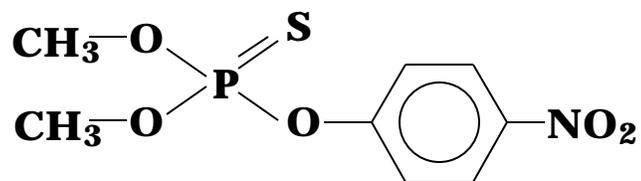


# EVALUATION OF METHYL PARATHION AS A TOXIC AIR CONTAMINANT



## Part B

### Exposure Assessment



California Environmental Protection Agency  
Sacramento, California

October 1999

TAC 99-02B

# **Department of Pesticide Regulation**

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Methyl Parathion  
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**Part B  
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**Worker Health and Safety Branch  
Department of Pesticide Regulation  
California Environmental Protection Agency  
Sacramento, CA**

**May 1999**

Part B

Public Exposure to Airborne Methyl Parathion  
in California  
HS-1766

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## SUMMARY

Methyl parathion is an organophosphate pesticide that is used on a wide range of fruits, vegetables and grains. The major use is on rice, comprising 20% to 30% of the annual total use in California. Peak applications to rice are made during May in rice-growing areas of Colusa and Sutter Counties. The general population of regions where methyl parathion is applied is potentially exposed to methyl parathion in the ambient air.

This document is a quantitative assessment of public exposure to airborne methyl parathion and is prepared as Part B of the evaluation of methyl parathion as a toxic air contaminant (TAC) under the requirements of Assembly Bill 1807. Part A is the environmental fate and part C is the health assessment. Ambient and application site air monitoring studies that were discussed in Part A (Environmental Fate) were used in this document to estimate public exposure. To assess methyl parathion concentrations in the ambient air, monitoring studies were conducted during the application season at small towns and residential communities in close proximity to fields treated with methyl parathion. Application site air monitoring studies were conducted to monitor airborne methyl parathion following a specific application to a specific field at various distances from the treated field. Air monitoring studies detected methyl parathion and its degradation product, methyl paraoxon in the ambient air of some areas in California. Methyl parathion concentrations ranged from non-detectable to 26 ng/m<sup>3</sup> and methyl paraoxon concentrations ranged from non-detectable to 5 ng/m<sup>3</sup> during the application season. Application site air monitoring studies conducted in California and North Carolina showed concentrations of methyl parathion ranging from 512 ng/m<sup>3</sup> (California) at 20 yards to 7400 ng/m<sup>3</sup> (North Carolina) at one yard from the edge of the treated fields during and immediately following the applications. These application site air monitoring studies did not monitor for methyl paraoxon.

Short-term (daily), intermediate (seasonal), and long-term (annual) exposures of children, adult males, and adult females were estimated based on the concentrations of the methyl parathion and methyl paraoxon in the air and the inhalation rates for each subgroup. Children had the highest estimates of exposure to methyl parathion and methyl paraoxon in the ambient air. The highest estimated daily, seasonal, and annual exposures to methyl parathion in the ambient air were 22, 6, and 5 ng/kg/day, respectively, for a six-year old child. The highest estimated daily, seasonal, and annual exposures to methyl paraoxon in the ambient air were 4.3, 1.3, and 1.0 ng/kg/day, respectively, for a six-year old child. The estimates of acute exposure to application site airborne methyl parathion at 20 yards downwind from the application ranged from 40 ng/kg/day for an adult female to 160 ng/kg/day for a child. Seasonal or chronic exposure to application site airborne methyl parathion is not expected since airborne concentrations reach background levels within a few days after the application and only a few repeated applications could be made to a crop during a season due to label restrictions.

## 1. INTRODUCTION

In 1983, the California Legislature enacted Assembly Bill 1807 into law, requiring the Department of Pesticide Regulation to determine pesticides qualifying as toxic air contaminants (TAC). The evaluation of methyl parathion as a possible TAC consists of three parts. Part A is the environmental fate. Part C is the health assessment. This part is a quantitative assessment of public exposure to airborne methyl parathion, and is prepared as Part B of the evaluation of methyl parathion as a TAC. The assessment of occupational exposure to methyl parathion is not included in this document. California has other laws and regulations that govern occupational health and safety.

Methyl parathion, CAS # 298-00-0, is the common name for O,O-dimethyl O-(4-nitrophenyl) phosphorothioate. It has an empirical formula of  $C_8H_{10}NO_5PS$  with a molecular weight of 263.2. Methyl parathion is a white crystal that melts at 35 to 36 °C. It has a vapor pressure of  $1.7 \times 10^{-5}$  mmHg at 25 °C (Spencer *et al.*, 1979) and an octanol-water partition coefficient ( $K_{ow}$ ) of 629 at 25 °C (Kabler, 1988). It is practically insoluble in water (50 ppm) but readily soluble in most organic solvents. Methyl parathion can oxidize in the environment to methyl paraoxon. This oxon analogue is more toxic than methyl parathion.

Methyl parathion is an insecticide/acaricide that is used on a wide range of crops. A substantial amount of methyl parathion use is on fruit trees and vines such as plums, peaches, nectarines, apples, and grapes. Rice is the major crop use of methyl parathion. It is used on flooded rice fields to control rice leafminer and tadpole shrimp. Methyl parathion is not registered for residential or domestic use.

