

Appendix 1
Registrant Proposed Field Adjustment Factors for
Methyl Bromide and Chloropicrin

Analysis of Methyl Bromide Emissions in the San Joaquin Valley in 1990 and 2004

Abstract

This report calculates and summarizes the total amount of methyl bromide emitted from agricultural and non-agricultural usage in the San Joaquin Valley in 1990 and 2004 during the peak ozone season (May 1 to October 31 of each year). All methyl bromide use data were obtained from the CDPR Pesticide Information Portal (CALPIP) – Pesticide Use Report (PUR) online database. Using the method that CDPR historically has used, which assumes that 100% of the applied methyl bromide is emitted into the air, approximately 2.56 million pounds of methyl bromide was emitted in the eight counties comprising the San Joaquin Valley in 1990 (6.974 tons/day); and approximately 884,615 pounds of methyl bromide was emitted in 2004. The difference between 1990 and 2004 represents a 65.4% reduction in methyl bromide total emissions. An alternative VOC equation, based on mass loss studies and discrete usage data, was developed that takes into account the proportion of methyl bromide that is degraded in the soil (for soil fumigations). It is believed that this alternative VOC emission equation more accurately reflects the total amount of methyl bromide emitted by each crop or site and method of application. Using this new equation, approximately 1.6 million pounds of methyl bromide was emitted in 1990 (4.387 tons/day), and approximately 423,358 pounds of methyl bromide were emitted in 2004 (1.150 tons/day). The difference between 1990 and 2004, using the corrected VOC equation, represents a 73.8% reduction in methyl bromide total emissions.

Data Acquisition and Overall Use Statistics

The CALPIP search queries were by *Year* (“1990” and “2004”) and *Chemical Name* (“methyl bromide”). In this way, all PUR data for methyl bromide were included, regardless of formulation, product name, crop or site of application, etc. Both *Agricultural* and *Non-Agricultural* (under *Other Criteria: Reporting Type*) use reports were included.

The aggregate 1990 and 2004 PUR files for methyl bromide were downloaded and contained all PUR reports for the entire State of California. The 1990 Statewide PUR file contained 11,475 records of application that, collectively, totaled 20,139,409.92 pounds of methyl bromide. The 2004 Statewide PUR file contained 5,186 records of application that, collectively, totaled 7,105,109.84 pounds of methyl bromide (Table 1).

The 1990 and 2004 Statewide PUR files were then processed to include only the 8 counties that comprise the San Joaquin Valley: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare. While only part of Kern County is technically included in the San Joaquin Valley VOC non-attainment area, all PUR records for Kern County were included in these analyses as a conservative measure, because it was not possible to distinguish between the applications that occurred in the non-attainment area and those that did not.

The 1990 PUR file for the San Joaquin Valley contained 3,319 records of application that, collectively, totaled 6,381,933.24 pounds of methyl bromide. The 2004 PUR file for the San Joaquin Valley contained 1,805 records of application that, collectively, totaled 1,494,252,924 pounds of methyl bromide (Table 1).

The 1990 and 2004 San Joaquin Valley PUR files were then processed to include only the applications that occurred between May 1 and October 31 of each year, as this period is considered the “peak ozone season”. The 1990 PUR file for the San Joaquin Valley Ozone Season contained 1,125 records of application that, collectively, totaled 2,556,412.799 pounds of methyl bromide. These 1,125 records consisted of 512 records for which the dates of application were listed and occurred between May 1 and October 31, and an additional 613 records for which no date of application was listed. As a conservative measure, these 613 no-date records were assumed to have occurred during the peak ozone season. The 2004 PUR file for the San Joaquin Valley Ozone Season contained 735 records of application that, collectively, totaled 884,615.4696 pounds of methyl bromide (Table 1).

The total amount of methyl bromide applied in the San Joaquin Valley during the peak ozone season in 2004 (884,615.4696 lbs.) is approximately 34.6% of what was applied in 1990 (2,556,412.799 lbs.), representing a 65.4% reduction in usage.

Table 1. Cumulative number of records and total pounds of methyl bromide applied in California (whole-year) and the San Joaquin Valley (whole-year and during the “peak ozone season”) for all Agricultural and Non-Agricultural applications in 1990 and 2004.

Year	Area & Period	No. of Records	Amount of MeBr Applied (total lbs.)
1990	Statewide, 12-month	11,475	20,139,409.92
	San Joaquin Valley, 12-month	3,319	6,381,933.24
	San Joaquin Valley, May 1 to October 31	1,125	2,556,412.799
2004	Statewide, 12-month	5,186	7,105,109.84
	San Joaquin Valley, 12-month	1,805	1,494,252.924
	San Joaquin Valley, May 1 to October 31	735	884,615.4696

Analysis of VOC Emissions based on CDPR Procedures

CDPR uses the following equation to calculate VOC emissions from pesticide applications, where *EP* is defined as the Emissions Potential (VOC fraction) of a given pesticide product:

$$VOC\ emission\ (lbs.) = [lbs.\ of\ product\ applied] * [product-specific\ EP]$$

For all methyl bromide products, CDPR assigns a default EP value of 100%. This assumes that 100% of the applied amount of methyl bromide is volatilized from the soil or other site, such that the total methyl bromide VOC emissions are equal to the amount of methyl bromide applied during a specific period, location, etc.

Using this equation for the total amounts applied in Table 1, it can be calculated that the average daily VOC emissions in the San Joaquin Valley during the peak ozone season were approximately 6.947 tons/day in 1990 and 2.404 tons/day in 2004 (2000 pounds = 1 ton; 184 days in May 1 to October 31 period) (Table 2). This represents a 4.543 tons/day (or 65.4%) reduction in methyl bromide VOC emissions in 2004 compared to 1990.

Alternative Analysis of VOC Emissions based on Mass Loss Studies

While 100% of the applied methyl bromide can theoretically be emitted from a given end-use site, numerous studies have demonstrated that, at least for soil fumigation, a portion of the methyl bromide is degraded in the soil and is not emitted into the air (i.e., via mass loss studies). With respect to this fact, any methyl bromide VOC emission calculation that assumes 100% emission would considerably overestimate methyl bromide's contribution to the VOC burden in the San Joaquin Valley or any other area with significant methyl bromide use in soil fumigation. For non-soil fumigation sites (commodity fumigation, structural fumigation, etc.), where there is little opportunity for methyl bromide degradation, the 100% emissions is likely accurate.

Yates *et al.* (1996) provide a detailed review of the techniques and mass loss studies that have determined estimates of methyl bromide emission loss and degradation in the soil from various soil fumigation application methods. These mass loss studies can be used to more accurately estimate total methyl bromide emissions from soil fumigation activity. Based primarily on Yates *et al.* (1996) review, an additional component to the VOC emissions calculation was added, where *EF* = the Emissions Factor, or the proportion of methyl bromide that is emitted from the application field or site. This alternative calculation is:

$$VOC\ emission\ (lbs.) = [lbs.\ of\ product\ applied] * [product-specific\ EP] * [application-specific\ EF]$$

By example, if methyl bromide was applied to 10 acres of almond at 200 lbs. a.i. (active ingredient) per acre, the total amount applied would be 2,000 lbs. of methyl bromide. The EP value remains 100% (1.0 by proportion), based on 100% of the product being volatile. The EF value would be based on mass loss studies where, in this case, the application is a deep injection (20⁺ in.) with HDPE tarp, which was estimated to result in 26% emission (0.26 by proportion) of the applied chemical. So, for this example:

$$VOC\ emission\ (lbs.) = [2000\ lbs.] * [1.0] * [0.26] = 520\ lbs.\ emitted.$$

Therefore, based on this approach, only 520 lbs. of the 2,000 lbs. of methyl bromide that was applied, was emitted during this application.

Based on Yates *et al.* (1996), the following *EF* values were used to calculate total emissions for each crop or site (e.g., soil fumigation vs. structural fumigation), type of fumigation (e.g., almond acres vs. almond nuts prior to packaging), type of application (e.g., shallow vs. deep shank; tarp or no tarp; hot-gas), where the type of application was determined by the “Unit Treated” field of the PUR records:

Unit Treated:

- A = acres
 - Shallow injection (6-15 in.), bed or broadcast, no tarp= 82% emission (EF = 0.82)
 - Shallow injection (6-15 in.), bed or broadcast, LDPE tarp = 82% emission* (EF = 0.82)
 - Shallow injection (6-15 in.), bed or broadcast, HDPE tarp = 43% emission (EF = 0.43)
 - Deep injection (20+ in.), bed or broadcast, no tarp = 38% emission (EF = 0.38)
 - Deep injection (20+ in.), bed or broadcast, LDPE tarp = 38% emission* (EF = 0.38)
 - Deep injection (20+ in.), bed or broadcast, HDPE tarp = 26% emission (EF = 0.26)

* Note: No studies were found that determined mass loss of methyl bromide through LDPE films, regardless of injection depth. However, based on Yates *et al.* (1996), LDPE film is at least twice as permeable to methyl bromide as HDPE films. Because of this, it is assumed that LDPE film provides virtually no retention properties and, therefore, the *EF* values for shallow injection + LDPE tarp and deep injection + LDPE tarp were considered to be equal to the *EF* values for shallow injection + no tarp (82%) and deep injection + no tarp (38%).

- C = cubic feet (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- K = thousand cubic feet (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- P = pounds (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- S = square feet (for greenhouse treatments, etc.; assume 100% loss; EF = 1.0)
- T = tons (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- U = miscellaneous unit (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- Not Listed = (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)

As an aggregate example, the following data for 2004 methyl bromide Almond fumigation is used to illustrate the incorporation of application-specific *EF* values into the VOC equation:

ALMOND (2004)

Number of Records: 92

Total Pounds of Chemical Applied: 25,789.45151

Units Treated: A (acres), C (cubic feet), K (thousand cubic feet), T (tons), U (misc. unit)

Pounds Applied by Unit Treated:

58 records = A (deep injection + HDPE tarp; *EP* = 1.0; *EF* = 0.26) for 19,946.71286 total lbs.

17 records = C (assume 100% loss; *EP* = 1.0; *EF* = 1.0) for 1278.769651 lbs.

3 records = K (assume 100% loss; *EP* = 1.0; *EF* = 1.0) for 2387.379 lbs.

6 records = T (assume 100% loss; *EP* = 1.0; *EF* = 1.0) for 989 lbs.

4 records = U (assume 100% loss; *EP* = 1.0; *EF* = 1.0) for 1187.59 lbs.

VOC emissions for treated acres of almond = 19,946.71286 x 0.26 = 5,186.14534 lbs.

VOC emissions for all other almond applications = 5,842.73865 x 1.0 = 5,842.73865 lbs.

Total VOC emissions for Almond = 11,028.884 lbs.

This same aggregate analysis was performed for all SITE/CROP listings within both the 1990 and 2004 PUR files. The aggregate analysis and summary table for 1990 applications are provided in Appendix A. The aggregate analysis and summary table for 2004 applications are provided in Appendix B. These analyses assume the following:

- Approximately 90% of methyl bromide soil fumigations in 1990 were non-tarped and 10% were tarped using LDPE film.
- LDPE film is considered to have little gas retention properties, and therefore, any 1990 applications with LDPE film had EF values that were the same as non-tarped applications.
- LDPE film was only used in 1990 and not in 2004.
- All CDPR-approved HDPE films were assigned the same EF, which was based on mass loss studies.
- All 2004 soil applications used HDPE film, regardless of injection depth.
- All non-acre applications are assumed to result in 100% emission of product.

Based on the sum values for the *EF*-corrected VOC emission equations that were applied to each Crop/Site by year, it is calculated that 1,614,281.682 lbs. of methyl bromide were emitted in the eight counties comprising the San Joaquin Valley during the peak ozone season in 1990 (4.387 tons/day), and 423,357.7978 lbs. of methyl bromide were emitted in 2004 (1.150 tons/day). The 2004 VOC total is approximately 26.2% of the 1990 total, which equates to a 73.8% reduction in methyl bromide emissions.

Table 2. Default and Corrected methyl bromide VOC emissions.

