Appendix I. The HED Chapter of the Reregistration Eligibility Decision Document (RED) for Naled (Case Number 0092, Chemical Number 034401) and The Revised Human Health Risk Assessment for Dichlorvos (Case Number 0310, Chemical Number 084001)

Summary of HED Data

	Naled		**DDVP**	
Test	**Results**	**Source**	**Result**	**Source**
Acute Oral LD_{50}	Rat Corn oil carrier: 230 mg/kg-bw (F); 325 mg/kg-bw (M) Carboxymethyl-cellulose[2] carrier: 92 mg/kg-bw (F); 191 mg/kg-bw (M)	00142660	Rat 56 mg/kg-bw (F) (96.5 mg/kg-bw, expressed as naled); 80 mg/kg-bw (M) (137.8 mg/kg-bw, expressed as naled)	00005467
Acute Dermal LD_{50}	Rabbit 360 mg/kg-bw (F); 390 mg/kg-bw (M)	00146493	Rat 75 mg/kg-bw (F) (129.2mg/kg-bw, expressed as naled); 107 mg/kg-bw (M) (184.4 mg/kg-bw, expressed as naled)	00005467
Acute Inhalation LC_{50}	Rat 0.19 mg/L (F); 0.20 mg/L (M) for 4 hr. exposure	00146494	> 0.198 mg/L (>0.0090)	00137239
Primary eye irritation[1]	Rabbit Severe irritation	00074826	Mild irritant	00146921
Primary dermal irritation[1]	Rabbit Corrosive (escharotic)	00074825	Mild irritant	00146920
Dermal sensitization[1]	Guinea pig Weakly positive	00074657	No study available	None

[1] Data pertaining to eye irritation, dermal irritation and skin sensitization are not required to support the reregistration of the TGAI. These data are presented for information purposes.

[2]A preliminary study to a cytogenetics assay obtained somewhat lower oral LD_{50} values of 85.1 mg/kg/day for male rats and 81.2 mg/kg/day for females using CMC as the vehicle (MRID 00142665).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

October 12, 1999

MEMORANDUM

SUBJECT: **NALED**. Revised HED Risk Assessment for RED.
PC Code 034401. DP Barcode D260129

FROM: Susan Hummel, Chemist, and Branch Senior Scientist
Reregistration Branch 4
Health Effects Division (7509C)

TO: Tom Myers, Biologist
Reregistration Branch 2
Special Review and Reregistration Division (7508C)

and

Kathy Monk, Chief
Reregistration Branch 2
Special Review and Reregistration Division (7508C)

Please find attached the revised HED Risk Assessment for the Naled RED. Thanks go to the Risk Assessment team, Rob Travaglini as the former Risk Assessor, Sue Hummel, David Hrdy, and David Soderberg for the Dietary Exposure assessment, Tim Leighton and Dave Jaquith for the Occupational and Residential Exposure Assessment, Jerry Blondell and Monica Spann for the Epidemiology assessment, and Pam Hurley for the Toxicology assessment. Thanks also to Steve Knizner and to Kathleen Martin for the editing.

HUMAN HEALTH RISK ASSESSMENT

Naled

U.S. Environmental Protection Agency
Office of Pesticide Programs
Health Effects Division (7509C)

Susan Hummel, Risk Assessor
October 13, 1999

HUMAN HEALTH RISK ASSESSMENT
Naled
Phase 5

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I. Executive Summary

Background

Provided in this document is a revised Risk Assessment for naled (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate). Naled is an organophosphate insecticide registered for use primarily to control adult mosquito and blackfly populations. Naled is also used on food and feed crops, in greenhouses, and for pet flea collars. The insecticide acts as a contact poison to kill aphids, army worms, blackflies, cockroaches, deer flies, earwigs, fleas, gnats, grasshoppers, gypsy moth, horn fly, houseflies, lice, midges, mites, mosquitoes, ticks, and weevils.

Naled was first registered in the United States in 1959 for use as an insecticide-acaricide. The Agency issued a Registration Standard for naled in September, 1983 (NTIS #PB-84-158989). In November, 1991, the Agency issued a Data Call-In for naled requiring certain ecological effects and occupational/residential exposure data. Additional occupational and residential exposure data were called in during 1993.

Dichlorvos (DDVP), a registered organophosphate insecticide, is a metabolite of naled. A preliminary risk assessment for dichlorvos, which encompassed dichlorvos derived from naled was completed by the Health Effects Division (HED) on December 3, 1998 and addresses all exposure concerns including dietary for this metabolite. This document therefore, addresses concerns solely for naled *per se.*

Health Effects

Toxicity

The toxicological database for naled is complete. It provides evidence that naled, like other organophosphates, has anticholinesterase activity in all species tested (including dogs, rabbits, hens, rats, and mice). Clinical signs of cholinesterase (ChE) inhibition include tremors, salivation, nasal discharge, and abnormal respiration. Inhibition of plasma, erythrocyte and brain cholinesterase activity occurs by the oral, dermal, and inhalation routes of exposure, and following exposure for various durations (acute, short- intermediate-term, and chronic). In an acute delayed neurotoxicity study in hens, naled did not produce frank delayed neurotoxicity, but a degenerative neuronal effect was manifest in the spinal cord. In the hen subchronic neurotoxicity study, no delayed neuropathy was observed. No neurological effects were noted in the acute rat neurotoxicity study, however, in the subchronic rat neurotoxicity study minimal neurological effects were noted.

The FQPA Safety Factor Committee recommended that the 10X FQPA Safety Factor be removed for naled based on: the completeness of the toxicology database; toxicological data indicating no enhanced sensitivity for infants or children (as demonstrated in the

developmental and reproductive toxicity studies); and availability of adequate actual data, surrogate data, and/or modeling outputs to satisfactorily assess exposures for dietary, drinking water, and residential drift to bystanders from mosquito/blackfly control applications.

By the oral, dermal, and inhalation exposure routes, technical naled is classified in Toxicity Category II. For eye and dermal irritation, naled is classified in Toxicity Category I. Naled was weakly positive in a guinea pig dermal sensitization study. In the oral acute toxicity studies, females appear to be more sensitive than males.

The chronic Population Adjusted Dose (PAD) for naled is 0.002 mg/kg/day based on: a No Observed Adverse Affect Level (NOAEL) of 0.2 mg/kg/day from a two-year gavage study in the rat; an uncertainty factor (UF) of 100 to account for interspecies extrapolation (10X) and intraspecies variability (10X) and 1X for the FQPA Safety Factor. Brain ChE inhibition was seen at the Lowest Observed Adverse Affect Level (LOAEL) of 2.0 mg/kg/day.

For acute dietary risk assessment, the acute PAD is 0.01 mg/kg/day. The acute PAD was calculated using: a NOAEL of 1.0 mg/kg/day; a UF of 100 that includes 10X for interspecies extrapolation and 10X for intraspecies variation; and 1X for the FQPA Safety Factor. The NOAEL is based on mild clinical cholinergic signs and plasma and brain ChE inhibition at 10 mg/kg/day (LOAEL) in a 28-day oral study with rats.

Although the Agency has determined that there is evidence of non-carcinogenicity in humans for naled *per se* (i.e., naled is a Group E chemical); dichlorvos (DDVP), a metabolite of naled, has been classified as a Group C (possible human) carcinogen.

For occupational and residential risk assessments, short- and intermediate-term dermal and inhalation toxicological endpoints were identified. The toxicological endpoint for both the short- and intermediate-term dermal risk assessment is based on the NOAEL of 1 mg/kg/day observed in a 28-day rat dermal toxicity study. Cholinesterase inhibition and neurological clinical signs were observed at the LOAEL of 20 mg/kg/day. For inhalation risk assessments (any duration of exposure) the NOAEL of 0.053 mg/kg/day (or 0.2 μg/L) derived from a 13-week rat inhalation toxicity study was used. The LOAEL in this study was 1 μg/L based on depression of plasma and erythrocyte (red blood cell) ChE activities.

Dietary Exposure and Risk Estimates

Tolerances are listed in 40 CFR §180.215 for the residues of naled and its conversion product dichlorvos (2,2-dichlorovinyl dimethyl phosphate), expressed as naled equivalents.

Acute Dietary (Food) Exposure and Risk Estimate

The acute dietary exposure and risk estimates do not exceed HED's levels of concern. A refined probabilistic (Monte Carlo) acute dietary risk analysis was performed. This assessment was refined using anticipated residues (ARs) and percent of crop treated data. The acute ARs used in the exposure analysis are based on that portion of the tolerance level attributed to naled residues (that is to say the contribution of dichlorvos residues to the tolerance expression has been removed). All naled ARs used in the acute dietary exposure analyses can thus be considered high-end estimates because they are based on field trials.

The acute dietary risk analysis estimated the distribution of single-day exposures. These analyses evaluated individual food consumption as reported by respondents in the USDA 1989-1992 Continuing Survey of Food Intake by Individuals (CSFII). At the 99.9th percentile exposure level, the percent of the acute PAD occupied ranged from 18% for the US Population to 39% for children 1-6 years old.

Chronic Dietary (Food) Exposure and Risk Estimates

Chronic dietary (food) exposure and risk estimates do not exceed HED's level of concern. Anticipated residues and percent of crop treated information were used to calculate the chronic dietary exposure to naled. Anticipated residues for the chronic dietary analysis are based on average residues of naled obtained from field trials, corrected by cooking factors where applicable. One half the limit of detection was assumed in calculating ARs if residues were not detectable and the detection limit for the RAC was available. If no AR and no detection limits were available, total residues expressed in naled equivalents were apportioned between naled and dichlorvos by extrapolating from data from another raw agricultural commodity (RAC). Reduction factors for celery, collards, oranges, strawberries, and grapes were available for naled. Where naled reduction factors were not available, reduction factors for dichlorvos were assumed. A reduction factor of 0.1X was applied to all cooked forms of naled.

The percent of the chronic PAD occupied ranged from 1.6% for the US Population to 3.2% for children 1-6 years old.

Drinking Water Exposure

Currently, HED uses drinking water levels of comparison (DWLOCs) as a surrogate to capture risk associated with exposure to pesticides in drinking water. A DWLOC is the concentration of a pesticide in drinking water that would not be of concern as an upper limit in light of total aggregate exposure to that pesticide from food, water and residential uses (if any). A DWLOC may vary with drinking water consumption patterns and body weights for specific subpopulations.

Based on the acute and chronic dietary (food) exposure estimates summarized above, DWLOCs were calculated using the Agency's default body weights and consumption values (70 kg/2L (adult male); 60 kg/2L (adult females) and 10 kg/1L (child)). Acute DWLOCs

range from 61 ppb for children to 285 ppb for the US Population. Chronic DWLOCs range from 19 ppb for children to 69 ppb for the US Population.

The Ecological Fate and Effects Division (EFED) provided estimated environmental concentrations (EECs) for naled in surface water. Based on PRZM-EXAMS modeling, Tier 2 exposure analysis, the following EECs of naled for surface water were calculated: Acute - 12.7 ppb and Chronic - 0.56 ppb (based on 10 year return).

Comparing these EECs for naled to the DWLOCs, both the acute and chronic EECs do not exceed HED's DWLOC's.

EFED also provided EECs for naled in ground water. Based on SCI-GROW modeling the groundwater concentration of naled was estimated to be 0.005 ppb for acute and chronic values. These relatively low EECs of naled in groundwater do not exceed HED's levels of concern for either chronic or acute exposures.

Occupational Exposure and Risk Estimates

Mixing/Loading/Application Exposure and Risk Estimates

The occupational risk assessment identified total margins of exposure (MOEs) less than 100 for some of the agricultural and mosquito/blackfly handler activities. Some of the total MOEs may be artificially low based on the poorly defined NOAEL in the 28-day dermal rat study. The NOAEL in the 28-day dermal rat study is 1 mg/kg/day (the LOAEL is 20 mg/kg/day) compared to the NOAEL in the 28-day oral rat study of 1 mg/kg/day. Based on dermal absorption data on two very similar compounds, dichlorvos and trichlorfon, the existing dermal toxicity study likely overestimates dermal toxicity because of the 20 fold difference between the lowest adverse effect level (LOAEL) and the no adverse effect level (NOAEL).

The MOEs for the mosquito/blackfly control uses are not well defined because of the need to extrapolate exposure data from agricultural applications to mosquito control applications, due to the lack of scenario-specific data. The registrant has agreed to limit the use of naled to trained and professional applicators (i.e., not for use by homeowners) and to disallow certain high exposure application methods, such as backpack sprayers. Other uses associated with MOEs that cannot be adequately mitigated by such measures continue to exceed HED's level of concern.

Postapplication Exposure and Risk Estimates

The Agency is requiring new interim restricted-entry intervals (REIs), provided the registrant agrees to submit supplementary DFR data to determine definitive REIs for all crop

groups/use sites on which naled is registered for use. The new interim REIs are two days for grapes along with all other crops with an application rate of 0.938 lb ai/acre. A three-day REI is required for all other crops with a higher application rate than grapes. Current naled labels contain REIs of 24 hours for all crops. Postapplication/reentry exposure studies are required as confirmatory data to determine definitive REIs for all crop groups/use sites on which naled is registered.

Residential Exposure and Risk Estimates

The current registrant of record for naled, Amvac Chemical Corporation, has indicated to EPA in a letter of December 11, 1998, that residential and domestic uses, with the exception of flea pet collars, will not be supported for reregistration. Therefore, this document addresses only occupational exposure scenarios and residential exposures resulting from public health uses (i.e., mosquito/blackfly abatement) and exposures from flea pet collars.

To assess residential (bystander) exposures from the mosquitocide and blackfly uses of naled, HED considered dermal exposures and incidental oral exposures (hand-to-mouth, object-to-mouth, and ingestion of soil) that could result from deposition of naled on turf. The HED Residential Standard Operating Procedures (SOPs, December 17, 1997) were used with a few modifications.

Dermal MOEs for postapplication exposure for all aerial mosquito application scenarios do not exceed HED's level of concern.

- Dermal MOEs ranging from 97 for adult dermal turf contact to 1.3×10^6 for toddler soil ingestion.

The aerial blackfly rate scenario produced two MOEs less than 100. The aerial blackfly use has the highest application rate (residential rate of 0.1 lb ai/A), followed by the aerial mosquito use (residential rate of 0.05 lb ai/A).

- MOEs of ~50 for adults and toddlers contacting turf.

Dermal MOEs for postapplication exposures following ground-based fogger application (rate of 0.02 lb ai/A) did not exceed HED's level of concern.

- Lowest MOE of 1,500.

None of the exposure scenarios for hand-to-mouth, object-to-mouth, or ingestion of soil resulted in MOEs that exceed HED's level of concern.

Therefore, the only scenarios with MOEs less than 100 are for the dermal exposure resulting from aerial blackfly application rate at 0.1 lb ai/acre. These MOEs are not of

concern because the existing dermal toxicity study likely overestimates dermal toxicity because of the 20 fold difference between the lowest adverse effect level (LOAEL) and the no adverse effect level (NOAEL).

Based on information obtained from the labels of the products registered for flea pet collars, and using HED's SOPs for Residential Exposure Assessments (December 18, 1997), HED has estimated exposures of individuals exposed to naled via the flea pet collar use. None of the calculated MOEs for children were above 100 (i.e., all pet collar exposure scenarios for children exceeded HED's level of concern). Therefore, additional refinement of the pet collar scenario is warranted.

Aggregate Risk Estimates and Risk Characterization

Acute Aggregate Risk Estimates (food and water)

The acute aggregate risk assessment considers acute (single day) food and water exposures. The acute dietary (food) risk estimates do not exceed HED's level of concern. Tier 1 groundwater and Tier 2 (PRZM-EXAMS) surface water EECs do not exceed HED acute DWLOCs. Therefore, aggregate acute risk estimates for naled do not exceed HED's levels of concern.

Chronic Aggregate Risk Estimates (food and water)

The chronic aggregate risk assessment considers chronic (lifetime) food and water exposures. The chronic dietary (food) risk estimates do not exceed HED's levels of concern. Tier 1 groundwater and Tier 2 (PRZM-EXAMS) surface water EECs do not exceed HED chronic DWLOCs. Therefore, aggregate chronic risk estimates for naled do not exceed HED's levels of concern.

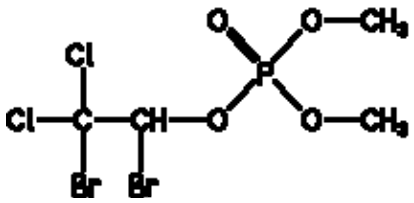
Short- and Intermediate-term Aggregate Risk Estimates (food, water, and non-occupational)

The short- and intermediate-term risk assessments consider residential exposures along with average food and water exposure. Some of the short- and intermediate-term aggregate risk estimates for naled exceed HED's level of concern. None of the estimated MOEs for children exceeded 100 using the screening-level assessment for the pet collar use (i.e., without further refinement, all pet collar exposure scenarios for children exceeded HED's level of concern). Short- and intermediate-term residential exposures exceed HED's level of concern for the ULV aerial blackfly applications. However, short- and intermediate-term residential exposures do not exceed HED's level of concern for the ULV mosquito applications, a public health use.

II. Product Chemistry

A. Description and Identification of the Active Ingredient

The chemical structure and physical/chemical characteristics of naled are described below:



Empirical Formula: $C_4H_7O_4PBr_2Cl_2$
Molecular Weight: 381 g/mole
Chemical Name: 1,2-dibromo-2,2-dichloroethyl dimethyl phosphate

Pure naled is a white solid with a melting point of 27 C. The vapor pressure has been reported to be 2 $x10^{-4}$ mm Hg at 20 C to 2 $x10^{-3}$ mm Hg. Naled is practically insoluble in water, has limited solubility in aliphatic solvents, and is highly soluble in oxygenated solvents such as ketones and alcohols.