Air monitoring studies showed methyl parathion in the ambient air of residential communities near agricultural fields treated with methyl parathion. Residents close to farming areas, particularly residents of rice growing areas in California where methyl parathion is applied, are potentially exposed to methyl parathion in the ambient air. Methyl parathion is an organophosphate that can cause cholinesterase inhibition.

## 2. SOURCES OF ATMOSPHERIC METHYL PARATHION IN CALIFORNIA

### 1. Products

As of May 1999, there were 5 products registered in California that contain methyl parathion. Penncap-M<sup>®</sup> is a flowable microencapsulated product. It is a water-based suspension of capsules averaging 20 to 30 microns in diameter. All other products are emulsifiable concentrates (EC). The microencapsulated product is a toxicity category II pesticide with a “Warning” signal word on the product label. All the EC formulations are toxicity category I pesticides with a “Danger/Poison” signal word on their product labels. Toxicity category I

pesticides are those with a lethal oral dose (LD<sub>50</sub>) of 50 mg/kg or less and toxicity category II pesticides are those with an oral LD<sub>50</sub> >50 mg/kg and ≤ 500 mg/kg.

## 2. Usage

All registered methyl parathion products are Restricted Use Pesticides due to very high acute toxicity to humans and birds, and therefore, are for retail sale to and use only by certified applicators or persons under their direct supervision. Methyl parathion is used as an insecticide on a variety of fruits, vegetables, and grains. It is also used on alfalfa and ornamentals. Cotton use and non-crops uses such as rangeland, roadsides, and wastelands are minimal. Methyl parathion can be applied by ground or aerial equipment. Its use through any type of irrigation system is prohibited. The rates of application are 0.25 to 15 lb a.i./acre for vegetables, 0.25 to 0.7 lb a.i./acre for rice, and 0.25 to 1.0 lb a.i./acre for other small grains. The maximum application rates on cotton are 1.5 lb a.i./acre and 3.0 lb a.i./acre of microencapsulated and E.C. formulations, respectively. One product, Penncap-M<sup>®</sup> microencapsulated insecticide, allows use on fruit trees. The application rate for Penncap-M<sup>®</sup> microencapsulated insecticide is 0.75 to 30 lb a.i./acre on fruit trees. Table 1 shows the use of methyl parathion from 1990 through 1995. The data in Table 1 indicate a steady increase in overall use from 1991 to 1993 but a decline in 1994, rebounding in 1995. Rice has been the major crop with a use that appears to follow a declining pattern. Fruit tree and grape vine uses showed a steady increase over these six years, as the use figures for alfalfa remained somewhat unchanged and the use on other crops followed a steadily declining pattern.

## 3. PUBLIC EXPOSURE TO METHYL PARATHION IN THE AIR OF CALIFORNIA

Methyl parathion is used throughout the growing season, but peak applications occur in Spring (April to June), during applications to rice in areas of northern California and to fruit trees, vines, and alfalfa in areas of central California. Six-year average use report data (1990-1995) indicate that approximately 70% of the yearly total use is applied during the months of April, May, and June (see Table 4 of Part A, Environmental Fate). The use during the three months of November, December, and January accounted for approximately 3% of the yearly total use. The use report for these six years also indicates the use in Colusa County has declined from approximately 27,000 lb in 1990 to 4,000 lb in 1995. However, in Sutter County, another rice growing county, the use has increased from approximately 14,000 lb in 1990 to 23,000 lb in 1995. The uses of methyl parathion in Fresno, Tulare, and San Joaquin counties have dramatically increased over the past six years, reflecting the reported dramatic increases of use on fruit trees and vines as shown in Table 1.

**Table 1. Methyl Parathion Use Report in California During 1990 to 1995**

Commodity	1990 <sup>a</sup>		1991 <sup>b</sup>		1992 <sup>c</sup>		1993 <sup>d</sup>		1994 <sup>e</sup>		1995 <sup>f</sup>	
	Pounds	%										
Rice	53,950	51	24,830	34	34,290	33	50,450	30	23,500	17	31,150	20
Apples	2,450	2	1,900	3	5,420	5	12,540	7	4,090	3	10,180	7
Grapes	330	1	370	1	2,380	2	11,370	7	13,590	10	21,280	14
Nectarines	515	1	2,420	3	6,360	6	18,070	11	15,820	12	15,770	10
Peaches	6,490	6	6,340	9	11,100	11	25,740	15	28,220	21	25,890	17
Plums	810	1	4,320	6	13,330	13	20,100	12	23,420	17	20,170	13
Alfalfa	14,930	14	11,210	15	5,300	5	10,720	6	13,690	10	12,410	8
Others	25,500	24	21,100	29	25,190	25	20,510	12	12,800	10	16,700	11
<b>Total</b>	<b>104,980</b>	<b>100</b>	<b>72,520</b>	<b>100</b>	<b>103,370</b>	<b>100</b>	<b>169,500</b>	<b>100</b>	<b>135,130</b>	<b>100</b>	<b>153,580</b>	<b>100</b>

a - DPR, 1991

b - DPR, 1993

c - DPR, 1994

d - DPR, 1995

e - DPR, 1996

f - DPR, 1997

Methyl parathion is applied to flooded rice fields by aircraft. In 1986, when a study was conducted to monitor the levels of methyl parathion in the ambient air in Colusa and Sutter Counties, a total of 172,800 lb of methyl parathion were used in California, mainly on rice (28%) (CDFA, 1988). It appears that total use in the state and the use on rice in the recent years (1991 to 1995) have declined compared to those of 1986.