Year	Default VOC emissions (tons/day) ^z	VOC emissions corrected using mass loss data (tons/day) ^y
1990	6.947	4.387
2004	2.404	1.150

^z Values assume 100% emission of applied material.

^y Values incorporate empirically-derived mass loss data.

CONCLUSION

When the type of application is not considered and 100% of the applied methyl bromide is assumed to be emitted, the total VOC emissions of methyl bromide were reduced from 6.947 tons/day in 1990 to 2.404 tons/day in 2004. When the type of application is considered relative to the proportion of methyl bromide which is degraded in the soil, the total VOC emissions of methyl bromide were reduced from 4.387 tons/day in 1990 to 1.150 ton/day in 2004. The Product Names listed in the PUR database files are presented in Appendix 3.

Reference Cited:

Yates, S.R., J. Gan, F.F. Ernst, D. Wang, and M. Yates. 1996. Emissions of methyl bromide from agricultural fields: rate estimates and methods of reduction, pp. 116-134. *In* Seiber et al. 1996, Fumigants: Environmental Fate, Exposure, and Analysis. American Chemical Society, Washington, DC.

APPENDIX A

1990 Methyl Bromide VOC Emissions in the San Joaquin Valley

[since the default EP value is 100% (1.0) for all methyl bromide applications, this component of the equation was not included in the following calculations, as it does not affect the equations' product]

ALFALFA (FORAGE – FODDER) (ALL OR UNSPEC) -- 1990

Number of Records: 3

Total Pounds Chemical Applied: 16,193.625

Units Treated: A (acres), U (misc. unit)

Pounds Applied by Unit Treated:

2 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 16,019.5 lbs.

1 record = U (assume 100% loss; EF = 1.0) for 174.125 lbs.

VOC emissions for treated acres of Alfalfa = $16,019.5 \times 0.82 = 13,135.99$ lbs.

VOC emissions for all other Alfalfa applications = $174.125 \times 1.0 = 174.125$ lbs.

Total VOC emissions for Alfalfa = 13,210.115 lbs.

ALMOND -- 1990

Number of Records: 120

Total Pounds of Chemical Applied: 97,562.641

Units Treated: A (acres), C (cubic feet), K (thousand cubic feet), P (pounds), S (square feet),
T (tons), U (misc. unit).

Pounds Applied by Unit Treated:

26 records = A (deep injection + LDPE or no tarp, EF = 0.38) for 70,709.065 lbs.

19 records = C (assume 100% loss; EF = 1.0) for 3,472.831 lbs.

10 records = K (assume 100% loss; EF = 1.0) for 6,262.7 lbs.

6 records = P (assume 100% loss; EF = 1.0) for 1,316 lbs.

4 records = S (assume 100% loss; EF = 1.0) for 716.125 lbs.

18 records = T (assume 100% loss; EF = 1.0) for 10,159.375 lbs.

37 records = U (assume 100% loss; EF = 1.0) for 4,926.545 lbs.

VOC emissions for treated acres of almond = $70,709.065 \times 0.38 = 26,869.4447$ lbs.

VOC emissions for all other almond applications = $26,853.576 \times 1.0 = 26,853.576$ lbs.

Total VOC emissions for Almond = 53,723.0207 lbs.

APPLE -- 1990

Number of Records: 4

Total Pounds Chemical Applied: 11,968.9

Unit Treated: A (acres)

EF based on Application Method: 0.38 (deep injection + LDPE or no tarp)

VOC emissions for Apple = $11,968.9 \times 0.38 = 4,548.182$ lbs.

APRICOT -- 1990

Number of Records:5

Total Pounds Chemical Applied: 1,529.485

Units Treated: A (acres), U (misc. unit)

Pounds Applied by Unit Treated:

2 records = A (deep injection + LDPE or no tarp; EF = 0.38) = 1,395.985lbs.

3 records = U (assume 100% loss; EF = 1.0) = 133.5 lbs.

VOC emissions for treated acres of Apricot = 1,395.985 x 0.38 = 530.4743 lbs.

VOC emissions for all other Apricot applications = 133.5 x 1.0 = 133.5 lbs.

Total VOC emissions for Apricot = 663.9743 lbs.

BEANS (ALL OR UNSPEC) -- 1990

Number of Records: 12

Total Pounds Chemical Applied: 3,207

Units Treated: K (thousand cubic feet), P (pounds), S (square feet), T (tons), U (misc. unit)

Pounds Applied by Unit Treated:

1 record = K (assume 100% loss; EF = 1.0) for 76 lbs.

2 records = P (assume 100% loss; EF = 1.0) for 35 lbs.

2 records = S (assume 100% loss; EF = 1.0) for 216 lbs.

6 records = T (assume 100% loss; EF = 1.0) for 2,490 lbs.

1 record = U (assume 100% loss; EF = 1.0) for 390 lbs.

VOC emissions for Beans (All or Unspec) = 3,207 x 1.0 = 3,207 lbs.

BEANS, DRIED-TYPE -- 1990

Number of Records: 7

Total Pounds Chemical Applied: 3,349

Units Treated: C (cubic feet), P (pounds), T (tons)

Pounds Applied by Unit Treated:

2 records = C (assume 100% loss; EF = 1.0) for 304 lbs.

1 record = P (assume 100% loss; EF = 1.0) for 204 lbs.

4 records = T (assume 100% loss; EF = 1.0) for 2,805 lbs.

VOC emissions for Beans, Dried-Type = 3,349 x 1.0 = 3,349 lbs.

BEEHIVES (ALL OR UNSPEC) -- 1990

Number of Records: 4

Total Pounds Chemical Applied: 497.5

Units Treated: A (? Acres of beehives?)

EF value based on Application method: 1.0 (assume 100% loss; bee equipment)

VOC emissions for Beehives (all or Unspec) = 497.5 x 1.0 = 497.5 lbs.

BEEHIVES, BEE COLONY (DISEASED, NUISANCE) -- 1990

Number of Records: 2

Total Pounds Chemical Applied: 53.9

Unit Treated: C (cubic feet)

EF value based on application method: 1.0 (assume 100% loss)

VOC emissions for Beehives, Bee Colony = 53.9 x 1.0 = 53.9 lbs.

CARROT, GENERAL -- 1990

Number of Records: 2

Total Pounds Chemical Applied: 398

Unit Treated: A (acres)

EF value based on application method: 0.82 (shallow injection + no tarp)

VOC emissions for Carrots, General = 398 x 0.82 = 326.36 lbs.

CHERRY -- 1990

Number of Records: 53

Total Total Pounds Chemical Applied: 23,246.8726

Units Treated: A (acres), T (tons), U (misc. unit)

Pounds Applied by Unit Treated:

40 records = A (deep injection + LDPE or no tarp, EF = 0.38) for 20,653.5776 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 737 lbs.

12 records = U (assume 100% loss, EF = 1.0) for 1,856.295 lbs.

VOC emissions for treated acres of Cherry = 20,653.5776 x 0.38 = 7,848.359488 lbs.

VOC emissions for all other Cherry applications = 2,593.295 x 1.0 = 2,593.295 lbs.

Total VOC emissions for Cherry = 10,441.654488 lbs.

COMMODITY FUMIGATION -- 1990

Number of Records: 25

Total Pounds Chemical Applied: 5,070.745

Unit Treated: Unknown (assume 100% loss)

EF based on application Method: 1.0

VOC emissions for Commodity Fumigation = 5,070.745 x 1.0 = 5,070.745 lbs.

COTTON, GENERAL -- 1990

Number of Records: 2

Total Pounds Chemical Applied: 6,500.335

Unit Treated: A (acres)

EF based on Application Method: 0.82 (shallow injection + LDPE or no tarp)

VOC emissions for Cotton = 6,500.335 x 0.82 = 5,330.2747 lbs.

FIG -- 1990

Number of Records: 9

Total Pounds Chemical Applied: 1,267.88

Units Treated: A (acres), T (tons)

Pounds Chemical Applied by Unit Treated:

2 records = A (deep injection + LDPE or no tarp; EF = 0.38) for 200 lbs.

7 records = T (assume 100% loss; EF = 1.0) for 1,067.88 lbs.

VOC emissions for treated acres of Fig = 200 x 0.38 = 76 lbs.

VOC emissions for all other Fig applications = 1,067.88 x 1.0 = 1,067.88 lbs.

Total VOC emissions for Fig = 1,143.88 lbs.

FOREST TREES, FOREST LANDS (ALL OR UNSPEC) -- 1990

Number of Records: 4

Total Pounds Chemical Applied: 32.34

Unit Treated: C (cubic feet)

EF value based on application method: 0.82 (shallow injection + LDPE or no tarp)

VOC emissions for Forest Trees = 32.34 x 0.82 = 26.5188

FRUITS (ALL OR UNSPEC) -- 1990

Number of Records: 6

Total Pounds Chemical Applied: 2,648.95

Units Treated: C (cubic feet), K (thousand cubic feet), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

2 records = C (assume 100% loss; EF = 1.0) for 680 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 1,617 lbs.

3 records = U (assume 100% loss; EF = 1.0) for 351.95 lbs.

VOC emissions for Fruits (all or unspec) = 2,648.95 x 1.0 = 2,648.95 lbs.

GRAINS (ALL OR UNSPEC) -- 1990

Number of Records: 1

Total Pounds Chemical Applied: 0.98

Unit Treated: U (misc. unit)

EF value based on Application Method: 1.0

VOC emissions for Grains = 0.98 x 1.0 = 0.98 lbs.

GRAPES-- 1990

Number of Records: 34

Total Pounds Chemical Applied: 76,258.236

Units Treated: A (acres), C (cubic feet), K (thousand cubic feet), S (square feet), T (tons),
U (misc. unit)

Pounds Chemical Applied by Unit Treated:

16 records = A (deep injection + LDPE or no tarp; EF = 0.38) for 61,348.381 lbs.

3 records = C (assume 100% loss; EF = 1.0) for 1,135 lbs.

7 records = K (assume 100% loss; EF = 1.0) for 11,659.105 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 360 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 3 lbs.

6 records = U (assume 100% loss; EF = 1.0) = 1,752.75

VOC emissions for treated acres of Grapes = 61,348.381 x 0.38 = 23,312.38478 lbs.

VOC emissions for all other Grape applications = 14,909.855 x 1.0 = 14,909.855 lbs.

Total VOC emissions for Grapes = 38,222.23978 lbs.

GRAPES, WINE -- 1990

Number of Records: 13

Total Pounds Chemical Applied: 537,163.545

Units Treated: A (acres)

EF value based on application method: 0.38 (deep injection + LDPE or no tarp)

VOC emissions for Grapes, Wine = 537,163.545 x 0.38 = 204,122.1471 lbs.

KIWIFRUIT -- 1990

Number of Records: 1

Total Pounds Chemical Applied: 2,585.01

Unit Treated: A (acre)

EF value based on application method: 0.38 (deep injection + LDPE or no tarp)

VOC emissions for Kiwifruit = 2,585.01 x 0.38 = 982.3038 lbs.

LANDSCAPE MAINTENANCE -- 1990

Number of Records: 28

Total Pounds Chemical Applied: 3,802.02

Unit Treated: Unknown

EF value based on application method: 0.82 (assume shallow injection + LDPE or no tarp)

VOC emissions for Landscape Maintenance = 3,802.02 x 0.82 = 3,117.6564 lbs.

NECTARINE -- 1990

Number of Records: 111

Total Pounds Chemical Applied: 192,746.285

Units Treated: A (acres), C (cubic feet), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

29 records = A (deep injection + LDPE or no tarp; EF = 0.38) for 163,243.605 lbs.

1 record = C (assume 100% loss; EF = 1.0) for 55.9 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 155 lbs.

80 records = U (assume 100% loss; EF = 1.0) for 29,291.78 lbs.

VOC emission for treated acres of Nectarine = 163,243.605 x 0.38 = 62,032.5699 lbs.

VOC emission for all other Nectarine applications = 29,502.88 x 1.0 = 29,502.88 lbs.

Total VOC emissions for Nectarine = 91,535.4499 lbs.