B. Other Product Chemistry Considerations

There is one technical product for naled, the 90% technical (EPA Reg. No. 5481-478). The following data are required; these data are considered confirmatory.

- Discussion of formation of the impurities (guideline 830.1670)
- Preliminary Analysis (guideline 830.1700)
- Certification of Ingredient Limits (guideline 830.1750)
- Flammability (guideline 830.6315)
- UV/Visible Absorption (guideline 830.7050)
- Dissociation Constant (guideline 830.7370)
- Vapor Pressure (guideline 830.7960)

III. Hazard Assessment

A. Toxicology Assessment

The naled toxicology database is adequate to support reregistration eligibility. No further data are required at this time. Dichlorvos, a registered organophosphate insecticide, is a metabolite of naled. A preliminary risk assessment for dichlorvos, which encompassed dichlorvos derived from naled was completed by HED on December 3, 1998 and addresses all exposure concerns including dietary for this metabolite. This document therefore, addresses concerns solely for naled *per se*.

1. Acute Toxicity

The acute oral studies indicated that naled was more toxic when administered as an aqueous suspension in 0.5% carboxymethylcellulose (CMC) than when administered as a corn oil preparation. Table 1 presents the acute mammalian toxicity data for naled.

Table 1. Acute Mammalian Toxicity for Technical Naled

Test	% AI	MRID	Results	Category
Oral LD_{50}--rat		00142660	Corn oil: 325 mg/kg (males); 230 mg/kg (females) Carboxymethyl-cellulose[2]: 191 mg/kg (males); 92 mg/kg (females)	II
Dermal LD_{50}--rabbit		00146493	390 mg/kg (males) 360 mg/kg (females)	II
Inhalation LC_{50}--rat		00146494	0.20 mg/L (males) 0.19 mg/L (females) for 4 hr. exposure	II
Eye irritation--rabbit[1]	85%	00074826	Severe irritation	I
Dermal irritation--rabbit[1]	85%	00074825	Corrosive (escharotic)	I
Skin sensitization--guinea pig[1]		00074657	Weakly positive	N/A

[1] Data pertaining to eye irritation, dermal irritation and skin sensitization are not required to support the reregistration of the TGAI. These data are presented for information purposes.
[2]A preliminary study to a cytogenetics assay obtained somewhat lower oral LD_{50} values of 85.1 mg/kg/day for male rats and 81.2 mg/kg/day for females using CMC as the vehicle (MRID 00142665).

2. Subchronic Toxicity

The subchronic feeding study requirements are satisfied by the two-year rat and one-year dog studies. No further data are required at this time.

A 13-week inhalation study exposed male and female Fischer-344 rats to filtered air (control group) or aerosols containing 0.2, 1, or 6 μg/L of naled for 6 hours/day, 5 days/week. Additional control and high-dose groups recovered for six weeks. Exposure to the highest concentration of 6 μg/L resulted in clinical signs of toxicity manifested as tremors, salivation, nasal discharge, abnormal respiration and anogenital staining. The clinical signs were consistent with cholinergic effects and the observed inhibition of ChE activity. Brain ChE was inhibited at 6 μg/L, while plasma and RBC cholinesterases were inhibited at 1 and 6 μg/L. Only plasma ChE continued to be inhibited six weeks after exposure to the high concentration. No other treatment-related effects were observed. The NOAEL for ChE inhibition was 0.2 μg/L and the LOAEL was 1 μg/L based on depression of plasma (25-30% throughout the study) and RBC (50-60% early in study and 25-30% at 13-weeks) ChE activities. The NOAEL for systemic toxicity was 1 μg/L and the LOAEL was 6 μg/L based on clinical signs of toxicity (MRID 00164224).

A 28-day dermal study conducted with male and female CD/Sprague-Dawley rats applied naled to intact skin at dose levels of 0, 1, 20, or 80 mg/kg/day for 6 hours/day, 5 days/week. Carboxymethylcellulose was the vehicle. The two highest doses were extremely irritating to the skin and produced severe erythema and edema, necrosis and exfoliation. After 28 days, histopathological findings in the skin included acute ulcerative inflammation, necrosis and epidermal hyperplasia. Exposure to 20 and 80 mg/kg/day also produced systemic toxicity. Body weight gain by males was depressed despite increased food consumption. Plasma, RBC and brain cholinesterases were inhibited by 20 and 80 mg/kg/day. Other treatment-related findings were confined to the 80 mg/kg/day groups. Liver and adrenal weights of females were increased and clinical chemistry changes were suggestive of mild renal effects. Both sexes displayed increased blood urea nitrogen and decreased creatinine, total protein and albumin. No treatment-related histopathological changes were observed other than those of the skin. The NOAEL was 1 mg/kg/day for dermal irritation, systemic toxicity and ChE inhibition. The LOAEL was 20 mg/kg/day based on the findings of dermal irritation, reduced weight gain and ChE (60% brain, approximately 50% plasma and approximately 25% RBC) inhibition (MRID 00160750).

In a 28-day oral study rats (10/sex/dose level) received 0, 0.25, 1, 10 or 100 mg/kg/day of naled by gavage. The 100 mg/kg/day dose level produced mortality and marked cholinergic signs. The 10 mg/kg/day dose produced mild cholinergic signs and 50% reduction in plasma and brain ChE. The 1 mg/kg/day dosage produced 15% plasma ChE inhibition without clinical signs. Although this study was classified as supplemental, it was adequate to establish a NOAEL of 1 mg/kg/day and a LOAEL of 10 mg/kg/day based on cholinergic effects (MRID 00088871).

3. Chronic Toxicity

A dietary stability study of naled incorporated into standard rodent feed indicated that the test material rapidly degraded at room temperature (with a half-life of 1.5 days at 21 C).

Consequently, most long-term studies administered naled by gavage. Unless specified differently, all of the following studies used naled suspended in aqueous CMC (0.5% w/w) as a test material due to the increased toxicity of the CMC preparations of naled over the corn oil preparations as demonstrated by the acute toxicity studies.

In a one-year study with male and female beagle dogs, naled was administered at dose levels of 0, 0.2, 2, or 20 mg/kg/day by gavage. Clinical signs of emesis, diarrhea and statistically-significant increases in mineralization of the lumbar spinal cord in both sexes were associated with doses of 2 and 20 mg/kg/day. Plasma, RBC, and brain ChE activities were depressed at these same dose levels (brain was depressed at 2 mg/kg/day in females only). Anemia was also evident at 2 and 20 mg/kg/day. Erythrocyte count, hemoglobin and hematocrit were reduced. At the high dose only, liver and kidney weights were increased but unaccompanied by histopathological changes. The NOAEL was 0.2 mg/kg/day for ChE inhibition and systemic toxicity. The LOAEL was 2 mg/kg/day based on depressed ChE activity (43-58% RBC, 24-48% plasma and 5-17% brain), anemia and mineralization of the lumbar spinal cord (MRID 00160751).

A two-year chronic toxicity/carcinogenicity study administered naled to male and female Sprague-Dawley CD rats at doses of 0, 0.2, 2, or 10 mg/kg/day by gavage. Plasma, RBC, and brain ChE activities were depressed at dose levels of 2 and 10 mg/kg/day. At 2 mg/kg/day RBC ChE was depressed 4-33%, plasma 54-60%, and brain 24%. No other treatment-related findings were observed. The NOAEL for ChE inhibition was 0.2 mg/kg/day and the LOAEL was 2 mg/kg/day. The NOAEL for systemic toxicity was the highest dose tested, 10 mg/kg/day (MRID 00141784).

4. Carcinogenicity

The Agency has classified naled as a Group E Chemical (evidence of noncarcinogenicity for humans) based on the lack of evidence of carcinogenicity in mice and rats.

A two-year chronic toxicity/carcinogenicity study administered naled to male and female Sprague-Dawley CD rats at doses of 0, 0.2, 2, or 10 mg/kg/day by gavage. No neoplastic lesions were related to treatment. The only effect was depression of ChE activity at 2 and 10 mg/kg/day. The NOAEL for ChE inhibition was 0.2 mg/kg/day. The systemic NOAEL was 10 mg/kg/day (the highest dose tested). Dose selection was supported by the results of a 28-day pilot study demonstrating mortality at 100 mg/kg/day and mild cholinergic signs (lethargy and muscle weakness) accompanying 50% reductions in plasma and brain ChE activities at 10 mg/kg/day. Therefore, the high dose of 10 mg/kg/day was considered adequate to test for carcinogenic potential (MRID 00141784, 00088871).

An 89-week carcinogenicity study administered naled to male and female CD-1 mice at doses of 0, 3, 15, or 75 mg/kg/day by gavage. The high dose of 75 mg/kg/day was reduced to 50 mg/kg/day after 26 weeks due to high mortality. Mortality was 10 and 13% for high dose males and females, respectively, compared to 2% for control after 26 weeks.

Tremors were observed in three of eight high dose females that died during the first 26 weeks. The only other treatment-related finding was a slight reduction (3-5%) in weight gain by males showing a dose-related trend at the middle- and high-dose levels. Cholinesterase activity was not determined. No neoplastic findings were related to treatment. The dose selection was supported by the results of a pilot study, which indicated the use of a high dose between 50 and 100 mg/kg/day in the carcinogenicity study to avoid excessive toxicity and mortality. In the pilot study, a dose level of 300 mg/kg/day for two weeks produced mortality (60 to 80%), 150 mg/kg/day for two weeks produced cholinergic signs and 50 mg/kg/day for four weeks produced a slight decrease in body weight gain and a significant reduction in food consumption. The mortality rate associated with the 75 mg/kg/day dose level after 26 weeks justified reduction of the high dose to 50 mg/kg/day (MRID 00148569).

5. Developmental Toxicity

A developmental toxicity study using pregnant Sprague-Dawley rats administered naled at doses of 0, 2, 10, or 40 mg/kg/day by gavage on days 6 through 19 of gestation. Dams were sacrificed on day 20 of gestation. The high dose of 40 mg/kg/day was maternally-toxic producing clinical signs and reduced weight gain. The clinical signs included tremors, hypoactivity, discharge from the mouth and eyes, and dyspnea. No developmental toxicity was related to treatment. There may have been a marginal effect on resorptions at the high dose because there were six litters with two or more resorptions. Since these resorptions were observed at a dose that was maternally toxic, they were not considered significant enough to change the NOAEL for developmental toxicity. The NOAEL for maternal toxicity was 10 mg/kg/day and the LOAEL was 40 mg/kg/day based on clinical signs and reduced weight gain. The developmental toxicity NOAEL was 40 mg/kg/day, the highest dose tested (MRIDs 00138682, 00144026).

Another developmental toxicity study using artificially inseminated New Zealand rabbits administered doses of 0, 0.2, 2, or 8 mg/kg/day of naled by gavage on days 7 through 19 of gestation. Does were sacrificed on day 29 of gestation. No maternal or developmental toxicity was related to treatment. Although no maternal toxicity was elicited by the highest dose, dose selection was supported by the results of a pilot study with inseminated animals. In the pilot study dose levels of 20 mg/kg/day and higher produced mortality, 10 mg/kg/day and above produced marked cholinergic signs, and 2 mg/kg/day produced clinical signs consistent with mild cholinergic effects. The clinical effects at 10 mg/kg/day indicated that the high dose of 8 mg/kg/day in the definitive study was sufficient for testing developmental toxicity. The NOAEL for maternal toxicity and developmental toxicity was 8 mg/kg/day, the highest dose tested (MRID 00146496).

6. Reproductive Toxicity

A two-generation reproduction study was conducted with Sprague-Dawley-derived Charles River CD rats. Naled was administered at doses of 0, 2, 6, or 18 mg/kg/day by gavage. Systemic effects were observed in adult male rats of both

generations. Body weight gain was depressed at the 18 mg/kg/day dose for F_0 males and at all dose levels for F_1 males. Reproductive indices were unaffected in both generations. Survival of pups was reduced at 18 mg/kg/day in the F_1 and F_{2b} generations. A consistent decrease in pup weight was also noted during lactation in both generations. The NOAEL for parental systemic effects was 6 mg/kg/day. The LOAEL was 18 mg/kg/day based on decreased body weight gain in both generations. The reproductive toxicity NOAEL was 18 mg/kg/day, which was the highest dose tested (MRID 00146498).

7. Mutagenicity

An *in vivo* gene mutation study (mouse spot test) was conducted with pregnant C57BL/6 mice given 0, 3, 20, or 150 mg/kg/day of naled by gavage for four days of gestation (days 8-12). Litters were scored for coat color mutations ("spots") on post-partum days 12 and 28. The test was presumably indicative of mutation events consisting of intragenic base-pair changes, deletions and somatic crossing-over. The high dose of naled was very toxic producing maternal mortality, decreased maternal body weight and decreased pup survival. Naled exhibited no potential to induce coat color spots (MRID 00141571).

Naled was tested for gene mutation in the *Salmonella typhimurium* reverse mutation assay (Ames assay) using tester strain TA 100 with and without metabolic activation (PCB-induced mouse liver S9 fraction). Naled was tested at concentrations of 0.5, 1 and 2 μM. The highest concentration was toxic in the absence of metabolic activation but was mutagenic with metabolic activation. The middle concentration of 1 μM was positive both with and without metabolic activation. The low concentration of 0.5 μM was marginally positive (less than two-fold DMSO control) (MRID 00142662).

Naled was tested for DNA damage in *Proteus mirabilis* strains PG273 (wild type) and PG713 (thr^-, rec^-, hcr^-). Naled was negative in both strains at inhibitory concentrations of 10 and 40 μM (MRID 00142662).

Naled was tested for cytogenetic effects *in vivo* in the mouse bone marrow micronucleus assay. Naled was administered to male and female Swiss mice as a single oral dose by gavage. Dose levels were 0, 55, 110, or 220 mg/kg for males and 0, 55, 110, or 290 mg/kg for females. Dose selection was based on preliminary studies indicating oral LD_{50} values of 257 mg/kg for males and 336 mg/kg for females. Bone marrow cells were harvested 24, 48 and 72 hours after treatment. The highest dose produced mortality (16-24%) and clinical signs of toxicity. Naled had no cytotoxic effect on bone marrow at these dose levels and produced no nuclear anomalies (MRID 00146497).

In another *in vivo* cytogenetics study, male and female Sprague Dawley rats were administered naled as a single oral dose by gavage. Dose levels were 0, 3.88, 12.93, or 38.80 mg/kg for males and 0, 6.17, 20.57, or 61.70 mg/kg for females. Dose selection was based on preliminary studies conducted at the same laboratory indicating oral LD_{50} values of 85.1 mg/kg for males and 81.2 mg/kg for females. Bone marrow cells were harvested 6, 24 and 48 hours after treatment. High dose females showed signs of toxicity including ataxia,

dyspnea and oral exudate. Cytotoxicity in bone marrow was not evident at any dose level. Naled had no clastogenic effect. The highest dose was considered to be near a maximum tolerated dose based on the clinical signs observed in females and the results of preliminary studies indicating the high dose for males was approximately one-half the oral LD_{50} (MRID 00142665).

8. Metabolism

The Agency waived the data requirement for a general rat metabolism study since existing animals studies demonstrate that naled is rapidly absorbed, distributed and excreted. No further data are required at this time.

O,O-Dimethyl-2,2-dichlorovinyl phosphate (DDVP or dichlorvos) is an expected metabolite of naled. Limited data have shown metabolites to include dichlorvos and hydrolysis products. In a study with a single cow, some metabolites were tentatively identified: methyl phosphates (mono- and di-), O-methyl 2,2-dichlorovinyl phosphate (desmethyl DDVP) and inorganic phosphate (MRID 00013546).

Three metabolites were identified in a *in vitro* study using rat liver homogenates: dichlorvos, dichloroacetaldehyde and bromodichloroacetaldehyde (BDCA) (MRID 00074857).

9. Neurotoxicity

In an acute delayed neurotoxicity study adult domestic hens (set 1) were given an acutely toxic dose of naled (42 mg/kg, LD_{50}) preceded by treatment with atropine sulfate and 2-PAM to protect from acute cholinergic effects. The hens were observed for neurotoxic signs for 21 days, re-dosed, observed an additional 21 days, then sacrificed for histopathological examination of central and peripheral nervous tissue. A second set of hens was administered a single dose of 8 or 42 mg/kg and sacrificed 24 hours later for determination of brain ChE and neurotoxic esterase activities. Two of 10 controls and 4/40 treated hens (set 1) died during the study. All treated hens (set 1) showed clinical signs of neurotoxicity (i.e., "subdued," unsteady). None displayed locomotor ataxia characteristic of delayed neurotoxicity. Axonal degeneration in the spinal cord was increased in naled-treated hens compared to controls (concurrent and historical), but it was less severe than that produced by the positive control. Brain ChE was markedly depressed (50%, 42 mg/kg) in naled treated hens. Neurotoxic esterase activity was unaffected. Naled did not produce frank delayed neurotoxicity, but a degenerative neuronal effect was manifest in the spinal cord (MRID 41630701).

A 28-day subchronic delayed neurotoxicity study was conducted with laying hens administered technical naled at oral dose levels of 0, 0.4, 2.0 and 4.0 mg/kg/day. Minimal and transient body weight depression was recorded in the high dose (4.0 mg/kg/day) and significant decreases in brain acetyl ChE were noted at both 2.0 and 4.0 mg/kg/day. No treatment related clinical or delayed neuropathy was observed (MRID 43223902).

