Shaughnessy No.: 081301

Date Out of EAB: JUL 12 1988

TO: Eugene Wilson
Product Manager
Registration Division (TS-767C)

FROM: Frank L. Davido, Chief
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Exposure Assessment Branch/HED (TS-769C)

THRU: Paul F. Schuda, Chief
Exposure Assessment Branch/HED (TS-769C) Paul F. Schuda

Attached, please find the EAB review of...

Reg./File # : 239-1246

Chemical Name: CAPTAN

Type Product : Fungicide

Product Name :

Company Name : Chevron Chemical Company

Purpose : Submission of foliar dissipation and exposure data from Strawberry and Apple crops

Action Code: 660

EAB #(s) : 60845

Date Received: 12/18/1986

TAIS Code: 50

Date Completed: 7/12/1988

Total Reviewing Time: 21 days

Monitoring study requested: No

Monitoring study voluntarily: No

Deferrals to:

____ Ecological Effects Branch

____ Residue Chemistry Branch

____ Toxicology Branch

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REVIEW OF REENTRY DATA

1. CHEMICAL

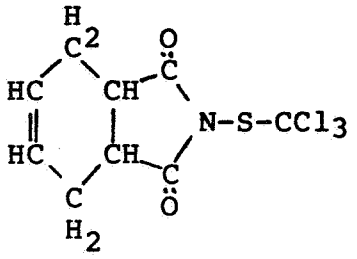
Common name: Captan

Product name: ORTHOCIDE

Chemical name:

N-(trichloromethylthio)-cis-cyclohex-4-ene-1,2-dicarboximide

Structure: $C_9H_8Cl_3NO_2S$ MWt 300.59



Other names: Captane, Merpan, Pillarcap, Vondcaptan, Vancide 89, CAS # 133-06-2, RTECS # GW5075100.

2. TEST MATERIAL:

ORTHOCIDE 50W

3. STUDY/ACTION TYPE:

Dissipation of Foliar Dislodgeable Residues and Monitoring of Human Dermal Exposure.

4. STUDY IDENTIFICATION:

Reg. File No. 239-1246
Record No. 179849
Accession Nos. 252447, 24933, 256804. [There are a number of studies in these packages. See the individual reviews below for citations of the individual studies.]

5. REVIEWED BY:

James D. Adams, PhD
Chemist
Field Studies and Special Projects Section #5 7/12/1988

6. APPROVED BY:

Frank Davido, Chief
Field Studies and Special Projects Section #5
Exposure Assessment Branch 7/12/1988

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7. CONCLUSIONS:

Application of Captan at moderate usage rates (e.g. 3 lbs a.i./A): leads to very high levels of foliar dislodgeable residues; those residues do not dissipate rapidly; and human exposure to those residues can be very high. These conclusions agree with findings of a review that I did in 1984 for use of Captan on strawberries. A copy of that review is attached to this one.

8. RECOMMENDATIONS:

For the use of Captan, the following reentry intervals should be set: 3 days for harvesting strawberries in non-arid areas, 1 day for harvesting apples or other tree fruit. Captan exposure to strawberry pickers in arid areas (rainfall less than 26 inches per year) and to strawberry weeders in any area is not resolved and data should be submitted for those exposures.

9. BACKGROUND:

Captan was originally placed in RPAR status in 1978 because of concerns with chronic effects. Several interested parties other than the Registrant started to gather exposure and/or dissipation data at that time. These groups include a state regulatory agency (California Department of Food and Agriculture), Universities, USDA, and growers.

10. DISCUSSION OF INDIVIDUAL TESTS OR STUDIES:

Not all of the data submitted are required under 40 CFR § 158.390. One of the studies listed in this submission was not included in the data package, and three of the studies have been reviewed previously by EAB as review number 6691. In that review an allowable exposure level of 12 mg/hr was calculated from toxicity data.

There are a number of studies in this submission. Since the studies can differ as to author, date, site, environmental conditions, crop, etc.; it is necessary to treat each individually. See the individual reviews below for citations to the individual studies. There are also studies on subjects other than reentry in this submission such as dermal penetration, metabolism, and human exposure to the formulated/diluted product. Those studies are not reviewed here.