N-GRNHS GRWN CUT FLWRS OR GREENS -- 1990

Number of Records: 5

Total Pounds Chemical Applied: 103.3099

Units Treated: A (acres), C (cubic feet), S (square feet)

Pounds Chemical Applied by Unit Treated:

2 records = A (shallow injection + LDPE tarp or no tarp; EF = 0.82) for 91.54 lbs.

2 records = C (assume 100% loss; EF = 1.0) for 11.76 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 0.0099 lbs.

VOC emissions for treated acres of N-GGCFOG = 91.54 x 0.82 = 75.0628 lbs.

VOC emissions for all other N-GGCFOG = 11.7699 x 1.0 = 11.7699 lbs.

Total VOC emissions for N-GGCFOG = 86.8327

N-GRNHS GRWN TRNSPLNT/PRPGTV MTRL -- 1990

Number of Records: 7

Total Pounds Chemical Applied: 86.645

Units Treated: S (square feet), Unknown

Pounds Chemical Applied by Unit Treated:

3 records = S (assume 100% loss; EF = 1.0) = 25.95 lbs.

4 records = Unknown (assume 100% loss; EF = 1.0) = 60.695 lbs.

VOC emissions for N-GGT/PM = 86.645 x 1.0 = 86.645 lbs.

N-OUTDR CONTAINER/FLD GRWN PLANTS -- 1990

Number of Records: 66

Total Pounds Chemical Applied: 794,109.03

Unit Treated: A (acres)

EF value based on Application Method: 0.82 (shallow injection + LDPE tarp or no tarp)

VOC emissions for N-OC/FGP = 794,109.03 x 0.82 = 651,169.4046 lbs.

N-OUTDR GRWN TRNSPLNT/PRPGTV MTRL -- 1990

Number of Records: 47

Total Pounds Chemical Applied: 186,321.0915

Units Treated: A (acres), K (thousand cubic feet), S (square feet); Unknown

Pounds Chemical Applied by Unit Treated:

34 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 184,581.4965 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 1,194 lbs.

2 records = S (assume 100% loss; EF = 1.0) for 464.05 lbs.

10 records = Unknown (assume 100% loss; EF = 1.0) = 81.545 lbs.

VOC emissions for N-OGT/PM = 184,581.4965 x 0.82 = 151,356.82713 lbs.

VOC emissions for all other N-OGT/PM = 1,739.595 x 1.0 = 1,739.595 lbs.

Total VOC emissions for N-OGT/PM = 153,096.42213 lbs.

NUT CROPS, NUT TREES (ALL OR UNSPEC) -- 1990

Number of Records: 12

Total Pounds Chemical Applied: 4,938.55

Units Treated: C (cubic feet), S (square feet), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

6 records = C (assume 100% loss; EF = 1.0) for 77.61 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 39.8 lbs.

4 records = T (assume 100% loss; EF = 1.0) for 4,817.14 lbs.

1 record = U (assume 100% loss; EF = 1.0) for 4 lbs.

VOC emissions for Nut Crops = 4,938.55 x 1.0 = 4,938.55 lbs.

ONION -- 1990

Number of Records: 7

Total Pounds Chemical Applied: 8,648.54

Units Treated: A (acres), S (square feet)

Pounds Chemical Applied by Unit Treated:

6 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 8,529.14 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 119.4 lbs.

VOC emissions for treated acres of Onion = 8,529.14 x 0.82 = 6,993.8948 lbs.

VOC emissions for all other Onion applications = 119.4 x 1.0 = 119.4 lbs.

Total VOC emissions for Onion = 7,113.0348 lbs.

ORANGE -- 1990

Number of Records: 3

Total Pounds Chemical Applied: 4,956.865

Unit Treated: A (acres)

EF based on Application Method: 0.38 (deep injection + LDPE or no tarp)

VOC emissions for Orange = 4,956.865 x 0.38 = 1,883.6087 lbs.

PEACH -- 1990

Number of Records: 77

Total Pounds Chemical Applied: 188,637.64

Units Treated: A (acres), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

53 records = A (deep injection + LDPE or no; EF = 0.38) for 187,714.41 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 13 lbs.

23 records = U (assume 100% loss; EF = 1.0) for 910.23 lbs.

VOC emission for treated acres of Peach = 187,714.41 x 0.38 = 71,331.4758 lbs.

VOC emission for all other Peach applications = 923.23 x 1.0 = 923.23 lbs.

Total VOC emissions for Peach = 72,254.7058 lbs.

PEAR -- 1990

Number of Records: 1

Total Pound Chemical Applied: 1,333.3

Units Treated: A (acres)

EF value based on Application Method: 0.38 (deep injection + LDPE or no tarp)

VOC emissions for Pear = 1,333.3 x 0.38 = 506.654 lbs.

PEAS, FIELD OR SOUTHERN (BLACKKEYED, ETC.) -- 1990

Number of Records: 1

Total Pounds Chemical Applied: 450

Unit Treated: T (tons)

EF value based on Application Method: 1.0 (assume 100% loss)

VOC emissions for Peas, Field or Southern (Blackeyed, etc.) = 450 x 1.0 = 450 lbs.

PEAS, GENERAL -- 1990

Number of Records: 5

Total Pounds Chemical Applied: 706

Units Treated: C (cubic feet), K (thousand cubic feet), S (square feet), T (tons)

Pounds Chemical Applied by Unit Treated:

1 record = C (assume 100% loss; EF = 1.0) for 171 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 38 lbs.

2 records = S (assume 100% loss; EF = 1.0) for 252 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 245 lbs.

Total VOC emissions for Peas, General = 706 x 1.0 = 706 lbs.

PEAS, SOUTHERN (COWPEAS, BLACKEYED, CROWDER, ETC.) -- 1990

Number of Records: 2

Total Pounds Chemical Applied: 1,692

Units Treated: C (cubic feet), S (square feet)

Pounds Chemical Applied by Unit Treated:

1 record = C (assume 100% loss; EF = 1.0) for 1,008 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 684 lbs.

VOC emissions for Peas, Southern (Cowpeas, etc.) = 1,692 x 1.0 = 1,692 lbs.

PETS (ALL OR UNSPEC) -- 1990

Number of Records: 2

Total Pounds Chemical Applied: 9.95

Unit Treated: S (square feet)

EF value based on application method: 1.0 (assume 100% loss)

VOC emissions for Pets = 9.95 x 1.0 = 9.95 lbs.

PISTACHIO (PISTACHE NUT) -- 1990

Number of Records: 38

Total Pounds Chemical Applied: 10,449.525

Unit Treated: A (acres), C (cubic feet), K (thousand cubic feet), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

1 record = A (deep injection + LDPE or no tarp; EF = 0.38) for 721 lbs.

28 records = C (assume 100% loss; EF = 1.0) for 8,619.545 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 731 lbs.

3 records = U (assume 100% loss; EF = 1.0) for 377.98 lbs.

VOC emissions for treated acres of Pistachio = 721 x 0.38 = 273.98 lbs.

VOC emissions for all other Pistachio applications = 9,728.525 x 1.0 = 9728.525 lbs.

Total VOC emissions for Pistachio = 10,002.505 lbs.

PLUM (INCLUDES WILD PLUMS FOR HUMAN CONSUMPTION) -- 1990

Number of Records: 16

Total Pounds Chemical Applied: 51,002.88

Unit Treated: A (acres)

EF value based on application method: 0.38 (deep injection + LDPE or no tarp)

Total VOC emissions for Plum = 51,002.88 x 0.38 = 19,381.0944 lbs.

PUBLIC HEALTH PEST CONTROL -- 1990

Number of Records: 2

Total Pounds Chemical Applied: 405.52

Unit Treated: Unknown

EF value based on application method: 1.0 (assume 100% loss)

VOC emissions for Public Health Pest Control = 405.52 x 1.0 = 405.52 lbs.

RICE -- 1990

Number of Records: 3

Total Pounds Chemical Applied: 14

Units Treated: C (cubic feet), T (tons)

Pounds Chemical Applied by Unit Treated:

2 records = C (assume 100% loss; EF = 1.0) for 6 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 8 lbs.

VOC emissions for RICE = 14 x 1.0 = 14 lbs.

RIGHTS OF WAY -- 1990

Number of Records: 12

Total Pounds Chemical Applied: 4,228.52

Unit Treated: A (acres), Unknown (assume shallow injection + LDPE or no tarp)

Pounds Chemical Applied by Unit Treated:

1 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 199 lbs.

11 records = Unknown (EF = 0.82) for 4,029.52 lbs.

Total VOC emissions for Rights of Way = 4,228.52 x 0.82 = 3,467.3864 lbs.

SOIL APPLICATIONS, (HOUSEPLANT POTTING SOIL) -- 1990

Number of Records = 1

Total Pounds Chemical Applied: 8.9555

Unit Treated: S (square feet)

EF value based on application method: 1.0 (assume 100% loss))

VOC emissions for Soil Applications (Houseplant Potting Soil) = 8.9555 x 1.0 = 8.9555 lbs.

SOIL APPLICATIONS, PREPLANT – OUTDOOR (SEEDBEDS, ETC.) -- 1990

Number of Records: 14

Total Pounds Chemical Applied: 6,214.595

Units Treated: A (acres), C (cubic feet), K (thousand cubic feet), S (square feet)

Pounds Chemical Applied by Unit Treated:

5 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 5,398.675 lbs.

7 records = C (assume 100% loss; EF = 1.0) for 638.795 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 3 lbs.

1 record = S (assume 100% loss; EF= 1.0) for 174.125 lbs.

VOC emissions for treated acres of Soil Applications = 5,398.675 x 0.82 = 4,426.9135 lbs.

VOC emissions for all other Soil Applications = 815.92 x 1.0 = 815.92 lbs.

Total VOC emissions for Soil Applications, Preplant = 5,242.8335 lbs.

STRAWBERRY -- 1990

Number of Records: 23

Total Pounds Chemical Applied: 65,198.27616

Unit Treated: A (acres)

EF value based on application method: 0.82 (shallow injection + LDPE or no tarp)

VOC emissions for Strawberry = 65,198.27616 x 0.82 = 53,462.5864512 lbs.

STRUCTURAL PEST CONTROL -- 1990

Number of Records: 189

Total Pounds Chemical Applied: 40,433.14062

Unit Treated: Unknown (assume 100% loss)

EF value based on Application method: 1.0

VOC emissions from Structural Pest Control = 40,433.14062 x 1.0 = 40,433.14062 lbs.

TOMATO -- 1990

Number of Records: 7

Total Pounds Chemical Applied: 3,583.58

Units Treated: A (acres), S (square feet)

Pounds Chemical Applied by Unit Treated:

3 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 3,384.58 lbs.

4 records = S (assume 100% loss; EF = 1.0) for 199 lbs.

VOC emissions for treated acres of Tomato = 3,384.58 x 0.82 = 2,775.3556 lbs.

VOC emissions for all other Tomato applications = 199 x 1.0 = 199 lbs.

Total VOC emissions for Tomato = 2,974.3556 lbs.

UNCULTIVATED AGRICULTURAL AREAS (ALL OR UNSPEC) -- 1990

Number of Records: 21

Total Pounds Chemical Applied: 59,089.7157

Unit Treated: A (acres), S (square feet)

Pounds Chemical Applied by Unit Treated:

20 records = A (shallow injection + LDPE or no tarp; EF = 0.82) for 59,077.9557 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 11.76 lbs.

VOC emissions for treated acres of Uncult. Ag = 59,077.9557 x 0.82 = 48,443.923674 lbs.

VOC emissions for all other Uncultivated Ag applications = 11.76 x 1.0 = 11.76 lbs.

Total VOC emissions from Uncultivated Ag Areas = 48,455.683674 lbs.

UNCULTIVATED NON-AG AREAS (ALL OR UNSPEC) -- 1990

Number of Records: 5

Total Pounds Chemical Applied: 7,229.9

Units Treated: A (acres); C (cubic feet), S (square feet)

Pounds Chemical Applied by Unit Treated:

3 records = A (shallow injection + LDPE or no tarp; EF = 0.82) = for 7,210.98 lbs.

1 record = C (assume 100% loss; EF = 1.0) for 15 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 3.92 lbs.

