105001

105001

Date Out EFB: 04 NOV 1983

TO: Wm. Miller
Product Manager 16
TS-767

FROM: Dr. Richard Moraski
Acting Chief
Review Section No. 1
Exposure Assessment Branch
Hazard Evaluation Division

Attached please find the environmental fate review of:

Reg./File No.: 241-238

Chemical: Terbufos

Type Product: Insecticide

Product Name: Counter

Company Name: American Cyanamid

Submission Purpose: Review aerobic and anaerobic soil metabolism study and exposure assessment study.

ZBB Code: ?

ACTION CODE: 400

Date in: 7/8/83

EFB # 3447

Date Completed: 04 NOV 1983

TAIS (level II) Days

67 8

Deferrals To:

_____ Ecological Effects Branch

_____ Residue Chemistry Branch

_____ Toxicology Branch

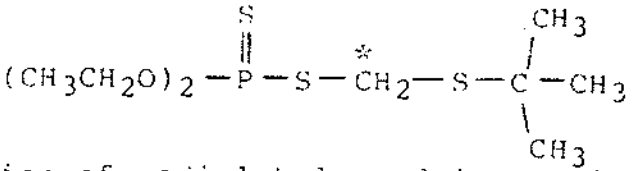
1.0 INTRODUCTION

American Cyanamid Company has submitted an aerobic and anaerobic soil metabolism study and exposure analysis to support the registration of Counter 15G, EPA Reg. No. 241-238 (terbufos, as a.i.).

1.1 Chemical

Common name: Terbufos
Chemical name: S-[[1,1-dimethylethyl)thio]methyl] O,O-diethylphosphorodithioate

Chemical structure:



*-Denotes position of radiolabel used in studies considered in this review.

2.0 DIRECTIONS FOR USE

No use directions were included in the submission (no new uses were proposed).

3.0 DISCUSSION OF DATA

COUNTER Terbufos (CL 92,100): Aerobic and Anaerobic Metabolism of CL 92,100 in a Silt Loam Soil. January 27, 1983. R. P. Peterson. Cyanamid Report No. PD-M Volume 20-4. Acc. No. 250661.

Procedure

Air-dried, sieved (to 2 mm) Wisconsin silt loam soil (characterized in Table 1) was fortified to 5 ppm methylene-^{14}C-terbufos. Distilled water was added to give 75% field moisture capacity at 1/3 bar. Flasks were covered with aluminum foil and incubated at 19° C ± 2° C. To trap volatiles and CO_2 from soil, humid air was passed over soil and into traps of ethylene glycol (volatiles trap) and then monoethanolamine (CO_2 trap).

For the anaerobic soil, flasks were incubated aerobically for 30 days then flooded with water to initiate anaerobic conditions. Incubation period was 60 days.

CYANAMID
American Cyanamid Company
Agricultural Research Division
Princeton, New Jersey

Table 1. Analysis of Plantation Soil*

Soil Texture	Silt Loam
pH (Salt Buffer)	6.7
Field Moisture (at 1/ Bar) (%)	24.45
Organic Matter (%)	3.2
Sand (%)	33.6
Silt (%)	51.2
Clay (%)	15.2
C.E.C. (meq/100 g)	14.17
NO_3-N (ppm)	7.4
Bulk Density on Dry Soil (g/cc)	1.35
Phosphorus (ppm-P)	90
Potassium (ppm-K)	642
Magnesium (ppm-Mg)	654
Calcium (ppm-Ca)	2408
pH (Soil)	5.9

*Performed by: United States Testing Company, Incorporated
Memphis Laboratory
Cotton Exchange Building
Memphis, Tennessee 38103

Note: Soil obtained from Collierville, Tennessee

Aerobic soil was sampled over the 365 day incubation period. Anaerobic soil was sampled at initiation of anaerobic conditions (day 0) and then 30 and 60 days later.

Soil was either extracted immediately or frozen at approximately 0° C until analysis. Serial extraction of soil was carried out with: 10% aqueous methanol; methanol; then acidified (0.5% HCL) methanol. Aliquots were partitioned with methylene chloride. The dried methylene chloride fractions were analyzed by two-dimensional TLC.

