DISSIPATION OF DDVP AND PROPOXUR FOLLOWING THE RELEASE OF AN INDOOR FOGGER - A PRELIMINARY STUDY

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SUMMARY

Air samples and fallout pads were collected at several intervals following the release of a widely used home fogging product containing DDVP and propoxur to determine the dissipation rate of these pesticides. Two to four rooms in several homes were treated in accord with the label of the pesticide product chosen for this study. In most homes half of the rooms were opened for ventilation at the end of the required two-hour treatment period while the other half were left closed for the entire 24-hour sampling period. The results showed wide variation and were difficult to interpret in this "real world" situation (rooms varied greatly in size, furnishings, construction, etc.). In order to further evaluate indoor fogger behavior studies into the aerosol dispersal, pesticide behavior indoors, mixing dynamics, as well as toxicological properties as related to indoor settings, need to be conducted.

INTRODUCTION

For several years, concern has continued over possible health hazards presented by single use indoor insecticide fogging products. Such products, often referred to as "bug bombs" or "home foggers," are designed to rapidly dispense the entire contents of an aerosol pesticide container into a room without user intervention aside from the initial setting and triggering. Home foggers are readily available to the public from retail outlets, such as supermarkets and hardware stores, where they are sold to control home "nuisance" pests including fleas, roaches, ants, spiders, and moths.

Several different active ingredients are commonly used in home fogging products, either singly or in various combinations. Active ingredients include synthetic pyrethrin/piperonyl butoxide combinations, methoprene, DDVP, and propoxur. One of the more common combinations of materials, DDVP and propoxur, were selected for this study.

DDVP (2,2-dichlorovinyl O,O-dimethyl phosphate, CAS #62-73-7) is a highly toxic organophosphate insecticide, with an oral LD_{50} of 56 mg/kg (female rat), and a dermal LD_{50} of 75 mg/kg (female rat) (Gaines, 1960). It is considered to be highly volatile, with a vapor pressure of 1.2×10^{-2} mm Hg at 20°C (Worthing, 1979). An 8-hour workday/40-hour workweek time weighted average (TWA) exposure level of 1 mg/m^3 (1000 ug/m^3) has been established both as an American Conference of Governmental Industrial Hygienists (ACGIH, 1983) Threshold Limit Value (TLV) and as a California Occupational Safety and Health Administration (Cal/OSHA) Permissible Exposure Level (PEL). The ACGIH has not set a 15-minute Short-Term Exposure Limit (STEL) for DDVP; calculations specified in Subsection C of Section 5155 of Cal/OSHA's General Industrial Safety Orders (GISO, Title 8, California Administrative Code) would lead to a ceiling exposure limit of 3 mg/m^3 (3000 ug/m^3).

Propoxur (o-isopropoxyphenyl N-methylcarbamate, CAS #114-26-1) is a moderately to highly toxic N-methyl-carbamate insecticide with an oral LD_{50} of 86 mg/kg (female rat) and a dermal LD_{50} of greater than 2400 mg/kg (rat, both sexes) (Gaines, 1969). It is considerably less volatile than DDVP with a vapor pressure of 1.0×10^{-2} mm Hg at 120°C (Worthing, 1979). Both the TLV and the PEL for propoxur are 0.5 mg/m^3 (500 ug/m^3); the ACGIH has established a STEL of 2 mg/m^3 (2000 ug/m^3) while calculations specified in the GISO result in a exposure ceiling limit of 1.5 mg/m^3 (1500 ug/m^3).

Both pesticides have similar modes of action in mammalian systems, disrupting nervous system function by blocking acetylcholinesterase activity, DDVP by phosphorylation and propoxur by carbamylation. Medical management of poisoning is nearly identical, including supportive treatment and the use of atropine (sulfate) to antagonistically compete with the pesticide. In the case of organophosphate poisoning, oximes such as protopam chloride are considered to be adjunctive therapy to the atropine; there is disagreement over the utility of such therapy for n-methyl carbamate poisoning.

This study is a continuation of range finding studies performed by the the Worker Health and Safety Unit of the California Department of Food and Agriculture (see also Maddy, et.al., 1981) to determine home fogger behavior under "real world" conditions.