VOC emissions for treated acres of Uncult. Non-Ag Areas = 7,210.98 x 0.82 = 5,913.0036 lbs.

VOC emissions for all other Uncult. Non-Ag applications = 18.92 x 1.0 = 18.92 lbs.

Total VOC emissions from Uncultivated Non-Ag Areas = 5,921.9236 lbs.

VERTEBRATE PEST CONTROL -- 1990

Number of Records: 1

Total Pounds Chemical Applied: 33.67866

Units Treated: Unknown (assume 100% loss)

EF value based on application method: 1.0

VOC emissions for Vertebrate Pest Control = 33.67866 x 1.0 = 33.67866 lbs.

WALNUT -- 1990

Number of Records: 109

Total Pounds Chemical Applied: 130,416.4909

Units Treated: A (acres), C (cubic feet), K (thousand cubic feet), P (pounds), S (square feet),
T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

38 records = A (deep injection + LDPE or no tarp; EF = 0.38) for 68,035.46945 lbs.

14 records = C (assume 100% loss; EF = 1.0) for 2,358.75 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 70 lbs.

9 records = P (assume 100% loss; EF = 1.0) for 2,322.5 lbs.

2 records = S (assume 100% loss; EF = 1.0) for 1,213 lbs.

20 records = T (assume 100% loss; EF = 1.0) for 49,984.99 lbs.

25 records = U (assume 100% loss; EF = 1.0) for 6,431.7815 lbs.

VOC emissions for treated acres of Walnut = 68,035.46945 x 0.38 = 25,853.478391 lbs.

VOC emissions for all other Walnut applications = 62,381.0215 lbs.

Total VOC emissions for Walnut = 88,234.499891 lbs.

WOOD PROTECTION TREATMENTS (ALL OR UNSPEC) -- 1990

Number of Records = 3

Total Pounds Chemical Applied: 27.86

Unit Treated: C (cubic feet)

EF value based on application method: 1.0 (assume 100% loss)

VOC emissions for Wood Protection Treatments = 27.86 x 1.0 = 27.86 lbs.

Summary of 1990 Default and Corrected VOC Emissions Data by Crop/Site

CROP/SITE	Default VOC emission (lbs.)	Corrected VOC emission (lbs.)
Alfalfa	16,193.625	13,210.115
Almond	97,562.641	53,723.0207
Apple	11,968.9	4,548.182
Apricot	1,529.485	663.9743
Beans (all or unspec) - all beans	6,556	6,556
Beehives (all or unspec) – all beehives	551.2	551.2
Carrots	398	326.36
Cherry	23,246.8726	10,441.654488
Commodity Fumigation	5,070.745	5,070.745
Cotton	6,500.335	5,330.2747
Fig	1,267.88	1,143.88
Forest Trees	32.34	26.5188
Fruits (dried)	2,648.95	2,648.95
Grains	0.98	0.98
Grapes	76,258.236	38,222.23978
Grapes, Wine	537,163.545	204,122.1471
Kiwifruit	2,585.01	982.3038
Landscape Maintenance	3,802.01	3,117.6564
Nectarine	192,746.285	91,535.4499
N-Grnhs Grwn Cut Flwrs or Greens	103.3099	86.8327
N-Grnhs Grwn Trnsplnt/Prpgtv Mtrl	86.645	86.645
N-Outdr Container/Fld Grwn Plants	794,109.3	651,169.4046
N-Outdr Grwn Trnsplnt/Prpgtv Mtrl	186,321.0915	153,096.42213
Nut Crops, Nut Trees	4,938.55	4,938.55
Onion	8,648.54	7,113.0348
Orange	4,956.865	1,883.6087
Peach	188,637.64	72,254.7058
Pear	1,333.3	506.654
Peas – all peas	1,848	1,848
Pets	9.95	9.95
Pistachio	10,449.525	10,002.505
Plum	51,002.88	19,381.0944
Public Health Pest Control	405.52	405.52
Rice	14	14
Rights of Way	4,228.52	3,467.3864
Soil Applications (houseplant soil)	8.9555	8.9555
Soil Applications (preplant)	6,214.595	5,242.8335
Strawberry	65,198.27616	53,462.5864512
Structural Pest Control	40,433.14062	40,433.14062
Tomato	3,583.58	2,974.3556
Uncultivated Ag Areas	59,089.7157	48,455.683674
Uncultivated Non-Ag Areas	7,229.9	5,921.9236
Vertebrate Pest Control	33.67866	33.67866
Walnut	130,416.4909	88,234.49891
Wood Protection treatments	27.86	27.86
TOTAL	2,556,412.779	1,614,281.682

APPENDIX B

2004 Methyl Bromide VOC Emissions in the San Joaquin Valley

[since the default EP value is 100% (1.0) for all methyl bromide applications, this component of the equation was not included in the following calculations, as it does not affect the equations' product]

ALFALFA (FORAGE – FODDER) (ALL OR UNSPEC) -- 2004

Number of Records: 1

Total Pounds Chemical Applied: 11.76

Unit Treated: A (acres)

EF based on Application Method: 0.43 (shallow injection + HDPE tarp)

VOC emissions for Alfalfa = 11.76 x 0.43 = 5.0586 lbs.

ALMOND -- 2004

Number of Records: 92

Total Pounds of Chemical Applied: 25,789.45151

Units Treated: A (acres), C (cubic feet), K (thousand cubic feet), T (tons), U (misc. unit)

Pounds Applied by Unit Treated:

58 records = A (deep injection + HDPE tarp, EF = 0.26) for 19,946.71286 lbs.

17 records = C (assume 100% loss; EF = 1.0) for 1278.769651 lbs.

3 records = K (assume 100% loss; EF = 1.0) for 2387.379 lbs.

6 records = T (assume 100% loss; EF = 1.0) for 989 lbs.

4 records = U (assume 100% loss; EF = 1.0) for 1187.59 lbs.

VOC emissions for treated acres of almond = 19,946.71286 x 0.26 = 5,186.14534 lbs.

VOC emissions for all other almond applications = 5,842.73865 x 1.0 = 5,842.73865 lbs.

Total VOC emissions for Almond = 11,028.884 lbs.

APPLE -- 2004

Number of Records: 1

Total Pounds Chemical Applied: 997.2991

Unit Treated: A (acres)

EF based on Application Method: 0.26 (deep injection + HDPE tarp)

VOC emissions for Apple = 997.2991 x 0.26 = 259.297766 lbs.

APRICOT -- 2004

Number of Records: 9

Total Pounds Chemical Applied: 784.700504

Units Treated: C (cubic feet), P (pounds), U (misc. unit)

Pounds Applied by Unit Treated:

2 records = C (assume 100% loss; EF = 1.0) for 15.70275 lbs.

4 records = P (assume 100% loss; EF = 1.0) for 638.2216 lbs.

3 records = U (assume 100% loss; EF = 1.0) for 130.776154 lbs.

Total VOC emissions for Apricot = 784.700504 lbs.

CASHEW -- 2004

Number of Records: 1
Total Pounds Chemical Applied: 3
Unit Treated: T (tons; assume 100% loss)
EF based on application method: 1.0
VOC emissions for Cashew = 3 x 1.0 = 3.0 lbs.

CHERRY -- 2004

Number of Records: 33
Total Pounds Chemical Applied: 25,753.4966
Units Treated: A (acres), P (pounds), S (square feet)
Pounds Applied by Unit Treated:
31 records = A (deep injection + HDPE tarp, EF = 0.26) for 25,214.4966 lbs.
1 record = P (assume 100% loss; EF = 1.0) for 68.6 lbs.
1 record = S (assume 100% loss, EF = 1.0) for 470.4 lbs.
VOC emissions for treated acres of cherry = 25,214.4966 x 0.26 = 6,562.78912
VOC emissions for all other cherry applications = 539 x 1.0 = 539 lbs.
Total VOC emissions for Cherry = 7,101.78912 lbs.

COMMODITY FUMIGATION -- 2004

Number of Records: 38
Total Pounds Chemical Applied: 16,300.83535
Unit Treated: Unknown
EF based on application Method: 1.0 (assume 100% loss)
VOC emissions for Commodity Fumigation = 16,300.83535 x 1.0 = 16,300.83535 lbs.

COTTON -- 2004

Number of Records: 1
Total Pounds Chemical Applied: 54.1034
Unit Treated: A (acres)
EF based on Application Method: 0.43 (shallow injection + HDPE tarp)
VOC emissions for Cotton = 54.1034 x 0.43 = 23.264462 lbs.

CRANBERRY -- 2004

Number of Records: 3
Total Pounds Chemical Applied: 9.1
Unit Treated: T (tons)
EF based on Application Method: 1.0 (assume 100% loss)
VOC emissions for Cranberry = 9.1 x 1.0 = 9.1 lbs.

EGGPLANT (ORIENTAL EGGPLANT) -- 2004

Number of Records: 1
Total Pounds Chemical Applied: 799.98
Unit Treated: A (acres)
EF based on Application Method: 0.43 (shallow injection + HDPE tarp)
VOC emissions for Eggplant = 799.98 x 0.43 = 343.9914 lbs.

FIG -- 2004

Number of Records: 9

Total Pounds Chemical Applied: 4,653.4975

Units Treated: C (cubic feet), K (thousand cubic feet)

Pounds Chemical Applied by Unit Treated:

8 records = C (assume 100% loss; EF = 1.0) for 64.815 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 4,588.6925 lbs.

Total VOC emissions for Fig = 4,653.4975 lbs.**FRUITS (DRIED OR DEHYDRATED) -- 2004**

Number of Records: 20

Total Pounds Chemical Applied: 5,967.549

Units Treated: C (cubic feet), T (tons)

Pounds Chemical Applied by Unit Treated:

19 records = C (assume 100% loss; EF = 1.0) for 5,409.229 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 558.32

Total VOC emission for Fruits (dried or dehydrated) = 5,967.549 lbs.**FUMIGATION, OTHER -- 2004**

Number of Records: 49

Total Pounds Chemical Applied: 14,239.27303

Unit Treated: Unknown

EF value based on Application Method: 1.0 (assume 100% loss)

VOC emissions for Fumigation, Other = 14,239.27303 x 1.0 = 14,239.27303 lbs.**GRAPES -- 2004**

Number of Records: 27

Total Pounds Chemical Applied: 13,182.7389

Units Treated: C (cubic feet), P (pounds), T (tons)

Pounds Chemical Applied by Unit Treated:

24 records = C (assume 100% loss; EF = 1.0) for 11,916.1638 lbs.

2 records = P (assume 100% loss; EF = 1.0) for 1,264.576 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 2 lbs.

Total VOC emissions for Grapes = 13,182.7389 lbs.**NECTARINE -- 2004**

Number of Records: 29

Total Pounds Chemical Applied: 9,771.0202

Units Treated: A (acres), C (cubic feet), P (pounds), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

2 records = A (deep injection + HDPE tarp; EF = 0.26) for 6,188.2 lbs.

1 record = C (assume 100% loss; EF = 1.0) for 175.8 lbs.

11 records = P (assume 100% loss; EF = 1.0) for 986.9432 lbs.

5 records = T (assume 100% loss; EF = 1.0) for 1,008.607 lbs.

10 records = U (assume 100% loss; EF = 1.0) for 1,411.47 lbs.

VOC emission for treated acres of Nectarine = 6,188.2 x 0.26 = 1,608.932 lbs.

VOC emission for all other Nectarine applications = 3,582.8202 x 1.0 = 3,582.8020 lbs.

Total VOC emissions for Nectarine = 5,191.734 lbs.

N-OUTDR CONTAINER/FLD GRWN PLANTS -- 2004

Number of Records: 67

Total Pounds Chemical Applied: 414,159.2887

Unit Treated: A (acres)

EF value based on Application Method: 0.43 (shallow injection + HDPE tarp)

VOC emission for N-Outdr Container Plants = 414,159.2887 x 0.43 = 178,088.494 lbs.

N-OUTDR GRWN TRNSPLNT/PRPGTV MTRL -- 2004

Number of Records: 52

Total Pounds Chemical Applied: 131,928.32

Unit Treated: A (acres)

EF value based on Application Method: 0.43 (shallow injection + HDPE tarp)

VOC emission for N-Outdr Trnsplnt/Prpgtv = 131,928.32 x 0.43 = 56,752.3976 lbs.