An acute neurotoxicity study was conducted with rats given a single dose of 0, 25, 100, or 400 mg/kg of naled by gavage. Functional observational battery and motor activity evaluations were made pre-treatment, 30 minutes after treatment (time of peak effect) and seven and 14 days after treatment. The high dose of 400 mg/kg produced mortality and overt clinical signs of toxicity (e.g., orange/yellow material on body surfaces; red material around mouth/nose/eyes). Body weight gain by the high-dose group was transiently decreased (days 0-7). Animals given 100 and 400 mg/kg doses showed marked effects in the functional observational battery on the day of treatment. Observed changes included convulsions, tremors, increased secretions, exophthalmus, respiratory changes, reduced muscle strength, and slowed response to stimuli. Total motor activity was also reduced. A few treatment-related effects were observed on the day of treatment in one to two females given the low dose of 25 mg/kg. One female had tremors, two displayed exophthalmus during handling and one exhibited reduced hind limb grip strength. These changes were not observed in concurrent controls or historical controls (from three studies). No treatment-related neurological effects were observed seven or 14 days after treatment at any dose level. The NOAEL for acute neurotoxicity was 25 mg/kg in males, the lowest dose tested. The LOAEL for males was therefore 100 mg/kg. Although a NOAEL for females was not identified in this study, an estimate of this parameter can be reasonably set for females at 5 mg/kg, based upon minimal neurological compromise at 25 mg/kg in the main study, coupled with no toxicity at 5 or 25 mg/kg in the preliminary range-finding study. Therefore, the NOAEL for females was 5 mg/kg and the LOAEL for females was 25 mg/kg (MRID 42861301).

A subchronic (90-day) neurotoxicity study in Sprague-Dawley rats administered the test article (94.35%) by gavage at dose levels of 0, 0.4, 2.0 or 10.0 mg/kg/day. Neurological parameters were measured by both the functional observational battery and locomotor activity. Minimal neurological effects were observed in three out of 10 of the high dose females, but no other clinical effects were observed in either sex at any other dose level. The observed effects included sporadic occurrences of tremors (forelimb, hindlimb and/or whole body). The NOAEL for neurotoxicity was 2.0 mg/kg/day for females and 10.0 mg/kg/day for males (MRID 43223901).

10. Domestic Animal Safety

Subchronic (16-week) dermal toxicity studies were conducted with dog and cat antiflea collars containing naled (7%, cat collar; 15%, dog collar) and Propoxur (2.4%, cat collar; 4.2%, dog collar) as the active ingredients. Endpoints evaluated in each study included clinical signs, dermal irritation, body weight, urinalysis, blood chemistry, hematology and histopathology (including brain and spinal cord). Plasma and RBC ChE activities were determined on days 3 and 7 and weeks 2, 3, 4, 5, 6, 7, 8, 12 and 16.

Male and female mixed breed cats wore a placebo, one, two, or four collar(s) for 16 weeks. Cats wearing four collars exhibited more extensive flaking of the skin on the neck than controls or other treatment groups. A slight, transient decrease in plasma ChE was

observed for the group wearing one (days 3 & 7), two (day 7), or four (through week 5) treated collars. RBC ChE was unaffected. No other treatment-related effects were observed (MRID 00079549).

Male and female mixed breed dogs wore a placebo, one, two, or four collar(s) for 16 weeks. Two dogs wearing four collars showed dry flaky skin on the neck during week 10. Plasma ChE was lower for dogs wearing four collars through the first four weeks of the study. No other treatment-related effects were observed (MRID 00060430).

B. Dose-Response Assessment

1. Determination of Susceptibility

The Hazard Identification Assessment Review Committee (HIARC) convened on May 12-14, 1998 to conduct a comprehensive review of 40 organophosphates, including naled.

The FQPA Safety Factor Committee met on June 15 and 16, 1998 to evaluate the hazard and exposure data for naled and recommend retention, reduction or removal of the FQPA Safety Factor (as required by Food Quality Protection Act of August 3, 1996), to ensure the protection of infants and children from exposure to these pesticides.

The FQPA Safety Factor Committee recommended that the 10X FQPA Safety Factor be removed for naled based on the following
weight-of-evidence considerations:

(a). In prenatal developmental toxicity studies following *in utero* exposure in rats and rabbits, there was no evidence of developmental effects being produced in fetuses at lower doses than maternal animals nor was there evidence of an increase in severity of effects at or below maternally-toxic doses.

(b). In the pre-/post-natal two-generation reproduction study in rats, there was no evidence of enhanced susceptibility in pups when compared to adults (i.e., effects noted in offspring occurred at maternally-toxic doses or higher).

(c). There was no evidence of abnormalities in the development of the fetal nervous system in the pre-/post-natal studies submitted to the Agency.

(d). The toxicology database is complete. There are no data gaps for the Subdivision F Guideline requirements.

(e). Adequate actual data, surrogate data, and/or modeling outputs are available to satisfactorily assess exposures for dietary (food), drinking water, and residential drift to bystanders from mosquito control treatment.

2. Toxicology Endpoint Selection

a. Acute Dietary Exposure (1 day)

The acute PAD is derived from a NOAEL of 1.0 mg/kg/day and a UF of 100 that includes 10X for interspecies extrapolation, 10X for intraspecies variation and 1X for FQPA. The NOAEL is based on mild cholinergic signs and 50% decrease in plasma and brain ChE inhibition at 10 mg/kg/day (LOAEL) in a 28-day oral study with rats. This endpoint is supported by the findings in the
one-year dog study where a 43% decrease in red blood cell (RBC) ChE inhibition was seen at 20 mg/kg/day for seven days and 27% plasma ChE inhibition was seen at 2 mg/kg/day for seven days.

Acute PAD = 1.0 mg/kg/day (NOAEL) = **0.01 mg/kg**
100 (UF and FQPA Safety Factor)

b. Chronic Dietary Exposure

The chronic PAD is derived from a NOAEL of 0.2 mg/kg/day and a UF of 100 that includes 10X for interspecies extrapolation, 10X for intraspecies variation and 1X for FQPA. The NOAEL is based on brain ChE inhibition at 2 mg/kg/day (LOAEL) in a chronic toxicity/carcinogenicity study in rats. This NOAEL and endpoint is supported by the findings in the 1-year dog study where plasma, RBC and brain ChE inhibition was seen at 2 mg/kg/day.

Chronic PAD = 0.2 mg/kg/day (NOAEL) = **0.002 mg/kg**
100 (UF and FQPA Safety Factor)

c. Short-Term Dermal Occupational Exposure (1-7 days)

A NOAEL of 1 mg/kg/day based on the neurotoxic clinical signs (coarse or fine tremors) and plasma, RBC, and brain ChE inhibition at 20 mg/kg/day in the 28-day dermal toxicity study with rats is selected for this risk assessment. An MOE of 100 is adequate. Since a dermal NOAEL was selected a dermal absorption factor is not required.

d. Intermediate-Term Dermal Occupational Exposure (1 week-several months)

A NOAEL of 1 mg/kg/day based on the neurotoxic clinical signs (coarse or fine tremors) and plasma, RBC and brain ChE inhibition at 20 mg/kg/day in the 28-day dermal toxicity study with rats is selected for this risk assessment. An MOE of 100 is adequate. Since a dermal NOAEL was selected a dermal absorption factor is not required.

e. Long-Term Dermal Occupational Exposure (Several Months to Life-Time)

An oral NOAEL of 0.2 mg/kg/ day based on brain ChE inhibition at 2 mg/kg/day (LOAEL) in a chronic toxicity/carcinogenicity study in rats is selected for this risk assessment. Since an oral NOAEL was selected, a oral equivalent dermal absorption factor of 100% should be used due to lack of dermal absorption data. The target MOE is 100.

f. Inhalation Exposure (Any Time Period)

A NOAEL of 0.23 μg/L (0.053 mg/kg/day) based on plasma and RBC ChE inhibition at 1.29 μg/L (0.298 mg/kg/day) in a 13-week inhalation toxicity study in rats was selected for this risk assessment.

IV. Exposure Assessment

For the purposes of exposure assessment, which includes all routes of exposure (dietary and occupational) this document solely addresses pesticidal residues of naled *per se*.

A. Dietary Exposure (Food Sources)

Tolerances are established for residues of naled (1,2-dibromo-2,2-dichloroethyl dimethyl phosphate) and its conversion product 2,2-dichlorovinyl dimethyl phosphate (dichlorvos or DDVP), calculated as naled equivalents in/on RACs (40 CFR § 180.215). Tolerances range from 0.5 ppm in almonds, dry beans, and other commodities to 10.0 ppm in forage grasses and legumes. No tolerances have been established in processed foods or feeds. Adequate enforcement methods are available for the determination of the regulated compounds in/on plant and livestock commodities.

The qualitative nature of the residue in plants is adequately understood. Naled is generally considered to be non-systemic based on studies with a variety of plants including cucumbers, cotton and Swiss chard. Metabolism studies with oranges and tomato processed fractions have also been conducted to investigate the nature and magnitude of organic brominated components of the residue derived from naled *per se* or from its bromine-containing impurities. These studies indicated that the only residues of organic bromine compounds are naled, the parent and metabolite BDCA, both of which are rapidly debrominated by sulfhydryl compounds or by hydrolysis.

The qualitative nature of the residue in animals is adequately understood based on acceptable poultry and ruminant metabolism studies reflecting oral exposure. The residues of concern in animal commodities – naled and dichlorvos – are also those which are currently included in the tolerance expression.

Adequate residue analytical methods are available for the purposes of reregistration. Two GC methods, Method I and A, are listed in the Pesticide Analytical Manual (PAM, Vol. II §180.215) for tolerance enforcement. Method I, a GC method using a thermionic detector (RM-3G), is applicable for the separate analysis of residues of naled and dichlorvos in/on

crops and in animal commodities and milk. Method A, a microcoulometric GC method (RM-3C), is applicable for the combined residues of naled and dichlorvos in/on fruits and vegetables. The limits of detection are 0.01-0.02 ppm (milk and tissues) and 0.05 ppm, for Method I and Method A, respectively. Other GC methods (RM-3G-3 and the method of Boone) using thermionic detectors for separate determination of naled and dichlorvos are adequate for tolerance enforcement purposes. In addition, a GC method (RM-3G-4 revision of Method RM-3G-3) using nitrogen-phosphorous detection is adequate for enforcement of tolerances for residues in almonds, broccoli, oranges, and alfalfa. The limit of detection for both compounds is 0.01 ppm. Additional revisions to residue analytical method RM-3G-4 are required before it can be forwarded to FDA for inclusion in PAM, Vol. II. The technical registrant has agreed to make the necessary changes.

For residue data collection, adequate methods for analysis of naled and its metabolite dichlorvos either in combination or separately are available. Methods RM-3, RM-3A, and RM-3E are ChE inhibition methods, methods RM-3G and RM-3G-3 are GC methods using thermionic detection, and method RM-3C and the method of Boone are microcoulometric GC methods. Method RM-3 determines naled and dichlorvos in combination, method RM-3C determines naled and dichlorvos as dichlorvos, and methods RM-3A, RM-3E, RM-3G, and the method of Boone determine naled and dichlorvos separately. Residue data submitted for tolerance reassessment were collected using the current or proposed enforcement methods.

The requirements for storage stability data are not fully satisfied for the purposes of reregistration. Information concerning the storage intervals and conditions of residue data previously submitted in support of tolerance establishment has been submitted. Storage stability data are adequate to support all existing field trial data on RACs and to support existing livestock feeding studies for reregistration.

Data depicting the decline in levels of naled and its metabolite dichlorvos in commodities stored under the range of conditions and for the range of intervals specified are required for any remaining registered crops or for any crops for which the registrant wishes to establish or re-establish tolerances/registrations, including Brussels sprouts, eggplant and tangerines. Finally, the outstanding field trials and processing studies are required to be validated by adequate storage stability data.

1. Magnitude of the Residue in Plants

The reregistration requirements for magnitude of the residue in plants are fulfilled for the following commodities: almond hulls; almond nutmeat; beans (dry and succulent); broccoli; Brussels sprouts; celery; cottonseed; cow pea (bean) vines; eggplant; grapefruit; grapes; grass forage; hops (provided label requires a 21-day retreatment interval); lemons; melons; oranges; peaches (provided label is revised to specify a 31-day PHI); peas (succulent); pea, field, vines; peppers; safflower seed; spinach (and chard); squash, summer; strawberries; sugar beet roots and tops; tangerines; and walnuts. Adequate field trial data depicting the combined residues of naled and dichlorvos (expressed as naled) following

treatments according to the maximum registered use patterns have been submitted for these commodities. The reregistration requirements for magnitude of the residue in wide area and general outdoor treatments for area pest (mosquito and fly) are also fulfilled.

The available data indicate that the established tolerances for the following commodities are too high and that the tolerance levels may be reduced: beans, dry; beans, succulent; beets, sugar, roots; broccoli; Brussels sprouts; celery; cottonseed; grapes; and peas, succulent.

Additional field residue data are required for the following commodities before a complete tolerance reassessment can be made: cabbage; cauliflower; collards; hops; and squash, winter. The required data for collards will be translated to kale. The required data for winter squash will be translated to pumpkins.

The established tolerances on the following commodities: cucumbers, lettuce, mushrooms, rice, tomatoes, and turnip tops should be revoked since these uses are not registered. If the registrant, or any registrant intends to support the use of naled on these commodities, residue data reflecting the maximum intended use pattern is required.

The established 10-ppm crop group tolerance for "legumes, forage" is inappropriate since the registrant does not intend to support naled uses on soybeans, which is the third representative crop of the foliage of legume vegetables group. Therefore, this crop group tolerance should be revoked concomitant with the establishment of individual tolerances for beans, forage; beans, hay; peas, vines; and peas, hay.

The available data for grapefruit, lemons, and oranges suggest that a crop group tolerance of 3.0 ppm for the citrus fruits group is appropriate. The individual tolerances for grapefruit, lemons, oranges, and tangerines should be revoked concomitant with the establishment of a crop group tolerance for citrus fruits.

Based on the available field trial data, revised or new tolerances are required for the following commodities: beans (dry and succulent), broccoli, celery, cotton gin byproducts, cotton seed, grapes, grass hay, hops, peas (succulent), sugar beet roots, group tolerance for citrus, and RACs resulting from wide area and general outdoor treatment.

2. Magnitude of the Residue in Processed Food/Feed

The reregistration requirements for magnitude of the residue in processed food/feed commodities are fulfilled for cottonseed, grapes, oranges, sugar beets and soybeans. Processing studies involving rice, and tomatoes will not be required provided all registered uses of naled on these crops are canceled. It should be noted that revisions in the livestock feeds table for Subdivision O, require no further data on cannery waste of beans.

Adequate processing studies have been submitted for grapes, oranges and soybeans. These studies indicate that the combined residues of naled and dichlorvos are expected to

concentrate only in orange oil. The orange processing study indicates that residues of dichlorvos concentrated in oil 13 times (13X) during processing of oranges treated with naled. Residues of naled were non-detectable in both unprocessed oranges and all orange processed commodities in the submitted orange processing study. The study also indicates that residues of dichlorvos did not concentrate in the citrus processed commodities wet pulp, dried pulp, molasses, and juice. The Agency previously concluded that for the purposes of establishing food additive tolerances, if appropriate, the combined residues of naled and dichlorvos will be assumed to concentrate 13X during processing of citrus treated with naled. The highest average field trial (HAFT) for naled on oranges is 2.2 ppm. The HAFT, multiplied by the concentration factor of 13X, would result in a residue of about 30 ppm in orange oil.

3. Magnitude of Residue in Meat, Milk, Poultry and Eggs

The previously established tolerances of 0.05 ppm for the combined residues of naled and dichlorvos (expressed as naled) in the eggs, milk and tissues of animals have been revoked. The contribution of the combined residues of naled and dichlorvos to eggs, milk and meat from the indirect uses of naled in livestock premises is not expected to be significant in relation to the levels which result from dietary sources.

The calculated maximum dietary burdens of naled for poultry and livestock animals are: 10 ppm (horses), 8 ppm (dairy cattle), 5 ppm (beef cattle), 5 ppm (sheep), 0.6 ppm (swine) and 0.1 ppm (poultry). As a result of tolerance reassessment as well as the possible cancellation of naled uses on rice, tomatoes and turnips which are considered feed commodities, the maximum dietary burdens are expected to be even lower. There is no reasonable expectation of finite residues in meat, milk, poultry, and eggs (Category (3) of 40 CFR §180.6 (a)).

4. Reduction of Residues

Data reflecting residue decline are available. These data include common practices such as special processing and cooking that could reduce dietary exposure to naled. These data were used in the dietary risk assessments.

5. Confined/Field Rotational Crops

Confined rotational crop studies are adequate for all products with application rates no higher than 2 lb ai/A for crops that may be rotated or intercropped. The Agency has determined that if an application rate greater than 2 lb ai/A becomes necessary, then an additional confined rotational crop study at the higher rate or additional label restrictions will be required. The maximum rate presently registered for naled on rotational crops (e.g., collard and eggplant) is 1.8 lb ai/A.

The confined rotational crop study indicated that the total radioactive residues (expressed as naled equivalents) were at most 0.03 ppm in/on mature lettuce (tops and roots),

wheat (grain, bran and straw), and carrots (tops and roots) harvested at 30-day plantback interval from pots of loam soil that had been surface-treated with [ethyl 1-^{14}C]naled at a nominal application rate of 2 lb ai/A. The rapid degradation of naled and dichlorvos and the fact these materials can be readily metabolized to CO_2 indicate that there is not a large potential for naled residues to accumulate in rotational crops in soil treated with naled. Limited or extensive field rotational crop studies are not required. Furthermore, rotational crop tolerances and plantback interval restrictions are not needed.