The data included in the document with Accession Number 249333 is limited to a study of the dermal absorption of Captan. The data and conclusions of that study are relevant in the calculation of an Allowable Exposure Level for a Reentry Interval, and EAB will rely on the Toxicology Branch's review of that data.

The data included in the document with Accession Number 256804 is limited to a toxicology study and a study of exposure of spray applicators to Captan. Neither of these studies are required for reentry exposure assessment under 40 CFR § 158.390 [Previously identified as § 158.140] and will not be reviewed here.

10-1 No Accession Number given.

- Dissipation of Dislodgeable Captafol Residues on Almond Leaves. Chevron Chemical Co. March 1, 1985.

This study was listed as being among the studies that the Registrant had submitted and felt would satisfy the data required under § 158.390. No Accession Number was supplied with this study although all of the others were identified with an Accession Number. From the title of this study, those data appear to be useful for Captafol reentry-exposure assessment. If the study is in the Agency files, it should be reviewed for estimation of Captafol exposure, but it will not have a direct bearing on exposure to Captan residues. These are different, though structurally related, pesticides. The structure of a pesticide has a strong influence on its reactivity, volatilization, etc. A difference in structures could cause different dissipation rates and, therefore, different exposure rates.

10-2 Accession Number 252447.

- A Breakdown Study of Captan (ORTHOCIDE) on Strawberry Foliage and Fruit in Ventura County, California, April 1977. by Keith T. Maddy, Susan Edmiston, Charles S. Kahn, Terry Jackson, and A. Scott Fredrickson. Worker Health and Safety Unit, CDFA.

After having completed this and the review in paragraph 10-3, I found that this study had been reviewed before by Mathew Lorber, EAB, on 6/4/1986 as part of EAB Review Number 6691.

The Toxicology Branch (Judy Hauswirth, Bill Burnam) reports that the dermal penetration rate and the data previously used by Mat Lorber to calculate the Allowable Exposure Level (AEL) have not changed. Therefore, that 12 mg/hr AEL remains valid.

A. MATERIALS AND METHODS

A wettable powder formulation, Orthocide 50 W [EPA Registration number 239-533AA] was applied by ground rig to 30 acres of strawberries at the rate of 3 pounds a.i./A. Plictran at 1.75 pounds a.i./A and Benlate at 0.5 pounds a.i./A were also applied at that time as a mixture in 100 gallons of water per acre. The site of application, Ventura County, is a coastal area in Southern California, northwest of Los Angeles.

Approximately 100, 2.5-cm-diameter, leaf-disc samples were taken with a variation of the Dislodgeable Residue Procedure of Gunther et al. Samples were taken on days 1, 2, 3, 7, and 9 after pesticide application. The leaf samples were weighed. There is no indication of a way to convert weight to surface area for the dislodgeable residues. Some leaf samples were blended at high speed and used to quantify total residues on and in the leaves while the other leaf samples were used to quantify dislodgeable residues only.

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Berries were also picked and analyzed for total residue levels. All residue levels were quantified by glc using an electron capture detector.

B. REPORTED RESULTS

There was no rainfall during the study, and no spray irrigation water was applied. Otherwise, the weather conditions were much as would be found in April along that part of the California Coast. The temperature ranged from 41 to 71 °F during the study with the minimum and maximum temperatures averaging 47.0 and 68.4 °F, respectively. Although the report does not say so, morning dew could have been a common occurrence under those conditions.

The critical data, foliar dislodgeable residues, are reported in this study as ppm [cf Table 1]. Data in that form are useless for estimation of strawberry harvester exposure unless the data can be converted into residues per unit area. There is no conversion factor provided in the report and an accurate estimation of the dislodgeable residues in ug/cm^2 is not possible without it. Total and dislodgeable foliar residues and fruit surface residues are plotted as log values with respect to time in the report.

In order to have a more realistic value for the conversion of the part-per-million data to weight/area values and at my request, Warren Bontoyan, Analytical Chemistry Laboratory, BUD, (Beltsville) measured areas and weights of strawberry and apple leaves obtained locally. That data is reported below.