NUT CROPS, NUT TREES (ALL OR UNSPEC) -- 2004

Number of Records: 5

Total Pounds Chemical Applied: 79

Unit Treated: T (tons)

EF value based on Application Method 1.0 (assume 100% loss)

VOC emission for Nut Crops = 79 x 1.0 = 79 lbs.

ONION -- 2004

Number of Records: 4

Total Pounds Chemical Applied: 4,416.64

Unit Treated: A (acres)

EF value based on Application Method: 0.43 (shallow injection + HDPE tarp)

VOC emissions for Onion = 4,416.64 x 0.43 = 1,899.1552

ORANGE -- 2004

Number of Records: 23

Total Pounds Chemical Applied: 4,417.24

Unit Treated: A (acres)

EF based on Application Method: 0.43 (shallow injection + HDPE tarp)

VOC emissions for Orange = 4,417.24 x 0.43 = 1,899.4132 lbs.

ORNAMENTAL TURF -- 2004

Number of Records: 7

Total Pounds Chemical Applied: 16,576.7

Unit Treated: A (acres)

EF based on Application Method: 0.43 (shallow injection + HDPE tarp)

VOC emissions for Ornamental Turf = 1,576.7 x 0.43 = 7,127.981 lbs.

PEACH -- 2004

Number of Records: 31

Total Pounds Chemical Applied: 18,962.44635

Units Treated: A (acres), C (cubic feet), P (pounds), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

3 records = A (deep injection + HDPE tarp; EF = 0.26) for 10,492.12325 lbs.

4 records = C (assume 100% loss; EF = 1.0) for 85.215 lbs.

9 records = P (assume 100% loss; EF = 1.0) for 601.8271 lbs.

7 records = T (assume 100% loss; EF = 1.0) for 6,505.4 lbs.

8 records = U (assume 100% loss; EF = 1.0) for 1,277.88 lbs.

VOC emission for treated acres of Peach = $10,492.12325 \times 0.26 = 2,727.95205$ lbs.

VOC emission for all other Peach applications = $8,470.3231 \times 1.0 = 8,470.3231$ lbs.

Total VOC emissions for Peach = 11,198.2751 lbs.

PEAR -- 2004

Number of Records: 3

Total Pounds Chemical Applied: 72.54

Units Treated: A (acres), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

2 records = A (acres; deep injection + HDPE tarp; EF = 0.26) for 27.44

1 record = U (misc. unit; assume 100% loss; EF = 1.0) for 45.1 lbs.

VOC emissions for treated acres of Pear = $27.44 \times 0.26 = 7.1344$

VOC emissions for all other Pear applications = $45.1 \times 1.0 = 45.1$ lbs.

Total VOC emissions for Pear = 52.2344 lbs.

PECAN -- 2004

Number of Records: 1

Total Pounds Chemical Applied: 6

Unit Treated: T (tons)

EF value based on Application Method: 1.0 (assume 100% loss)

VOC emissions for Pecan = $6 \times 1.0 = 6$ lbs.

PINEAPPLE -- 2004

Number of Records: 1

Total Pounds Chemical Applied: 68.3

Unit Treated: P (pounds)

EF value based on Application Method: 1.0 (assume 100% loss)

VOC emissions for Pineapple = $68.3 \times 1.0 = 68.3$ lbs.

PISTACHIO -- 2004

Number of Records: 6

Total Pounds Chemical Applied: 1,155.994

Unit Treated: C (cubic feet), T (tons)

Pounds Chemical Applied by Unit Treated:

2 records = C (assume 100% loss; EF = 1.0) for 177 lbs.

4 records = T (assume 100% loss; EF = 1.0) for 987.994 lbs.

Total VOC emissions for Pistachio = $1,155.994 \times 1.0 = 1,155.994$ lbs.

PLUM (INCLUDES WILD PLUMS FOR HUMAN CONSUMPTION) -- 2004

Number of Records: 33

Total Pounds Chemical Applied: 3,104.2867

Unit Treated: A (acres), C (cubic feet), P (pounds), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

2 records = A (deep injection + HDPE tarp; EF = 0.26) for 999.6 lbs.

8 records = C (assume 100% loss; EF = 1.0) for 231.9215 lbs.

12 records = P (assume 100% loss; EF = 1.0) for 661.3392 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 0.026 lbs.

10 records = U (assume 100% loss; EF = 1.0) for 1,211.4 lbs.

VOC emissions for treated acres of Plum = $999.6 \times 0.26 = 259.896$ lbs.

VOC emissions for all other Plum applications = $2,104.6867 \times 1.0 = 2,104.6867$ lbs.

Total VOC emissions for Plum = 2364.5827 lbs.

PRUNE -- 2004

Number of Records: 2

Total Pounds Chemical Applied: 555

Unit Treated: C (cubic feet), P (pounds)

Pounds Chemical Applied by Unit Treated:

1 record = C (assume 100% loss; EF = 1.0) for 350 lbs.

1 record = P (assume 100% loss; EF = 1.0) for 205 lbs.

Total VOC emissions for Prune = $555 \times 1.0 = 555$ lbs.

RESEARCH COMMODITY -- 2004

Number of Records:

Total Pounds Chemical Applied: 2,113.85

Unit Treated: A (acres)

EF value based on application method: 0.43 (shallow injection + HDPE tarp)

VOC emissions for Research Commodity = $2,113.85 \times 0.43 = 908.9555$ lbs.

RIGHTS OF WAY -- 2004

Number of Records: 2

Total Pounds Chemical Applied: 58.8

Unit Treated: Unknown

EF value based on application method: 0.82 (assume shallow injection, non-tarped)

VOC emissions for Rights of Way = $58.8 \times 0.82 = 48.216$ lbs.

SOIL APPLICATIONS, PREPLANT – OUTDOOR (SEEDBEDS, ETC.) -- 2004

Number of Records: 27

Total Pounds Chemical Applied: 60,945.91

Units Treated: A (acres), C (cubic feet)

Pounds Chemical Applied by Unit Treated:

20 records = A (shallow injection + HDPE tarp; EF = 0.43) for 59,671.91 lbs.

7 records = C (assume 100% loss; EF = 1.0) for 1,274 lbs.

VOC emissions for treated acres of Soil Applications = $59,671.91 \times 0.43 = 25,658.9213$ lbs.

VOC emissions for all other Soil Applications = $1,274 \times 1.0 = 1,274$ lbs.

Total VOC emissions for Soil Applications = 26,932.9213 lbs.

STORAGE AREAS & PROCESSING EQUIPMENT (ALL/UNSPEC) -- 2004

Number of Records: 23

Total Pounds Chemical Applied: 2,741.6668

Unit Treated: C (cubic feet)

EF value based on application method: 1.0 (assume 100% loss)

VOC emissions for Storage Areas = 2,741.6668 x 1.0 = 2,741.6668 lbs.

STRAWBERRY -- 2004

Number of Records: 31

Total Pounds Chemical Applied: 9,644.98

Unit Treated: A (acres)

EF value based on application method: 0.43 (shallow injection + HDPE tarp)

VOC emissions for Strawberry = 9,644.98 x 0.43 = 4,147.3414 lbs,

STRUCTURAL PEST CONTROL -- 2004

Number of Records: 28

Total Pounds Chemical Applied: 4,986.445

Unit Treated: Unknown

EF value based on Application method: 1.0 (assume 100% loss)

VOC emissions from Structural Pest Control = 4,986.445 x 1.0 = 4,986.445 lbs.

UNCULTIVATED AGRICULTURAL AREAS (ALL OR UNSPEC) -- 2004

Number of Records: 5

Total Pounds Chemical Applied: 51,265.76

Unit Treated: A (acres)

EF value based on Application method: 0.43 (shallow injection + HDPE tarp)

VOC emissions from Uncultivated Ag Areas = 51,265.76 x 0.43 = 22,044.2768 lbs.

UNCULTIVATED NON-AGRICULTURAL AREAS (ALL OR UNSPEC) -- 2004

Number of Records: 5

Total Pounds Chemical Applied: 1,657.8918

Unit Treated: A (acres)

EF value based on Application method: 0.43 (shallow injection + HDPE tarp)

VOC emissions from Uncultivated Ag Areas = 1,657.8918 x 0.43 = 712.893474 lbs.

WALNUT -- 2004

Number of Records: 63

Total Pounds Chemical Applied: 37,380.6043

Units Treated: A (acres), C (cubic feet), S (square feet), T (tons), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

22 records = A (acres; deep injection + HDPE tarp; EF = 0.26) for 22,450.0859 lbs.

7 records = C (cubic feet; assume 100% loss; EF = 1.0) for 906.5 lbs.

3 records = S (square feet; assume 100% loss; EF = 1.0) for 85.2984 lbs.

20 records = T (tons; assume 100% loss; EF = 1.0) for 8,497.661 lbs.

11 records = U (misc. unit; assume 100% loss; EF = 1.0) for 5,441.059 lbs.

VOC emissions for treated acres of Walnut = 22,450.0859 x 0.26 = 5,837.022334 lbs.

VOC emissions for all other Walnut applications = 14,930.5184 lbs.

Total VOC emissions for Walnut = 20,767.540734 lbs.

Summary of 2004 Default and Corrected VOC Emissions Data by Crop/Site

CROP/SITE	Default VOC emission (lbs.)	Corrected VOC emission (lbs.)
Alfalfa	11.76	5.0586
Almond	25,789.45141	11,028.884
Apple	997.2991	259.297766
Apricot	784.700504	784.700504
Cashew	3	3
Cherry	25,753.4966	7,101.78912
Commodity Fumigation	16,300.83535	16,300.83535
Cotton	54.1034	23.264462
Cranberry	9.1	9.1
Eggplant	799.98	343.9914
Fig	4,653.4975	4,653.4975
Fruits (dried)	5,967.549	5,967.549
Fumigation (other)	14,239.27303	14,239.27303
Grapes	13,182.7389	13,182.7389
Nectarine	9,771.0202	5,191.734
N-Outdr Container/Fld Grwn Plants	414,159.2887	178,088.494
N-Outdr Grwn Trnsplnt/Prpgtv Mtrl	131,928.32	56,752.3976
Nut Crops, Nut Trees	79	79
Onion	4,416.64	1,899.1552
Orange	4,417.24	1,899.4132
Ornamental Turf	16,576.7	7,127.981
Peach	18,962.44635	11,198.2751
Pear	72.54	52.2344
Pecan	6	6
Pineapple	68.3	68.3
Pistachio	1,155.994	1,155.994
Plum	3,104.2867	2,364.5827
Prune	555	555
Research Commodity	2113.85	908.9555
Rights of Way	58.8	48.216
Soil Applications (Preplant)	60,945.91	26,658.9213
Storage Areas & Processing Eq.	2,741.6668	2,741.6668
Strawberry	9,644.98	4,417.3414
Structural Pest Control	4,986.445	4,986.445
Uncultivated Ag Areas	51,265.76	22,044.2768
Uncultivated Non-Ag Areas	1,657.8918	712.893474
Walnut	37,380.6043	20,767.540734
TOTAL	884,615.4696	423,357.7978

APPENDIX C

PRODUCT NAMES from PUR database that are included in the analyses.