6. Anticipated Residues

The tolerance for naled is expressed in terms of combined residues of naled and dichlorvos, expressed as naled equivalents. The acute and chronic ARs are based on that portion of the tolerance level attributed to naled residues (that is to say the contribution of dichlorvos residues to the tolerance expression has been removed). All naled ARs used in the acute and chronic dietary exposure analyses are based on tolerance levels or field trials.

Anticipated residues for the chronic dietary analysis are based on average residues of naled and dichlorvos obtained from field trials, corrected by cooking factors where applicable. One half the limit of detection was assumed in calculating ARs if residues were not detectable and the detection limit for the RAC was available. If no AR and no detection limits were available, total residues expressed in naled equivalents were apportioned between naled and dichlorvos by extrapolating from data from another RAC. Anticipated residues for cucumbers, melons, pumpkins, peppers, and eggplants were generated by extrapolating data from tomato data. Anticipated residues for collards, kale, and Swiss chard were generated by extrapolating from spinach data. Reduction factors for celery, collards, oranges, strawberries, and grapes were available for naled. Where naled reduction factors were not available, reduction factors for dichlorvos were assumed. A reduction factor of 0.1X was applied to all cooked forms of naled for the chronic analysis.

High-end ARs were used in the acute dietary exposure analysis. Field trial residues or the tolerance is generally the high-end residue estimate used in acute risk assessment. Acute ARs were calculated by using the ratios of naled residues and dichlorvos residues to total residues in naled equivalents. This ratio was used to determine an AR for naled *per se*, based on the tolerance level. As field trial data were used in generating the chronic ARs, it is reasonable to assume that the ratios between naled and dichlorvos residues observed in chronic ARs would also be appropriate for use in generating acute ARs. As per HED policy, residues on food items from the mosquitocide (widespread) use of naled were not considered in the naled acute analysis.

B. Dietary Risk Assessments and Risk Characterization

Dichlorvos, a registered organophosphorus insecticide, is a metabolite of naled. The risk assessment for dichlorvos, will encompass dichlorvos derived from naled and will address all exposure concerns including dietary for this metabolite. This document therefore, addresses concerns solely for naled *per se*.

1. Acute Dietary (Food) Exposure and Risk Estimates

A probabilistic (Monte Carlo) acute dietary risk analysis was performed, assessing exposure to residues of naled in food. This dietary assessment was refined by using percent of crop treated data. The acute ARs used in the dietary exposure analysis are based on that portion of the tolerance level attributed to naled residues (that is to say the contribution of dichlorvos residues to the tolerance expression has been removed). All naled ARs used in the acute dietary exposure analyses can thus be considered upper-bound estimates because they are based on tolerance levels. Further refinements would lead to lower dietary risk estimates.

As indicated in Table 2 below, the acute dietary exposure estimates at the 99.9th percentile exposure do not exceed HED's levels of concern.

Acute Dietary (Food) Exposure Estimate and Percent of Acute PAD Occupied for Naled

Population	90th Percentile		99th Percentile		99.9th Percentile	
	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
U.S. Population	0.000231	2.3	0.000485	4.9	0.001844	18.4
Non-nursing Infants (< 1 yr)	0.000432	4.3	0.000612	6.1	0.002200	22.0
Children 1-6	0.000388	3.9	0.001059	10.6	0.003882	38.8
Children 7-12	0.000256	2.6	0.000649	6.5	0.002382	23.8

2. Chronic Dietary (Food) Exposure and Risk Estimates

Anticipated residues and refined percent of crop treated information, as described above, were used to calculate the chronic dietary exposure estimates for naled. These exposure estimates were then compared to the PADs for naled to calculate chronic dietary risk estimates.

The chronic naled dietary exposure estimate for the U.S. population is 0.000032 mg/kg bw/day, which represents 1.6% of the chronic PAD. The subgroup most highly exposed, children (aged 1-6), has an exposure estimate of 0.000063 mg/kg bw/day, or 3.2% of the PAD. Based on these analyses, HED has determined that chronic dietary risk estimates from naled do not exceed a level of concern. The chronic dietary exposure estimates are presented in Table 3 below:

Table 3. Chronic Dietary (Food) Exposure Estimates for Naled

Population	Exposure (mg/kg/day)	% PAD
U.S. Population	0.000032	1.6
Non-nursing Infants (< 1 year)	0.000022	1.1
Children (1-6)	0.000063	3.2
Children (7-12)	0.000043	2.1

3. Drinking Water Exposure and Assessment

Currently, HED uses DWLOCs as a surrogate to capture risk associated with exposure to pesticides in drinking water. A DWLOC is the concentration of a pesticide in drinking water that would not be of concern as an upper limit in light of total aggregate exposure to that pesticide from food and water. A DWLOC may vary with drinking water consumption patterns and body weights for specific subpopulations.

Based on the acute and chronic dietary exposure estimates presented in Tables 2 and 3, DWLOCs were calculated using the formulas presented below.

$$DWLOC_{acute} = \frac{[\text{acute water exposure (mg/kg/day)} \times \text{(body weight)}]}{[\text{consumption (L)} \times 10^{-3}\ \text{mg/µg}]}$$

where, acute water exposure (mg/kg/day) = [aPAD - acute food exposure (mg/kg/day)]

$$DWLOC_{chronic} = \frac{[\text{chronic water exposure (mg/kg/day) x (body weight)}]}{[\text{consumption (L) x } 10^{-3}\ \text{mg/µg}]}$$

*where,*chronic water exposure (mg/kg/day) = [PAD - (chronic food exposure) (mg/kg/day)]

The Agency's default body weights and consumption values used to calculate DWLOCs are as follows: 70 kg/2L (adult male); 60 kg/2L (adult females) and 10 kg/1L (child).

Since acute and chronic dietary exposures to pesticidal residues of naled do not exceed EPA's levels of concern, EPA used the acute and chronic PADs and the acute and chronic exposure values to calculate the DWLOCs for the U.S. population and the three most sensitive subgroups identified in the dietary exposure assessments for acute and chronic exposures. Provided in Tables 4 (based on acute dietary (food) exposure at the 99.9th percentile) and 5 are the acute and chronic DWLOCs.

Table 4. Acute DWLOCs

Population	DWLOC
U.S. Population (spring season)	285 ppb
Non-Nursing Infants (<1 yr)	78 ppb
Children (1-6)	61 ppb

Table 5. Chronic DWLOCs

Population	DWLOC
U.S. Population	69 ppb
Non-Nursing Infants (<1 yr)	20 ppb
Children (1-6)	19 ppb

a. Surface Water

EFED (J. Peckenpaugh, 3/18/99) EECs for naled in surface water. Based on PRZM-EXAMS modeling, Tier 2 exposure analysis, the following EECs of naled for surface water were calculated:

Acute: 12.7 ppb
Chronic: 0.56 ppb; annual average (based on 10 year return)

Comparing these EECs for naled to the DWLOCs, the acute and chronic surface water EECs do not exceed HED's level of concern for any potentially exposed subpopulation group.

b. Groundwater

EFED (J. Peckenpaugh, 3/18/99) provided EECs for naled in groundwater. Based on SCI-GROW modeling the groundwater concentration of naled was estimated to be 0.005 ppb for acute and chronic values. These relatively low EECs for naled in groundwater do not exceed HED's levels of concern for either chronic or acute exposures.

C. Occupational Exposure and Risk Assessment

Currently naled may be applied by: aerial equipment/helicopter; tractor-drawn groundboom; airblast; mist blower ultra low volume (ULV) cold fog generator; dog/cat collar; and by hot plate/pan.

The current registrant of record for naled, Amvac Chemical Corporation, has indicated to EPA in a letter of December 11, 1998, that residential and domestic uses, with the exception of flea pet collars, will not be supported for reregistration. Therefore, this document addresses only occupational exposure scenarios and residential bystander exposures resulting from public health uses (i.e., mosquito abatement) and exposures from flea pet collars.

1. Mixer/Loader/Applicator Exposure and Risk Characterization

a. Occupational Exposures and Assumptions

The Agency has determined that mixers, loaders, applicators, and other handlers may be exposed to naled from the following nine use patterns identified on the naled labels:

(1) mixing/loading liquids,
(2) applying with aerial equipment,
(3) applying with groundboom equipment,
(4) applying with airblast equipment,
(5) applying with thermal fog generator,
(6) applying with ULV cold fog generator,
(7) applying by evaporating liquid using a hot plate and pan,
(8) flagger (liquids),
(9) aerial and ground based ULV mosquito application

(i). Mixer/Loader/Applicator Exposure

Mixer/loader/applicator (M/L/A) exposure data for naled were not required in the 1983 naled registration standard or a subsequent Data Call-In. Therefore, the Agency used data from the Pesticide Handlers Exposure Database (PHED), Version 1.1, to estimate the potential exposures to M/L/A resulting from registered uses of naled.

PHED was designed by a Task Force of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide Regulation, and member companies of the American Crop Protection Association. PHED is a software system consisting of two parts -- a database of measured exposure values for workers involved in the handling of pesticides under actual field conditions and a set of computer algorithms used to subset and statistically summarize the selected data. Currently, the database contains values for over 1,700 monitored individuals (i.e., replicates).

Users select criteria to subset the PHED database to reflect the exposure scenario being evaluated. The subsetting algorithms in PHED are based on the central assumption that the magnitude of handler exposures to pesticides are primarily a function of activity (e.g., mixing/loading, applying), formulation type (e.g., wettable powders, granulars), application method (e.g., aerial, groundboom), and clothing scenarios (e.g., gloves, double layer clothing). Once the data for a given exposure scenario has been selected, the data are normalized (i.e., divided by) by the amount of pesticide handled resulting in standard unit exposures (milligrams of exposure per pound of active ingredient handled). Following normalization, the data are statistically summarized. The distribution of exposure values for each body part (e.g., chest, upper arm) is categorized as normal, lognormal, or "other" (i.e., neither normal nor lognormal). A central tendency value is then selected from the distribution of the exposure values for each body part. These values are the arithmetic mean for normal distributions, the geometric mean for lognormal distributions, and the median for all "other" distributions. Once selected, the central tendency values for each body part are composited into a "best fit" exposure value representing the entire body.

(ii). Greenhouse Use Handler Exposures

Because of a lack of chemical specific exposure data for the hot plate/pan green house use, the following four scenarios were formulated to estimate applicator exposures.

Greenhouse Handler Scenario One - Hot Plate Activated by Automatic Timer

The use directions indicate that the handler must pour the recommended amount (1 fluid ounce per 10,000 cubic feet) of formulated product into a metal pan. The pan is placed on a hot plate and heated until the liquid vaporizes. The label for Dibrom 8 Emulsive (Reg. Number 59639-15) states that it contains 62% naled (7.5 pounds per gallon). Therefore, one ounce contains 0.059 pounds of active ingredient. The handler must pour the end-use product from a 5-gallon container into a measuring container and, in turn, from the measuring container into the metal pan. The label directions do not specify how many

separate hotplates per greenhouse; however, it is assumed that in larger greenhouses, hot plates would be distributed evenly throughout the floor area (every 10,000 ft^3) to promote even distribution of the vapor. Handlers in this scenario would experience possible dermal and inhalation exposure during the period of time they are opening the 5-gallon container of end-use product, pouring it into a measuring container and then pouring it into a pan. No chemical-specific data are available to estimate this exposure, but PHED data for handlers mixing/loading liquid formulations in an open system could be used as a surrogate.

The use report for DDVP is the best estimate available at this time for the size of a greenhouse facility that grows flowers. Based on this information approximately seven greenhouses could be treated in a workday. The amount of active ingredient handled per day if all seven houses (85000 ft^3 each) were treated in a single day with the slightly more concentrated product:

The unit exposures from the PHED Surrogate Exposure Guide for single layer clothing and chemical- resistant gloves indicate that the dermal exposure component is 0.023 mg of exposure per one pound of active ingredient handled and the respiratory component is 1.2 µg/lb ai (without a respirator).

The estimated potential daily dermal and inhalation exposures (not corrected for dermal absorption) are:

With a short or intermediate NOAEL of 1.0 mg/kg/day the MOE becomes:

The total MOE is 440.

Greenhouse Handler Scenario Two - Hot Plate Activated Manually

Some naled labels specify that the hot plate must be activated by an automatic timer after all workers have vacated the greenhouse and the greenhouse is locked. However, other labels do not contain such a requirement. When the hot plate is turned on by handlers, rather than by timer, the handlers would experience potential inhalation exposure for the remainder of the time they are in the greenhouse. Particularly if the handlers do not exit the greenhouse immediately, but move to other locations in the greenhouse to measure and pour the product and activate another hot plate, the possible inhalation exposure could be significant.

However, given the small volume per greenhouse (8.5 fl. oz. - about one cup) it seems unlikely that an applicator would separately measure volumes for each of the hot plates (if multiple units are actually used), particularly if they had to be filled from a 5-gallon can. Exposure times for these workers would likely be a matter of a few minutes to a maximum of a half hour. No actual measurements exist to determine: (1) the duration of application in a large greenhouse operation if each hot plate is activated by the applicator; (2) the amount of time required to vaporize the naled formulation from the hot plate; and (3) ultimately what the air concentration in the greenhouse would be during the application period. The only information available to the Agency is the saturation concentration of naled (4.1 mg/m^3 if the vapor pressure is 2×10^{-4} mm Hg or 41 mg/m^3 if the vapor pressure is 2×10^{-3} mm Hg). The applicator would not be sufficiently protected, even with an O/V respirator with a 10-fold protection factor, for half an hour at either of these concentrations using the inhalation NOAEL of 0.23 µg/L or the 1-day oral NOAEL of 1 mg/kg/day and a UF of 100.

Route-Specific Calculation: 90-day inhalation study

(NOAEL = 0.23 µg/L)

MOE = <1, where AF is the activity factor.

Route-to-Route Calculation: 1-day acute oral
(1 mg/kg/day)

$$\text{MOE} = \frac{\text{NOAEL 1 mg/kg/day}}{\text{Exposure 0.015 mg/kg}}$$

MOE = 67

It is important to note that the saturation concentration would most likely not be reached within the few minutes to half an hour it would take an applicator to complete the task. Additionally, the NOAEL of 0.23 ug/L is from a 90-day rat inhalation study and does not match the exposure duration.

Greenhouse Handler Scenario Three - Activating Ventilation System

Following treatment, the label indicates the greenhouse must be closed for at least three hours and may remain closed as long as overnight. At this point, the greenhouse must be ventilated before entry by *workers* is allowed. Often a person must enter the greenhouse to activate the ventilation system. These persons are defined as handlers under the Worker Protection Standard (WPS). Handlers in this scenario would experience possible inhalation exposure from the time they enter the greenhouse, while they activate the ventilation system, and until they exit the greenhouse. They would also experience possible dermal exposure, since the vapor may have condensed onto surfaces in the greenhouse, including the ventilation system. Activation of the ventilation system would take only a short time. The above route-to-route equation (scenario one) using the oral endpoint and a respirator providing a 10-fold PF or better should provide adequate protection. The likelihood of achieving saturation of 41 mg/m^3 is greater for the time period just prior to ventilation.

Greenhouse Handler Scenario Four - Removal of Hot Plates

The label specifies that the pan used for the application must be removed from the greenhouse before workers are allowed to enter. Persons removing the pan are defined as

handlers under WPS. Handlers in this scenario would experience possible dermal exposure while handling and disposing of the pans. (They would experience possible inhalation exposure, unless the entry to retrieve the pans is delayed until the ventilation criteria are met.)

Activation of the ventilation system would take only a short time. It would be expected that the PPE would protect the worker in this scenario. The exposure discussion in the above scenario for the ventilation system would also apply to this scenario. Without any other data, this task (removal of the hot plates) should wait until the ventilation is complete, although it is unknown exactly how much protection this would provide for the worker.

b. Occupational Risk Characterization

In assessing the risks of naled due to occupational and residential exposures, the assessment calculates MOEs as the ratio of NOAEL to exposure. The occupational and residential risk assessment uses a NOAEL of 1.0 mg/kg/day from the 28-day rat dermal study to calculate the dermal MOE and a NOAEL of 0.053 mg/kg/day (or 0.2 μg/L) from the 13-week rat inhalation study to calculate the inhalation MOE. The dermal study demonstrated a LOAEL of 20 mg/kg/day based on dermal irritation, reduced weight gain and brain, plasma and RBC ChE inhibition. The LOAEL in the inhalation study was 1 μg/L based on depression of plasma and RBC ChE levels.

The agricultural use and non-agricultural use tables list the parameters that the Agency used to conduct its occupational risk assessment. The "PPE" columns in these tables show the calculated MOEs for workers wearing coveralls over long pants, long-sleeve shirts, and chemical-resistant gloves. In addition to this PPE, the airblast applicator scenario reflects the use of chemical-resistant headgear that is required by current labeling. Current naled labels require no engineering controls, such as closed mixing systems or closed tractor cabs. The "engineering controls" columns in these tables show the calculated MOEs for workers using closed mixing systems and enclosed cockpits/cabs. PPE for workers using engineering controls includes long pants,
long-sleeved shirts and no gloves (except that chemical-resistant gloves are used by workers mixing liquid).