MATERIALS AND METHODS

Six-ounce (170 g) cans of a widely advertised and distributed home fogging product containing 0.5% DDVP and 1% propoxur were used. Containers were purchased at a local retail store, and were all of the same manufacturer's lot number.

Tests were conducted in the homes of Worker Health and Safety Unit personnel and associates. In most of the residences used, two separate rooms were treated. In one, the fogger was used following label directions, which call for ventilation of treated areas two hours after the initial triggering of the fogger. In the other room, there was no ventilation for 24 hours after the application.

In all rooms treated, air samples were collected prior to application to determine possible background levels of either pesticide. Windows and ventilators were closed, and foggers were set up according to label directions, on sheets of newspaper placed on the floor near the center of the room. The foggers were triggered and the rooms were closed. After the specified 2-hour "treatment period" the rooms were reentered and the empty fogger container and the newspaper was discarded outside the room. Air samples were then collected using the following timetable:

Time	Duration	Flow Rate
0-15 min	15 min	2 L/min
15-30 min	15 min	2 L/min
30-60 min	30 min	1 L/min
1-2 hrs	1 hour	1 L/min
2-3 hrs	1 hour	1 L/min
3-4 hrs	1 hour	1 L/min
4-6 hrs	2 hours	1 L/min
6-8 hrs	2 hours	1 L/min
8-12 hrs	4 hours	1 L/min
23-24 hrs	1 hour	2 L/min

All samples were collected using commercially prepared XAD-4 resin tubes (SKC #226-30-11-04) with air drawn using MSA models S and TD personal air sampling pumps. XAD-4 tubes were connected to the pumps using a 10 cm length of beverage grade polyethylene tubing; tube assemblies were pointed upright, and pumps were placed on the floor in the same location as the fogger. All airflow rates were calibrated before and after sampling using Kurz Model 540S mass (air) flow calibrators, which automatically compensated for temperature, barometric pressure, and relative humidity.

Prior to the triggering of the fogger, ten 100 cm^2 aluminum foil "fallout pads" were placed on the floor in a grid pattern 1.3 m from the fogger. One pad was immediately placed into a prewashed and baked sample jar to serve as a control. The remaining pads were randomly removed, placed into prewashed glass jars, and capped with aluminum foil at 30 minutes after the initial treatment period, 1 hour, 2 hours, 3 hours, 4 hours, 6 hours, 8 hours, 12 hours and 24 hours. All samples were chilled and transported to the Worker Health and Safety Laboratory in Sacramento for analysis by gas chromatography.

RESULTS

Results of air samples are summarized in Table 1 (DDVP levels in ventilated rooms), Table 2 (DDVP levels in unventilated rooms), Table 3 (propoxur levels in ventilated rooms), and Table 4 (propoxur levels in unventilated rooms). Theoretical total airborne levels of pesticide in treated rooms were calculated by multiplying the volumetric pesticide level (ug/m^3) by the total volume of the treated rooms. Calculation results are reported in Table 5 (total DDVP levels in ventilated rooms), Table 6 (total DDVP levels in unventilated rooms), Table 7 (total propoxur levels in ventilated rooms), and Table 8 (total propoxur levels in ventilated rooms).

Surface levels of DDVP and propoxur measured on the fallout pads are reported in Table 9 (DDVP surface levels in ventilated rooms), Table 10 (DDVP surface levels in unventilated rooms), Table 11 (propoxur surface levels in ventilated rooms), and Table 12 (propoxur surface levels in unventilated rooms).

Within the data sets, standard deviations were generally on the same order of magnitude as the average values. Less than 10% of the actual data points were within a +/- 0.25 range of the average values. When the high and low values within data sets were removed, average levels of airborne DDVP significantly decreased. When corrected for room volume dilution, air samples still showed wide variation. No correlation could be found between air data values and either room volume, or the amount found on fallout cards.

DISCUSSION

No reference levels are available to evaluate prolonged (non-occupational) exposure to either DDVP or propoxur. In the absence of such references, occupational exposure guidelines such as the PEL or TLV-TWA are occassionally extrapolated to produce such a reference. This extrapolation is performed by taking the TLV-TWA or PEL and reducing it by a factor of 4 (1/4) to expand the exposure base to a 24-hour day/7-day week, and further reducing this level by a factor of 10 (1/10) to add a safety margin for infants and the elderly. Using these calculations, DDVP would have an exposure guideline of 25 ug/m^3 and propoxur 12.5 ug/m^3. It should be noted that there is no strong scientific evidence to either support or refute such an extrapolation.

