQUIN	45,515	73,455	49,440	91,928	260,338
IMPERIAL	27,252	43,461	61,826	103,241	235,781
SHASTA	40,683	69,203	53,421	34,794	198,100
FRESNO	50,033	72,061	28,143	38,627	188,864
Total for Top 15 Counties	3,323,183	3,540,516	4,005,729	4,129,769	14,999,197
Percent of CA Total	91	93	94	95	93
Total Statewide Use	3,648,308	3,795,607	4,276,283	4,324,524	16,044,722

Table 6. Agricultural Chloropicrin Use by County for Years 1999-2002
(Pounds Active Ingredient)

COUNTY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
ALPINE												
ALAMEDA							137					
AMADOR												
BUTTE	4	136	31	96	181			4,097	1,984	5,897	3,250	2
CALAVERAS												
COLUSA												
CONTRA COSTA							1,226	537	1,208			743
DEL NORTE						510	4,966	21,204	905			
EL DORADO								1,639	812			
FRESNO	18,077	23,179	23,165	2,648	1,014	1,910	15,663	11,153	10,670	25,085	43,315	12,986
GLENN	17		11,969	35,904	35		360			602	516	42
HUMBOLDT								2,116	13,920			
IMPERIAL	24,757	5,360	5,965	1,350		1,864		8,860	56,575	83,957	7,651	39,442
INYO												
KERN	23,366	22,933	37,236	13,707	30,557	5,508	16,011	26,514	33,937	44,193	25,091	26,558
KINGS	22	33	629	524			934	559	1	1,903	13,588	40
LAKE										6		
LASSEN			3,669	347				79,225	55,614			
LOS ANGELES	83	3	260	5	7	8	4,782	19,261	5,017	935	41	23,608
MADERA	0	37	62	19	302	1	399	2,560	46	185	88	180
MARIN												
MARIPOSA												
MENDOCINO					18		12	28	85	133	34	
MERCED	6,222	5,231	73,471	29,714	18,795	292	5,033	19,444	30,093	20,411	12,717	41,440
MODOC								13,872				
MONO												
MONTEREY	2,290	4,015	26,053	12,560	63,953	150,210	272,536	786,450	1,634,163	1,456,532	213,779	3,667
NAPA				59			474	13	47	562	1,410	
NEVADA												
ORANGE	5,445	31,964	32,627	37,950	30,358	50,395	95,709	370,564	214,038	2,681		2,551
PLACER				299	487		139	742				
PLUMAS												
RIVERSIDE	92,996	58,952	38	108			684	24,342	23,199	2,895	13,230	111,001
SACRAMENTO	41			9,921	3,754		1,479	1,113		2,797	993	
SAN BENITO	2,090	2,237	1,545	20,688	4,485	3,807	12,245	30,954	15,767	48,925	26,296	3,023
SAN BERNARDINO						27		14,304	16,283	3,991		
SAN DIEGO	24,964	37,436	74,386	117,568	100,975	80,038	68,106	90,789	44,627	10,397	2,909	9,818
SAN FRANCISCO												
SAN JOAQUIN	2,096	23,451	30,526	116,639	27,939	2,643	3,777	2,063	29,191	15,985	3,300	2,727
SAN LUIS OPISBO	16,145	13,814	4,247	10,951	4,617	6,659	4,646	5,533	118,316	83,276	14,920	18,574
SAN MATEO			1		3,075	1,893	445	231	462		483	
SANTA BARBARA	4,990	3,545	15,344	13,303	27,095	16,938	9,151	77,640	486,107	545,422	38,035	10,771
SANTA CLARA			2,981	3,591	17	4,263			27,206	67,049	14,914	5,132
SANTA CRUZ	474	136	3,499	28,242	43,103	49,708	116,757	366,966	667,446	439,704	50,044	4,992
SHASTA			5,650	8,257	1,411	1,413	11,521	90,587	77,803		1,459	
SIERRA												
SISKIYOU			61,247	28,287	3,813		10,684	256,496	38,339	5,718	4,789	
SOLANO				1,943	759	88	2,113	4,627	297	396	1	35
SONOMA				6	109	166	345	943	558	6,248	4,569	
STANISLAUS	1,376	42	4,118	6,290	2,605	3,528	2,697	31,255	60,090	11,157	7,537	5,410

COUNTY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
SUTTER	230	25	465	63	1,007	127		44,666	1,658	6,772	13,910	681
TEHAMA	75		17,291	15,426	1,209	3	7	3,348	16,361	5,512	13,141	301
TRINITY												
TULARE	234	627	3,172	2,718	882	711	7,301	4,161	1,128	1,939	6,243	1,206
TUOLUMNE												
VENTURA	5,133	11,954	41,118	95,271	142,419	390,843	628,631	1,502,313	445,496	24,196	23,209	16,628
YOLO	13			659	189		1,569		1,104	21		8
YUBA							343	131		141	2,486	3