Total ^{14}C in solutions and on TLC separations were analyzed by LSC. ^{14}C on TLC plates was located by autoradiography. Tenative identification of extracted ^{14}C and separated on TLC plates was with co-chromatography of known standards. Unextracted (bound) ^{14}C in soil was determined by combustion of soil and analysis of $^{14}CO_2$.

Results

The author reports average recovery of 95.7% ± 3% for the aerobic soil samples and for the anaerobic soil was reported as 60.7% (volatiles were not collected).

Over the 365 day aerobic incubation period, $^{14}CO_2$ accounted for 46% of the total applied radioactivity. Other volatiles accounted for <0.5 % of the applied radioactivity. ^{14}C and bound material increased with incubation time. See Table 2.

Terbufos sulfoxide (Cl 94,301) and terbufos sulfone (Cl 94,320) were the two major metabolites of terbufos with maximum concentration occurring after 30 days and 60 days, respectively. Both metabolites then declined over the remainder of the incubation period. See Table 3.

The following half-lives were reported:

Compound	Half-life
Terbufos	5 days
Terbufos sulfoxide	100 days
Terbufos sulfone	100 days

American Cyanamid Company
Agricultural Research Division
Princeton, New Jersey

Final Volume 20-4

Table of Compounds

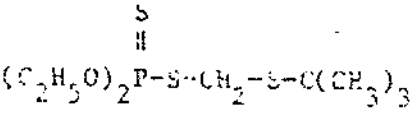
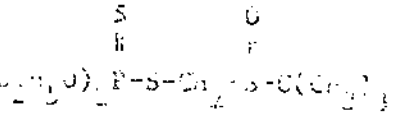
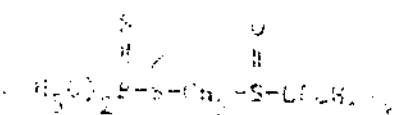
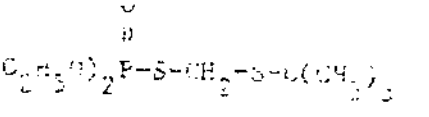
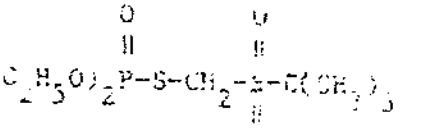
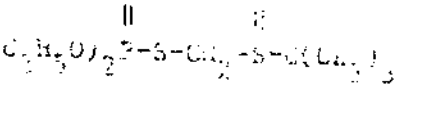
CL Number	Chemical Name	Structure
92,100	Phosphorodithioic acid, S-(t-butylthio methyl O,O-diethyl ester (terbufos)	
94,301	Phosphorodithioic acid, S-(t-butylsulfinyl) methyl O,O-diethyl ester (terbufos sulfoxide)	
94,320	Phosphorodithioic acid, S-(t-butylsulfonyl methyl O,O-diethyl ester (terbufos sulfone)	
94,221	Phosphorothioic acid, S-(t-butylthio) methyl O,O-diethyl ester (terbufoxon)	
94,302	Phosphorothioic acid, S-(t-butylsulfonyl) methyl O,O-diethyl ester (terbufoxon sulfone)	
94,365	Phosphorothioic acid, S-(t-butylsulfinyl) methyl O,O-diethyl ester (terbufoxon sulfoxide)	