Workers handling methyl parathion during application or handling treated crops after application have the greatest potential for exposure. California has other laws and regulations to insure the health and safety of these workers. California regulations require closed system mixing/loading when handling concentrate formulations of methyl parathion. California regulations also require restricted entry intervals into the fields after the application. The general population of regions where methyl parathion is applied are also potentially exposed to airborne methyl parathion. A substantial amount of methyl parathion is used in Fresno, Tulare, and San Joaquin Counties, on a variety of crops throughout the season. However, rice is the major use crop and the peak applications are made during May in rice-growing areas of Colusa and Sutter Counties. The potential for greatest exposure to the public may exist in these counties during the application season.

#### **4. HUMAN ILLNESSES ASSOCIATED WITH METHYL PARATHION**

California Health and Safety Code requires that any illness suspected of being caused by a pesticide be reported by the examining physician to the county health officer within 24 hours (CCR, Title 17, Section 105200). Review of these cases by the Pesticide Illness Surveillance Program of DPR indicated that there were a total of 18 illnesses reported from 1986 through 1995 that were attributed to methyl parathion exposure alone or in combination with other pesticides (DPR, 1997). The illnesses were predominantly systemic in nature with only a few eye and skin injuries. Of the 18 cases, there were only two cases in which methyl parathion alone was associated with the illnesses; the other 16 cases involved methyl parathion in combination with other pesticides. Sixteen of the reported illnesses for these ten years resulted from occupational exposure. One non-occupational case involved attempted suicide and the other was associated with drift from an aerial application. One incident that occurred in 1990 accounted for 9 cases. It involved an airplane collision between two aerial applicators that resulted in the death of one pilot and the injury of the other. Two flaggers and five members of the emergency response crew developed illnesses that were attributed to pesticide exposure. Of the 18 cases, one occurred in 1986, three in 1987, 12 in 1990, one in 1992 and one in 1994.

## 5. METHYL PARATHION CONCENTRATION IN THE AIR OF CALIFORNIA

Methyl parathion concentrations were monitored both in the ambient air of residential areas during the peak application season and in the air surrounding application sites. To assess methyl parathion concentrations in the ambient air, monitoring studies were conducted during the application season at small towns and residential communities in close proximity to fields treated with methyl parathion. Application site air monitoring studies were conducted to monitor airborne methyl parathion following a specific application to a specific field at various distances from the treated field.

### 1. Ambient Air

There are a number of studies in which methyl parathion concentrations in the ambient air of several rural and urban areas around the country, including California, were monitored. Most of these studies were conducted during the 1970s and early 1980s.

Stanley *et al.* (1971) found no detectable concentrations of methyl parathion at the monitoring sites in California near the cities of Fresno and Riverside, while they found detectable concentrations as high as 148 ng/m<sup>3</sup> (average 29 ng/m<sup>3</sup>) in the rural areas of three of the eight states where monitoring was conducted. They collected 12- or 24-hour samples during both high and low usage seasons. In a separate study, Arthur *et al.* (1976) monitored the ambient air of Stoneville, Mississippi during a three-year period in 1972 to 1974. They reported the maximum concentration of methyl parathion in the ambient air at 2,060 ng/m<sup>3</sup>, the highest reported in the literature.

Kutz *et al.* (1976) monitored ambient air at sites located in 15 different states, excluding California, over a three-year period 1970 to 1972. The monitoring sites were close to areas where methyl parathion was used. Methyl parathion concentrations ranged from non-detectable levels to a maximum of 278 ng/m<sup>3</sup>. The maximum concentration was detected in Oklahoma in 1970. More than 85% of the samples in all locations showed no detectable levels. The means of positive samples ranged from 3.8 to 15.9 ng/m<sup>3</sup>. Kutz (1983) monitored ambient air at 10 locations in eight states, including two urban locations in California (Pasadena and Fresno), for p-nitrophenol, a breakdown product of both methyl and ethyl parathion. There were 15 positive samples out of 123 samples that were collected. Average equivalent concentration was 2.9 ng/m<sup>3</sup> with maximum levels as high as 160 ng/m<sup>3</sup>. The location of the sample with the highest level was not provided.

Sava (1985) monitored the air of three residential sites in proximity to agricultural land in Salinas, California. Methyl parathion was detected at 17 ng/m<sup>3</sup> in only one sample at a site 1,200 feet downwind from the nearest agricultural field.

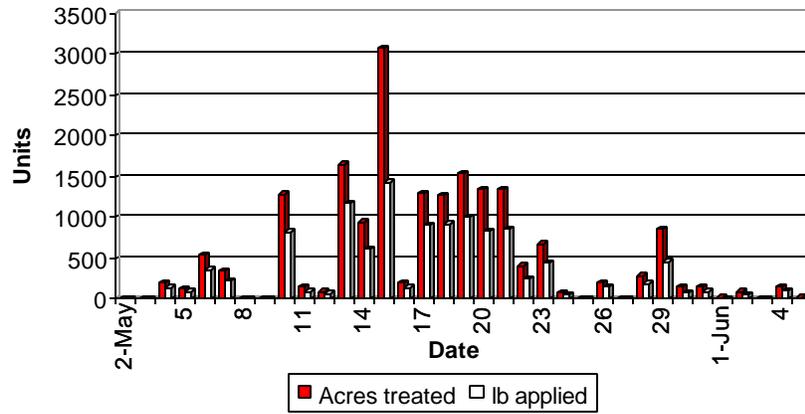
In order to evaluate the presence of methyl parathion in the ambient air of California, an ambient air monitoring study was conducted in 1986 by the Department of Environmental Toxicology at the University of California, Davis (UC, Davis) under a contract with Air