TABLE 1

MEASUREMENT OF SPECIFIC SURFACE AREAS OF STRAWBERRY AND APPLE FOLIAGE

STRAWBERRY LEAVES			APPLE LEAVES		
Leaf Areas,		Weight/leaf	Leaf Areas,		Weight/leaf
in^2	cm^2	Average, g	in^2	cm^2	Average, g
3.50	22.58	---	6.31	40.71	---
5.80	37.42	---	3.95	25.48	---
2.81	18.13	---	6.00	38.71	---
3.07	19.80	---	7.35	47.42	---
$\bar{X}$	24.48	0.36		38.07	0.77
SSA	68 cm^2/g			49.4 cm^2/g	

The effect of use of these factors rather than the worst case estimate of 20 cm^2/g will be to decrease exposure estimates by

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about 3.4 times for strawberry foliage and by 2.57 times for apple foliage.

C. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Any quality assurance procedures used during the study are not mentioned in this report.

The authors conclude that this treatment did not give fruit residue levels above the established tolerance level of 25 ppm at any time during the study.

D. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

The initial Foliar Dislodgeable Residues [FDRs] are very high although not the highest ever seen by EAB. These high levels are not anomalous for Captan on strawberry foliage; the studies that I reviewed in 1984 [on Captan dissipation and exposure in strawberry plants] had similar levels [Cf the attached review].

The Captan FDRs do not dissipate rapidly; the half life is about 4 days. This indicates that Captan could accumulate on leaves during the growing season if applications occur as frequently as the label allows.

TABLE 2

CAPTAN RESIDUE DISSIPATION AND HUMAN EXPOSURE

WITH STRAWBERRY PLANTS IN VENTURA COUNTY

Days After Application	Dislodgeable Residues, ppm	Dislodgeable Residues, ug/cm^2†	Human Exposure Rates, mg/hour	Human Exposure Rates, mg/day
1	118	1.735	19.07	152.59
2	86.1	1.266	13.46	107.72
3	80.2	1.179	12.45	99.57
7	40.6	0.597	5.87	46.94
9	35.1	0.516	4.99	39.95

† These data are calculated from the 68 cm^2/g Specific Surface Area (SSA) presented in Table 1 above. The FDRs in EAB review #6691 were estimates based on an assumed SSA of 20 cm^2/g.

A comparison of this data with the 12 mg/hr Allowable Exposure Level (AEL) indicates a reentry interval of 3 days.

The fact that this and the following study were conducted in two counties on the California coast indicates that the dissipation rates here may not be worst case. It is known that humidity and dew, such as could occur near the ocean, tend to increase rates of pesticide dissipation.

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10-3 Accession Number 252447.

° A Study of the Decay of Captan on the Foliage and Fruit of Strawberries in Santa Cruz County, California. May 1977. by Keith T. Maddy, Charles S. Kahn, Lucinda Riddle, and Jerry Alexander. Worker Health and Safety Unit, CDFA.

This study and the one reviewed in paragraph 10-2 have previously been reviewed by Mathew Lorber, EAB, on 6/4/1986 as part of EAB Review Number 6691. There does not appear to be need for further evaluation of this data except that the estimated exposure rates will be modified here using the 68 cm^2/g specific surface area.

TABLE 3

CAPTAN RESIDUE DISSIPATION AND HUMAN EXPOSURE

WITH STRAWBERRY PLANTS IN SANTA CRUZ COUNTY

Days After Application	Dislodgeable Residues, ppm	Dislodgeable Residues, ug/cm^2†	Human Exposure Rates, mg/hour	Human Exposure Rates, mg/day
0	66.4	0.976	10.100	80.80
1	95.5	1.404	15.095	120.76
2	8.8	0.129	1.079	8.64
3	5.0	0.074	0.584	4.67
7	11.2	0.165	1.416	11.33

† These data are calculated from the 68 cm^2/g Specific Surface Area (SSA) presented in Table 2 below. The FDRs in EAB review #6696 were estimates based on an assumed SSA of 20 cm^2/g for strawberry leaves.

A comparison of this data with the 12 mg/hr Allowable Exposure Level (AEL) indicates a reentry interval of 2 days.

10-4 Accession Number 252447.