Due to the high degree of variation within the data sets, definite conclusions can not yet be drawn from the data collected in this study in regards to the safety of this type of product, the adequacy of label instructions,

or in reference to extrapolated exposure guidelines. The excessive variation within data sets may be due to a number of interrelated factors including:

1) room temperature during application
2) changes in room temperature during 24-hour sampling period
3) variability of aerosol can dispersion/performance
4) room ventilation rates
5) leakage in unventilated rooms
6) room disturbances during sampling

Factors (1) and (2), and to a lesser degree (4), (5), and (6) would have direct impact on the volatility of the pesticides, especially DDVP. Factor (2) in particular, would strongly affect the apparent degradation/dispersion curves. Factors (4), (5), and (6) may also affect secondary aerosolization of the deposited pesticides, especially the less volatile propoxur. Factor (3) may significantly affect the amount of pesticides in the room from the start of the tests. CDFA Chemistry Laboratory Services personnel involved in product quality testing report that quantities of active ingredient yielded from aerosol cans during routine tests varied greatly depending on the length of time and vigor used in shaking the aerosol containers prior to triggering (Rivera, Personal Communication, 1984). In addition, there is at least one literature report (Heard, 1984) of a defective fogger "sputtering" material at a much slower rate than expected. Variance in dispersal may also cause loss of pesticide by altering the amount of pesticides deposited on the protective layer of newspaper placed under the fogger can, and removed at the end of the 2-hour treatment, consequently reducing the actual amount of material available for dispersion by volatilization and secondary aerosolization.

Correction for total room volume, as seen in Tables 5, 6, 7, and 8, may also be misleading or inaccurate as it assumes that perfect mixing (100% dispersal) occurred within each room, a highly unlikely event in real world situations.

CONCLUSIONS

Unexplained variability of data collected indicates that before evaluation of indoor fogger behavior is made, further research into the mechanics of pressurized aerosol can, the behavior of pesticides in indoor settings, and room mixing dynamics must be performed. Further evaluation of the toxicological properties and hazards of pesticides used in household settings in relation to the general population rather than to healthy workers in the workplace is needed. Finally, additional evaluation of actual fogger-related illnesses is needed to determine whether additional studies concerning household fogger performance is necessary.

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TABLE 1

DDVP AIR LEVELS (UNCORRECTED FOR ROOM VOLUME)
- Ventilated Rooms -

LOCATION	Pre-App	0-15 min	15-30 min	30-60 min	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1a	31.2	235.3	102.4	94.4	52.1	36.3	18.3	59.7	82.7	163.3	36.9
Room 2a	-nd-	403	74	94.8	127.6	62	46.1	42.4	58.9	75.5	65.4
Room 3a	-nd-	218.7	--	698.5	629.6	340.9	439.9	319.3	12625.3	112.4	60.7
Room 4a	1.4	203.8	177.3	114.7	90.9	47.4	141.1	22.5	9.8	4.2	--
Room 5a	-nd-	887.3	58.2	24.9	27.2	9.1	3.7	5.2	2.3	1.8	1.4
Room 6a	-nd-	151.6	177.3	114.7	90.9	47.4	141.1	22.5	9.8	4.2	--
Room 7a	-nd-	76.1	58.2	24.9	27.2	9.1	3.7	5.2	2.3	1.8	1.4
Room 8	-nd-	465.1	189	172.1	194.2	209.6	181	114.9	--	--	18.8
Room 9	-nd-	619.6	281.6	313.7	188.6	194.7	100.3	60.2	--	--	29.1
Room 10a	-nd-	258.9	93.1	254.7	128.8	107.2	100.6	.8	44.3	44.3	27.6
Room 11a	-nd-	2804.3	3078.2	2685.3	1982.7	1271	1172.1	490.8	136.6	215	111.3
max value		2804.3	3078.2	2685.3	1982.7	1271	1172.1	490.8	12625.3	215	111.3
min value		76.1	58.2	24.9	27.2	9.1	3.7	.8	2.3	0.3	1.4
n		11	10	11	10	11	11	11	9	9	10
avg value		574.9	443.3	444.3	356.6	232.3	221.1	120.4	1457.8	84.8	38
variance		547195.3	705380.8	531655.7	290438.7	116309.7	102877	20881.1	12756653	4537.6	884.9
standard dev		739.7	839.9	729.1	538.9	341	320.7	144.5	3571.6	67.4	29.7
centered avg		311	127.6	195.9	153.6	113.9	112.2	73.7	52.7	58.9	24.8