Table 2. Radiobalance of Applied Radioactivity in CL 92,100 Aerobic Soil Study

Fractions	Percent of Applied Dose at Indicated Time Interval[a]									
	0-Day	4-Day	7-Day	14-Day	30-Day	60-Day	120-Day	180-Day	270-Day	365-Day
Extract 1 (Aqueous/Methanol)	107.4	89.7	84.6	79.2	70.6	61.4	53.8	46.6	38.5	28.0
Extract 2 (Methanol)	0.1	0.8	0.8	0.9	0.9	1.2	0.8	2.9	0.9	0.7
Extract 3 (HCl/Methanol)	0.1	1.1	2.2	3.4	5.6	6.1	7.0	7.0	10.2	6.5
Soil Bare (Air-Dried)	0.1	0.4	2.0	3.5	4.6	5.8	10.0	11.1	12.2	21.4
Volatiles (Trap)	-	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	0.1	0.3
Carbon Dioxide (Trap)	-	1.8	4.9	9.0	13.5	18.8	22.0	25.3	33.6	45.9
TOTAL	107.7	94.4	94.6	96.1	95.3	93.4	93.6	92.9	95.5	93.8

a) Percentages are based upon the applied dose of 5.0 ppm carbon-14 CL 92,100.

Table 3. Nature and Distribution of CL 92,100 and its Metabolites in Methylene Chloride Extracts[a] of Aerobic Soil at Various Times

Compound	0-Day		4-Day		7-Day		14-Day		30-Day		60-Day		120-Day		180-Day		270-Day		365-Day	
	ppm[b]	%[c]	ppm	%	ppm	%	ppm	%	ppm	%	ppm	%	ppm	%	ppm	%	ppm	%	ppm	%
CL 92,100	4.31	86.2	2.61	52.1	1.95	38.9	0.77	15.4	0.21	4.1	0.06	1.2	0.03	0.6	0.04	0.8	-	-	[illegible]	0.38
CL 94,301	0.31	6.2	1.50	29.9	2.06	41.3	2.55	50.9	2.62	52.3	1.75	34.9	1.47	29.4	1.24	24.7	0.88	17.2	0.29	5.9
CL 94,320	-	-	0.11	2.3	0.11	2.5	0.40	8.1	0.53	10.5	1.00	20.1	0.85	17.0	0.71	14.3	0.60	12.0	0.11	2.1
CL 94,321	0.04	0.8	0.03	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CL 94,365	-	-	0.03	0.5	0.03	0.5	0.02	0.4	-	-	-	-	-	-	-	-	-	-	-	-
CL 94,392	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TLC Origin	0.02	0.4	0.10	2.0	0.03	0.5	0.01	0.2	0.01	0.1	0.01	0.2	0.02	0.4	0.01	0.2	0.01	0.1	0.01	0.1
Unknowns[d]	-	-	0.03	0.5	0.04	0.8	0.03	0.6	0.01	0.2	0.06	1.1	0.06	1.2	0.08	1.5	0.06	1.2	0.07	1.4
TOTALS	4.68	93.6	4.41	87.9	4.20	84.5	3.78	75.6	3.40	67.6	2.88	57.3	2.45	49.0	2.08	41.5	1.55	30.9	0.49	9.1

a) Soil extracts #1 and #2 (Table II) were combined, diluted with water and extracted with methylene chloride.

b) ppm of chemical in soil as calculated from amount found in methylene chloride phase.

c) Percent of applied dose based on ppm found divided by 5.0 ppm (applied dose).

d) No individual compound was greater than 0.1% of applied dose.

NOTE: EAB regression analysis indicated that, considering the data through 60 days incubation, EAB regression analysis calculated the half-life of terbufos to be aproximately 10 days (r^2 = .948853). See Table 4.

Also, EAB regression analysis of the decline of the metabolites indicated the half-lives for terbufos sulfoxide (CL 94,301) was approximately 122 days (r^2 =.922303) considering data over the period of decline from day of maximum conconcentration (day 30) to end of incubation period. Also, the half-life of terbufos sulfone (Cl 94,320) was calculated to be approximately 106 days (r^2 =.784916) considering data from the date of maximum concentration (day 60) to end of the incubation period. See Table 5.

Terbufoxon (oxygen analog of terbufos) and terbufoxon sulfoxide were found in minimum amounts during the initial part of the incubation period. Terbufoxon sulfone was not detected at any sampling period.

Under anaerobic conditions, terbufos sulfoxide and terbufos sulfone were also found. The concentration of both declined during the incubation period. The author reported that terbufos (parent) concentration actually increased during the anaerobic incubation period. This suggested that some terbufos sulfoxide present at the initiation of anaerobic conditions was reduced back to terbufos. See Table 6.