1990	2004
75/25	57-43
92-2 Contains 2% Chloropicrin	67-33 Preplant Soil Fumigant
Brom-O-Gas (Liquid)	92-2 Contains 2% Chloropicrin
Brom-O-Gas .5%	Brom-O-Gas (Liquid)
Brom-O-Gas 2%	Brom-O-Gas .5%
Brom-O-Gas Contains 1% Chloropicrin	MBC Concentrate Soil Fumigant
DOW Methyl Bromide	MBC-33 Soil Fumigant
Metabrom 100	Metabrom 100
Meth-O-Gas	Metabrom Q
Meth-O-Gas (Can)	Meth-O-Gas
Meth-O-Gas 100	Meth-O-Gas (Can)
Methyl Bromide 100	Meth-O-Gas 100
Methyl Bromide 98%	Methyl Bromide
Methyl Bromide 99.5%	Methyl Bromide 100
Methyl Bromide 99.75%	Methyl Bromide 98%
Namco Methyl Bromide	Methyl Bromide 99.5%
Namco Namfume	Methyl Bromide 99.75%
Shore Chemical Co. Methyl Bromide 100	Methyl Bromide Rodent Fumigant
Shore Chemical Co. Methyl Bromide 99.5%	Namco Namfume
Terr-O-Gas 57	Terr-O-Gas 57
Terr-O-Gas 75	Terr-O-Gas 67
Tri-Con 57/43	Terr-O-Gas 75
Tri-Con 67/33	Terr-O-Gas 98
Tri-Con 75/25	Tri-Con 50/50
Tri-Con 80/20	Tri-Con 57/43
	Tri-Con 67/33
	Tri-Con 75/25
	Tri-Con 80/20

Analysis of Chloropicrin Emissions in the San Joaquin Valley in 1990 and 2004

Abstract

This report calculates and summarizes the total amount of chloropicrin emitted from agricultural and non-agricultural usage in the San Joaquin Valley in 1990 and 2004 during the peak ozone season (May 1 to October 31 of each year). All chloropicrin use data were obtained from the CDPR Pesticide Information Portal (CALPIP) – Pesticide Use Report (PUR) online database. Using the method that CDPR historically has used, which assumes that 100% of the applied chloropicrin is emitted into the air, approximately 112,646 pounds of chloropicrin were emitted in the eight counties comprising the San Joaquin Valley in 1990 (0.306 tons/day); and approximately 120,808 pounds of chloropicrin were emitted in 2004 (0.328 tons/day). The difference between 1990 and 2004 represents a 7.2% increase in chloropicrin total emissions. An alternative VOC equation, based on mass loss studies and discrete usage data, was developed that takes into account the proportion of chloropicrin that is degraded in the soil (for soil fumigations). It is believed that this alternative VOC emission equation more accurately reflects the total amount of chloropicrin emitted by each crop or site and method of application. Using this new equation, approximately 70,931.59 lbs. of chloropicrin was emitted in 1990 (0.193 tons/day), and approximately 41,787.24169 pounds of chloropicrin were emitted in 2004 (0.114 tons/day). The difference between 1990 and 2004, using the corrected VOC equation, represents a 40.9% reduction in chloropicrin total emissions.

Data Acquisition and Overall Use Statistics

The CALPIP search queries were by *Year* (“1990” and “2004”) and *Chemical Name* (“chloropicrin”). In this way, all PUR data for chloropicrin were included, regardless of formulation, product name, crop or site of application, etc. Both *Agricultural* and *Non-Agricultural* (under *Other Criteria: Reporting Type*) use reports were included.

The aggregate 1990 and 2004 PUR files for chloropicrin were downloaded and contained all PUR reports for the entire State of California. The 1990 Statewide PUR file contained 6,418 records of application that, collectively, totaled 2,218,294.898 pounds of chloropicrin. The 2004 Statewide PUR file contained 3,551 records of application that, collectively, totaled 5,132,916.855 pounds of chloropicrin (Table 1).

The 1990 and 2004 Statewide PUR files were then processed to include only the 8 counties that comprise the San Joaquin Valley: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare. While only part of Kern County is technically included in the San Joaquin Valley VOC non-attainment area, all PUR records for Kern County were included in these analyses as a conservative measure, because it was not possible to distinguish between the applications that occurred in the non-attainment area and those that did not.

The 1990 PUR file for the San Joaquin Valley contained 960 records of application that, collectively, totaled 188,762.2068 pounds of chloropicrin. The 2004 PUR file for the San Joaquin Valley contained 439 records of application that, collectively, totaled 328,917.2909 pounds of chloropicrin (Table 1).

The 1990 and 2004 San Joaquin Valley PUR files were then processed to include only the applications that occurred between May 1 and October 31 of each year, as this period is considered the “peak ozone season”. The 1990 PUR file for the San Joaquin Valley Ozone Season contained 530 records of application that, collectively, totaled 112,645.6355 pounds of chloropicrin. These 530 records consisted of 228 records for which the dates of application were listed and occurred between May 1 and October 31, and an additional 302 records for which no date of application was listed. As a conservative measure, these 530 no-date records were assumed to have occurred during the peak ozone season. The 2004 PUR file for the San Joaquin Valley Ozone Season contained 153 records of application that, collectively, totaled 120,807.6326 pounds of chloropicrin (Table 1).

The total amount of chloropicrin applied in the San Joaquin Valley during the peak ozone season in 2004 (120,807.6326 lbs.) is approximately 107.2% of what was applied in 1990 (112,645.6355 lbs.), representing a 7.2% increase in usage.

Table 1. Cumulative number of records and total pounds of chloropicrin applied in California (whole-year) and the San Joaquin Valley (whole-year and during the “peak ozone season”) for all Agricultural and Non-Agricultural applications in 1990 and 2004.

Year	Area & Period	No. of Records	Amount of Chloropicrin Applied (total lbs.)
1990	Statewide, 12-month	6,418	2,218,294.898
	San Joaquin Valley, 12-month	960	188,762.2068
	San Joaquin Valley, May 1 to October 31	530	112,645.6355
2004	Statewide, 12-month	3,551	5,132,916.855
	San Joaquin Valley, 12-month	439	328,917.2909
	San Joaquin Valley, May 1 to October 31	153	120,807.6326

Analysis of VOC Emissions based on CDPR Procedures

CDPR uses the following equation to calculate VOC emissions from pesticide applications, where *EP* is defined as the Emissions Potential (VOC fraction) of a given pesticide product:

$$VOC\ emission\ (lbs.) = [lbs.\ of\ product\ applied] * [product-specific\ EP]$$

For all chloropicrin products, CDPR assigns a default EP value of 100%. This assumes that 100% of the applied amount of chloropicrin is volatilized from the soil or other site, such that the total chloropicrin VOC emissions are equal to the amount of chloropicrin applied during a specific period, location, etc.

Using this equation for the total amounts applied in Table 1, it can be calculated that the average daily VOC emissions in the San Joaquin Valley during the peak ozone season were approximately 0.306 tons/day in 1990 and 0.328 tons/day in 2004 (2000 pounds = 1 ton; 184 days in May 1 to October 31 period) (Table 2). This represents a 0.022 tons/day (or 7.2%) increase in chloropicrin VOC emissions in 2004 compared to 1990.

Alternative Analysis of VOC Emissions based on Mass Loss Studies

While 100% of the applied chloropicrin can theoretically be emitted from a given end-use site, studies have demonstrated that, at least for soil fumigation, a portion of the chloropicrin is degraded in the soil and is not emitted into the air (i.e., via mass loss studies). With respect to this fact, any chloropicrin VOC emission calculation that assumes 100% emission would considerably overestimate chloropicrin's contribution to the VOC burden in the San Joaquin Valley or any other area with significant chloropicrin use in soil fumigation. For non-soil fumigation sites (commodity fumigation, structural fumigation, etc.), where there is little opportunity for chloropicrin degradation, the 100% emissions is likely accurate.

Four unpublished studies previously submitted to CDPR provide an array of data on mass loss estimates of chloropicrin during various field fumigation scenarios. These mass loss studies can be used to more accurately estimate total chloropicrin emissions from soil fumigation activity. Based on these studies, an additional component to the VOC emissions calculation was added, where *EF* = the Emissions Factor, or the proportion of chloropicrin that is emitted from the application field or site. This alternative calculation is:

$$VOC\ emission\ (lbs.) = [lbs.\ of\ product\ applied] * [product-specific\ EP] * [application-specific\ EF]$$

By example, if chloropicrin was applied to 10 acres of strawberry at 200 lbs. a.i. (active ingredient) per acre, the total amount applied would be 2,000 lbs. of chloropicrin. The EP value remains 100% (1.0 by proportion), based on 100% of the product being volatile. The EF value would be based on mass loss studies where, in this case, the application is a broadcast shallow (6-15 in.) injection with HDPE tarp, which was estimated to result in 37% emission (0.37 by proportion) of the applied chemical. So, for this example:

$$VOC\ emission\ (lbs.) = [2000\ lbs.] * [1.0] * [0.37] = 740\ lbs.\ emitted.$$

Therefore, based on this approach, only 740 lbs. of the 2,000 lbs. of chloropicrin that was applied, was emitted during this application.

Based on the studies, the following *EF* values were used to calculate total emissions for each crop or site (e.g., soil fumigation vs. structural fumigation), type of fumigation (e.g., almond acres vs. almond nuts prior to packaging), type of application (e.g., shallow vs. deep shank; tarp or no tarp; drip-applied), where the type of application was determined by the “Unit Treated” and “Product Name” fields of the PUR records:

Unit Treated:

- A = acres
 - Shallow injection (6-15 in.), broadcast, no tarp= 62% emission (EF = 0.62) ¹
 - Shallow injection (6-15 in.), broadcast, LDPE tarp = 62% emission* (EF = 0.62) ²
 - Shallow injection (6-15 in.), broadcast, HDPE tarp = 37% emission (EF = 0.37) ³
 - Deep injection (20+ in.), broadcast, no tarp = 62% emission (EF = 0.62) ⁴
 - Deep injection (20+ in.), broadcast, LDPE tarp = 62% emission* (EF = 0.62) ⁴
 - Deep injection (20+ in.), broadcast, HDPE tarp = 37% emission (EF = 0.37) ⁴
 - Drip-application, surface or buried, HDPE tarp = 9% emission (EF = 0.09) ⁵

¹ Cited from: Beard et al. 1996. Monitoring of potential worker exposure, field flux and off-site air concentration during chloropicrin field application. Study # HEH160 (unpublished study submitted to CDPR).

² No studies were found that determined mass loss of chloropicrin through LDPE films, regardless of injection depth. However, based on data from other fumigants (e.g., methyl bromide, Yates *et al.* 1996), LDPE film is assumed to provide virtually no chloropicrin retention properties. Therefore, as a conservative measure, the EF values for all LDPE tarp applications were considered to be equal to the EF values for non-tarped applications.

³ The 37% mass loss estimate was derived as the average from the mass loss measurements from four different sites from which data are available. Using the average mass loss estimate allows for variability in soil type, soil moisture, and other factors that may influence mass loss of chloropicrin from field applications. Study sites and their mass loss estimates from which the average was derived were: Salinas, CA (15% mass loss; Lee *et al.* 1994); Yakima, WA (34% mass loss; Beard *et al.* 1996); Bradenton, FL (37% mass loss; Beard *et al.* 1996); and Phoenix, AZ (63% mass loss; Beard *et al.* 1996).

⁴ No studies were found that determined mass loss of chloropicrin at injection depths greater than what is considered shallow (6-15 in.) injection. Therefore, as a conservative measure, all deep injection EF estimates were based on the EF values for shallow injections, even though it is very plausible that deeper injection depths result in lower mass loss values, as was determined for methyl bromide (Yates *et al.* 1996).

⁵ The 9% mass loss estimate for drip applications was derived as the average from two mass loss studies because it was not possible to determine, from the PUR database, whether individual applications were buried-drip (3% mass loss; Gillis and Smith 2002) or surface-drip (15% mass loss; Rotondaro 2004).

- C = cubic feet (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- K = thousand cubic feet (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- P = pounds (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- S = square feet (for greenhouse treatments, etc.; assume 100% loss; EF = 1.0)
- T = tons (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- U = miscellaneous unit (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)
- Not Listed = (for commodity, potting media, etc.; assume 100% loss; EF = 1.0)

As an aggregate example, the following data for 2004 chloropicrin applications to outdoor grown greenhouse transplant/propagative material is used to illustrate the incorporation of application-specific *EF* values into the VOC equation:

N-OUTDR GRWN TRNSPLNT/PRPGTV MTRL

Number of Records: 40

Pounds Chemical Applied: 11,357.4905

Unit Treated: A (acres), K (thousand cubic feet), Unknown

Pounds Chemical Applied by Unit Treated:

31 records = A ($EF = 0.62$) for 11,351.1205 lbs.