notes-- nd = not detected
all values reported in micrograms/cubic meter

TABLE 2

DDVP AIR LEVELS (UNCORRECTED FOR ROOM VOLUME)
- Unventilated Rooms -

LOCATION	Pre-App	0-15 min	15-30 min	30-60 min	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1b		1488.6	1848.2	1362.8	931.1	766.3	540.1	580.3	665	236.7	89.6
Room 2b		1146.8	844.1	693.1	492.7	468.9	369.2	334.8	248.9	79	90.3
Room 3b	19.6	656.9	587.7	702.9	368.7	2.7	299.4	290.9	188.9	86.6	78.1
Room 4b	20.9	1213.9	698.2	708.5	467	431.3	320.1	287.2	188.6	177.2	62.8
Room 5b		674.6	721.4	510	416.6	479	316.5	296.1	--	--	58.9
Room 6b		474.5	469.0	378.1	260.6	166.6	4	88.6	77	43	60.2
Room 7b		--	46.7	18.1	15.1	27.9	46.5	14	28.2	5.5	1.4
Room 10b	1.1	534.1	537.2	248	296.9	286.6	283.2	301.4	228.7	130	52.5
Room 11b		3075	2870.2	2280.9	--	1053.6	1327.8	1217.6	631.1	608.7	186.1
max value		3075.01	2870.18	2280.85	931.13	1053.64	1327.75	1217.6	664.98	608.70	186.13
min value		474.45	46.70	18.11	15.06	2.69	3.99	14.04	28.17	5.54	1.35
n		8	9	9	8	9	9	9	8	8	9
avg value		1158.05	958.08	766.93	406.08	409.23	389.66	378.99	282.05	170.84	75.56
variance		569855.3	663237.5	411904.0	52708.69	104028.5	133242.4	110260.1	44037.69	28551.42	2149.84
standard dev		754.89	814.39	641.80	229.58	322.53	365.02	332.05	209.85	168.97	46.37
centered avg		712.34	631.99	509.49	285.81	289.86	239.69	240.14	193.41	92.06	52.73

TABLE 3

PROPUXUR AIR LEVELS (UNCORRECTED FOR ROOM VOLUME)
-Ventilated Rooms--

LOCATION	Pre-App-	0-15 m.	15-30 m.	30-60 m.	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	30.3	96.4	52.1	-nd-
Room 2a	-nd-	30.5	22.7	21.5	19.5	19.4	18	23.7	6.1	-nd-	-nd-
Room 3a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	49.8	-nd-
Room 4a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	21.8	19.7	-nd-
Room 5a	-nd-	46.9	-nd-	50	75.4	104.1	53.9	86.2	27.5	77	29.7
Room 6a	-nd-	-nd-	--	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 7a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	--
Room 8	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	37.4	--	--	-nd-
Room 9	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	21.4	--	--	-nd-
Room 10a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	9.4	-nd-
Room 11a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	29.5	-nd-	-nd-	-nd-
max value		46.9	22.7	50	75.4	104.1	53.9	86.2	96.4	77	29.7
min value		-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
n		11	10	11	11	11	11	11	9	9	10
avg value		7	2.3	6.5	8.6	11.2	6.5	20.8	16.9	23.1	3
variance		193.9	36.9	191.3	415.2	789.6	215.2	429.2	597.4	422.1	64
standard dev		13.9	6.1	13.8	20.4	28.1	14.7	20.7	24.4	20.5	8
centered avg		0.8	N/A	N/A	N/A	N/A	N/A	10.9	4.2	12.6	N/A