In the anaerobic soil, after 30 and 60 days incubation, 12.8% and 18.0%, respectively, of the applied ^{14}C was unextracted (i.e., bound).

Conclusion

Terbufos degraded rapidly with a half-life of approximately 10 days (EAB regression analysis) in silt loam soil maintained under aerobic soil conditions. Degradation continued through mineralization to CO_2. The major metabolites found were terbufos sulfoxide (with an EAB calculated half-life of approximately 122 days) and terbufos sulfone (with an EAB calculated half-life of approximately 106 days).

In anaerobic soil, the metabolites formed under aerobic conditions continued to disappear, with partial reduction of terbufos sulfoxide back to terbufos (i.e., terbufos concentration actually increased under anaerobic conditions). However, the larger portion of the disappearance of

TABLE 4

REGRESSION ANALYSIS OF RESIDUE DECLINE DATA

NAME: FLETCHER DATE: 10/24/83

TITLE: TERBUFOS DECLINE

REMARKS:

FILE NAME: RESIDUE LEVELS IN PPM INTERVALS IN DAYS

DATA ENTRIES 1 TO 6

4.31 at 0 DAYS	1.95 at 7 DAYS	.21 at 30 DAYS
2.61 at 4 DAYS	.77 at 14 DAYS	.06 at 60 DAYS

N= 6 SUM X= 115 SUM X†2= 4761 SUM Y=-1.54731 SUM Y†2= 13.9199 SUM X*Y=-210.771
For the 95% confidence level, the appropriate 't' VALUE=2.1314 (For a one tailed test)

DF=4 R SQUARED=.948853 CHI SQUARED=1.72872 % Probability of a good fit=63.1%
Y-INTERCEPT= 1.09979 RELATIVE % ERROR OF THE SLOPE= 11.6% % LOSS PER DAY= 6.84%

SLOPE= -.071, its UPPER 95% CL= -.053 and its LOWER 95% CL= -.088
HALF LIFE= 9.8 DAYS, its UPPER 95% CL= 13 DAYS and its LOWER 95% CL= 7.8 DAYS

DAY ZERO LEVEL=3.004 PPM, its UPPER 95% CL=8.284 PPM and its LOWER 95% CL=1.089 PPM

TABLE 5

REGRESSION ANALYSIS OF RESIDUE DECLINE DATA

NAME: FLETCHER

DATE: 10/25/83

TITLE: CL 94,301 DECLINE

REMARKS:

FILE NAME: RESIDUE LEVELS IN PPM INTERVALS IN DAYS

DATA ENTRIES 1 TO 6

2.62 at 0 DAYS	1.47 at 90 DAYS	.88 at 240 DAYS
1.75 at 30 DAYS	1.24 at 150 DAYS	.29 at 335 DAYS

N= 6 SUM X= 845 SUM X†2= 201325 SUM Y= .757456 SUM Y†2= 2.98425 SUM X*Y=-361.639
For the 95% confidence level, the appropriate 't' VALUE=2.1314 (For a one tailed test)

DF=4 R SQUARED=.922303 CHI SQUARED=.61171 % Probability of a good fit=89.4%
Y-INTERCEPT= .927428 RELATIVE % ERROR OF THE SLOPE= 14.5% % LOSS PER DAY= .57%

SLOPE= -.006, its UPPER 95% CL= -.004 and its LOWER 95% CL= -.007
HALF LIFE= 121.8 DAYS, its UPPER 95% CL= 176.4 DAYS and its LOWER 95% CL= 93.1 DAYS

DAY ZERO LEVEL=2.528 PPM, its UPPER 95% CL=4.602 PPM and its LOWER 95% CL=1.389 PPM

REGRESSION ANALYSIS OF RESIDUE DECLINE DATA

NAME: FLETCHER

DATE: 10/25/83

TITLE: CL 94320 DECLINE

REMARKS:

FILE NAME: RESIDUE LEVELS IN PPM INTERVALS IN DAYS

DATA ENTRIES 1 TO 5

1 at 0 DAYS	.71 at 120 DAYS	.11 at 305 DAYS
.85 at 60 DAYS	.6 at 210 DAYS	

N= 5 SUM X= 695 SUM X†2= 155125 SUM Y=-3.22311 SUM Y†2= 5.27672 SUM X*Y=-831.342
For the 95% confidence level, the appropriate 't' VALUE=2.3465 (For a one tailed test)

DF=3 R SQUARED=.784916 CHI SQUARED=.790041 % Probability of a good fit=67.4%
Y-INTERCEPT= .265885 RELATIVE % ERROR OF THE SLOPE= 30.2% % LOSS PER DAY= .65%

SLOPE= -.007, its UPPER 95% CL= -.002 and its LOWER 95% CL= -.011
HALF LIFE= 105.8 DAYS, its UPPER 95% CL= 363.8 DAYS and its LOWER 95% CL= 61.9 DAYS

DAY ZERO LEVEL=1.305 PPM, its UPPER 95% CL=5.238 PPM and its LOWER 95% CL=.325 PPM

Table 6. Nature and Distribution of CL 92,100 and Its Metabolites in Methylene Chloride Extracts[a] of Anerobic Soil at 30 and 60 Days

	0-Day[b]		30-Days		60-Days	
Compound	ppm[c]	%[d]	ppm	%	ppm	%
CL 92,100	0.21	4.1	0.57	11.4	0.55	11.0
CL 94,301	2.62	52.3	0.66	13.2	0.27	5.4
CL 94,320	0.53	10.5	0.08	1.6	0.05	1.0
CL 94,221	-	-	-	-	0.02	0.4
CL 94,365	-	-	0.01	0.2	-	-
CL 94,302	-	-	-	-	-	-
TLC Origin	0.01	0.1	0.01	0.2	0.01	0.2
Unknowns[e]	0.03	0.6	0.02	0.4	0.07	1.4
Total	3.40	67.8	1.35	27.0	0.97	19.4

(a) Soil extracts #1 and #2 were combined, diluted with water and extracted with methylene chloride.

(b) Data from 30-day aerobic sample which was "zero" day for anaerobic study.

(c) ppm of chemical in soil as calculated from amount found in methylene chloride phase.

(d) % of applied dose based on ppm found divided by 5 ppm applied.

(e) No individual compound was greater than 0.1% of applied dose.

metabolites from the anaerobic soil was unexplained. After 60 days anaerobic incubation, only 44.1% (19.4% extracted, characterized + 18.0% soil bound, unextracted + 6.7% HCl-methanol extracted, uncharacterized) of the applied radioactivity was accounted for in the material balance. Only 47.5% of the applied radioactivity was accounted for after 30 days anaerobic incubation.

The registrant should provide a half-life estimate for terbufos and a more complete material balance of the anaerobic soil metabolism study.

4.0 EXECUTIVE SUMMARY

4.1 The aerobic soil metabolism study satisfies this data requirement.

4.2 The registrant should be requested to provide a half-life estimate and a more complete material balance of residues for terbufos in soil maintained under anaerobic soil conditions. This information is necessary before this study can satify this data requirement.

4.3 The exposure analysis is appended to this environmental fate data review.

Clinton Fletcher
Review Section No. 1
Exposure Assessment Branch
Hazard Evaluation Division

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1.0 INTRODUCTION

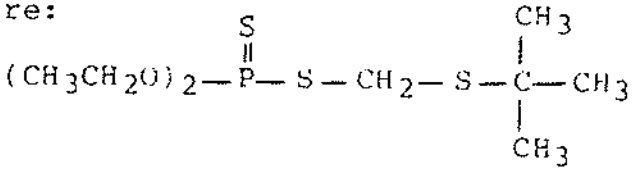
American Cyanamid has submitted an exposure analysis for the soil incorporated insecticide Counter 15G (terbufos, as a. i.)