To more accurately characterize the risk to pesticide handlers exposed to naled, the assessment calculates the MOEs for each scenario for each of the crop groups provided in Table 6, below:

Table 6. Crop Groups for Handler Assessment to Naled

Crop Group Label	Crops Contained in Group	Maximum Label Rate (lb ai/A)
A	Almonds, peaches	2.813

B	Broccoli, cabbage, cauliflower, Brussels sprouts, kale, collards, eggplant, pepper, melon, squash, walnut (air only)	1.875
C	Citrus	1.875
D	Beans, peas, celery, chard, spinach, seed alfalfa (ID, WA)	1.406
E	Cotton, strawberry, sugarbeet, hops, seed alfalfa (OR), rangeland	0.938
F	grapes, walnuts	0.938
G	safflower	0.703

To determine inhalation and dermal doses for each scenario, the assessment multiplies the dermal or inhalation unit exposure by the maximum application rate for each crop group and the number of acres treated daily to develop a dermal and inhalation exposure in mg/day. The result is divided by an assumed body weight of 70 kg to yield the daily dermal or inhalation dose.

$$\text{Daily dose (mg ai/kg bw/day)} = \frac{\text{Unit exposure(mg ai/lb ai)} \times \text{use(lb ai/A)} \times \text{daily acres (A/day)}}{\text{body wt (kg)}}$$

The dermal MOEs are then calculated by dividing the NOAEL by the daily dermal dose, while the inhalation MOEs are calculated by dividing the NOAEL by the daily inhalation dose.

The resulting total MOEs for naled are below 100 in most of the exposure scenarios (see summary Table 7 and Appendix A for results). MOEs are greater than 100 for the following four agricultural exposure scenarios and crop groupings with engineering controls:

❖ Mixing/loading liquid formulations (closed systems) for groundboom applications on crop group (G);

❖ Mixing/loading liquid formulations (closed systems) for airblast applications on crop group (F);

❖ Applying liquid formulations (enclosed cab) by groundboom for crop groups (E) and (G);

❖ Flaggers (enclosed cab) for applications of liquid formulations.

Although the remaining exposure scenarios and crop groups not listed above result in MOEs that are less than 100 (see Appendix A for detailed assessment), the dermal MOEs are likely to be an overestimation based on the use of the dermal NOAEL of 1 mg/kg/day. Since

a 28-day dermal toxicity study in rats (MRID 00160750) was available from the toxicology database, a NOAEL of 1.0 mg/kg is used for the short-and intermediate-term risk assessments, based on plasma, RBC, and brain ChE inhibition occurring at 20 mg/kg (LOAEL).

Based on dermal absorption data on two very similar compounds, dichlorvos and trichlorfon, the existing dermal toxicity study likely overestimates dermal toxicity because of the 20 fold difference between the lowest adverse effect level (LOAEL) and the no adverse effect level (NOAEL).

Another 28-day dermal toxicity study in rats using doses intermediate between 1 mg/kg and 20 mg/kg would better define the NOAEL and the LOAEL.

As confirmatory data, a dermal absorption study in rats may be used in conjunction with existing oral studies to better characterize the actual dermal absorption of naled.

The dermal MOEs for workers would likely increase with a better characterization of dermal absorption and toxicity.

Summary of MOE Values for Agricultural Uses of Naled

Exposure Scenario	Crop[1] Grouping	Dermal MOE[2]		Inhalation MOE[2]		Total MOE[2]		Confidence in PHED Estimates
		PPE	Control	PPE	Control	PPE	Control	
Mixer/Loader Exposure								
Mixing All Liquids for Aerial	(B)	4.3	12	53	66	4	10	High
	(D)	5.6	16	66	88	5	14	
	(E)	8.5	23	88	133	8	20	
	(G)	11	32	133	177	10	27	
Mixing All Liquids for Groundboom	(B)	19	50	177	265	17	42	High
	(D)	25	71	265	530	23	63	
	(E)	37	100	530	589	35	85	
	(G)	50	143	530	883	46	120	
Mixing of Liquids for Airblast	(A)	25	71	265	530	23	63	High
	©	37	100	530	589	35	85	
	(F)	77	250	757	1,325	70	210	
Applicator Exposure								
Aerial equipment (liquids)	(B)	No open cockpit uses	21	No open cockpit uses	76	NA	16	Medium
	(D)		27		106	NA	22	
	(E)		43		177	NA	35	
	(G)		59		265	NA	48	
Groundboom (liquids)	(B)	48	63	265	589	41	57	Medium
	(D)	63	91	530	883	56	82	
	(E)	91	125	757	1,325	81	110	
	(G)	125	167	883	1,767	110	150	

Summary of MOE Values for Agricultural Uses of Naled

Exposure Scenario	Crop[1] Grouping	Dermal MOE[2]		Inhalation MOE[2]		Total MOE[2]		Confidence in PHED Estimates
		PPE	Control	PPE	Control	PPE	Control	
Airblast equipment	(A)	4.8	38	66	88	4	27	High
	©	7.1	59	106	133	7	41	
	(F)	14.3	111	177	265	13	78	
Hot plate/pan (greenhouse)	See text for assessment							
Flagger Exposure								
Liquids	(B)	27	530	177	883	23	330	High
	(D)	34	710	265	1,325	30	460	
	(E)	53	1,000	530	1,767	48	640	
	(G)	71	1,400	530	5,300	63	1100	

[1]Crop groupings are: (A) almond, peach 2.8 lb ai/acre; (B) broccoli, cabbage, cauliflower, brussels sprouts, kale, collards, eggplant, pepper, melon, squash, walnut (air only) 1.9 lb ai/acre; © citrus 1.9 lb ai/acre; (D) beans, peas, celery, chard, spinach, seed alfalfa (ID, UT, WA) 1.4 lb ai/acre; (E) cotton, strawberry, sugarbeet, hops, seed alfalfa (OR), rangeland 0.94 lb ai/acre; (F) grape, walnut 0.94 lb ai/acre; and (G) safflower 0.7 lb ai/acre.

[2]Inhalation PPE exposure values based on an O/V respirator (10 fold PF). Engineering Control values are based on no respirators and using closed systems (i.e., closed mixing/loading and enclosed cabs/cockpits). The dermal PPE represents coveralls over long pants, long sleeve shirt, and chemical resistant gloves using open systems and chemical resistant head gear for airblast applicators. The engineering controls represent long pants, long-sleeve shirt, and no gloves (chemical resistant gloves used for closed mixing and enclosed cab airblast--no data are available for no glove scenarios), and closed systems (i.e., closed mixing/loading or enclosed cockpit/cabs).

In addition to the agricultural uses of naled, the non-agricultural uses (i.e., mosquito/blackfly) are also assessed. Four scenarios were selected for the mosquito/blackfly applications. The scenarios selected include:

- Mixing/loading liquids for aerial (ULV) applications;
- Mixing/loading liquids for ground-based (ULV) applications;
- Applying aerial ULV sprays; and
- Applying using ULV ground-based foggers.

No data were submitted in support of the naled mosquito/blackfly applications. Additionally, scenario-specific data for these unique types of application are not available in PHED. However, as a range finding assessment, agricultural equipment available in PHED were used as a surrogate. The mixing/loading scenarios from the agricultural scenarios are assumed to be representative of the mosquito/blackfly uses (e.g., closed mixing/loading systems). However, HED has insufficient data to determine if exposures to pilots applying pesticides in typical agricultural aerial applications are similar to the exposures to pilots applying mosquito control agents. Furthermore, PHED has no data for fogging techniques. In lieu of exposure data for fogging operations, airblast data were substituted. The representativeness of this scenario must be characterized as very uncertain. Additional data should be collected to better define the potential exposure that the ground-based fogger operator may receive.

The results of the mosquito/blackfly control uses are presented in Table 8. Total MOEs for all of the exposure scenarios are less than 100. The quality of the analytical data coupled with the number of replicates in the PHED data used to estimate exposures range from medium to high. The same discussion and concerns for using the dermal NOAEL above applies to the results of the MOEs for the mosquito scenarios.

Summary of Exposure/Risk for Mosquito/Blackfly Control Uses of Naled (Short- and Intermediate-Term)

Exposure Scenario	Dermal Exposure[1] (mg/lb ai)	Inhalation Exposure[2] (µg/lb ai)	Maximum Label Rate[3] (lb ai/A)	Daily Max Treated[4] (Acres)	Dermal Dose[6] (mg/kg/day)	Inhalation Dose[5] (mg/kg/day)	Dermal MOE[7]	Inhalation MOE[7]	Total MOE
Mixer/Loader									
Mixing/loading Liquids for Aerial (ULV) for Blackfly and Mosquito Control	0.0086 (gloves)	0.083	0.05	7,500	0.046	0.00044	22	120	18
			0.1		0.092	0.00089	11	60	9
			0.25		0.23	0.0022	4	24	4
Mixing/loading Liquids for Ground-based Fogger (ULV) for Blackfly and Mosquito Control	0.0086 (gloves)	0.083	0.05	3,000	0.018	0.00018	54	300	46
			0.1		0.037	0.00036	27	150	23
			0.25		0.092	0.00089	11	60	9
Applicator Exposure									
Aerial (ULV) for Blackfly and Mosquito Control	0.005	0.068	0.05	7,500	0.027	0.00036	37	150	30
			0.1		0.054	0.00073	19	73	15
			0.25		0.13	0.0018	7	29	6
Ground-based Fogger (ULV) for Blackfly and Mosquito Control using an airblast sprayer as a surrogate because of the lack of data	0.019 (gloves)	0.45	0.05	3,000	0.041	0.00096	25	55	17
			0.1		0.081	0.0019	12	27	8
			0.25		0.20	0.0048	5	11	3

Note: rounding errors based on spreadsheet calculations and rounding results to two significant figures.
[1]Dermal unit exposures reported as best fit mean for mixer/loaders, aerial, and ground-based foggers are based on closed mixing and enclosed cockpits/cabs while wearing long pants, long sleeved shirts, and chemical resistant gloves (including ground-based fogger because the no glove scenario is not available) except for aerial applicators (no gloves). Handheld sprayer equipment represents handlers wearing coveralls over long pants, long-sleeved shirts, and chemical-resistant gloves.
[2]Inhalation Exposure Values are reported as geometric means (lognormal distributions). A ten fold protection factor for backpack sprayers (only) was used to simulate workers wearing organic vapor removing respirators.
[3]Dibrom 8 Emulsive Label (Reg. No. 59639-15), Trumpet EC Insecticide (59639-90), and Dibrom Concentrate 85 percent; LUIS Reports for Naled dated 08/30/94 and 08/31/94.
[4]Values represent the maximum area or the maximum volume of spray solution which can be used in a single day to complete treatments for each exposure scenario of concern. Aerial treatment of 7,500 acres using ULV consists of spraying 35 to 105 gallons (59639-90). Ground-based foggers the label (59639-90) reports the rate while driving 15 mph treating a 300 ft swath [(6 hrs/day x 15 mph x 5280 ft/mile x 300 ft swath) / 43,500 sq.ft. per acre = 3277 acres per day].
[5]Daily Inhalation Dose (mg/kg/day) = Inhalation Exposure (mg/lb ai) * Max. Appl. Rate (lb ai/acre) * Max. Treated/70 kg
[6]Daily Dermal Dose (mg/kg/day) = Exposure (mg/lb ai) * Max. Appl. Rate (lb ai/acre) * Max. Treated /70 kg
[7]MOE = NOAEL/Daily Dose (mg/kg/day). Where: Dermal NOAEL = 1 mg/kg/day, 28 day dermal study, and inhalation NOAEL = 0.053 mg/kg/day.
[8]Total MOE = 1/((1/dermal MOE) + (1/inhalation MOE)).

2. Postapplication Exposure and Risk Characterization

a. Postapplication Exposure

EPA has determined that there is a potential for exposure to persons entering treated sites. The potential for exposure exists in a variety of postapplication scenarios, including agricultural and residential settings. In agricultural settings, postapplication exposure to workers is of concern for naled use on:

(1) vine crops (grapes);

(2) low- and medium- height crops (e.g., strawberries, cotton);

(3) orchard-type tree crops (e.g., citrus, peaches);

(4) greenhouse-grown ornamentals and vegetable crops;

(5) forestry uses; and

(6) livestock sites.

Residential exposure is addressed in the residential section, below.

A potential for both dermal and inhalation postapplication exposure exists for greenhouse use scenarios because workers routinely enter greenhouses to perform a variety of cultural tasks. The Agency is particularly concerned about dermal and inhalation exposures in greenhouses following applications of naled by boiling naled in hot plates/pans.

b. Postapplication Risk Characterization

Previously, the registrant at the time, Valent, Inc., submitted dislodgeable foliar residue (DFR) data on grapes (MRIDs 43223904 and 43223907). These data were deficient since the residues were measured within the same vineyard and only in two locations. These two samples are insufficient to capture the variability between vineyards.

The Agency is requiring new interim REIs, provided the registrant agrees to submit supplementary data that captures the inherent variability between vineyards treated with naled and confirmatory data to determine definitive REIs for all crop groups/use sites on which naled is registered for use. The new interim REIs are two days for grapes and all other crops with an application rate of 0.938 lb ai/acre and three days for all other crops with a higher application rate than grapes. Current naled labels contain REIs of 24 hours for all crops.

Postapplication/reentry exposure studies are required as confirmatory data to determine definitive REIs for all crop groups/use sites on which naled is registered. The

interim REIs established in this document will be adjusted, if necessary, upon submission and review of the additional data. Data requirements for grapes have been satisfied; however, confirmatory data are still required to support the use of naled on the following crop groups/use sites:

- Tree crops (orchard-type, i.e., citrus, peaches)
- Medium-height crops (such as cotton, tobacco)
- Low crops (such as strawberries, broccoli, cauliflower)
- Greenhouse-grown crops (roses and other ornamental plants)

Requirements for postapplication/reentry exposure studies are addressed by Subdivision K of the Pesticide Assessment Guidelines. The required data include:

- 875.2100 Foliar Residue Dissipation
- 875.2400 Postapplication Dermal Passive Dosimetry Exposure
- 875.2500 Postapplication Inhalation Passive Dosimetry Exposure

Greenhouse Post-Application Exposure

The WPS for Agricultural Chemicals establishes generic entry restrictions when vapors are applied in a greenhouse. No entry is permitted (other than entry by pesticide handlers who are trained and equipped with personal protective equipment (PPE) -- including respirators) into the greenhouse until the one of the WPS ventilation criteria has been met. The WPS ventilation criteria include: (1) ten air exchanges are completed; (2) two hours of mechanical ventilation; (3) four hours of passive ventilation; (4) eleven hours with no ventilation followed by one hour of mechanical ventilation; (5) eleven hours with no ventilation followed by two hours of passive ventilation; or (6) twenty-four hours with no ventilation.

The naled label indicates that the application period lasts from a minimum of three hours to as long as 12 hours (overnight). If the ten-air-exchange WPS ventilation option is chosen, the ventilation criteria could be met in as little as ten minutes following the end of application. Since naled is a liquid at room temperature and must be heated to form a vapor for even dispersal, it likely condenses back into liquid form as it cools, leaving some residue on greenhouse surfaces, including plant leaves. Since the vapor pressure is approximately $2x10^{-3}$ mm Hg at 20 C, it is possible that there is an off-gassing effect from the residue that continues after ventilation clears the remnants of the initial vapor. An estimate of the DFRs and corresponding exposures and MOEs are presented in Table 9. It is evident from that

table that an REI of approximately 32 hours is required before the target MOE of 100 is reached.

Greenhouse reentry exposures were derived from the DFR studies on grapes and should be considered highly conservative. Application rates to grapes are much higher than those for greenhouses. It is also unlikely that greenhouse applications would yield appreciable DFRs since the heat generated product is in vapor rather than aerosol form. Some of the labels specify to avoid direct application to plants as injury may result. While it is possible that there will be some deposition of naled on foliage due to condensation, the amount that would be deposited would be expected to be much less than that from a high application spray formulation.

Exposures of Workers Reentering Greenhouses Treated with Naled

Start Time of Work Period (hrs after aeration)	End Time of Work Period (hrs after aeration)	DFR ($\mu g/cm^2$)	Dermal Exposure (mg/kg/day)	MOE
0	8	0.070	0.064	16
1	9	0.066	0.060	17
2	10	0.062	0.057	18
3	11	0.059	0.053	19
4	12	0.055	0.050	20
5	13	0.052	0.047	21
6	14	0.049	0.045	22
7	15	0.046	0.042	24
8	16	0.044	0.040	25
9	17	0.041	0.038	27
10	18	0.039	0.035	28
11	19	0.037	0.033	30
12	20	0.034	0.031	32
13	21	0.033	0.030	34
14	22	0.031	0.028	36
15	23	0.029	0.026	38
16	24	0.027	0.025	40
17	25	0.026	0.023	43
18	26	0.024	0.022	45
19	27	0.023	0.021	48
20	28	0.022	0.020	51
21	29	0.020	0.018	54
22	30	0.019	0.017	57
23	31	0.018	0.016	61
24	32	0.017	0.015	65

Exposures of Workers Reentering Greenhouses Treated with Naled

Start Time of Work Period (hrs after aeration)	End Time of Work Period (hrs after aeration)	DFR ($\mu g/cm^2$)	Dermal Exposure (mg/kg/day)	MOE
25	33	0.016	0.015	69
26	34	0.015	0.014	73
27	35	0.014	0.013	77
28	36	0.013	0.012	82
29	37	0.013	0.012	87
30	38	0.012	0.011	92
31	39	0.011	0.010	98
32	40	0.011	0.010	104
33	41	0.010	0.009	110

Dislodgeable Foliar Residue (DFR) estimation is based on a DFR study in which naled was applied at 0.9 lb/acre to grapes. Residues declined rapidly over the first three days with apparent first order kinetics described by the equation DFR = DFR_0e^{-kT} where DFR_0 = 0.17 $\mu g/cm^2$. k = 0.059/hour and T is in hours. In greenhouses, naled is applied at a rate of 1 oz of a 7.5 lb/gal formulation per 10,000 ft^3, or 0.059 lb/10,000ft^3. For a typical greenhouse with a volume of 85,000 ft^3 and floor dimensions of 120 ft x 48 ft, this is equivalent to 0.5 lb/0.13 acre or 3.8 lb/acre. If deposition of naled at 0.9 lb/acre on grapes were normalized to deposition on greenhouse foliage at 3.8 lb/acre, DFR_0 in the decline curve would be 0.7 $\mu g/cm^2$. However, because naled in the greenhouse is generated as a vapor rather than a spray, we assume that deposition on greenhouse foliage will be much less than on grapes. HED has assumed that 90% of naled generated in the greenhouse will be off gassed via the ventilation system and that DFR_0 in the decay curve = 0.07 $\mu g/cm^2$.