Resources Board (ARB) (Seiber *et al.*, 1987). Air in the rice growing counties of Colusa and Sutter was monitored during the peak methyl parathion application season. Twenty-four-hour air samples were collected at two rural towns in Sutter County (Trowbridge and Robbins) and two rural towns in Colusa County (Maxwell and Williams). East Nicolaus High School was the monitoring site in Trowbridge and Robbins Elementary School was the monitoring site in Robbins. Maxwell High School and Williams City Hall were the monitoring sites in towns of Maxwell and Williams, respectively. All the monitoring sites were within half a mile of rice fields, except the site in Williams that was located within the city limit. In addition, two to four three-hour sequential samples that were followed by single 12- to 18-hour samples were collected every Monday at Maxwell to observe peak concentrations. Background samples were taken on the UC, Davis campus in Yolo County. Two high-volume air samplers were used at each site except at Maxwell where three high-volume samplers were used. The sampler pumps were modified to allow an air flow of approximately 50 liters per minute. Flow rates were recorded at the beginning and the end of each sampling period and the average of these two readings was used to calculate the sample volume. Samples were collected four days a week on Teflon™ sampler cups containing XAD-4 resin backed by glass wool. The cups were placed two meters apart and were located 1.67 meters above the roof of the structures at each site. Sample collection started on May 12 and ended on June 12.

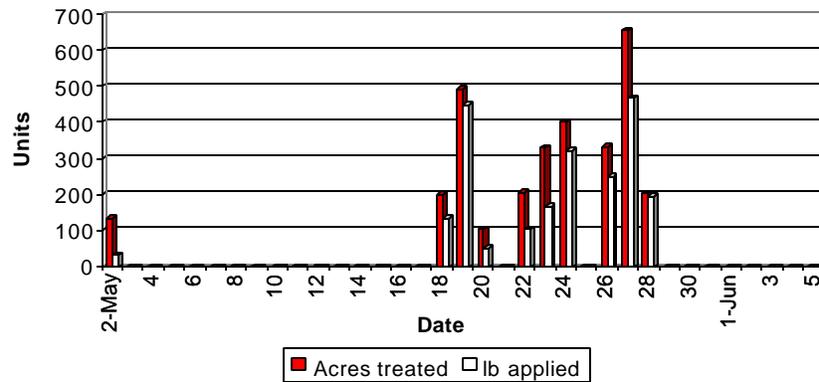
All samples were placed on dry ice until delivery to the laboratory where they were stored at -20 °C until analysis. Samples were analyzed for methyl parathion and methyl paraoxon within one month of collection. Samples were extracted by three consecutive washings with ethyl acetate. The combined eluants were concentrated on a steam bath to approximately 6 mL. Samples were analyzed on a Hewlett Packard™ 5710A gas chromatograph equipped with a nitrogen-phosphorous detector. The minimum detection limits (MDL) were 0.2 and 0.5 ng/m<sup>3</sup> for methyl parathion and methyl paraoxon, respectively. Recoveries of spiked XAD-4 resin were good, ranging from 87% to 111%. Recoveries for XAD-4 resin media that were spiked with methyl parathion or methyl paraoxon and stored at -20 °C for 11 weeks were 86% and 67%, respectively. Trapping efficiency for the media was 82%.

Pesticide use reporting for the period of May 1 through June 12, 1986 indicated that a total of 11,600 lb of methyl parathion was used to treat 18,550 acres in the Maxwell and Williams areas. Much less methyl parathion was used in the Trowbridge and Robbins areas where 2,200 lb were used to treat 3,100 acres during the same period. Figure 1 shows that peak applications occurred between May 10 to May 23 in the Maxwell and Williams areas during the application season. As Figure 2 shows, all applications during the season occurred between May 18 and May 28 in the Trowbridge and Robbins areas, except for one application that occurred on May 2 and another on June 12 (June 12 data are not shown in Figure 2). The uses on May 2 and June 12 were minor, totaling less than 70 lb.

**Figure 1. Methyl Parathion Use and Area Treated Adjacent to Maxwell and Williams (Colusa County) in 1986**



**Figure 2. Methyl Parathion Use and Area Treated Adjacent to Trowbridge and Robbins (Sutter County) in 1986**



**Table 2. Methyl Parathion and Methyl Paraoxon Concentrations (ng/m<sup>3</sup>) in the Ambient Air of Sutter and Colusa Counties During Application to Rice<sup>a</sup>.**