1.1 Chemical

Common name: Terbufos (CL 92,100)

Chemical name: S-[[(1,1-dimethylethyl)thio]metyl] O,O-diethylphosphorodithioate

Chemical structure:



2.0 DIRECTIONS FOR USE

Application was made according to the use directions appended to this review.

Counter 15G is a 15% terbufos granular formulation which is applied with a ground applicator properly calibrated to deliver:

Field Corn	Sugar Beets
75 gm/100m (0.17 lb/328 ft) row with minimun 75 cm (30 inch) row spacing (1.4 lb. a. i./A).	45 gm/100m (0.10 lb/328 ft) row with minimum 50 cm (20 inch) row spacing (1.14 lb. a. i./A).

Only one application is made. The label directions prohibit applying later than at planting time.

The label bears the restriction to wear protective clothing and gloves while handling product.

3.0 Exposure Assessment

3.1 COUNTER Terbufos (CL 92,100/15G): Farmer Exposure Study with Counter 15G (BAND; 3.1 ONT, 1982). American Cyanamid Report No. C-2085. November 1, 1982. R. Peterson and G. Picard.

The protocol by which this study was conducted is attached to this review. The field procedures actually followed are summarized below.

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Procedure

Eleven farmers participated in the study as workers (coded A-K). Another five farmers served as controls (coded 1-5). Standard protective clothing, including coveralls and cotton gloves were worn while mixing/loading. Gloves were not worn during application. The same individual did both tasks-mixing/loading and application.

For measurement of potential dermal exposure, a total of six guaze patches were placed on the outside of the protective clothing and located in the chest area, upper back area, front lower leg below the right knee, above the knee on the right thigh, on the back of the right forearm and on the front of the right upper arm. An equal number of patches were located inside the protective clothing similarily placed but not directly under the outside patches.

Respiratory exposure was monitored by taking air samples in the breathing zone. Stainless steel tubes, filled with XAD-2 resin were,attached to the worker's collar and to a MSA personal monitoring pump calibrated at 1.5 l/min.

Urine and blood samples were collected as well. Urine samples were subsampled and analyzed (1) for creatinine determination (to determine completeness of 24 hour urine samples) and (2) for CL 92,100-related phosphorus esters (to determine degree of adsorption of CL 92,100).

Immediately after all planting activities, patches were removed and stored in polyethylene bags. Collected patches were stored at -25° C until analysis.

Analysis of gauze patches and air-collection tubes for total CL 92,100 and related compounds was by patch and resin extraction with acetone then quantitation by gas chromatogrpahy using a flame photometric detector. [NOTE: For patches, the method sensitivity was 5.0 ng/cm^2 (recovery ranged from 73 to 100% at fortification levels of 5 to 496 ng/cm^2 for CL 92,100, terbufos sulfone and a 4:1 mixture of same). For air samples, the method sensitivity is 0.35 ng/L, assuming 720 liters of air and 0.25 ug of compound are drawn into the AXD-2 resin tube (recovery ranged from 77 to 129% at fortification levels of 0.35 to 44 ng/l for CL 92,100 and terbufos sulfone)].

Gauze patch storage stablity data were presented showing 78 to 91% recovery for 2 and 8 weeks frozen storage of gauze patches fortified at 124 ng/cm^2 of the 4:1 mixture.

[Note: Analytical methods for blood and urine samples will be briefly mentioned. EAB defers to Toxicology Branch for review and validation of the submitted data].

Cholinesterase levels were measured in both plasma and red blood cells by using a modified potentiometric method of Michel [J. Lab. Clin. Med. 34, 1564-1568 (1949)].

Urine creatinine analyses were performed using the alkaline picrate Jaffe reaction. Urinary alkyl phosphate metabolite analysis was determined using a gas chromatography.

Results

Workers had a average exposure time of 7.4 hours (range: 4.7 to 11.9 hours), applying an average of 166 kg Counter 15G (range: 92 to 380 kg) on an average of 16.9 hectares (range: 8.1 to 38.9 hectares). See Table I. (Note: averages calculated by EAB.)