notes-- nd = not detected
all values reported in micrograms/cubic meter

TABLE 4

PROPOXUR AIR LEVELS (UNCORRECTED FOR ROOM VOLUME)
- Unventilated Rooms -

LOCATION	Pre-App	0-15 m.	15-30 m.	30-60 m.	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1b	-nd-	-nd-	-nd-	-nd-	-nd-	54.3	-nd-	75.9	148.7	116	-nd-
Room 2b	-nd-	64.4	47.4	39.4	45.6	40.7	30.4	76.2	25.4	7.3	19.2
Room 3b	-nd-	153.5	100.4	-nd-	-nd-	59.5	54	67	44.4	21.1	-nd-
Room 4b	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	55.7	55.6	-nd-
Room 5b	-nd-	59.2	72.5	48.7	80.1	51	87	48.1	--	-nd-	35.8
Room 6b	-nd-	-nd-	-nd-	-nd-	24.8	10.2	-nd-	6.3	-nd-	4.2	-nd-
Room 7b	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 10b	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	41.9	42.5	49	42.9	-nd-
Room 11b	-nd-	-nd-	-nd-	-nd-	--	-nd-	-nd-	55.7	-nd-	30.6	-nd-
max value		153.5	100.4	48.7	80.1	59.5	87	76.2	148.7	116	35.8
min value		-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
n		9	9	9	8	9	9	9	8	9	9
avg value		30.8	24.5	9.8	18.8	24	23.7	41.3	40.4	30.9	6.1
variance		1886.1	953.8	264.8	501	373.8	587.7	505.1	1363.1	1038.4	116
standard dev		43.4	30.9	16.3	22.4	19.3	24.2	22.5	36.9	32.2	10.8
centered avg		11.7	11.3	2.4	6.8	15.4	12	30.8	19.8	16	0.1

note-- nd = not detected
all values are reported in micrograms/cubic meter

TABLE 5

DDVP AIR LEVELS (CORRECTED FOR ROOM VOLUME)
- Ventilated Rooms -

LOCATION	Volume	0-15 min	15-30 min	30-60 min	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1a	37.63	8855.3	5754.6	9436.8	--	6431.5	4902.7	5065.1	5157.4	5507.6	818.2
Room 2a	25.28	10187	5714.7	4640.6	3637	2688.1	2489.5	1862.8	578.5	8.8	188
Room 3a	129.82	28390.6	13292.4	12257.1	6758.8	4708.7	2369.3	7746.6	10731.4	21200.1	4794.6
Room 4a	40.78	8309.3	3017.7	3866.9	5202.7	2526.5	1880.6	1728,5	2400.7	3079.5	2668.1
Room 5a	25.76	22857.6	--	17992.8	16218.8	8782.8	11332.6	8224.9	325227.7	2896.2	1563.3
Room 6a	115.58	17522.7	20495.5	13259.5	10501.9	5475.8	16310.3	2601	1134.3	488.9	--
Room 7a	161.95	12331.2	9426.5	4028.2	4411.8	1479.7	602.9	849.4	369.9	287.8	219.3
Room 8	43.01	20002.4	8127.9	7401.2	8352.9	9016.4	7786.9	4943.8	--	--	807.8
Room 9	34.5	21375.8	9713.7	10823.5	6507.4	6716.3	3460.6	2077.8	--	--	1004.1
Room 10a	33.16	8584.6	3086	8445.8	4272.4	3555.5	3337	25.1	1468,5	1468.5	914.5
Room 11a	26.88	75379.3	82741.2	72180.3	53295.8	34165.3	31505.5	13192.1	3671.9	5780.4	2992.7
n		11	10	11	10	11	11	11	9	9	10
avg value		21254.2	16137	14939.3	11916	7777	7816.2	4392.5	38971.1	4524.2	1597.1
variance		3.3477e8	5.1725e8	3.4004e8	2.0297e8	75225205	76229732	14347080	1.025e10	38813907	1925105.
standard dev		18296.7	22743.1	18440.1	14246.7	8673.2	8731	3787.8	101252.8	6230.1	1387.5