Date	Methyl Parathion				Methyl Paraoxon <sup>c</sup>	
	Sutter County		Colusa County		Colusa County	
	Trowbridge	Robbins	Maxwell	Williams	Maxwell	Williams
12-May	0.55	0.70	6.67	1.00	nd	nd
13	1.05	0.50	25.67	4.70	2.33	1.15
14	0.55	0.55	21.50	21.75	0.83	0.75
15	nd	0.35	13.80	5.60	4.98	0.85
16 to 18	-	-	-	-	-	-
19	nd	nd	14.90	5.30	1.30	0.53
20	nd	nd	5.00	5.25	0.67	0.95
21	nd	0.25	14.00	4.75	1.52	1.00
22	nd	0.30	7.70	1.45	3.07	0.63
23 to 26	-	-	-	-	-	-
27	nd	-	2.17	1.35	nd	0.48
28	nd	nd	5.70	1.80	1.75	0.70
29	nd	nd	2.90	-	0.63	-
30	nd	nd	1.57	-	0.47	-
31 to 1-June	-	-	-	-	-	-
2	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd
4	nd	0.10	nd	nd	nd	nd
5	nd	0.10	nd	nd	nd	nd
6 to 8	-	-	-	-	-	-
9	nd	nd	nd	nd	nd	nd
10	nd	nd	0.23	0.35	nd	nd
11	-	nd	0.70	0.65	nd	nd
12	0.50	nd	0.35	0.30	nd	nd
Mean	0.27	0.21	6.17	3.04	1.00	0.52
SD	0.32	0.19	7.77	5.13	1.24	0.31
95th percentile	1.05	0.57	21.71	8.02	3.17	1.02
Mean <sup>b</sup>	0.37	0.28	8.44	4.16	1.82	.92
SD <sup>b</sup>	0.44	0.26	10.63	7.02	2.25	0.57
95th percentile <sup>b</sup>	1.44	0.77	29.70	10.97	5.76	1.87

nd - Non-detectable. For samples below the MDL, 1/2 MDL (0.10 and 0.25 ng/m<sup>3</sup> for methyl parathion and methyl paraoxon, respectively) was used. SD - Standard deviation

- = No samples were collected.

a - After Seiber *et al.*, 1987 (24-hour samples; average of 2 to 3 samples if more than one sample).

b - Methyl parathion values were corrected for 85% trapping efficiency and 87% storage recovery; and methyl paraoxon values were corrected for 82% trapping efficiency and 67% storage recovery.

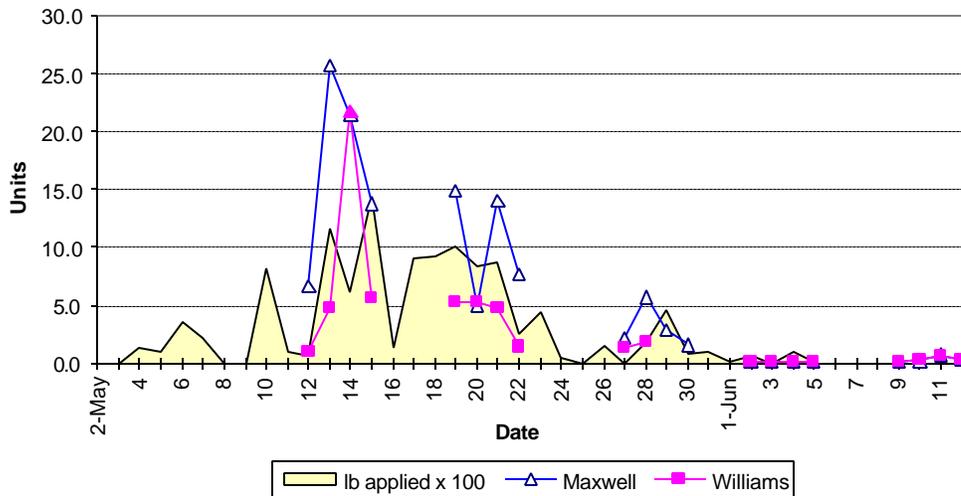
c - No methyl paraoxon was detected in Trowbridge and Robbins towns of Sutter County.

Methyl parathion and methyl paraoxon concentrations in 24-hour samples in four locations in Colusa and Sutter Counties are shown in Table 2. Samples with no detectable residues were assumed to have residues at half the MDL. At Trowbridge and Robbins, 77% and 73% of the samples respectively, were below the MDL for methyl parathion. At Maxwell and Williams, 30% and 31% of the samples respectively, were below the MDL for methyl parathion. No methyl paraoxon was detected in either Trowbridge or Robbins location in Sutter County. At Maxwell and Williams in Colusa County, 59% and 58% of samples respectively, were below the MDL for methyl paraoxon.