1 record = K (assume 100% loss; $EF = 1.0$) for 6 lbs.

8 records = Unknown (assume 100% loss; $EF = 1.0$) for 0.37 lbs.

VOC emissions for shank-injected chloropicrin = $11,351.1205 \times 0.62 = 7,037.69471$ lbs.

VOC emissions for drip-injected chloropicrin = $6.37 \times 1.0 = 6.37$ lbs.

VOC emissions for N-Outdr Trnsplnt/Prpgtv Mtrl = 7,044.06471 lbs.

This same aggregate analysis was performed for all SITE/CROP listings within both the 1990 and 2004 PUR files. The aggregate analysis and summary table for 1990 applications are provided in Appendix A. The aggregate analysis and summary table for 2004 applications are provided in Appendix B. These analyses assume the following:

- Approximately 90% of chloropicrin soil fumigations in 1990 were non-tarped and 10% were tarped using LDPE film (primarily as co-formulations with methyl bromide).
- LDPE film is considered to have little gas retention properties, and therefore, any 1990 applications with LDPE film had *EF* values that were the same as non-tarped applications.
- LDPE film was only used in 1990 and not in 2004.
- All CDPR-approved HDPE films were assigned the same *EF*, which was based on mass loss studies.
- All 2004 soil applications where chloropicrin was co-formulated with methyl bromide used HDPE film, regardless of injection depth.
- All 2004 drip-applications of chloropicrin were assumed to be tarped with HDPE.
- All non-acre applications are assumed to result in 100% emission of product.

Based on the sum values for the *EF*-corrected VOC emission equations that were applied to each Crop/Site by year, it is calculated that 70,931.59 lbs. of chloropicrin were emitted in the eight counties comprising the San Joaquin Valley during the peak ozone season in 1990 (0.193 tons/day), and 41,787.24169 lbs. of chloropicrin were emitted in 2004 (0.114 tons/day). The 2004 VOC total is approximately 59.1% of the 1990 total, which equates to a 40.9% reduction in chloropicrin emissions.

Table 2. Default and Corrected Chloropicrin VOC emissions.

Year	Default VOC emissions (tons/day) ^z	VOC emissions corrected using mass loss data (tons/day) ^y
1990	0.306	0.193
2004	0.328	0.114

^z Values assume 100% emission of applied material.

^y Values incorporate empirically-derived mass loss data.

CONCLUSION

When the type of application is not considered and 100% of the applied chloropicrin is assumed to be emitted, the total VOC emissions of chloropicrin increased from 0.306 tons/day in 1990 to 0.328 tons/day in 2004. When the type of application is considered relative to the proportion of chloropicrin that is degraded in the soil, the total VOC emissions of chloropicrin were reduced from 0.193 tons/day in 1990 to 0.114 tons/day in 2004.

The Product Names listed in the PUR database files are presented in Appendix 3.

References Cited:

Beard, et al. 1996. Monitoring of potential worker exposure, field flux and off-site air concentration during chloropicrin field application. Study # HEH160. Unpublished study submitted to CDPR.

Gillis, M. and G.S. Smith. 2002. Chloropicrin emissions and offsite drift from tarped and non-tarped fields treated by a drip irrigation application method. Study # TC350. Unpublished study submitted to CDPR.

Lee, H., K.V. Natta, and M. Gillis. 1994. TC246/BR707 Chloropicrin workers exposure, flux and offsite monitoring and dispersion modeling for tarped broadcast application – pilot study. Unpublished study submitted to CDPR.

Rotondaro, A. 2004. Monitoring of chloropicrin emissions from field and greenhouse drip irrigation applications, and implied worker inhalation exposure from applications of chloropicrin by shank injection, drip irrigation systems and at tree replant sites. Study # PRS02004. Unpublished study submitted to CDPR.

Yates, S.R., J. Gan, F.F. Ernst, D. Wang, and M. Yates. 1996. Emissions of methyl bromide from agricultural fields: rate estimates and methods of reduction, pp. 116-134. *In* Seiber et al. 1996, Fumigants: Environmental Fate, Exposure, and Analysis. American Chemical Society, Washington, DC.

APPENDIX A

1990 Chloropicrin VOC Emissions in the San Joaquin Valley

ALFALFA (FORAGE, FODDER) (ALFALFA HAY)

Number of Records: 4

Pounds of Chemical Applied: 1,863.375

Units Treated: A (acres), T (tons), U (misc. unit)

Total Pounds Applied by Unit Treated:

2 records = A (EF = 0.62) for 80.5 lbs.

1 record = T (assume 100% loss; EF = 1.0) for 1,782 lbs.

1 record = U (assume 100% loss; EF = 1.0) for 0.875 lbs.

VOC emissions for shank-injected chloropicrin = $80.5 \times 0.62 = 49.91$ lbs.

VOC emissions for all other Alfalfa applications = $1,782.875 \times 1.0 = 1,782.875$ lbs.

VOC emissions for Alfalfa = 1,832.785 lbs.

ALMOND

Number of Records: 22

Total Pounds of Chemical Applied: 80.076

Units Treated: A (acres), S (square feet), T (tons), U (misc. unit)

Total Pounds Applied by Unit Treated:

6 records = A (EF = 0.62) for 74.316 lbs.

1 record = S (assume 100% loss; EF = 1.0) for 0.875 lbs.

1 records = T (assume 100% loss; EF = 1.0) for 0.825 lbs.

14 records = U (assume 100% loss; EF = 1.0) for 7.06 lbs.

VOC emissions for shank-injected chloropicrin = $74.316 \times 0.62 = 40.07592$ lbs.

VOC emissions for all other Almond applications = $8.76 \times 1.0 = 8.76$ lbs.

VOC emissions for Almond = 54.83592 lbs.

APRICOT

Number of Records: 2

Pounds Chemical Applied: 7.015

Unit Treated: A (acres)

EF based on application method: 0.62

VOC emissions for Apricot = $7.015 \times 0.62 = 4.3493$ lbs.

BEEHIVES (ALL OR UNSPEC)

Number of Records: 4

Pounds Chemical Applied: 2.5

Unit Treated: A (acres) ?

EF based on application method: 1.0 (assume 100% loss))

VOC emissions for Beehives = $2.5 \times 1.0 = 2.5$ lbs.

CHERRY

Number of Records: 7

Total Pounds Chemical Applied: 9.8424

Units Treated: A (acres)

EF based on application method: 0.62

VOC emissions for Cherry = 9.8424 x 0.62 = 6.102288 lbs.

COTTON, GENERAL

Number of Records: 1

Pounds Chemical Applied: 7.3

Unit Treated: A (acres)

EF based on application Method: 0.62

VOC emissions for Cotton, General = 7.3 x 0.62 = 4.526 lbs.

GRAPES

Number of Records: 6

Pounds Chemical Applied: 186.179

Unit Treated: A (acres), K (thousand cubic feet)

EF based on Application Method: 0.62 (shank injection) for 177.284 lbs.

1.0 (commodity fumigation) for 8.895 lbs.

VOC emissions for shank-injected chloropicrin = 177.284 x 0.62 = 109.91608 lbs.

VOC emissions for all other Grape applications = 8.895 x 1.0 = 8.895 lbs.

VOC emission Grapes = 118.81108 lbs.

GRAPES, WINE

Number of Records: 10

Pounds Chemical Applied: 2,876.135

Unit Treated: A (acres)

EF based on application method: 0.62

VOC emissions for Grapes, Wine = 2,876.135 x 0.62 = 1,783.2037 lbs.

KIWIFRUIT

Number of Records: 1

Pounds Chemical Applied: 12.99

Unit Treated: A (acres)

EF based on Application Method: 0.62

VOC emissions for Kiwifruit = 12.99 x 0.62 = 8.0538 lbs.

LANDSCAPE MAINTENANCE

Number of Records: 6

Pounds Chemical Applied: 0.35

Unit Treated: Unknown

EF based on Application Method: 1.0 (assume 100% loss)

VOC emissions for Landscape Maintenance = 0.35 x 1.0 = 0.35 lbs.

NECTARINE

Number of Records: 15

Pounds Chemical Applied: 576.575

Unit Treated: A (acres)

EF based on Application Method: 0.62

VOC emissions for Nectarine = $576.575 \times 0.62 = 357.4765 \text{ lbs.}$

N-GRNHS GRWN TRNSPLNT/PRPGTV MTRL

Number of Records: 7

Pounds Chemical Applied: 4.139

Units Treated: S (square feet); Unknown

EF value based on application method: 1.0 (assume 100% loss)

VOC emissions for N-Grnhs Grwn Trnsplnt/Prpgtv Mtrl = $4.139 \times 1.0 = 4.139 \text{ lbs.}$

N-OUTDR CONTAINER/FLD GRWN PLANTS

Number of Records: 31

Pounds Chemical Applied: 57,373.252

Unit Treated: A (acres)

EF value based on Application Method: 0.62

VOC emissions for N-Outdr Container Plants = $57,373.252 \times 0.62 = 35,571.41624 \text{ lbs.}$

N-OUTDR GRWN TRNSPLNT/PRPGTV MTRL

Number of Records: 40

Pounds Chemical Applied: 11,357.4905

Unit Treated: A (acres), K (thousand cubic feet), Unknown

Pounds Chemical Applied by Unit Treated:

31 records = A (EF = 0.62) for 11,351.1205 lbs.

1 record = K (assume 100% loss; EF = 1.0) for 6 lbs.

8 records = Unknown (assume 100% loss; EF = 1.0) for 0.37 lbs.

VOC emissions for shank-injected chloropicrin = $11,351.1205 \times 0.62 = 7,037.69471 \text{ lbs.}$

VOC emissions for drip-injected chloropicrin = $6.37 \times 1.0 = 6.37 \text{ lbs.}$

VOC emissions for N-Outdr Trnsplnt/Prpgtv Mtrl = $7,044.06471 \text{ lbs.}$

NUT CROPS, NUT TREES (ALL OR UNSPEC)

Number of Records: 8

Pounds Chemical Applied: 15.45

Unit Treated: C (cubic feet), S (square feet), T (tons)

EF value based on Application Method: 1.0 (assume 100% loss for C, S, T units)

VOC emissions for Nut Crops = $15.45 \times 1.0 = 15.42 \text{ lbs.}$

ONION

Number of Records: 4

Pounds Chemical Applied: 22.86

Unit Treated: A (acres)

EF value based on Application Method: 0.62

VOC emissions for Onion = $22.86 \times 0.62 = 14.1732 \text{ lbs.}$

ORANGE

Number of Records: 2
Pounds Chemical Applied: 24.835
Unit Treated: A (acres)
EF based on Application Method: 0.62
VOC emissions for Orange = $460 \times 0.62 = 285.2$ lbs.

PEACH

Number of Records: 12
Pounds Chemical Applied: 218.3
Unit Treated: A (acres), U (misc. unit)
Pounds Chemical Applied by Unit Treated:
11 records = A (EF = 0.62) for 218.22 lbs.
1 record = U (assume 100% loss; EF = 1.0) for 0.08 lbs.
VOC emissions for shank-injected chloropicrin = $218.22 \times 0.62 = 135.2964$ lbs.
VOC emissions for all other Peach applications = $0.08 \times 1.0 = 0.08$ lbs.
VOC emissions for Peach = 135.3764 lbs.

PEAR

Number of Records: 1
Pounds Chemical Applied: 6.7
Unit Treated: A (acres)
EF value based on Application Method: 0.62
VOC emissions for Pear = $6.7 \times 0.62 = 4.154$ lbs.

PETS

Number of Records: 2
Pounds Chemical Applied: 0.05
Unit Treated: S (square feet)
EF value based on Application Method: 1.0 (assume 100% loss)
VOC emissions for Pets = $0.05 \times 1.0 = 0.05$ lbs.

PLUM (INCLUDES WILD PLUM FOR HUMAN CONSUMPTION)

Number of Records: 10
Pounds Chemical Applied: 180.765
Unit Treated: A (acres)
EF value based on Application Method: 0.62
VOC emissions for Plum = $180.765 \times 0.62 = 112.0743$ lbs.