Table 7. Annual Cropland Use of Chloropicrin by Top 15 Commodities
(Pounds of Active Ingredient)

CROP	1999	2000	2001	2002	Total
STRAWBERRY	2,443,812	2,361,655	3,011,624	2,906,890	10,723,980
SOIL APPLICATION, PREPLANT- OUTDOOR (SEEDBED)	287,248	223,774	262,585	260,193	1,033,800
TOMATO	141,777	109,082	139,679	226,885	617,423
OUTDOOR GROWN TRANSPLANT	126,612	153,374	122,245	152,992	555,223
PEPPERS (FRUITING VEGETABLE), (BELL, CHILLI, ETC.)	59,005	128,962	123,469	148,881	460,317
OUTDOOR GROWN CUT FLOWERS OR GREENS	99,936	115,747	87,869	71,034	374,586
RASPBERRY	35,028	83,033	105,836	124,362	348,258
LETTUCE, HEAD	88,969	135,999	77,524	39,329	341,820
OUTDOOR CONTAINER/FIELD GROWN PLANTS	90,615	113,879	57,246	48,443	310,183
CARROTS, GENERAL	46,534	53,544	36,258	43,270	179,606
WATERMELONS	17,744	33,690	31,359	57,882	140,675
CANTALOUPE	46,134	6,105	31,236	43,855	127,330
UNCULTIVATED AGRICULTURAL AREAS	20,754	64,214	7,902	16,856	109,727
ONION (SPANISH, WHITE, RED, ETC.)	32,975	3,019	25,720	46,843	108,558
WALNUT (ENGLISH AND PERSIAN)	2,313	26,834	13,046	13,004	55,197
Total for Top 15 Commodities	3,539,455	3,612,913	4,133,598	4,200,718	15,486,684
Percent of CA Total	97	95	97	97	97
Total Statewide Use	3,648,308	3,795,607	4,276,283	4,324,524	16,044,722

C. APPLICATION SITE AIR MONITORING RECOMMENDATIONS

Structural applications

The historical trends for structural sulfuryl fluoride and chloropicrin applications indicate that the highest use areas are where the largest populations reside, Los Angeles and Orange Counties for sulfuryl fluoride and Los Angeles and San Diego Counties for chloropicrin, although almost all counties have some applications during the years of 1997-2000. Tables 4 and 6 indicate that structural application uses of both sulfuryl fluoride and chloropicrin occur throughout the year. The sulfuryl fluoride label allows aeration through open windows and doors with the use of

interior fans for at least 1 hour, and aeration completion by different times depending on application rate. The chloropicrin label states that aeration should be done by opening doors and windows with the use of interior fans for 12 to 24 hours until the air concentrations are below 0.1 ppm. DPR does not specify a preference of aeration method for the monitoring study.

Since chloropicrin is always used as a warning agent for sulfuryl fluoride application to structural fumigation, DPR recommends three monitoring studies for both sulfuryl fluoride and chloropicrin simultaneously. A target 24-hour quantitation limit of $30 \mu\text{g}/\text{m}^3$ is recommended for sulfuryl fluoride and $0.1 \mu\text{g}/\text{m}^3$ for chloropicrin. DPR's target quantitation limit should be viewed as a goal, not a requirement or lower bound. The application dosage of sulfuryl fluoride can vary, for a typical single-family house fumigation, from 6 – 16 ounces per 1,000 cubic feet for termites to a higher application rate necessary to control Powderpost beetle. DPR recommends selecting a site with a volume of at least 26,000 cubic feet, no obstructions between the samplers and the structure, and an exposure time of at least 36 hours but no more than 48 hours that will be treated for the Powderpost beetle to assure a higher application rate. A smaller volume structure may be used if unable to locate a larger structure with no obstructions surrounding the area. The label rate for chloropicrin use as a "warning agent" is one ounce per 10,000 cubic feet of space to be fumigated.

If sulfuryl fluoride becomes registered for use in California for post-harvest product fumigation, DPR may recommend that ARB substitute a product fumigation for the structural fumigation. When determined, ARB should notify DPR of the date and location of fumigations to be monitored.

DPR recommends close coordination with the county agricultural commissioner to select the most appropriate sampling sites. Permission from property owner must be obtained before the monitoring start. The structure selected for monitoring must have enough clearance surrounding it to allow for sampler placement at a distance of 5 and 10 feet from the edge of the structure. Four background samples should be taken prior to application. Twelve samplers should be placed surrounding the structure as three rings. The first ring consists of four samplers located at the middle of and 5 feet from each side of the structure. The second ring consists of four samplers 10 feet out from each corner of the structure. The third ring contains four samplers which would be placed 30 to 50 feet from each side or corner of the structure. A thirteenth sampler will be collocated with one sampler in the first ring and at the site that is expected to be downwind during aeration. The collocated sample will be collected at this site during each sampling interval. Sample intake should be 1.5 to 2.0 meters above ground. There should be no large obstructions between the structure and the furthest samplers.