Exposures were derived from the equation $0.001 x T_C x AUC/BW$ where T_C (Transfer Coefficient) = 10,000 cm^2/hr, BW (Body Wt.) = 70 kg and 0.001 converts µg to mg. AUC (area under the curve) in this instance refers to the area under the residue decline curve in the interval from T to T+8 hrs. In this calculation AUC = $(DFR_T - DFR_{T+8})/k$ where k=0.059/hr.

D. Residential Exposure and Risk Characterization (bystander)

In residential settings, postapplication bystander exposure to residents (children and adults) can result from treatment on pets (from treated collars), and as a mosquito and black fly control agent.

1. Residential Exposure

As discussed above under the occupational (M/L/A) risk characterization, in assessing the risks of naled due to occupational and residential exposures, the assessment calculates MOEs as the ratio of NOAEL to exposure. The occupational and residential risk

assessment uses a NOAEL of 1.0 mg/kg/day from the 28-day rat dermal study to calculate the dermal MOE and a NOAEL of 0.053 mg/kg/day (or 0.2 μg/L) from the 13-week rat inhalation study to calculate the inhalation MOE. The dermal study demonstrated a LOAEL of 20 mg/kg/day based on dermal irritation, reduced weight gain and brain, plasma and RBC ChE inhibition. The LOAEL in the inhalation study was 1 μg/L based on depression of plasma and RBC ChE levels.

HED has determined that there are potential bystander postapplication exposures to residents even though residential uses have been voluntarily canceled by the registrant. The potential residential bystander exposures to adults and children result from aerial and ground-based fogger blackfly and mosquito control uses. Potential exposures are estimated because of the concern for the residues that may be deposited during the ULV aerial and ground-based fogger applications in the vicinity of residential dwellings. This assessment has been developed to ensure that the potential exposures are not underestimated and to represent a conservative model that encompasses potential exposures received in other recreational areas (e.g., school playgrounds, parks, athletic fields). The scenarios likely to result in postapplication exposures are listed in Table 10 and are as follows:

❖ Dermal exposure from residues deposited on turf (adult and child);

❖ Incidental nondietary ingestion of residues deposited on lawns from hand-to-mouth transfer (toddler);

❖ Incidental nondietary ingestion of residues deposited on lawns from object-to-mouth transfer (toddler); and

❖ Incidental ingestion of soil from treated areas (toddler).

Although the incidental ingestion of soil and object-to-mouth scenarios are not expected to contribute significantly in comparison to the dermal route and/or the hand-to-mouth activity, they are included in this assessment to account for all potential pathways of exposure. It is unnecessary to include these pathways in the aggregate exposure because they would be rounded out of the final value.

Chemical-specific data for mosquito uses are not available. Therefore, the equations and assumptions used for each of these four scenarios were taken from the Draft SOPs for Residential Exposure Assessments guidance document, and are provided below.

The Residential SOPs have been followed with the exception that the initial turf transferable residue level has been modified in this assessment using additional information that has become available since the publishing of the SOPs. Although the SOPs were initially developed for direct turf applications, the models are used in this assessment to determine if there is a potential concern using a screening level approach. In addition to the use of the SOPs, the unique nature of the mosquito control uses requires additional information in determining the deposition rate of naled (i.e., amount of ai deposited on

residential turf) because the application technique is meant to keep the spray aloft. The determination of the deposition rates are consistent with HED's assessment developed in the fenthion mosquito use risk assessment. The following information was used to determine the deposition rates for ground-based foggers and aerial applications.

a. Ground-based Foggers

In the study conducted by Moore *et al.*, [*Downwind Drift and Deposition of Malathion on Human Targets From Ground Ultra-Low Volume Mosquito Sprays*: J.C. Moore, J.C. Dukes, J.R. Clark, J. Malone, C.F. Hallmon, and P.G. Hester; Journal of the American Mosquito Control Association; Vol. 9, No. 2 (June, 1993)] both human exposure and deposition was quantified over five separate application events. A 91 percent formulation of malathion was applied in April and May of 1989 in the early evening (a time of day for relative atmospheric stability). A Leco HD ULV cold aerosol generator (Lowndes Engineering Company, Valdosta Georgia) was used to make each application. The application parameters included a fluid flow rate of 4.3 fluid ounces per minute, a vehicle groundspeed of 10 mph, and a nominal application rate of 0.05 lb ai/acre (i.e., equates to a theoretical 100% deposition rate of 0.56 µg/cm^2). Deposition was monitored at three locations downwind from the treatment area (i.e., 15.2 m, 30.4 m, and 91.2 m). For the events considered in the deposition calculations, "average amounts of malathion deposited on ground level at 15.2, 30.4, and 91.2 m were not significantly different." The percentage of the application rate reported to have been deposited ranged from one to 14 percent of the theoretical rate. The mean deposition value for all measurements was 4.3 percent (n=35, CV=98).

In the study conducted by Tietze *et al.*, [*Mass Recovery of Malathion in Simulated Open Field Mosquito Adulticide Tests*: N.S. Tietze, P.G. Hester, and K.R. Shaffer; Archives of Environmental Contamination and Toxicology; 26: 473-477 (1994)] only deposition was quantified over six separate application events (i.e., one event was not included in deposition calculations "due to negative air stability"). The application parameters were similar to that used by Moore *et al*. A 95 percent formulation of malathion was applied from May to August of 1993. A Leco 1600 ULV cold aerosol generator (Lowndes Engineering Company, Valdosta Georgia) was also used to make each application. The application parameters included a fluid flow rate of 4.3 fluid ounces per minute, a vehicle groundspeed of 10 mph, and a nominal application rate of 0.057 lb ai/acre (i.e., equates to a theoretical 100% deposition rate of 0.64 µg/cm^2). Deposition was monitored at four locations downwind from the treatment area (i.e., 5 m, 25 m, 100 m and 500 m). For the events considered in the deposition calculations, "malathion mass deposited differed significantly between the 500 m site and the three closer sites (df = 3; F-value = 3.42; P<0.05)." The percentage of the application rate reported to have deposited (not including 500 m samples which were much less) ranged up to
5.8 percent. The mean deposition value for all measurements was 3.8 percent.

After considering the data that are available in the Tietze *et al.* and Moore *et al.* papers, an off-target deposition rate of five percent of the application rate was used by HED

to evaluate ground-based ULV applications (i.e., five percent of application rate is the deposition rate of which 5 and 20 percent is assumed to be available for dislodging for dermal contact and hand to mouth activities, respectively). A value slightly higher than the mean values for both studies was selected because of the variability in the data and the limited number of data points. It should be noted that this value is also consistent with the draft modeling assessment for ground-ULV approaches completed by S.T. Perry and W.B. Petersen of EPA's Office of Research and Development (i.e., within a factor of five). Perry and Petersen used "the INPUFF Lagrangian puff model" as the basis for their assessment (Petersen and Lavdas, 1986: *INPUFF 2.0 - A Multiple Source Gaussian Puff Dispersion Algorithm, User's Guide*, EPA/600/8-86/024). Depending on the scenario selected from this document, deposition rates ranged from approximately 2.5 percent deposition 450 m downwind to 15 to 20 percent deposition immediately adjacent to the treatment zone.

b. Aerial Applications

Data similar to that for ground applications discussed above were not available for the aerial deposition. Therefore, to calculate deposition from aerial ULV applications, HED used *AgDRIFT* (V 1.03 -- June 1997) which is the model that was developed as a result of the efforts of the *Spray Drift Task Force (SDTF)*. For a more comprehensive discussion of the model selection for malaria vector control applications, readers are referred to the Agency's fenthion risk assessment. In summary, the SDTF is a coalition of 38 pesticide registrants whose primary objectives were to develop a comprehensive database of off-target drift information in support of pesticide registrations and an appropriate model system. This model was selected based on the consensus of several experts in the spray drift area because it represents the current
state-of-the-art. It is important to note that no proprietary SDTF data were used in the completion of this assessment. The following inputs were used as the basis of the *AgDRIFT* calculations:

- **AgDRIFT Model Tier**: 3.

- **Droplet Size Distribution**: $D_{v0.1}$ = 39.02 µm; $D_{v0.5}$ = 54.82 µm; $D_{v0.9}$ = 77.5 µm; and <141 µm = 98 percent (developed to reflect droplet spectrum requirements of Trumpet label).
Note: The droplet distribution was developed based on the Trumpet label.

- **Spray Material:** User-defined option (oil option). Inputs include: nonvolatile rate 2.5 lb per acre, specific gravity 1.2 (calculated based on approximately 10 pounds per gallon), spray rate 0.25 gallons/acre, active ingredient application rate (0.1 lb ai/acre), and evaporation rate (1 μm^2/deg C/sec).
Note: Several of these parameters do not exactly coincide with the Trumpet label but were used because the Trumpet label inputs exceeded the allowable input parameters. These differences are not expected to significantly affect the AgDRIFT results because a nonvolatile oil was selected, hence the critical input is the active ingredient application rate. Additionally, no proprietary SDTF physical property data were used in the completion of this assessment.

- **Aircraft:** User-defined option (fixed-wing option). Inputs include: Douglas DC3, wingspan -- 94.6 ft (semispan 47.28 ft); typical application airspeed -- 228 mph; weight – 21397 pounds; planform area – 1009.63 ft^2; propeller RPM -- 2550; propeller radius -- 5.81 feet; engine vertical distance – -1.22 feet; and engine forward distance -- 6.1 feet. *Note:* DC3-specific inputs were obtained from the *FSCBG (V4)* aircraft library.

- **Nozzles**: User-defined option. Inputs include number of nozzles: 60, vertical distance of nozzles from wing: -2.66 feet, horizontal distance from wing: -0.82 feet, and horizontal distance limit: 75 percent.

- **Meteorology**: Inputs were not changed from Tier 3 recommendations of wind speed: 2 mph, wind direction: -90 degrees (perpendicular to flight path), temperature: 86°F, and relative humidity: 50 percent.

- **Control:** Inputs were altered from the Tier 3 recommendations. The parameters that were used included a spray release height of 300 feet, 20 spray lines (aircraft passes) in each application event, a swath width of 500 feet, and a swath displacement based on the aircraft centerline.

- **Advanced Settings**: Inputs were not changed from Tier 3 recommendations of wind speed height (2 meters), maximum compute time (600 seconds), maximum downwind distance (795 meters), vortex decay rate (0.56 m/s), aircraft drag coefficient (0.1), propeller efficiency (0.8), and ambient pressure (1013 mb).

AgDRIFT is capable of producing a variety of useful outputs. The key for HED in this assessment was to determine from the model what percentage of the application volume remained aloft and what percentage of the resulting droplets deposited on the surfaces in the treatment area as well as downwind from the treatment area. AgDRIFT is generally intended to calculate deposition rates in areas that are downwind from the treatment area (i.e., presented from the border of the treatment area to areas of interest downwind). HED has used the values at the border of the treatment area to represent the deposition rate within the treated area. The results that HED used to determine the percentage of application rate that is deposited are presented in Figure 1 (Tier 3 Deposition presented as a Fraction of Application Rate vs. Distance Downwind). It is clear from Figure 1 that from the edge of the treatment area to 2000 feet downwind, approximately 30 percent of the theoretical application is deposited.

Figure 1.

c. General Assumptions

- The amount of residue deposited on the turf from aerial application is 30 percent of the application rate and ground-based foggers are assumed to deposit five percent of the application rate.

- Five percent of the amount of residue deposited from the mosquito application is available from the turfgrass as a transferable residue for dermal exposure. Twenty percent is available for oral exposure (e.g., hand-to-mouth). The percent available for oral exposure is expected to be higher because to account for a child's "sticky" hands.

- Postapplication was assessed on the same day the pesticide is applied because it was assumed that adults and children could be exposed to turfgrass immediately after application. Therefore, postapplication exposures were based on day 0.

- Adults were assumed to weigh 70 kg. Toddlers (3 years old), used to represent the 1 to 6 year old age group, were assumed to weigh 15 kg.

❖ Application rates for mosquito aerial applications range from 0.05 to 0.1 lb ai/acre. The 0.05 lb ai/acre rate is the mosquito rate used for residential areas while the 0.1 lb ai/acre rate is the maximum labeled rate and is used for mosquito treatments in areas of heavy vegetation (i.e., not residential areas). The residential blackfly rate is 0.1 lb ai/acre and the labeled maximum rate for blackfly treatments is for heavy vegetation areas -- 0.25 lb ai/acre. The labeled maximum rates are not assessed for postapplication exposure because these rates are intended for heavy vegetation areas that are not likely to occur in residential areas.

❖ Specific assumptions related to each of the four exposure scenarios are discussed below.

(i). Dermal exposure

Potential dermal exposures to adults and toddlers engaged in a high-end exposure activity (e.g., playing and rolling on turf) are estimated using the following equation:

$ADD = (DFR_t * CF1 * Tc * ET)/BW$

where:

ADD = average daily dose (mg/kg/day)
DFR_t = dislodgeable foliar residue on day "t" (µg/cm^2)
CF1 = weight unit conversion factor to convert µg units in the DFR value to mg for the daily dose (0.001 mg/µg)
Tc = transfer coefficient (cm^2/hr)
ET = exposure time (hr/day)
BW = body weight (kg)

and

$DFR_t = AR * F * (1-D)^t * CF2 * CF3$

where:

AR = application rate (lb ai/acre) x percentage deposited (i.e., 30 percent for aerial and five percent for ground-based foggers)
F = fraction of ai available on the foliage as dislogeable residue (0.05 for dermal and 0.20 for oral routes, unitless)
D = fraction of residue that dissipates daily (0.10, unitless)
t = postapplication day on which exposure is being assessed (day 0)
CF2 = weight unit conversion factor to convert the lbs ai in the application rate to µg for the DFR value ($4.54x10^8$ µg/lb)
CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the DFR value ($2.47x10^{-8}$ acre/cm^2 if the application rate is per acre)

- ❖ The mean dermal transfer coefficient representing a high contact activity (e.g., playing and rolling on turf) was assumed to be 43,000 cm^2/hr for adults and 8,700 cm^2/hr for toddlers. At this time, these transfer coefficients are the best available data to estimate potential contact to turf for these types of activities.

- ❖ The duration of exposure for toddlers and adults was assumed to be two hours per day (95th percentile duration for playing on grass, Exposure Factors Handbook).

(ii). Hand-to-Mouth

Incidental ingestion resulting from a child's hand in their mouth is estimated using the following equation and assumptions:

$$ADD = (DFR_t * SA * FQ * ET * CF1)/BW$$

where:

ADD	=	average daily dose (mg/kg/day)
DFR_t	=	dislodgeable foliar residue on day "t" (µg/cm^2 turf) -- see Dermal above
SA	=	surface area of the hands (cm^2/event)
FQ	=	frequency of hand-to-mouth activity (events/hr)
ET	=	exposure time (hr/day)
CF1	=	weight unit conversion factor to convert µg units in the DFR value to mg for the daily exposure (0.001 mg/µg)
BW	=	body weight (kg)

- ❖ The median surface area of both hands was assumed to be 350 cm^2 for a toddler (age 3 years).

- ❖ Replenishment of the hands with pesticide residues was assumed to be an implicit factor in this assessment.

- ❖ It was assumed that there is a one-to-one relationship between the dislodgeable residues on the turf and on the surface area of the skin after contact (i.e., if the dislodgeable residue on the turf is 1 mg/cm^2, then the residue on the human skin is also 1 mg/cm^2 after contacting the turf).

- ❖ The mean rate of hand-to-mouth activity is 0.026 events/minute (i.e.,1.56 events/hr) for toddlers (3 to 5 years old).

- ❖ The duration of exposure for toddlers was assumed to be two hours per day (95th percentile duration for playing on grass, Exposure Factors Handbook).

(iii). Object-to-Mouth

"Mouthing" of a toy or handful of grass by a toddler is estimated using the following equation and assumptions:

$$ADD = (GR_t * IgR * CF1)/BW$$

where:

ADD = average daily dose (mg/kg/day)
GR_t = object (e.g., toy or grass) residue on day "t" (µg/cm^2)
IgR = surface area of object (cm^2/day)
CF1 = weight unit conversion factor to convert the µg of residues on the object to mg to provide units of mg/day ($1x10^{-3}$ mg/µg)
BW = body weight (kg)

and,

$$GR_t = AR * F * (1-D)^t * CF2 * CF3$$

where:

AR = application rate (lb ai/acre) x percentage deposited (i.e., 30 percent for aerial and five percent for ground-based fogger)
F = fraction of ai available on the object (0.20, unitless)
D = fraction of residue that dissipates daily (unitless)
t = postapplication day on which exposure is being assessed
CF2 = weight unit conversion factor to convert the lbs ai in the application rate to µg for the object residue value ($4.54x10^8$ µg/lb)
CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the object residue value ($2.47x10^{-8}$ acre/cm^2 if the application rate is per acre)

❖ The assumed surface area of an object for mouthing for toddlers (age 3 years) is 25 cm^2/day (i.e., 2 x 2 inches or 4 in^2). This value was intended to represent the approximate area from which a child may grasp a handful of grass or mouth a toy.