Air concentration for CL 92,100-related compounds averaged 6.5 ng/l (range: 1.6 to 16.0 ng/l) for the 11 exposed workers. Average hourly estimated respiratory exposure is calculated to be 11.3 ug/hr (range 2.8 to 27.4 ug/hr). See Table II.

Summary of dermal patch concentrations were reported as:

Area	Total CL 92,100-Related Compounds[a] (ng/cm^2)			
	Outside Patches		Inside Patches	
	Average	Range	Average	Range
Chest	109	26-529	20	ND[b]-89
Back	104	5-573	2	ND-9
Upper arm	191	14-819	8	ND-43
Lower arm	96	8-350	11	ND-57
Upper leg	463	43-2073	36	ND-255
Lower leg	42	ND-175	6	ND-21

[a]Taken from Tables III and IV.
[b]ND = <5 ng/cm^2, the sensitivity of analytical method.

From the data in the above table, the estimated dermal exposure can be caculated:

Estimated Dermal Exposure[a]
(ug/hr)

1.

Area	Unexposed Areas (Inside Patches)	
	Average	Range
Chest	9.3	ND-38.9
Back	1.4	ND--6.0
Upper arm	1.6	ND 11.4
Lower arm	2.0	ND-10.5
Upper leg	17.1	ND-97.9
Lower leg	2.5	ND--9.9
TOTAL[b]	34.1	4.1-119.2

[a]Summary of data in Table V.
[b]Average total from Table V-the average of the 11 individual farmer's total, not sum of averages given here.

2.

Area	Exposed Areas (Outside Patches)	
	Average	Range
Hands[a]	14.4	1.1-45.3
Head/Neck[a]	23.9	2.1-101.3
Lower arm[b]	16.8	1.4-54.2

[a]Data from Table V.
[b]Calculated by EAB. See Table X.

Summary

For exposed areas (outside patches), average estimated dermal exposure for a worker wearing coveralls but no gloves is reported as 14.4 ug/hr for hands and 23.9 ug/hr for head and neck. The average dermal exposure from unexposed areas is reported as 34.1 ug/hr.

Thus, the average total dermal exposure is estimated to be 72.4 ug/hr (14.4 + 23.9 + 34.1 ug/hr) for a worker wearing coveralls but no gloves. The registrant reports that this value over-estimates the actual since the label call for wearing gloves while handling product.

Conclusion

EAB concludes that the data presented for respiratory and dermal exposure adequately reflects the expected exposure potential of the mixer/loader and applicator of terbufos when used according to the attached label directions.

EAB notes that the registrant uses data of the lower arm outside patch to extrapolate to hand exposure. EAB notes that analysis of the cotton gloves themselves would have been preferable for determining hand exposure. However, lacking actual hand exposure measurement, EAB will accept this extrapolation. Moreover, this value may under-estimate the actual value for dermal exposure to unprotected hands.

Also, some minor calculation/tabulation errors were found in the data tables. They did not affect the final estimations.

Data from analyses of the dermal or respiratory exposure were not presented for the workers serving as controls. No were data presented for blank samples of gauze or XAD-2 resin.

EAB defers to the Toxicology Branch for review and validation of the data for blood and urine analyses (Tables VII - IX) and for the % Toxic dose/hr calculation (Table VI).

3.2 RESPIRATORY EXPOSURE

Hourly respiratory exposure for CL 92,100-related compounds averaged 11.3 ug/hr (range: 2.8 to 27.4 ug/hr) for the 11 exposed workers.

3.3 DERMAL EXPOSURE - WITHOUT PROTECTIVE CLOTHING

For this estimation, EAB assumes the worker wears a short sleeved shirt and long-legged pants. No gloves are worn.

The average dermal exposure through exposed hands, lower arms and head/neck is estimated to be 87.0 ug/hr [14.4 ug/hr (hands) + 16.8 ug/hr (lower arms) + 23.9 ug/hr (head and neck) + 31.9 ug/hr (unexposed chest, back, upper arms, legs)].