RIGHTS OF WAY

Number of Records: 1
Pounds Chemical Applied: 1
Unit Treated: A (acres)
EF value based on Application Method: 0.62
VOC emissions for Rights of Way = $1 \times 0.62 = 0.62$ lbs.

SOIL APPLICATIONS, PREPLANT – OUTDOOR (SEEDBEDS, ETC.)

Number of Records: 1

Pounds Chemical Applied: 0.045

Units Treated: S (square feet)

EF based on application method: 1.0 (assume 100% loss)

VOC emissions for Soil Applications = 0.045 x 1.0 = 0.045 lbs.

STRAWBERRY

Number of Records: 20

Pounds Chemical Applied: 35,693.099

Unit Treated: A (acres)

EF value based on application method: 0.62

VOC emissions for Strawberry = 35,693.099 x 0.62 = 22,129.72138 lbs.

STRUCTURAL PEST CONTROL

Number of Records: 265

Pounds Chemical Applied: 967.196405

Unit Treated: Unknown

EF value based on Application method: 1.0 (assume 100% loss)

VOC emissions from Structural Pest Control = 967.196405 x 1.0 = 967.196405 lbs.

TOMATO

Number of Records: 6

Pounds Chemical Applied: 144.787

Units Treated: A (acres); S (square feet)

Pounds Chemical Applied by Unit Treated:

2 records = A (EF = 0.62) for 144.787 lbs.

4 records = S (assume 100% loss; EF = 1.0) for 1 lb.

VOC emissions for treated acres of Tomato = 144.787 x 0.62 = 89.76794 lbs.

VOC emissions for all other tomato applications = 1 x 1.0 = 1 lb.

Total VOC emissions for Tomato = 90.76794 lbs.

UNCULTIVATED AGRICULTURAL AREAS (ALL OR UNSPEC)

Number of Records: 14

Pounds Chemical Applied: 448.295

Units Treated: A (acres)

EP value based on application method: 0.62

VOC emissions for Uncultivated Ag Areas = 448.295 x 0.62 = 277.9429 lbs.

WALNUT

Number of Records: 18

Pounds Chemical Applied: 169.3191505

Units Treated: A (acres), U (misc. unit)

Pounds Chemical Applied by Unit Treated:

11 records = A (EF = 0.62) for 166.4606505 lbs.

7 records = U (assume 100% loss; EF = 1.0) for 2.8585 lbs.

VOC emissions for treated acres of Walnut = 166.4606505 x 0.62 = 103.20560331 lbs.
 VOC emissions for all other Walnut applications = 2.8585 x 1.0 = 2.8585 lb.
VOC emissions for Walnut = 106.06410331 lbs.

WOOD PROTECTION TREATMENTS

Number of Records: 3
 Pounds Chemical Applied: 0.14
 Units Treated: C (cubic feet)
 EP value based on Application method: 1.0 (assume 100% loss)
Total VOC emissions for Wood Protection Treatments = 0.14 x 1.0 = 0.14 lbs.

Summary of 1990 Default and Corrected VOC Emissions Data by Crop/Site

CROP/SITE	Default VOC emission (lbs.)	Corrected VOC emission (lbs.)
Alfalfa	1,863.375	1,832.785
Almond	80.076	54.83592
Apricot	7.015	4.3493
Beehives (all or unspec) – all beehives	2.5	2.5
Cherry	9.8424	6.102288
Cotton	7.3	4.526
Grapes	186.179	118.81108
Grapes, Wine	2,876.135	1,783.2037
Kiwifruit	12.99	8.0535
Landscape Maintenance	0.35	0.35
Nectarine	576.575	357.4765
N-Grnhs Grwn Trnsplnt/Prpgtv Mtrl	4.139	4.139
N-Outdr Container/Fld Grwn Plants	57,373.252	35,571.41624
N-Outdr Grwn Trnsplnt/Prpgtv Mtrl	11,357.4905	7,044.06471
Nut Crops, Nut Trees	15.45	15.45
Onion	22.86	14.1732
Orange	24.835	285.2
Peach	218.3	135.375
Pear	6.7	4.154
Pets	0.05	0.05
Plum	180.765	112.0743
Rights of Way	1	0.62
Soil Applications (preplant)	0.045	0.045
Strawberry	35,693.099	22,129.72138
Structural Pest Control	967.196405	967.196405
Tomato	144.787	90.76794
Uncultivated Ag Areas	448.295	277.9429
Walnut	169.3191505	106.06410331
Wood Protection treatments	0.14	0.14
TOTAL	112,645.6355	70,931.59

APPENDIX B

2004 Chloropicrin VOC Emissions in the San Joaquin Valley

ALMOND

Number of Records: 5
Total Pounds of Chemical Applied: 67.23
Units Treated: C (cubic feet), U (misc. unit)
Total Pounds Applied by Unit Treated:
 3 records = C (assume 100% loss; EF = 1.0) for 26.145 lbs.
 2 records = U (assume 100% loss; EF = 1.0) for 41.085 lbs.
VOC emissions for Almond = 67.23 x 1.0 = 67.23 lbs.

CARROTS

Number of Records: 1
Pounds Chemical Applied: 70
Unit Treated: A (acres)
EF based on application method: 0.37
VOC emissions for Carrots = 70 x 0.37 = 25.9 lbs.

CHERRY

Number of Records: 2
Total Pounds Chemical Applied: 0.66
Units Treated: A (acres)
EF based on application method: 0.37
VOC emissions for Cherry = 0.66 x 0.37 = 0.2442 lbs.

EGGPLANT

Number of Records: 1
Pounds Chemical Applied: 394.02
Unit Treated: A (acres)
EF based on application Method: 0.37
VOC emissions for Eggplant = 394.02 x 0.37 = 145.7874 lbs.

FUMIGATION, OTHER

Number of Records: 4
Pounds Chemical Applied: 12.874
Unit Treated: Unknown
EF based on Application Method: 1.0 (assume 100% loss)
VOC emission for Fumigation, Other = 12.874 x 1.0 = 12.874 lbs.

MELONS

Number of Records: 1
Pounds Chemical Applied: 674.6642604
Unit Treated: A (acres)
EF based on Application Method: 0.09 (drip)
VOC emissions for Melons = 674.6642604 x 0.09 = 60.719783436 lbs.

NECTARINE

Number of Records: 1
Pounds Chemical Applied: 17.8
Unit Treated: A (acres)
EF based on Application Method: 0.37
VOC emissions for Nectarine = 17.8 x 0.37 = 6.586 lbs.

N-OUTDR CONTAINER/FLD GRWN PLANTS

Number of Records: 28
Pounds Chemical Applied: 44,621.52827
Unit Treated: A (acres)
EF value based on Application Method: 0.37 (shank) and 0.09 (drip)
VOC emissions for shank injected chloropicrin = 41,342.75515 x 0.37 = 15,296.8194055 lbs.
VOC emissions for drip-injected chloropicrin = 3,278.773123 x 0.09 = 295.08949107lbs.
Total VOC emissions for N-Outdr Container Plants = 15,591.90889657 lbs.

N-OUTDR GRWN TRNSPLNT/PRPGTV MTRL

Number of Records: 40
Pounds Chemical Applied: 45,867.845
Unit Treated: A (acres)
EF value based on Application Method: 0.37
VOC emissionsn for N-Outdr Trnsplnt/Prpgtv = 45,867.845 x 0.37 = 16,971.10265 lbs.

ONION

Number of Records: 5
Pounds Chemical Applied: 2,595.36
Unit Treated: A (acres)
EF value based on Application Method: 0.37
VOC emissions for Onion = 2,595.36 x 0.37 = 960.2832

ORANGE

Number of Records: 1
Pounds Chemical Applied: 460
Unit Treated: A (acres)
EF based on Application Method: 0.37
VOC emissions for Orange = 460 x 0.37 = 170.2 lbs.

RESEARCH COMMODITY

Number of Records: 2
Pounds Chemical Applied: 1,041.15
Unit Treated: A (acres)
EP value based on application method: 0.37
VOC emissions for Research Commodity = 1,041.15 x 0.37 = 385.2255 lbs.

SOIL APPLICATIONS, PREPLANT – OUTDOOR (SEEDBEDS, ETC.)

Number of Records: 14

Pounds Chemical Applied: 14,693.47

Units Treated: A (acres)

EF based on application method: 0.09 (drip) for 1,142.46 lbs.

0.37 (shank) for 13,551.01 lbs.

VOC emissions for shank injected chloropicrin = $13,551.01 \times 0.37 = 5,013.8737$ lbs.

VOC emissions for drip-injected chloropicrin = $1,142.46 \times 0.09 = 102.2814$ lbs.

Total VOC emissions for Soil Applications = 5,116.6951 lbs.

STRAWBERRY

Number of Records: 29

Pounds Chemical Applied: 4,804.89

Unit Treated: A (acres)

EF value based on application method: 0.37

VOC emissions for Strawberry = $4,804.89 \times 0.37 = 1,777.8093$ lbs.

STRUCTURAL PEST CONTROL

Number of Records: 15

Pounds Chemical Applied: 20.02974

Unit Treated: Unknown

EF value based on Application method: 1.0 (assume 100% loss)

VOC emissions from Structural Pest Control = $20.02974 \times 1.0 = 20.02974$ lbs.

WALNUT

Number of Records: 1

Pounds Chemical Applied: 0.2

Units Treated: A (acres)

EF value based on Application method: 0.37

VOC emissions for Walnut = $0.2 \times 0.37 = 0.074$ lbs.

WATERMELONS

Number of Records: 3

Pounds Chemical Applied: 5,465.911344

Units Treated: A (acres)

EF value based on Application method: 0.09 (drip) for 4,975.911373 lbs.

0.37 (shank) for 490 lbs.

VOC emissions for drip injected chloropicrin = $4,975.911373 \times 0.09 = 447.83202357$ lbs.

VOC emissions for shank-injected chloropicrin = $72.27 \times 0.37 = 26.7399$ lbs.

Total VOC emissions for Watermelons = 474.57192357 lbs.

Summary of 2004 Default and Corrected VOC Emissions Data by Crop/Site

CROP/SITE	Default VOC emission (lbs.)	Corrected VOC emission (lbs.)
Almond	67.23	67.23
Carrots	70	25.9
Cherry	0.66	0.2442
Eggplant	394.02	145.7874
Fumigation (other)	12.874	12.874
Melons	674.6642604	60.719783436
Nectarine	17.8	6.586
N-Outdr Container/Fld Grwn Plants	44,621.52827	15,591.90889657
N-Outdr Grwn Trnsplnt/Prpgtv Mtrl	45,867.845	16,971.10265
Onion	2,595.36	960.2832
Orange	460	170.2
Research Commodity	1,041.15	385.2255
Soil Applications (Preplant)	14,693.47	5,116.6951
Strawberry	4,804.89	1,777.8093
Structural Pest Control	20.02974	20.02974
Walnut	0.2	0.074
Watermelons	5,465.91134	474.57192357
TOTAL	120,807.6326	41,787.24169

APPENDIX C

PRODUCT NAMES from PUR database that are included in the analyses.

1990	2004
75/25	57-43
Chlor-O-Pic	67-33 Preplant Soil Fumigant
Chloropicrin-100	Chlor-O-Pic
Chloropicrin 100 Soweco Brand	Chloropicrin-100
Larvacide 100	InLine
Methyl Bromide 98%	MBC-33 Soil Fumigant
Methyl Bromide 99.5%	Metapicrin
Methyl Bromide Fumigant	Methyl Bromide 98%
Namco Namfume	Methyl Bromide 99.5%
Namco Chloropicrin	Namco Namfume
Shore Chemical Co. Methyl Bromide 99.5%	Telone C-35
SMCP Chloropicrin Fumigant	Terr-O-Gas 57
Soweco Larvacide 100	Terr-O-Gas 67
Terr-O-Gas 57	Terr-O-Gas 75
Terr-O-Gas 75	Tri-Clor
Tri-Con 57/43	Tri-Con 50/50
Tri-Con 67/33	Tri-Con 57/43
Tri-Con 75/25	Tri-Con 67/33
Tri-Con 80/20	Tri-Con 75/25
Tri-Form 40/60	Tri-Con 80/20