(iv). Incidental Soil Ingestion

Ingestion of soil by a toddler is estimated using the following equation and assumptions:

$$ADD = (SR_t * IgR * CF1)/BW$$

where:

ADD = average daily dose (mg/kg/day)
SR_t = soil residue on day "t" (µg/g)
IgR = ingestion rate of soil (mg/day)
CF1 = weight unit conversion factor to convert the µg of residues on the soil to grams to provide units of mg/day ($1x10^{-6}$ g/µg)
BW = body weight (kg)

and

$$SR_t = AR * F * (1-D)^t * CF2 * CF3 * CF4$$

where:

AR = application rate (lb ai/acre) x percentage deposited (i.e., 30 percent for aerial and five percent for ground-based foggers)
F = fraction (100 percent) of ai available in uppermost cm of soil (fraction/cm)
D = fraction of residue that dissipates daily (unitless)
t = postapplication day on which exposure is being assessed
CF2 = weight unit conversion factor to convert the lbs ai in the application rate to µg for the soil residue value ($4.54x10^8$ µg/lb)
CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the SR value ($2.47x10^{-8}$ acre/cm^2 if the application rate is per acre)
CF4 = volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (U.S. EPA, 1992) (0.67 cm^3/g soil)

❖ On the day of application, it was assumed that 30 percent for aerial and five percent for ground-based foggers of the application rate are located within the soil's uppermost 1 cm.

❖ The assumed soil ingestion rate for children (ages 1-6 years) was assumed to be 100 mg/day.

2. Residential Risk Characterization

a. Risk Calculations

The exposure and risk calculations are presented in Table 10. The short- and intermediate-term MOEs were calculated as follows:

$$MOE = \frac{NOAEL}{DermalDose}$$

In summary, the short- and intermediate-term MOEs are greater than or equivalent to 100 for the following ULV aerial and ground-based fogger mosquito and blackfly applications.

- ❖ Dermal contact for adults and toddlers for mosquito aerial applications.
- ❖ Dermal contact for adults and toddlers for all ground-based foggers;
- ❖ Hand-to-mouth exposures for aerial and ground-based foggers for all application rates;
- ❖ Object-to-mouth for aerial and ground-based foggers for all application rates; and
- ❖ Incidental soil ingestion for aerial and ground-based foggers for all application rates;

The short- and intermediate-term MOEs are less than 100 for the following ULV aerial blackfly application:

- ❖ Dermal contact for adults and toddlers for blackfly aerial applications.

b. Discussion of Risk

The above risks are based on a screening-level assessment to ensure that the exposure/risk is not underestimated. Although this is regarded as a screening-level assessment, attempts were made to use a reasonable deposition rate determined from the literature and the Ag Drift model. The adult and toddler dermal exposure scenario for blackfly treatments, the only scenario with MOEs less than 100, is believed to be a conservative estimate and a more refined assessment could be completed with: (1) chemical-specific deposition data for the aerial applications; (2) application timing for blackfly treatments (e.g., if applications were made in the evening then residue dissipation could be accounted for in the exposure assessment); (3) HED is currently revising the Residential SOPs including the assumptions used in estimating dermal and hand-to-mouth exposures; and (4) a dermal absorption study and a new dermal toxicity study which would better characterize dermal absorption and toxicity.

Based on dermal absorption data on two very similar compounds, dichlorvos and trichlorfon, the existing dermal toxicity study likely overestimates dermal toxicity because of the 20 fold difference between the lowest adverse effect level (LOAEL) and the no adverse effect level (NOAEL).

Another 28-day dermal toxicity study in rats using doses intermediate between 1 mg/kg and 20 mg/kg would better define the NOAEL and the LOAEL.

As confirmatory data, a dermal absorption study in rats may be used in conjunction with existing oral studies to better characterize the actual dermal absorption of naled.

The dermal MOEs for bystanders would likely increase with a better characterization of dermal absorption and toxicity.

Table 10. Naled Residential Postapplication Estimated Risks Resulting from ULV Aerial and Ground-based Fogger Mosquito and Blackfly Applications

Scenario	Receptor	Application Rate Per Treatment (AR) (lbs ai/A)	DFR (ug/cm^2)[1]	GRt (ug/cm^2)[2]	SRt (ug/g)[3]	Transfer Coefficient (Tc) (cm^2/hr)	Exposure Time (ET) (hrs/day)	Surface Area (SA) (cm^2/event)	Freq. (FQ) (events/hr)	IgR (cm^2/day) or (mg/day)[4]	BW (kg)	Dermal Dose (mg/kg/day)[5]	MOE[6]
Dermal exposure	Adult	0.02 (Ground)	0.00062	-	-	43,000	2	-	-	-	70	0.00069	1,500
		0.05 (Aerial mosquito)	0.0084									0.010	97
		0.1 (Aerial blackfly)	0.017									0.021	48
Dermal exposure	Toddler	0.02 (Ground)	0.00062	-	-	8,700	2	-	-	-	15	0.00065	1,500
		0.05 (Aerial mosquito)	0.0084									0.0097	100
		0.1 (Aerial blackfly)	0.017									0.019	51
Hand-to-Mouth	Toddler	0.02 (Ground)	0.0022	-	-	-	2	350	1.56	-	15	0.00016	6,100
		0.05 (Aerial mosquito)	0.034									0.0024	410
		0.1 (Aerial blackfly)	0.067									0.0049	200
Object-to-mouth	Toddler	0.02 (Ground)	-	0.0022	-	-	-	-	-	25	15	$3.7x10^{-6}$	$2.7x10^{5}$
		0.05 (Aerial mosquito)		0.034								$5.6x10^{-5}$	18,000
		0.1 (Aerial blackfly)		0.067								0.00011	8,900
Incidental soil ingestion	Toddler	0.02 (Ground)	-	-	0.0075	-	-	-	-	100	15	$5x10^{-8}$	$2x10^{7}$
		0.05 (Aerial mosquito)			0.113							$7.5x10^{-7}$	$1.3x10^{6}$
		0.1 (Aerial blackfly)			0.225							1.5E-6	6.7E+5

Note: The ground-based fogger rate is 0.02 lb ai/acre for mosquitos, the aerial rate is 0.05 lb ai/acre for mosquitos in residential areas, and 0.1 lb ai/acre for blackflies in residential areas. Calculations were performed in spreadsheets, therefore, rounding errors may have occurred.

[1]Dislodgeable foliar residue (ug/cm^2) = [AR (lbs ai/A) * 30 percent aerial and 5 percent ground-based foggers * fraction ai available as dislodgeable (5 % dermal and 20% oral exposures) * $4.54x10^{8}$ ug/lb * $2.47x10^{-8}$ A/cm^2]

[2]"Object" residue (GRt) (ug/cm^2) = [AR (lbs ai/A) * 30 percent aerial and 5 percent ground-based foggers * fraction ai available on a toy or grass as dislodgeable (20%) * $4.54x10^{8}$ ug/lb * $2.47x10^{-8}$ A/cm^2]

[3]Soil residue (SRt) (ug/g) = [AR (lbs ai/A) * 30 percent aerial and 5 percent ground-based foggers * fraction ai retained on soil (100 %) * $4.54x10^{8}$ ug/lb * $2.47x10^{-8}$ A/cm^2 * 0.67 cm^3/g soil]

[4]Ingestion rate: cm^2/day for grass ingestion, and mg/day for incidental soil ingestion.

[5]Daily dermal dose (mg/kg/day)

Dermal exposure: = [DFR (ug/cm^2) * Tc (cm^2/hr) * mg/1,000 ug * ET (hrs/day) * absorption factor (1.0)] / [BW (kg)];

Hand-to-mouth: = [DFR (ug/cm^2) * SA (cm^2/event) * FQ (events/hr) * mg/1,000 ug * ET (2 hrs/day)] / [BW (kg)];

Turfgrass ingestion: = [GRt (ug/cm^2) * IgR (cm^2/day) * mg/1,000 ug] / [BW (kg)]; and

Incidental soil ingestion: = [SRt (ug/g) * IgR (mg/day) * g/1,000,000 ug] / [BW (kg)].

[6]MOE = 28-day oral rat study and 28-day dermal rat study NOAELs (both 1 mg/kg/day) / ADD. Uncertainty factors for oral and dermal routes are both 100.

c. Residential Exposure Estimates from Flea Pet Collar Application

Several flea pet collar products are marketed containing naled as the active ingredient. HED has no data addressing the exposures of individuals from the use of pet flea collar products. A number of these products are currently registered. In lieu of such data it is necessary to estimate exposures from this scenario using HED's SOPs for Residential Exposure Assessments. The SOP specifies that in the absence of actual field data "One percent (0.01) of the active ingredient applied to the pet to be available for dermal and inhalation exposure from handling flea collars. This assumption is based on the best professional judgement of the OPP/HED staff and assumed to be an upper-percentile value." Additionally "Adults are assumed to weigh 71.8 kg (use 60 kg for females when the endpoint is from a reproductive or developmental study). A body weight of 71.8 kg represents the mean body weight for all adults (i.e., male and female, ages 18 and older) and is the value recommended. A body weight of 60 kg represents the average body weight for females between ages 13 and 54 years. The average body weight for a 10 to 12 year old youth is 39.1 kg. This represents the mean of the median values for males and females at ages 10, 11, and 12 years." Body weights for age groups not included in the SOPs were obtained from the Agency's Exposure Factors Handbook. The values for children of ages 1-2 years, 3-5 years, and 6-8 years were 12.3 kg, 17 kg, and 25 kg, respectively. The estimated exposures for each of the pet collar products for each age class are presented in Table 11.

The maximum MOE based upon the exposure estimate for pet collar products was 222 for the lowest concentration of ai
(1 gram) in the collar for adult long-term exposure (see Table 11). The adult exposure MOE for the collar with 1.4 grams ai was 125. However, these collars exceed the Agency's level of concern for children (MOE below 100). For the products that contain more than 1.4 grams of naled, active ingredient, the risks are a concern for both adults and children.

Estimates of Exposure of Individuals From Naled in Pet Collar Products[1]

		EPA No. 2517-43	EPA No. 2517-44	EPA No. 2517-45	EPA No. 2517-46	EPA No. 2517-52
Grams Naled in Product		3.8	1.4	3.8	1	2.6
Total mg of exposure		38	14	38	10	26
Days of Use		150	120	150	150	150
Population Group	**BW (Kg)**	**Exposure (mg/kg/day) and MOE[2]**				
Adult		0.0035	0.0016	0.0035	0.0009	0.0024
	71.8	57	125	57	222	83
		0.0206	0.0095	0.0206	0.0054	0.0141
Child, 1-2 Yrs.	12.3	10	21	10	37	14
		0.0149	0.0069	0.0149	0.0039	0.0102
Child, 3-5 Yrs.	17	13	29	13	51	20
		0.0101	0.0047	0.0101	0.0027	0.0069
Child, 6-8 Yrs.	25	20	43	20	74	29
		0.0065	0.003	0.0065	0.0017	0.0044
Child, 10-12 Yrs.	39.1	31	67	31	118	45

[1]The Residential SOPs were used (i.e., assumed that 1 percent of the ai was available for dermal and respiratory exposure) to estimate total amount of naled available for exposure. Exposures were amortized over use time assuming linear dissipation.

[2]Exposure = Total mg exposure/days of use/BW. MOE = Exposure /NOAEL; where the NOAEL was 0.2 mg/kg/day from an oral long term carcinogenicity study in rats, and assuming 100 percent dermal absorption. The dermal MOEs for pet collar products are likely to increase with a better characterization of dermal absorption and toxicity.

V. Aggregate Risk Estimates and Risk Characterization

A. Acute Aggregate Risk Estimate (food and water)

The acute aggregate risk assessment considers acute (single day) food and water exposures. The acute dietary (food) risk estimates do not exceed HED's level of concern. Tier 1 groundwater and Tier 2 (PRZM-EXAMS) surface water EECs do not exceed HED acute DWLOCs. Therefore, aggregate acute risk estimates for naled do not exceed HED's levels of concern.

B. Short and Intermediate-Term Aggregate Risk Estimate (food, water, and non-occupational)

The short- and intermediate-term risk assessments consider residential exposures along with average food and water exposure. Some of the short- and intermediate-term risk estimates for naled exceed HED's level of concern. None of the estimated MOEs for children exceeded 100 using the screening-level assessment for the pet collar use (i.e., without further refinement, all pet collar exposure scenarios for children exceeded HED's level of concern). Short- and intermediate-term residential exposures exceed HED's level of concern for the ULV aerial blackfly applications. However, short- and intermediate-term residential exposures do not exceed HED's level of concern for the ULV mosquito applications, a public health use.

C. Chronic Aggregate Risk Estimates (food and water)

The chronic aggregate risk assessment considers average food and water exposures. The chronic dietary (food) risk estimates do not exceed HED's levels of concern. Tier 1 groundwater and Tier 2 (PRZM-EXAMS) surface water EECs do not exceed HED chronic DWLOCs. Therefore, aggregate chronic risk estimates for naled do not exceed HED's levels of concern.

D. Occupational Risk Estimates

The assessed MOEs are less than 100 for most exposure scenarios for naled except for the four following scenarios:

- Mixing/loading liquid formulations (closed systems) for groundboom applications on crop group (G);
- Mixing/loading liquid formulations (closed systems) for airblast applications on crop group (F);

- ❖ Applying liquid formulations (enclosed cab) by groundboom for crop groups (E) and (G);

- ❖ Flaggers (closed cab) for applications of liquid formulations.

Based on dermal absorption data on two very similar compounds, dichlorvos and trichlorfon, the existing dermal toxicity study likely overestimates dermal toxicity because of the 20 fold difference between the lowest adverse effect level (LOAEL) and the no adverse effect level (NOAEL).

Another 28-day dermal toxicity study in rats using doses intermediate between 1 mg/kg and 20 mg/kg would better define the NOAEL and the LOAEL.

As confirmatory data, a dermal absorption study in rats may be used in conjunction with existing oral studies to better characterize the actual dermal absorption of naled.

The dermal MOEs for workers would likely increase with a better characterization of dermal absorption and toxicity.

VI. Tolerance Reassessment

Tolerances are listed in 40 CFR §180.215 for the residues of naled and its conversion product dichlorvos (2,2-dichlorovinyl dimethyl phosphate), expressed as naled. A summary of naled tolerance reassessments is presented in the following table.

Sufficient data are available to ascertain the adequacy of the established tolerances listed in 40 CFR §180.215 for the following commodities: almonds, hulls; almonds, nutmeat; beans, dry; beans, succulent; broccoli; Brussels sprouts; celery; cottonseed; eggplant; grapefruit; grapes; grass forage; lemons; melons; oranges; peaches; peas, succulent; peppers; spinach (and chard); squash, summer; strawberries; sugar beet roots; sugar beet tops; tangerines; and walnuts. Sufficient data are also available to support the established tolerances for eggs, milk, and tissues of animals resulting from dietary sources or through exposure via animal premise treatment.

The available data indicate that the established tolerances for the following commodities are too high and that the tolerance levels may be reduced: beans, dry; beans, succulent; beets, sugar, roots; broccoli; Brussels sprouts; celery; cottonseed; grapes; and peas, succulent.

Additional field residue data are required for the following commodities before a complete tolerance reassessment can be made: cabbage; cauliflower; collards; hops; and squash, winter. The required data for collards will be translated to kale. The required data for winter squash will be translated to pumpkins.

The established tolerances on the following commodities: cucumbers, lettuce, mushrooms, rice, tomatoes, and turnip tops should be revoked since these uses are not registered. If the registrant, or any registrant intends to support the use of naled on these commodities, residue data reflecting the maximum intended use pattern is required.

The established 10-ppm crop group tolerance for "legumes, forage" is inappropriate since the registrant does not intend to support naled uses on soybeans, which is the third representative crop of the foliage of legume vegetables group. Therefore, this crop group tolerance should be revoked concomitant with the establishment of individual tolerances for beans, forage; beans, hay; peas, vines; and peas, hay.

The available data for grapefruit, lemons, and oranges suggest that a crop group tolerance of 3.0 ppm for the citrus fruits group is appropriate. The individual tolerances for grapefruit, lemons, oranges, and tangerines should be revoked concomitant with the establishment of a crop group tolerance for citrus fruits.

The Agency classifies the registered Section 24© use of naled on alfalfa grown for seed to be a non-food use as long as there is appropriate label language for disposal and record keeping of seed screenings, prohibitions for feeding any portion of the treated plant for food or feed purposes, and the tagging of conditioned seeds which forbids the use of the seeds for human consumption or animal feed. Additionally, the Agency must have evidence that the respective states to which the special local need (SLN) use is registered has adequate regulatory mechanisms in place to enforce these limitations. If there is no evidence of adequate enforcement mechanisms, the alfalfa use will be considered a food use requiring tolerances and supporting residue data.

The established 0.5-ppm tolerance from use of naled for area pest control is adequate. The current tolerance for area pest control should be revised to include residues of dichlorvos as follows:

" A tolerance of 0.5 part per million is established for the pesticide naled and its conversion product 2,2-dichlorovinyl dimethyl phosphate, expressed as naled equivalents, in or on all RACs, except those otherwise listed in this section, from use of the pesticide for area pest (mosquito and fly) control."

Tolerances of meat, milk, poultry, and eggs have been revoked. These uses fall under Category (3) of 40 CFR §180.6 (a)), no reasonable expectation of finite residues.

A. Tolerances That Need To Be Proposed Under 40 CFR §180.215

The livestock feeds table for Subdivision O (September, 1995) indicates that data on cotton gin byproducts (commonly called gin trash) are required. The registrant must propose a tolerance for this commodity.

The registrant must also propose a tolerance for grass hay supported by adequate data.