3.4 DERMAL EXPOSURE - WITH PROTECTIVE CLOTHING

For this estimation, EAB assumes clothing includes coveralls and cotton gloves will be worn during mixing/loading.

[NOTE: EAB generally does not consider cotton gloves as protective clothing. However, they are acceptable in this case for a granular pesticide formulation and used once.]

The average dermal exposure to a worker wearing coveralls and cotton gloves but exposed head and neck is estimated to be 59.6 ug/hr [1.6 ug/hr* (hands) + 23.9 ug/hr (exposed head and neck) + 34.1 ug/hr (unexposed chest, back, arms, and legs)].

*EAB calculated value. See Table X.

3.5 ESTIMATED TOTAL EXPOSURE

Condition	Exposure		Total Exposure
	Respiratory	Dermal	
Without protective clothing[a]	11.3 ug/hr.	87.0 ug/hr.	98.3 ug/hr.
With coveralls, no gloves	11.3 ug/hr.	72.4 ug/hr.	83.7 ug/hr.
With protective clothing[b]	11.3 ug/hr.	59.6 ug/hr.	70.9 ug/hr.

[a]Worker wearing short-sleeved shirt, long-legged pants and no gloves.
[b]Worker wearing coveralls and cotton gloves.

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Review Section No. 1
Exposure Assessment Branch
Hazard Evaluation Division

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SAMPLE CALCULATIONS USED IN THIS REVIEW.

1. Estimated hourly repiratory exposure (ug/hr)

$$\frac{\text{Total ug/hr found}}{\text{Application time (hr)}} \times \text{Human inhalation rate factor}$$

e.g. Farmer A $\frac{2.0 \text{ ug}}{8.2 \text{ hr.}} \times 19.3 = 4.7$ ug/hr

2. Estimated hourly dermal exposure (ug/hr)

$$\frac{\text{Dermal patch conc. (ug/cm}^2\text{) X regional surface area}}{\text{Application time (hr)}}$$

e.g. Farmer A Chest (inside dermal patch)

$$\frac{0.011 \text{ug/cm}^2 \times 3063 \text{ cm}^2}{8.2 \text{ hr}} = 4.1 \text{ ug/hr}$$

Farmer A Hands (outsider dermal patch/ lower arm)

$$\frac{0.107 \text{ ug/cm}^2 \times 1075 \text{ cm}^2}{8.2 \text{ hr}} = 14.0 \text{ ug/hr}$$

Farmer A Head and neck (average outside dermal patch chest and back)

$$\frac{\frac{185 \text{ ug/cm}^2}{2} \times 1305 \text{ cm}^2}{8.2 \text{ hr}} = 14.7 \text{ ug/hr}$$

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Pages 20 through 28 are not included. The pages contain detailed test results submitted by American Cyanamid.

Table X. Estimated Dermal Exposure
(ug/hr)

Farmer	Exposure time (hrs)	Exposed Lower Arm (1286 cm^2)	Unexposed Hands* (1075 cm^2)
A	8.2	16.7	---
B	8.3	54.2	1.3
C	4.6	24.0	2.3
D	3.8	6.8	---
E	11.9	9.4	1.3
F	4.7	20.3	2.1
G	7.3	1.4	---
H	7.0	10.8	8.8
I	9.6	1.3	---
J	6.9	11.7	0.8
K	9.0	27.8	2.0
	AVERAGE	16.8	1.6

* Used inside value for lower arm.

Sample caluclations:

Farmer A Exposed lower arm

$$\frac{107\ ng/cm^2 \times 1286\ cm^2}{8.2\ hr. \times 1{,}000\ ng/ug} = 16.7\ ug/hr.$$

FArmer C Unexposed hands

$$\frac{10\ ng/cm^2 \times 1075\ cm^2}{4.6\ hr. \times 1{,}000\ ng/ug} = 2.3\ ug/hr.$$

Ecological Effects Branch Reviews - Terbufos

Pages 30 through 38 are not included. The pages contain a detailed test protocol submitted by American Cyanamid.