note--all values are reported in total micrograms/room

TABLE 6

DDVP AIR LEVELS (CORRECTED FOR ROOM VOLUME)
- Unventilated Rooms -

LOCATION	Volume	Pre-App	0-15 min	15-30 min	30-60 min	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1b	26.88		40014.4	49680.7	36631.5	25028.9	20598.9	14517.9	15598.1	17874.5	6361.7	2409.4
Room 2b	23.07		26454.4	19472.6	15989.6	11366.5	10817.2	8517.1	7722.7	5741.6	1821.5	2083.2
Room 3b	28.92	19.6	18995.7	16995.6	20326.9	10661.9	77.6	8659.4	8412.6	5464	2503.9	2258.4
Room 4b	32.15	20.9	39022	22444.6	22776	15011.6	13864.4	10291.3	9232.7	6061.3	5697.1	2020.3
Room 5b	30.58		20627.7	22056.2	15593.2	12737.4	14646.5	9678.6	9053.8	--	--	1800.5
Room 6b	49.45		23460.6	23192.9	18696.1	12884.9	8239.3	197.3	4378.6	3806.9	2126.6	2978.6
Room 7b	161.95		--	7563.3	2932.1	2438.8	4521.5	7535.8	2274.5	4562.7	897.4	219.3
Room 10b	36.84	1.1	19677.4	19791.2	9137.9	10938.9	10559.4	10433.8	11105.1	8426.4	4789.3	1935.5
Room 11b	17.92		55104.2	51433.6	40872.8	--	18881.2	23793.3	21819.4	11309.9	10908	3335.4
n			8	9	9	8	9	9	9	8	8	9
avg value			30419.55	25847.86	20328.46	12633.61	11356.22	10402.72	9955.28	7905.91	4388.19	2115.62
variance			1.59 e8	1.94 e8	1.30 e8	3.50 e7	3.82 e7	3.51 e7	3.03 e7	1.99 e7	9.70 e6	6.75 e5
standard dev			12613.07	13927.02	11380.41	5994.11	6179.99	5923.07	5504.68	4464.20	3114.83	821.73

note--all values reported in total micrograms/room

TABLE 7

PROPUXUR AIR LEVELS (CORRECTED FOR ROOM VOLUME)
- Ventilated Rooms -

LOCATION	Volume	Pre-App	0-15 m.	15-30 m.	30-60 m.	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24
Room 1a	37.63	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	1138.5	3629.3	1962.3	-nd-
Room 2a	25.28	-nd-	771.1	574.3	543	492.7	491.4	454.2	599.6	154.1	-nd-	-nd-
Room 3a	129.82	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	6462.2	-nd-
Room 4a	40.78	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	890.5	804.7	-nd-
Room 5a	25.76	-nd-	1208.2	--	1287.5	1941.8	2681.3	1388.5	2221.2	709.4	1982.4	766.1
Room 6a	115.58	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 7a	161.95	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	--
Room 8	43.01	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	1610.2	--	--	-nd-
Room 9	34.5	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	737.3	--	--	-nd-
Room 10a	33.16	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	313	-nd-
Room 11a	26.88	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	793.8	-nd-	-nd-	-nd-
n			11	10	11	11	11	11	11	9	9	10
avg value			179.9	57.4	166.4	221.3	288.4	167.5	645.5	598.1	1280.5	76.6
variance			127900.7	26717.6	108562.5	275797	524288	143002.4	335367.4	1053687.3	3218884.7	47540
standard dev			357.6	163.5	329.5	525.2	724.1	378.2	579.1	1026.5	1794.1	218

notes-- nd = not detected
all values given are in total micrograms/room

TABLE 8

PROPOXUR AIR LEVELS (CORRECTED FOR ROOM VOLUME)
- Unventilated Rooms -

LOCATION	Volume	Pre-App	0-15 m.	15-30 m.	30-60 m.	1-2 hr	2-3 hr	3-4 hr	4-6 hr	6-8 hr	8-12 hr	23-24 hr
Room 1b	26.88	-nd-	-nd-	-nd-	-nd-	-nd-	1460	-nd-	2040.1	3997	3117.3	-nd-
Room 2b	23.07	-nd-	1485.6	1094.6	908.9	1053	938.3	700.4	1758.1	585.4	169.5	442
Room 3b	28.92	-nd-	4438.7	2904.1	-nd-	-nd-	1719.4	1562.6	1938	1282.7	611.3	-nd-
Room 4b	32.15	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	1789.9	1786.4	-nd-
Room 5b	30.58	-nd-	1809.1	2216.6	1490.5	2450.4	1559.9	2659.2	1471.1	--	-nd-	1094.7
Room 6b	49.45	-nd-	-nd-	-nd-	-nd-	1225.5	505.8	-nd-	312.1	-nd-	205.9	-nd-
Room 7b	161.95	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 10b	36.84	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	1545.1	1564.6	1804.1	1580.4	-nd-
Room 11b	17.92	-nd-	-nd-	-nd-	-nd-	--	-nd-	-nd-	997.4	-nd-	548.5	-nd-
n			9	9	9	8	9	9	9	8	9	9
avg value			859.3	690.6	266.6	591.1	687	718.6	1120.2	1182.4	891	170.7
variance			1567385.	821273.9	212274.6	509100.4	280145.5	573521	323405.3	1130500.	824319.9	103041.2
standard dev			1252	906.2	460.7	713.5	529.3	757.3	568.7	1063.2	907.9	321