° Harvest Exposure to Captan During Apple-Picking: Preliminary Evaluation of Pennsylvania State University Data. by Richard D. Knarr. Stauffer Chemical Co. Feb. 8, 1982.

This study and the ones discussed above in paragraphs 10-3 and 10-4 have previously been reviewed by Mathew Lorber, EAB, on 6/4/1986 as part of EAB Review Number 6691. Exposure rates were not developed in that review since actual human exposure data were gathered and submitted in the report.

The measured value of 49.4 cm^2/g listed above will be used here to recalculate the FDRs and estimate dermal exposure levels. The 49.4 cm^2/g value is based on apple leaves taken from trees in Prince George County, Maryland.

A. MATERIALS AND METHODS

Both dislodgeable residues and human exposures were measured during this study.

B. REPORTED RESULTS

The FDRs were reported in ppm [micrograms (ug) of residue per gram of leaf tissue]. The data are contained in the Table below.

C. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Any quality assurance prodedures used during the study are not mentioned in this report.

D. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

The FDR data and the human exposure monitoring data in this study are very high. In fact, the 2.591 ug/cm^2 value is the highest dislodgealbe residue from tree foliage that has been reported to the EPA. These reported human exposure levels are also very high although not the highest ever reported before.

TABLE 4

CAPTAN RESIDUE DISSIPATION AND HARVESTER EXPOSURE WITH APPLE FOLIAGE

Days After Application	Dislodgeable Residues, ppm	Dislodgeable Residues, ug/cm^2†	Exposure Rates, mg/hour Estimated*	Exposure Rates, mg/hour Measured@
1	128	2.591	29.7	12.2
3	85	1.721	18.9	10.6
7	37	0.749	7.5	9.8
14	39	0.789	8.0	6.1

† These values were calculated by dividing the ppm values by 49.4 cm^2/g.
* These values were estimated from the dislodgeable residue data in ug/cm^2 and using EAB's surrogate exposure data base.
@ These data were gathered in the submitted study.

A comparison of the 12 mg/day AEL with these measured exposure levels indicates a 1 day interval.

This study is interesting and useful for a reason other than the assessment of Captan exposure to fieldworkers. It provides an opportunity for evaluation of EAB's method for estimating exposure levels from FDRs. EAB commonly estimates human exposure from a correlation of FDRs and human exposure monitoring data. These two types of data were gathered simultaneously during normal field activities and by researchers at facilities across the country. In order to compare the Registrant's submitted data with results from EAB's surrogate data base, exposures were estimated from the

dislodgeable residue data below in Table 4. Those estimates are presented in the fourth column under "Estimated". The submitted exposure data are presented in column five.

Comparison of those two columns shows that the EAB estimates are initially about double the measured exposure rates, but the two sets of data are quite similar at the two lower residue levels. The disagreement of the two methods at the high levels may be due to the normal variability of data from an agricultural operation. That variability could be on the part of either set of data or both in combination. However, the disagreement raises a question of the linearity of the EAB data base at high residue levels. That is, is it possible that exposure reaches a maximum at high residue levels? Further research should be done on this topic.

Whatever the reason for disagreements in the data, there is no doubt that Captan application leads to high levels of foliar residues and to high levels of human exposure to those residues.

10-5 Accession Number 252447.

- Dermal and Inhalation Exposure of Commercial Apple Growers to the RPAR Pesticide Captan. by Howard M. Deer. University of Minnesota. September 1981.

This study contains mixer/loader/applicator exposure data that may be useful for assessment of exposure of those workers to the formulated/dilute pesticide, but it has no data useful for the assessment of fieldworker exposure to the residue of Captan after application. This study does not fulfill any of the requirements of 40 CFR 158.390.

10-6 Accession Number 252447.

- Potential Exposure of Workers During Seed Potato Treatment with Captan. by Edwin R. Stevens and James E. Davis. Bull. Environm. Contam. Toxicol. 26:681-688 (1981).

In this study, workers were monitored for Captan exposure during a variety of work tasks. All of these tasks involved exposure either during application of the pesticide or immediately after the application. These work tasks do not appear to fall within the area of reentry exposure, i.e. there was little if any time for the pesticide to dissipate. A reentry interval in this case is meaningless - either the exposure at application is acceptable or it isn't.