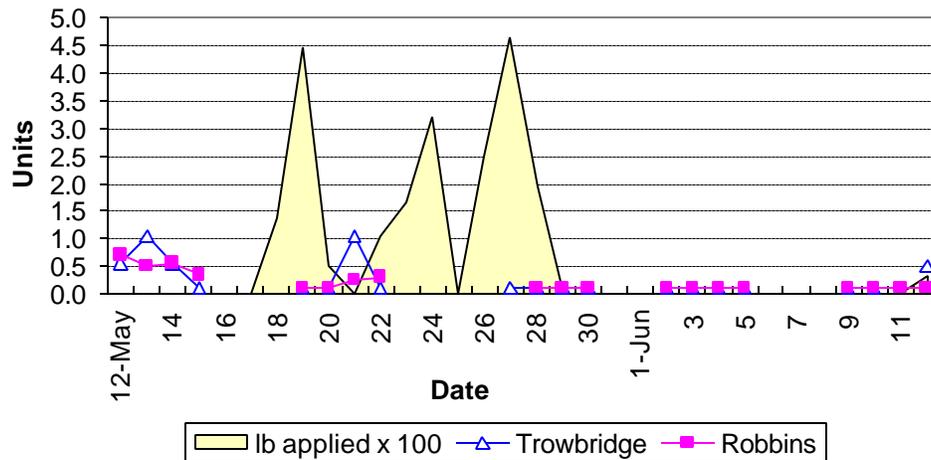
A total of 42 three-hour samples were collected at Maxwell on May 12, 19, 27, June 2, and June 9, 1996. Only samples collected on May 19 showed detectable concentrations of methyl parathion and methyl paraoxon. Methyl parathion was detectable in five of the six samples collected on May 19. Methyl parathion concentrations ranged from 2.6 ng/m<sup>3</sup> to 8.9 ng/m<sup>3</sup> with an average of 6.0 ng/m<sup>3</sup>. Three of the same five samples were positive for methyl paraoxon. Methyl paraoxon concentrations ranged from 2.2 ng/m<sup>3</sup> to 4.6 ng/m<sup>3</sup> with an average of 3.1 ng/m<sup>3</sup>. All other three-hour samples were below the MDL for methyl parathion and methyl paraoxon.

Figures 3 and 4 show that methyl parathion levels dropped to low or non-detectable levels during the month of June when there were no more applications at these areas.

**Figure 3. Methyl Parathion Concentrations (ng/m<sup>3</sup>) and Use (lb x 100) in Maxwell and Williams (Colusa County)**



**Figure 4. Methyl Parathion Concentrations (ng/m<sup>3</sup>) and Use (lb x 100) in Trowbridge and Robbins (Sutter County)**



## 2. Application Site Air

In May 1989, ARB conducted a study in Sutter County to assess Application site levels of methyl parathion measured immediately following an application to a rice field (ARB, 1989). An aerial application of methyl parathion was made at a rate of one lb a.i./acre to an 80-acre rice field. One sampling station was located 20 yards (18 meters) upwind from the treated field. There were two sampling stations downwind, one 20 yards and the other 250 yards (228 meters) from the treated field. Low-volume air sampling pumps were used to collect air samples at a flow rate of approximately 1.5 liters per minute. Each sampler was fitted with duplicate cartridges containing XAD-2 resin adsorbent. Background samples were collected one hour prior to the application. Samples were collected at all three stations both during and one hour after the application. After that, samples were collected only at the 20-yard stations at intervals ranging from 3 to 11 hours for the first 24 hours post-application followed by 24-hour samples for the next two days. The wind was variable, mostly blowing from the south and southwest during the first 48 hours and from the north during the remainder of the sampling period. The sampling station located to the north of the field was considered downwind since the wind blew mostly from the south and southwest. Samples were stored on ice until delivery to the laboratory where they were kept frozen until analysis. Recoveries of spiked XAD-2 resin were good, ranging from 90% to 105%. Recoveries for XAD-2 resin media that were spiked with methyl parathion and stored in the freezer for two weeks were between 97% and 102%.

No methyl parathion was detected (MDL = 20 ng/m<sup>3</sup>) in samples collected during and one hour after the application at the station located 250 yards from the field. The highest concentration was 512 ng/m<sup>3</sup> methyl parathion 20 yards downwind immediately after application. Application site concentrations showed a declining pattern over the 73-hour sampling period. Table 3 shows application site air concentrations at stations located 20 yards from the field.

**Table 3. Methyl Parathion Concentrations (ng/m<sup>3</sup>) Twenty Yards from the Application Site<sup>a</sup>.**

Hours after application	North (downwind)	South (upwind)
0-1	512	219
1-3	161	199
3-7	121	277
7-18	312	99
18-25	70	34
25-49	43	10
49-73	28	30
TWA <sup>b</sup>	215.4	125.8

a - ARB, 1989.

b - Time-weighted average (first 24 hours)

To measure application site methyl parathion concentrations in the air, Seiber and McChesney (1987) placed a single air sampler at 17 yards (15.5 meters) downwind of a flooded rice field in Glenn County, California. Samples were collected at 1, 7, 48, and 55 hours after methyl parathion application to the flooded rice field and methyl parathion concentrations were 1,030, 1,160, 51, and 48 ng/m<sup>3</sup>, respectively. Methyl parathion levels 1 to 7 hours after the application were approximately 60-fold greater than the background levels measured a few days before the application. These concentrations at 17 yards from the edge of the field were based on a sampling duration of 1.5 hours immediately following the application. There were not adequate sampling intervals to derive a TWA concentration for the first 24 hours after the application. Assuming that the methyl parathion dissipation pattern in the first 24 hours post-application was identical to that observed in the ARB (1989) study, a 24-hour TWA of 487 ng/m<sup>3</sup> (42% of initial concentration) may be calculated.

Jackson and Lewis (1978; 1979) measured methyl parathion application site air concentration at approximately one yard (one meter) from tobacco fields in North Carolina. The fields were treated with either an E.C. or encapsulated formulation of methyl parathion at 1.0 lb a.i./acre. The air sampler collected air at a flow rate of 11 m<sup>3</sup>/hour and was located 110 cm<sup>2</sup> above the ground level. Samples were collected for one to two hours immediately, 1, 3, 6, and 9 days post-application. For the first three days after the application, methyl parathion levels in the

air were higher in fields treated with the E.C. formulation compared to those treated with the encapsulated formulation. After a light rain on day six, airborne levels were drastically lower than the first few days, and there was not much difference in the airborne levels between the two treated fields. Table 4 shows application site methyl parathion concentrations following the application of either formulation.