For both sulfuryl fluoride and chloropicrin, samples should be taken before application, during application, during mechanical and tarp removal aeration (alternate Daytime/ Overnight sampling according to the duration of aeration), and post aeration for two Daytime/Overnight sampling periods. Additionally, after completion of aeration, two 24-hour samples should be taken at each of two different locations inside the fumigated structure for 48 hours sampling duration (total of four samples inside structure). To minimize exposure to sampling personnel, DPR recommends selecting structure that would aerate for 24 hours and follow the revised sampling schedule:

Sample period begins:	Sample duration time
Background (pre-application)	24 hours
Fumigation start	Start of fumigation until 1 hour before sunset
1 hour before sunset	¹ Overnight (until 1 hour after sunrise)
1 hour after sunrise	Daytime (1 hour before sunset)
1 hour before sunset	Overnight (until 1 hour after sunrise)
1 hour after sunrise	Daytime (until mechanical aeration begins); do not have to sample if this period will be less than 3 hours
Start of mechanical aeration	Until the tarp is completely removed (about 1.5 hours)
Beginning of Aeration	Until 1 hour before sunset
1 hour before sunset	Overnight (until 1 hour after sunrise)
1 hour after sunrise	Until end of Aeration (when cleared): do not have to sample if this period will be less than 3 hours
<i>End of Aeration (if before noon)</i>	<i>Until 1 hour before sunset</i>
<i>End of Aeration (if after noon)</i>	<i>Until 1 hour after sunrise</i>
<i>As appropriate based on the time of aeration end:</i>	
1 hour before sunset <i>or,</i>	Overnight (until 1 hour after sunrise)
1 hour after sunrise	Daytime (1 hour before sunset)
<i>in addition: after aeration is complete</i>	24-hour sample inside structure
24-hour post aeration	24-hour sample inside structure

¹All over night samples must include the period from one hour before sunset to one hour after sunrise.

Soil applications

Application monitoring should be done for field application of chloropicrin. DPR will recommend the method of application after evaluating the results from the 2003 monitoring, but it will most likely be a drip irrigation application or bed fumigation of chloropicrin. Ideally, monitoring should occur at a site using the highest allowed rates of use (i.e., between 150 to 400 pounds per acre overall). Most applications of chloropicrin using these methods occur in the central coast area.

DPR recommends close coordination with the county agricultural commissioner to select the best sampling sites and date. Ideally, the monitoring study should include samples taken before, during, and post application for 72 hours. To minimize exposure to sampling personnel, we recommend the following revised sampling schedule:

Sample period begins:	Sample duration time
Background (pre-application)	Minimum 12 hours
During application and post-application	Start of application until 1 hour before sunset
1 hour before sunset	Overnight ¹ (until 1 hour after sunrise)
1 hour after sunrise	Daytime (until 1 hour before sunset)
1 hour before sunset	Overnight (until 1 hour after sunrise)
1 hour after sunrise	Daytime (until 1 hour before sunset)
1 hour before sunset	Overnight (until 1 hour after sunrise)

¹All over night samples must include the period from one hour before sunset to one hour after sunrise.

For quality assurance, trip spikes should be prepared in the lab and maintained under the same conditions with the samples. Field spikes for chloropicrin will be run in the field with samples, whereas sulfuryl fluoride field spikes will be run at the lab.

DPR requests the following information be included in the monitoring report:

- 1) an accurate record of the positions of the monitoring equipment with respect to the structure, including the exact direction and distance of the samplers from the edge of the structure and a record of three dimensions of the structural;
- 2) an accurate record of pesticide application, including application time, method, dosage (rate), fumigation duration, aeration method and duration, etc.
- 3) an accurate drawing of the monitoring site showing the precise location of the meteorological equipment, trees, other buildings, and other obstacles with respect to North (identified as either true or magnetic North);
- 4) for structural fumigation study, meteorological data collected at 1-minute intervals including wind speed and direction, humidity, air temperature, and comments regarding degree of cloud cover. For field application, meteorological data collected at 5-minute intervals.

D. SAFETY RECOMMENDATIONS

Most of the following safety precautions pertain to applicators. In this recommendation, the sampling schedule is arranged to prevent sampling personnel from being near the structure during application. Therefore, most of these precautions are for reference only.

Product labels for the fumigants carry a danger warning. Inhalation of the vapors may be fatal or cause acute illness or delayed lung or nervous system injury if exposed to high concentrations. Do not get in eyes, on skin, or on clothing. Chloropicrin is also a strong lachrymator causing painful irritation to the nose and throat and causing tearing of the eyes. The labels recommend application personnel wear loose-fitting or well-ventilated long-sleeve shirt and long pants, and socks and shoes; chloropicrin also requires a full-face shield or safety glasses with brow and temple shields.

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