notes-- nd = not detected
all samples are reported in total micrograms/room

TABLE 9

DDVP SURFACE LEVELS
- Ventilated Room -

LOCATION	control	30 min	1 hr	2 hr	3 hr	4 hr	6 hr	8 hr	12 hr	24 hr
Room 1a	-nd-	570.4	255.4	968.6	501.3	77.7	14.1	17.5	9.2	5
Room 2a	-nd-	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.3	0.2
Room 3a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 4a	1.2	0.4	0.5	0.6	0.6	0.6	0.6	0.5	0.3	--
Room 5a	0.4	-nd-	-nd-	0.1	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 6a	-nd-	1.1	0.8	0.3	0.3	0.7	0.7	0.2	-nd-	9.4
Room 7a	-nd-	-nd-	-nd-	-nd-	0.5	0.3	-nd-	-nd-	-nd-	-nd-
Room 8	-nd-	0.6	1.6	1.4	0.8	0.9	--	0.5	--	0.5
Room 9	-nd-	1.3	2	1.6	0.9	0.9	--	0.5	--	0.2
Room 10a	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	0.1	-nd-
Room 11a	-nd-	3.6	6.1	7.2	3	4.4	1.8	2.1	1.9	1.2
max value		570.4	255.4	968.6	501.3	77.7	14.1	17.5	9.2	9.4
min value		-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
n		11	11	11	11	11	9	11	9	10
avg value		52.6	24.3	89.1	46.2	7.8	1.0	2	1.3	1.7
variance		25806.5	5183.4	75183.4	20133.6	472.4	13	22	5.1	5.9
standard dev		160.6	72	274.2	141.9	21.7	3.6	4.7	2.3	2.4
centered avg		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

notes-- nd = not detected
all values reported in micrograms/square centimeter

TABLE 10

DDVP SURFACE LEVELS
- unventilated rooms -

LOCATION	control	30 m.	1 hr	2 hr	3 hr	4 hr	6 hr	8 hr	12 hr	24 hr
Room 1b	-nd-	671.1	341.4	213.2	121	14.9	17	10.6	3.8	-nd-
Room 2b	-nd-	10.4	4.6	4.7	3.2	3	2.9	1.7	1.3	1.3
Room 3b	-nd-	4.7	3.7	3.4	2	2.5	1.6	0.7	0.8	0.7
Room 4b	-nd-	2.2	2.9	2.5	2	2.1	1.9	1.5	1.2	0.7
Room 5b	-nd-	0.1	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
Room 6b	-nd-	0.6	1	0.5	-nd-	-nd-	0.3	-nd-	0.3	-nd-
Room 7b	-nd-	0.7	-nd-	-nd-	-nd-	0.3	-nd-	-nd-	-nd-	-nd-
Room 10b	-nd-	2.5	1.4	2.7	1.3	1.3	3.1	0.9	0.9	0.4
Room 11b	-nd-	56.9	72.9	22.1	12.7	8.1	9.3	5.1	2.9	1.3
max value		671.1	341.4	213.2	121	14.9	17	10.6	3.8	1.3
min value		0.1	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-	-nd-
n		9	9	9	9	9	9	9	9	9
avg value		83.2	47.5	27.7	15.8	3.6	4	2.3	1.2	0.5
variance		43481.2	10785.9	4170.2	1313.3	17.6	23.7	8.1	0.2	
standard dev		208.5	103.9	64.6	36.2	4.2	4.9	2.8	0.4	
centered avg		6.7	7.6	2	0.4	n/a	0.1	n/a	n/a	n/a

notes-- nd = not detected
all values are reported in micrograms/square centimeter