This study does not fulfill any of the requirements of 40 CFR 158.390.

11. COMPLETION OF ONE-LINER:

To be done.

12. CBI APPENDIX:

No CBI data were retained.

CAPTAN:

Fieldworker Exposure

by James D. Adams, EAB

There are 7 available studies of fieldworker exposure to captan applied to strawberries. See the attached table for detail of the data from these studies and calculations of yearly exposure.

One of the studies was performed in Oregon where school-age children are usually employed as pickers for about six weeks per season with 30 days of exposure per year (Popendorf, 1984). The children may only work for one season or less, and rarely work in the strawberry harvest for more than three years (As they get older, they can find better paying work.) The strawberry picker exposure rate for the Oregon study, at 4.70 mg/hr was the lowest rate in the 7 studies. Estimated lifetime captan exposure derived from this study is 3.39 grams for strawberry pickers in Oregon.

Six of the studies were performed in California where harvesting is usually done by residents of the area, and the harvest may last for 80 work-days. In this case, people may work in strawberry agriculture for as many as 20 years (Popendorf, 1984). One of these studies included exposure to weeders as well as pickers. In that case, exposure to weeders, at 94.13 mg/hr, was much higher than to pickers, at 17.41 mg/hr. However, the weeding of strawberries is performed only about 10 days/season.

The 6 California picker-exposure values range from 3.76 to 24.97 g/yr with a mean of 9.85 g/yr. Based on the mean of these measured values, lifetime exposure for a person only picking strawberries would be 197.0 g/lifetime. If a California worker only engaged in weeding strawberries, the exposure would be 150.6 g/lifetime. Combination of the two tasks (10 days of weeding and 70 days of picking per year) could lead to the largest lifetime exposure. I estimate that exposure to be: [(9.85 g/yr)(70/80) + 7.53 g/yr](20) = 323.0 g/lifetime.

Strawberry pickers and perhaps weeders have the oportunity to eat the fruit. That fruit is reported (Popendorf et al) to average 0.62 ppm (SD = 0.052) from 7 sets of residue data whose means range from undetectable to 1.20 ppm. If we assume that the workers eat a daily average of 430 g [(1 pint)(454 g/pint)(0.95 g/g density) = 430 g], a worker would ingest 0.00052 g/day [(430 g)(1.2 X 10^{-6} g/g) = 0.00052 g/day] of captan residues with the fruit. Addition of this ingestion exposure to the exposures above increases the estimated lifetime exposures. The estimated lifetime exposures are: 3.44 g for Oregon Pickers (0.00052 g/d)(30 d/yr)(3 yr) + 3.39 g]; 197.3 g for California Pickers (0.00052 g/d)(80 d/yr)(20 yr) + 197.8 g]; 151.4 g for California Weeders [(0.00052 g/d)(80 d/yr)(20 yr) + 150.6 g]; and 323.8 g for a combination of picking and weeding in California [(0.00052 g/d)(80 d/yr)(20 yr) + 323.0]. Ingestion exposure relative to total exposure is small, ranging from 1.4% in Oregon to 0.3% for combined picking and weeding in California. However, that exposure portion may be absorbed better than the dermal exposure.

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Discussion of captan exposure studies

The University of California, Berkeley (UCB) has performed six studies of strawberry harvester's exposure to captan. Five of these studies were performed in California and one in Oregon. The studies were funded by the Agency NPHAP as part of the Inter-agency Agreement with the Department of Labor's Wage and Hour Division. The five studies performed in 1981 are reported by Popendorf et al., 1982. The sixth study, performed in 1982, is reported by Zweig et al., 1983. In general, these studies were well performed and reported: Sufficient and appropriate samples were taken; They used good sampling media for exposure monitoring (i.e. gauze pads and cotton gloves as dermal dosimeters and Millipore personal inhalation monitors) and good sampling methodology for the foliar residue levels; They handled the samples well and performed appropriate residue recovery tests; Their analytical procedures were acceptable (except that they did not analyze for tetrahydrophthalimide (THPI) which is derived from captan in the environment and in vivo and is a contaminant of commercial captan); The data analysis was appropriate; and their conclusions are valid. For more information see the following comments on the individual reports and the attached table.