**Table 4. Methyl Parathion Concentrations (ng/m<sup>3</sup>) One Meter from a Tobacco Field After Application with Either E.C. or Microencapsulated Formulation<sup>a</sup>.**

Days after application	E.C.	Microencapsulated
0	7400	3800
1	3300	330
3	580	110
6	36	25
6	54	19
9	13	16

a - Jackson and Lewis, 1979

Application-site air monitoring studies have shown concentrations ranging from 512 ng/m<sup>3</sup> at 20 yards (ARB, 1989) to 1160 ng/m<sup>3</sup> at 17 yards (15.5 meters) (Seiber and McChesney, 1987) and 7400 ng/m<sup>3</sup> at approximately one yard (one meter) (Jackson and Lewis, 1978:1979) from the edge of the treated fields during and immediately following the application. After 2 to 6 days, these concentrations dropped to levels found in the background. These findings suggest that application site air concentrations decrease with an increase in distance from the edge of the treated field for the first few days, and then reach a level similar to the concentrations in the background regardless of the distance from the edge of the field. In addition, while the initial application site air concentrations were less in fields treated with microencapsulated formulation than those treated with an E.C. formulation, type of formulation did not seem to affect air concentrations after a few days (see Table 4).

## **6. ESTIMATE OF PUBLIC EXPOSURE TO AIRBORNE METHYL PARATHION IN CALIFORNIA**

### **1. Exposure to Methyl Parathion in Ambient Air**

Seiber *et al.*, 1987 found relatively higher concentrations of methyl parathion in Colusa County locations compared to those in Sutter County. This is expected since much less methyl parathion was used in the Trowbridge and Robbins areas than what was used in the Maxwell and Williams areas. The difference between methyl parathion concentrations in the ambient air of Maxwell and Williams may be associated with the difference in the distance of sampling sites from actual application sites. The data suggest that residents of these areas are exposed to

airborne methyl parathion and its degradation product, methyl paraoxon, during the application period to rice. The data also suggest that residents of other areas in California where methyl parathion is used are also potentially exposed to airborne methyl parathion and methyl paraoxon. However, the acute exposure of residents of Colusa County may be considered a worst-case scenario, since a substantial amount of the total use of methyl parathion (20-30%) is applied to the rice fields of northern California during a short period of time (May to mid-June). On the other hand, residents of areas where methyl parathion is used almost continuously throughout the season may be exposed to lower concentrations but for a longer period of time during a year compared to those who live in rice growing areas.

The Seiber *et al.*, 1987 study was used to estimate human exposure to methyl parathion in the ambient air in California, as shown in Table 5. Human exposure was calculated as an absorbed dosage. The absorbed dosage per unit of body weight varies between children, adult females, and adult males because the ratio of inhalation rate to the body weight varies from one subgroup to another. Therefore, the estimate of human exposure is separated into these three subgroups. Children of age six years were chosen as the highest exposure subgroup because they have the highest inhalation rate (during rest and light activity) to body weight ratio. For this reason, the exposure to a six-year-old child will be used as a conservative estimate of exposure for all children, including infants.

Since the level of exposure to airborne methyl parathion depends on the rate of inhalation and the rate of inhalation varies with the human activity, total daily (24 hours) inhalation rate for each subgroup was obtained from the inhalation rate of each subgroup during various daily (24 hours) activities. The U.S. EPA exposure factors handbook suggests an activity pattern for all age groups consisting of 11.2 hours of rest, 11.2 hours of light activity, 1.4 hours of moderate activity, and 0.2 hours of heavy activity during a 24-hour day (U.S. EPA, 1996).

The estimate of a single day or acute exposure to a person is expressed as the absorbed daily dosage (ADD). The 95th percentile of the airborne methyl parathion concentrations at each location during the entire application season to rice is used to calculate a single day exposure. Seasonal exposure to a person is expressed as seasonal average daily dosage (SADD). The mean (arithmetic) airborne methyl parathion level during the entire season at each location is used to calculate a SADD. A seasonal exposure period of 9 months in a year (see discussion of use report in Part A) was used to calculate annual exposure or annual average daily dosage (AADD).

**Table 5. Methyl Parathion and Methyl Paraoxon in Ambient Air and Estimates of Public Exposure in Four Areas in Colusa and Sutter Counties Based on Seiber *et al.* (1987) Data**

	Methyl Parathion (ng/m <sup>3</sup> )				Methyl Paraoxon <sup>a</sup> (ng/m <sup>3</sup> )	
	Sutter County		Colusa County		Colusa County	
	Trowbridge	Robbins	Maxwell	Williams	Maxwell	Williams
Mean	0.37	0.28	8.44	4.16	1.82	0.92
SD	0.44	0.26	10.63	7.02	2.25	0.57
95 <sup>th</sup> percentile	1.44	0.77	29.7	10.97	5.76	1.87
	(ng/kg/day)				(ng/kg/day)	
ADD (Child)	1.06	0.57	21.95	8.11	4.26	1.38
ADD (Adult male)	0.40	0.21	8.27	3.05	1.60	0.52
ADD (Adult female)	0.26	0.14	5.43	2.00	1.05	0.34
SADD (Child)	0.27	0.21	6.24	3.07	1.34	0.68
SADD (Adult male)	0.10	0.08	2.35	1.16	0.51	0.26
SADD (Adult female)	0.07	0.05	1.54	0.76	0.33	0.17
AADD(Child)	0.21	0.16	4.68	2.31	1.01	0.51
AADD(Adult Male)	0.08	0.06	1.76	0.87	0.38	0.19
AADD(Adult Female)	0.05	0.04	1.16	0.57	0.25	0.13

a - No methyl paraoxon was detected in Trowbridge and Robbins towns of Sutter County.