TABLE 11

PROPOXUR SURFACE LEVELS
- Ventilated Room -

LOCATION	control	30 min	1 hr	2 hr	3 hr	4 hr	6 hr	8 hr	12 hr	24 hr
Room 1a	-nd-	5871.5	6479.2	7278.5	6918.7	6233.2	4871	3585	3365	2057
Room 2a	--	336.7	307.7	414.3	409.6	401.9	403.4	399.8	293.3	257.5
Room 3a	-nd-	67.6	69.4	44.6	62.6	53	51.3	35.2	28.1	6.1
Room 4a	391	313	343.3	339.8	289.6	321.4	351.7	287.5	250.9	--
Room 5a	-nd-	-nd-	-nd-	1.8	1.7	-nd-	2.4	1.4	1.3	-nd-
Room 6a	-nd-	446	452	424	377	412	418	387	403	3632
Room 7a	-nd-	674.5	477.6	501	732.9	594.6	422	475.9	401	525.1
Room 8	-nd-	359.2	837.9	835	641.1	635	--	762.7	--	640.9
Room 9	-nd-	708.9	993.9	965.2	594.6	715	--	669.5	--	574.9
Room 10a	-nd-	217	99.6	91.9	244	152	156	130	104	84
Room 11a	-nd-	1305.7	1121.9	1112.6	1228.6	1292	1085.9	1158.3	1100	1176.4
max value		5871.5	6479.2	7278.5	6918.7	6233.2	4871	3585	3365	3632
min value		-nd-	-nd-	1.8	1.7	-nd-	2.4	1.4	1.3	-nd-
n		11	11	11	11	11	9	11	9	10
avg value		936.4	1016.6	1091.7	1045.5	982.7	862.4	717.5	660.7	895.4
variance		2473254.4	3016944	3951035.3	3555698.4	2787409.5	1716232.8	927110.7	826169.1	1007090.6
standard dev		1572.7	1736.9	1987.7	1885.7	1669.6	1310.1	962.9	908.9	1003.5
centered avg		400.6	425.6	427.9	414.4	414.1	318.9	389.4	284.7	530.2

notes-- nd = not detected
all values reported in micrograms/square centimeter

TABLE 12

PROPOXUR SURFACE LEVELS
- Unventilated Rooms -

LOCATION	control	30 m.	1 hr	2 hr	3 hr	4 hr	6 hr	8 hr	12 hr	24 hr
Room 1b	-nd-	4731.1	3525	3488	3561.5	2522.3	3090.1	2048	2009	13.1
Room 2b	-nd-	1411	1800.1	2098.4	1764.3	1579.7	1864.6	1312.4	1127.2	1432.4
Room 3b	-nd-	1066.5	964.7	932.7	1051.5	1193.4	1001.3	955.5	1070.3	940.6
Room 4b	-nd-	940.2	1057.8	964.5	936.9	1134.1	1056.8	958.9	975.6	1047.5
Room 5b	-nd-	-nd-	1.2	1.5	1.1	1.7	1	1.3	2.1	0.8
Room 6b	-nd-	379	446	404	378	438	372	371	344	361
Room 7b	-nd-	785.6	542.3	639.3	638	1118.6	566.1	902.8	1034.6	796.6
Room 10b	-nd-	1011	1170	1084	1118	1151	1174	940	912	785
Room 11b	-nd-	1867.4	1770.8	1510.2	1657.3	1629.5	1592.2	1553.5	1605.1	1516
max value		4731.1	3525	3488	3561.5	2522.3	3090.1	2048	2009	1516
min value		-nd-	1.2	1.5	1.1	1.7	1	1.3	2.1	0.8
n		9	9	9	9	9	9	9	9	9
avg value		1354.6	1253.1	1235.8	1234.1	1196.5	1190.9	1004.8	1008.9	765.9
variance		14979435.5	3412.6	961254.3	957851.4	456325	750320.7	323523.1	315584	270453.2
standard dev		1216.3	976.4	980.4	978.7	675.5	866.2	568.8	561.8	520.1
centered avg		827	859.3	846.1	836.2	914	845.5	775.1	783.4	595.3

notes-- nd = not detected
all values reported in micrograms/square centimeter

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