COMMENTS ON POPENDORF ET AL.

Exposures to a total of 78 fielworkers were monitored in five different studies, one in Oregon and four in the Salinas Valley of California. These were strictly monitoring studies where normal agricultural practices were being observed.

These reports contain a number of significant findings. Among these are:

1. The ratio of dermal to inhalation exposure is about 100 to 1.
2. The majority of the dermal exposure was to hands and lower arms, with hands receiving 60 to 88% and lower arms receiving 7 to 21% of total exposure.
3. The exposure levels for pickers are substantial and range from 4.70 to 17.41 mg/hr.
4. Higher worker productivity results in higher worker exposure.
5. There is a correlation between dislodgeable captan residue levels and picker dermal-exposure levels to captan.
6. Weeders in strawberry fields experienced much higher captan exposure levels (94.13 mg/hr) than harvesters.
7. Captan apeared to be more persistant in California than in Oregon, captan residue levels were higher, and picker exposure was higher.

COMMENTS ON ZWEIG ET AL.

This study was performed in California in 1982. Exposures of 10 pickers, ranging in age from 19 to 55 years, were monitored 4 days after the application of 4 lbs of captan Active Ingre-

dient per Acre (a.i.a.) and 1 lb of benomyl a.i.a. Hand exposures were monitored with light cotton gloves (commonly used in photographic darkrooms) as media for sorption of pesticide residues. Lower arm exposures were monitored with 3 in by 3 in, surgical gauze "dosimeters". Exposures to other body parts were not monitored. They chose not to monitor other body parts because previous studies (Popendorf et al., 1982 and Everhart and Holt, 1982) had shown that exposure to be minor.

They observed that the gloves became saturated with fruit juice and dew during picking, and for that reason, they changed the gloves every 2 hours.

Data from this report is summarized in the attached table as study number 6.

COMMENTS ON WINTERLIN ET AL.

The tables in this paper are poorly conceived and executed and can easily lead to mis-interpretation of the data reported. In order to estimate fieldworker exposure, it is necessary to make further calculations with some of the data and to carefully read the text that relates to the tables to avoid making false conclusions.

They used latex rubber gloves for the monitoring of hand exposure of strawberry pickers to captan. The use of latex gloves for exposure monitoring is bad methodology. These gloves are hydrofugic, particles do not cling to them, and-non polar materials would penetrate into the gloves and, thus, tend to be unextractable. The expected sum of these effects is that use of latex gloves as monitors of fieldworker hand-exposure greatly under-estimates hand exposure by some indeterminate amount. This point is especially important because hand exposure has been reported to be the major source of exposure for strawberry pickers.

In their Table X, they report dermal exposure levels found for several areas of the body [chest, sleeve, back, thigh, shin], but do not report dermal exposure for the hands. In papers that they cite [Popendorf et al. 1982b; Everhart and Holt, 1982; and Zweig et al. 1983] exposure to the hands and lower arms have been reported to be the large majority of total exposure. For that reason it is important to have an estimate of exposure to the hands to add to their "Total Exposure" listed in Table X [which is the total of the dermal exposures listed in the left columns of the table and is not inhalation exposure even though they listed it under the table heading of 'respirator' exposure]. It is possible to estimate/calculate hand exposure from the hand area for a 50 percentile man [Durham and Wolfe, 1962] and the data in their Table IX, but it takes a leap of faith and some ingenuity to do it. Their Table IX lists glove exposure for captan as 2.198 ug/cm^2 and THPI (derived from captan) as 0.0129

ug/cm^2 for a four hour exposure period. The sum of the residues is then 2.211 ug/cm^2/4-hr. The surface area of 2 hands is 820 cm^2 [Durham and Wolfe, 1962], and the total exposure to their gloves is:

$$(820\ cm^2)(2.211\ ug/cm^2/4\ hr)(10^{-3}\ mg/ug) = 0.453\ mg/hr$$

While the total dermal exposure exclusive of hands they report in Table X was 55.36/8 = 6.92 mg/hr. Adding that value to the 0.453 mg/hr for hand exposure gives 7.373 mg/hr or 58.98 mg/8-hr day as the total dermal exposure. On page 671, They state that the pickers' inhalation exposure would be 2.1 to 4.3 ug/8-hr day. Thus picker inhalation-exposure in this study is less than 0.007 percent of dermal exposure and is thus inconsequentially small.