Based on:

Inhalation rates of 21.4, 11.4, and 16.7 m<sup>3</sup>/day, respectively, for an adult male, an adult female, and a 6-year old child (U.S. EPA, 1996).

Body weights of 76.9, 62.4, and 22.6 kg, respectively, for an adult male, an adult female, and a 6-year old child (U.S. EPA, 1996).

A 100% inhalation uptake and inhalation absorption rate was assumed to calculate all exposure scenarios. A seasonal exposure period of 9 months in a year was used to calculate AADD.

Calculation Example:

$$\text{ADD} = (\text{UC} \times \text{IR}) / \text{BW}$$

$$\text{SADD} = (\text{MC} \times \text{IR}) / \text{BW}$$

$$\text{AADD} = (\text{SADD}) \times 9/12$$

UC - 95th percentile ambient air concentration (ng/m<sup>3</sup>)

MC - Mean ambient air concentration (ng/m<sup>3</sup>)

IR - inhalation rate (m<sup>3</sup>/day)

BW - body weight (kg)

## 2. Exposure to Methyl Parathion in Application Site Air

Exposure to application site air concentrations of methyl parathion at distances from the field such as those discussed earlier (1 to 20 yards) would be mainly occupational and for a short duration during a workday. In the ARB (1989) study, no detectable concentration of methyl parathion was found at 250 yards downwind from the application site during and after the

application. Thus, it appears that application site air concentrations of methyl parathion at distances where the potential for non-occupational public exposure exist might be non-detectable. However, methyl parathion air concentrations at 17 and 20 yards from the edge of the field were used as a worst case scenario to estimate short-term or acute exposure to residents (Table 6). Seasonal or chronic exposure to application site airborne methyl parathion levels is not expected since airborne concentrations reach ambient levels within a few days after the application; and the estimates of chronic exposure to concentrations in the ambient air are given in Table 5. In addition, methyl parathion can be used only once on some crops such as rice and grapes during a season and maybe two to five times a season on some other crops due to label restrictions.

**Table 6. Estimates of Acute Public Exposure to Application Site Airborne Methyl Parathion Based on ARB (1989) and Seiber and McChesney (1987) Data**

Distance from field	20 yards	17 yards
	ng/m <sup>3</sup>	ng/m <sup>3</sup>
TWA concentration	215.4	487.0
	ng/kg/day	ng/kg/day
ADD (Child)	159.18	359.86
ADD (Adult male)	59.95	135.52
ADD (Adult female)	39.35	88.97

Application site exposure to methyl paraoxon is not shown in Table 6 because investigators for these application site air monitoring studies did not sample for methyl paraoxon. However, in the ambient air monitoring study that was conducted in Colusa and Sutter Counties (Seiber *et al.*, 1987), it was observed that the ratio of average methyl paraoxon to average methyl parathion for positive samples was approximately 1/4 for the town of Maxwell as well as for the town of Williams (see Table 2). It is uncertain that the same ratio will hold true in an off-site situation after methyl parathion application, but in light of the aforementioned observation, such an assumption seems reasonable.

The estimates of exposure in this document were made assuming that airborne methyl parathion was in particulate phase and was absorbed 100% through inhalation. This is a conservative assumption because airborne methyl parathion should exist in both particulate and vapor phases and the vapor uptake of semivolatile chemicals rarely exceeds 75% (Raabe, 1988). In addition, the ambient and application site air monitoring studies used in assessment were conducted outdoors. Both adults and children spent more than 85% of their day indoors (U.S. EPA, 1990). In California, children under 12 years of age spent more than 85% of a day indoors (Phillips *et al.*, 1991). The public exposure to airborne methyl parathion was estimated assuming methyl parathion concentration is the same indoors and outdoors. This assumption may provide several-fold overestimation of exposure since studies have shown that the indoor ambient concentrations of tested volatile organic chemicals were up to eight-fold less than those outdoors (Sheldon, *et al.*, 1992).

While it is evident that the general population residing in communities close to agricultural fields with heavy methyl parathion uses are exposed to methyl parathion in the air through the inhalation route, there may also be the potential for exposure through the dermal route. However, there are no studies available that monitored dermal exposure of the general public to methyl parathion in the ambient air. Studies with pesticides have shown that clothing can serve as a protective barrier against dermal exposure. Clothing can reduce any dermal exposure to methyl parathion in the air by several fold. Thongsinthusak, *et al.* (1993) have suggested a default dermal exposure protection value of 10 fold or 90% for a long-sleeved shirt and long pants. In addition, human skin can serve as another layer of protection. While, there are no human dermal absorption studies available for methyl parathion, a dermal absorption study with ethyl parathion, a pesticide that is chemically similar to methyl parathion, showed a dermal absorption rate of approximately 10% in humans (Feldmann and Maibach, 1974).

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