On page 671, they calculate the applicator inhalation exposure as 45 to 114 ug/8-hr day; but in Table X, they report this same datum as 3.708 mg/8-hr day with no further discussion of the discrepancy.

COMPARISON OF DATA FROM THE TWO STUDIES

There are gross differences between the data from Winterlin et al. and the five studies performed in California by Popendorf et al. For example;

Body Area	Exposure, mg/d		Body Area
	Winterlin	Popendorf	
-----	------	2.32*	head and neck
Chest	2.568	1.98*	chest and stomach
sleeve	15.20	17.55*	upper and lower arms
back	1.92	2.76*	back and shoulders
thigh	25.63	-----	----------
shin	10.04	5.77*	lower legs
hands	3.63*	92.63*	hands
	58.99	123.0 total*	

* My calculation from their data

[(15.38 mg/hr)(8hr) = 123.0 mg/d total exposure rate]

The two sets of data are quite similar for exposures to: chest, sleeve, back, and perhaps shin; but are not similar for hands and thigh. Hand exposure is 75% of total dermal in Popendorf et al., but only 6.2% in Winterlin et al. This is probobly due to use of latex gloves as monitors of hand exposure by Winterlin et al. The failure of Winterlin et al. to measure/report exposure to head and neck is not very important because it is small. It appears from data of Winterlin et al. that Popendorf et al. may have underestimated dermal exposure by about 25 mg/d or about 16.9% of the total by not measuring thigh exposure.

ESTIMATION OF FIELDWORKER EXPOSURE TO CAPTAN IN STRAWBERRIES

Study No.	State	Task	Days after application	Non-ingestion Exposure				References
				mg/hr	hr/d	d/yr	g/yr	
1.	Calif	Picking	10	6.50	8	80	4.16	Popendorf et al. 1982a
2.	Oreg.	Picking	26	4.70	8	30	1.13	Popendorf et al. 1982a
3.	Calif	Picking	3	17.41	8	80	11.14	Popendorf et al. 1982a
"	"	Weeding	3	94.13	8	10	7.53	Popendorf et al. 1982a
4.	"	Picking	3	16.37	8	80	10.48	Popendorf et al. 1982a
5.	"	Picking	48	5.88	8	80	3.76	Popendorf et al. 1982a
6.	"	Picking	4	39.01	8	80	24.97	Zweig et al. 1983
7.	"	Picking	3	7.15*	8	80	4.58	Winterlin et al. 1984
Mean for 6 Calif. picking studies:				15.38	mg/hr		9.85	g/yr

* This has been corrected to include hand exposure.

REFERENCES

Durham, W.F. and H.R. Wolfe. 1962. Measurement of the exposure of workers to pesticides. Bull. World Health Org. 26:75.

Everhart, L.P., and R.F. Holt. 1982. Potential benlate fungicide exposure during mixer/loader operations, crop harvest, and home use. J. Agric. Food Chem. 30:222.

Popendorf, W. J. 1984. Personal communication, December 7, 1984.

Popendorf, W. J., J.T. Leffingwell, H.R. McLean, G. Zweig, and J.M. Witt. 1982a. "Youth in Agriculture - Pesticide Exposure to Strawberry Pickers; 1981 Studies", final report submitted to Office of Pesticide Programs, EPA, Washington, DC.

Popendorf, W. J., J.T. Leffingwell, and G. Zweig. 1982b. "Abstracts of Papers", 185th National Meeting of the American Chemical Society, Kansas City, MO, Sept 1982; American Chemical Society, Washington, DC; CHAS 33.

Winterlin, W.L., W.W. Kilgore, C.R. Mourer, and S.R. Schoen. 1984. Worker reentry studies for captan applied to strawberries in California. J. Agric. Food Chem. 32:664.

Zweig, Gunter, Ru-yu Gao, and William Popendorf. 1983. Simultaneous dermal exposure to captan and benomyl by strawberry harvesters. J. Agric. Food Chem. 31:1109.