B. Tolerances for Processed Commodities

Adequate processing studies have been submitted for cottonseed, grapes, oranges, and soybeans. Processing studies involving rice, and tomatoes will not be required provided all registered uses of naled on these crops are canceled.

The combined residues of naled and dichlorvos are not expected to concentrate in the processed commodities of grapes, oranges, and soybeans, except for orange oil. However, the available orange processing study indicates that residues of dichlorvos concentrated in oil 13X during processing of oil treated with naled; residues of dichlorvos did not concentrate in the citrus processed commodities wet pulp, dried pulp, molasses, and juice. Residues of naled were non-detectable both before and after processing of orange commodities. The Agency previously concluded that for the purposes of establishing tolerances, if appropriate, the combined residues of naled and dichlorvos will be assumed to concentrate 13X during processing of citrus treated with naled. Since this 13X concentration is less than the expected dilution of orange oil, a tolerance should be established at 30 ppm.

Tolerance Reassessment Summary

Commodity	Current Tolerance (ppm)	Tolerance Reassessment (ppm)	[*Correct Commodity Definition*]/ Comment
Tolerances Listed Under 40 CFR §180.215			
Almonds (hulls)	0.5	0.5	[*Almonds, hulls*]
Almonds (nuts)	0.5	0.5	[*Almonds, nutmeats*]
Beans (dry)	0.5	0.05	[*Beans, dry]*
Beans (succulent)	0.5	0.05	[*Beans, succulent]*
Beets, sugar, roots	0.5	0.05	[*Sugar beets, roots*]
Beets, sugar, tops	0.5	0.5	[*Sugar beets, tops*]
Broccoli	1	TBD[1]	
Brussels sprouts	1	TBD[1]	
Cabbage	1	TBD[1]	
Cauliflower	1	TBD[1]	
Celery	3	2	
Collards	3	TBD[1]	
Cottonseed	0.5	0.05	[*Cotton, undelinted seed*]
Cucumbers	0.5	Revoke	The tolerance should be revoked unless registrants other than AMVAC intend to support the use of naled on cucumbers and submit additional data.

Tolerance Reassessment Summary

Commodity	Current Tolerance (ppm)	Tolerance Reassessment (ppm)	[*Correct Commodity Definition*]/ Comment
Eggplant	0.5	0.5	
Grapefruit	3	Revoke	The tolerance should be revoked concomitant with the establishment of a crop group tolerance for citrus fruits group.
Grapes	0.5	0.05	
Grasses, forage	10	10	[*Grass, forage*]
Hops	0.5	TBD[1]	[*Hops, dried*]
Kale	3	TBD[1]	
Legumes, forage	10	Revoke	
Lemons	3	Revoke	The tolerance should be revoked concomitant with the establishment of a crop group tolerance for citrus fruits group.
Lettuce	1	Revoke	The tolerance should be revoked unless AMVAC or registrants other than AMVAC intend to support the use of naled on lettuce and submit additional data.
Melons	0.5	0.5	
Mushrooms	0.5	Revoke	The tolerance should be revoked unless registrants other than AMVAC intend to support the use of naled on mushrooms and submit additional data.
Oranges	3	Revoke	The tolerance should be revoked concomitant with the establishment of a crop group tolerance for citrus fruits group.
Peaches	0.5	0.5	
Peas (succulent)	0.5	0.05	[*Peas, succulent*]
Peppers	0.5	0.5	
Pumpkins	0.5	TBD[1]	
Rice	0.5	Revoke	The tolerance should be revoked unless registrants other than AMVAC intend to support the use of naled on rice and submit additional data.
Safflower, seed	0.5	0.5	
Spinach	3	3	
Squash, summer	0.5	0.5	
Squash, winter	0.5	TBD[1]	

Tolerance Reassessment Summary

Commodity	Current Tolerance (ppm)	Tolerance Reassessment (ppm)	[*Correct Commodity Definition*]/ Comment
Strawberries	1	1	
Swiss chard	3	3	
Tangerines	3	3	
Tomatoes	0.5	Revoke	The tolerance should be revoked unless registrants other than AMVAC intend to support the use of naled on tomatoes and submit additional data.
Turnips, tops	3	Revoke	The tolerance should be revoked unless registrants other than AMVAC intend to support the use of naled on turnips and submit additional data.
Walnuts	0.5	0.5	
Tolerances That Need To Be Proposed Under 40 CFR §180.215			
Beans, forage	None	1	
Beans, hay	None	TBD[1]	
Citrus fruits group	None	3	
Cotton, gin byproducts	None	0.05	
Grass, hay	None	TBD[1]	
Peas, hay	None	1	
Peas, vines	None	TBD[1]	
Citrus, oil	None	30	

[1]TBD = To be determined. Reassessment of tolerance(s) cannot be made at this time because additional data are required. AMVAC plans to propose a crop group tolerance for brassica leafy vegetables.

C. CODEX Harmonization

There are no Codex MRLs established or proposed for residues of naled. Therefore, there are no questions with respect to compatibility of U.S. tolerances with Codex MRLs.

APPENDIX A

Short- And Intermediate-term Handler Exposure/Risk

Tables A-1 Through A-3

Appendix A

Table A-1. Summary Exposure Values for Agricultural Uses of Naled (Short-Term and Intermediate-term)

Exposure Scenario	Dermal Unit Exposure[1] (mg/lb ai)		Inhalation Unit Exposure[2] (µg/lb ai)		Maximum Application Rate[3] (lb ai/A)	Daily Max. Treated[4] (acres)	Dermal Exposure[6] (mg/day)		Inhalation Exposure[5] (mg/day)	
	PPE	Eng. Controls	PPE	Eng. Controls			PPE	Eng. Controls	PPE	Eng. Controls
Mixer/Loader Exposure										
Mixing All Liquids for Aerial	0.025	0.009 (gloves)	0.12	0.08	(B/C) 1.875	350	16.4	5.9	0.079	0.053
					(D) 1.406		12.3	4.4	0.059	0.039
					(E) 0.938		8.2	3.0	0.039	0.026
					(G) 0.703		6.2	2.2	0.030	0.020
Mixing All Liquids for Groundboom					(B) 1.875	80	3.8	1.4	0.018	0.012
					(D) 1.406		2.8	1.0	0.013	0.009
					(E) 0.938		1.9	0.7	0.009	0.006
					(G) 0.703		1.4	0.5	0.007	0.004
Mixing of Liquids for Airblast					(A) 2.813	40	2.8	1.0	0.014	0.009
					© 1.875		1.9	0.7	0.009	0.006
					(F) 0.938		0.9	0.3	0.005	0.003
Applicator Exposure										
Aerial equipment (liquids)	No open cockpit uses[7]	0.005	No open cockpit uses[7]	0.07	(B/C) 1.875	350	No open cockpit uses[7]	3.3	No open cockpit uses[7]	0.046
					(D) 1.406			2.5		0.034
					(E) 0.938			1.6		0.023
					(G) 0.703			1.2		0.017
Groundboom (liquids)	0.01	0.007	0.07	0.04	(B) 1.875	80	1.5	1.1	0.011	0.006

Appendix A

Exposure Scenario	Dermal Unit Exposure[1] (mg/lb ai)		Inhalation Unit Exposure[2] (µg/lb ai)		Maximum Application Rate[3] (lb ai/A)	Daily Max. Treated[4] (acres)	Dermal Exposure[6] (mg/day)		Inhalation Exposure[5] (mg/day)	
	PPE	Eng. Controls	PPE	Eng. Controls			PPE	Eng. Controls	PPE	Eng. Controls
					(D) 1.406		1.1	0.79	0.008	0.004
					(E) 0.938		0.75	0.53	0.005	0.003
					(G) 0.703		0.56	0.39	0.004	0.002
Airblast equipment	0.13	0.016[8] (gloves)	0.5	0.4[8]	(A) 2.813	40	14.6	1.8	0.056	0.045
					© 1.875		9.8	1.2	0.038	0.030
					(F) 0.938		4.9	0.6	0.019	0.015
Hot plate/pan (greenhouse)	No data see detailed discussion in text									
Flagger Exposure										
Liquids	0.004	0.0002	0.03	0.006	(B) 1.875	350	2.6	0.13	0.020	0.004
					(D) 1.406		2.0	0.10	0.015	0.003
					(E) 0.938		1.3	0.07	0.010	0.002
					(G) 0.703		1.0	0.05	0.007	0.001

[1]PPE is coveralls over long pants, long sleeve shirt and chemical resistant gloves with open systems and chemical resistant head gear for airblast. The engineering controls are long pants, long-sleeve shirt and no gloves (chemical resistant gloves for closed mixing and enclosed cab airblast -- no data available for no gloves scenarios), and closed systems (i.e., closed mixing/loading or enclosed cockpit/cabs).
[2]PPE Inhalation Exposure Values are for workers wearing a respirator with organic vapor removing cartridge (10 fold PF used). The engineering controls values are for workers wearing no respirators, but mixing/loading and applying the pesticide within enclosed systems (e.g., enclosed cab).
[3]Crop groupings are: (A) almond, peach; (B) broccoli, cabbage, cauliflower, brussels sprouts, kale, collards, eggplant, pepper, melon, squash, walnut (air only); © citrus; (D) beans, peas, celery, chard, spinach, seed alfalfa (ID, UT, WA); (E) cotton, strawberry, sugarbeet, hops, seed alfalfa (OR), rangeland; (F) grape, walnut; and (G) safflower.
[4]Values represent the maximum area or the maximum volume of spray solution which can be used in a single day to complete treatments for each exposure scenario of concern.
[5]Daily Inhalation Exposure (mg/day) = Unit Inhalation Exposure (mg/lb ai) * Max. Appl. Rate (lb ai/A) * Max. Treated Acres
[6]Daily Dermal Exposure (mg/day) = Unit Dermal Exposure (mg/lb ai) * Max. Appl. Rate (lb ai/A) * Max. Treated Acres x 10^{-3} mg/ug
[7]Registrant has agreed to limit aerial applications to enclosed cockpits.
[8]Although enclosed cabs for airblast equipment may not be practical because the tractor cab will not pass through some orchards without damaging trees; they are practical for citrus orchards and are commonly used.

Table A-2. Summary Dose/Risk Values for Agricultural Uses of Naled (Short-Term and Intermediate-Term)

Exposure Scenario	Crop Grouping[1]	Daily Dermal Dose[3,4] (mg/kg/day)		Daily Inhalation Dose[2] (mg/kg/day)		Dermal MOE[6]		Inhalation MOE[7]		Total MOE[8]	
		PPE	Controls	PPE	Controls	PPE	Controls	PPE	Controls	PPE	Controls
Mixer/Loader Exposure											
Mixing All Liquids for Aerial	(B)	0.234	0.084	0.001	0.0008	4.3	12	53	66	4	10
	(D)	0.176	0.063	0.0008	0.0006	5.7	16	66	88	5	14
	(E)	0.117	0.043	0.0006	0.0004	8.5	23	88	133	8	20
	(G)	0.089	0.031	0.0004	0.0003	11	32	133	177	10	27
Mixing All Liquids for Groundboom	(B)	0.054	0.020	0.0003	0.0002	19	50	177	265	17	42
	(D)	0.040	0.014	0.0002	0.0001	25	71	265	530	23	63
	(E)	0.027	0.010	0.0001	0.00009	37	100	530	589	35	85
	(G)	0.020	0.007	0.0001	0.00006	50	143	530	883	46	120
Mixing of Liquids for Airblast	(A)	0.040	0.014	0.0002	0.0001	25	71	265	530	23	63
	©	0.027	0.010	0.0001	0.00009	37	100	530	589	35	85
	(F)	0.013	0.004	0.00007	0.00004	77	250	757	1,325	70	210
Applicator Exposure											
Aerial equipment (liquids)	(B)	No open cockpit uses[9]	0.047	No open cockpit uses[9]	0.0007	No open cockpit uses[9]	21	No open cockpit uses[9]	76	No open cockpit uses[9]	16
	(D)		0.036		0.0005		28		106		22
	(E)		0.023		0.0003		43		177		35
	(G)		0.017		0.0002		59		265		48
Groundboom (liquids)	(B)	0.021	0.016	0.0002	0.00009	48	63	265	589	41	57
	(D)	0.016	0.011	0.0001	0.00006	63	91	530	883	56	82
	(E)	0.011	0.008	0.00007	0.00004	91	125	757	1,325	81	110
	(G)	0.008	0.006	0.00006	0.00003	125	167	883	1,767	110	150

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Exposure Scenario	Crop Grouping[1]	Daily Dermal Dose[3,4] (mg/kg/day)		Daily Inhalation Dose[2] (mg/kg/day)		Dermal MOE[6]		Inhalation MOE[7]		Total MOE[8]	
		PPE	Controls	PPE	Controls	PPE	Controls	PPE	Controls	PPE	Controls
Airblast equipment[9]	(A)	0.209	0.026	0.0008	0.0006	5	38	66	88	4	27
	©	0.140	0.017	0.0005	0.0004	7	59	106	133	7	41
	(F)	0.070	0.009	0.0003	0.0002	14	111	177	265	13	78
Flagger Exposure											
Liquids	(B)	0.037	0.0019	0.0003	0.00006	27	530	177	883	23	330
	(D)	0.029	0.0014	0.0002	0.00004	34	710	265	1,325	30	460
	(E)	0.019	0.0010	0.0001	0.00003	53	1,000	530	1,767	48	640
	(G)	0.014	0.00071	0.0001	0.00001	71	1,400	530	5,300	63	1100

[1]Crop groupings are: (A) almond, peach; (B) broccoli, cabbage, cauliflower, brussels sprouts, kale, collards, eggplant, pepper, melon, squash, walnut (air only); © citrus; (D) beans, peas, celery, chard, spinach, seed alfalfa (ID, UT, WA); (E) cotton, strawberry, sugarbeet, hops, seed alfalfa (OR), rangeland; (F) grape, walnut; and (G) safflower.
[2]PPE inhalation exposure values based on an O/V respirator (10 fold PF). Control values are based on no respirators and using closed systems (e.g. enclosed cab).
[3]The PPE represents coveralls over long pants, long sleeve shirt, and chemical resistant gloves using open systems and chemical resistant head gear for airblast applicators. The engineering controls represents long pants, long-sleeve shirt, and no gloves (chemical resistant gloves used for closed mixing and enclosed cab airblast--no data are available for no glove scenarios), and closed systems (i.e., closed mixing/loading or enclosed cockpit/cabs).
[4]Daily Dermal Dose (mg/kg/day) = Dermal Exposure (mg/day)/70 kg
[5]Total Dose (mg/kg/day) = Daily Inhalation Dose (mg/kg/day) + Daily Dermal Dose (mg/kg/day)
[7] Inhalation MOE = NOAEL / Total Dose (mg/kg/day). Where: NOAEL = 0.053 mg/kg/day.
[8]Total MOE = 1/((1/dermal MOE) + (1/inhalation MOE)).
[9]Although the registrant contends that enclosed cabs for airblast applications are impractical (tractor cab will not pass through some orchards without damaging trees), the exposure/risk values for enclosed cab tractors are included.
Note: Registrant has agreed to limit aerial applications to enclosed cockpits.

Table A-3. Exposure Scenario Descriptions for Agricultural Uses of Naled

Exposure Scenario	Data Source	Standard Assumptions[1] (8-hr day)	Comments[2]
Mixer/Loader Exposure			
Mixing Liquids for Aerial, Groundboom, and Airblast Applications	PHED V1.1	350 acres aerial, 80 acres groundboom, and 40 acres airblast	PPE: "Best Available" grades: Hands, dermal, and inhalation acceptable grades. Hands = 59 replicates; Dermal = 25 to 122 replicates; Inhalation = 85 replicates. High confidence in dermal data and inhalation data. Engineering Controls: "Best Available" grades: Hands, dermal, and inhalation acceptable grades. Hands = 31 replicates; Dermal = 16 to 22 replicates; Inhalation = 27 replicates. High confidence in dermal and inhalation data. PHED data used for PPE and Engineering Controls. The following protection factors (PFs) were used for the PPE scenario: 50% to estimate the use of coveralls and a 10 fold PF for the addition of an organic vapor removing cartridge. No PFs were necessary for the Engineering Controls scenario.
Applicator Exposure			
Aerial equipment (liquids)	PHED V1.1	350 acres	Engineering Controls: "Best Available" grades: Hand grades acceptable. Dermal and inhalation grades A,B,C. Hands = 34 replicates; Dermal = 24 to 48 replicates; Inhalation = 23 replicates. Medium confidence in dermal and inhalation data. PHED data used for Engineering Controls, no PFs were necessary.
Groundboom (liquids)	PHED V1.1	80 acres	PPE: "Best Available" grades: Hand grades A,B,C, dermal and inhalation acceptable grades. Hands = 21 replicates; Dermal = 32 to 42 replicates; Inhalation = 22 replicates. Medium confidence in dermal data and high confidence in inhalation data. Engineering Controls: "Best Available" grades: Hands and dermal grades A,B,C; inhalation acceptable grades. Hands = 16 replicates; Dermal = 20 to 31 replicates; Inhalation = 16 replicates. Medium confidence in dermal data and high confidence in inhalation data. PHED data used for PPE and Engineering Controls. The following protection factors (PFs) were used for the PPE scenario: 50% to estimate the use of coveralls and 10 fold PF for the addition of an organic vapor removing cartridge. No PFs were necessary for the Engineering Controls scenario.

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Exposure Scenario	Data Source	Standard Assumptions[1] (8-hr day)	Comments[2]
Mixer/Loader Exposure			
Airblast equipment	PHED V1.1	40 acres	PPE: "Best Available" grades: Hand, dermal, and inhalation acceptable grades. Hands = 18 replicates; Dermal = 32 to 49 replicates; Inhalation = 47 replicates. High confidence in dermal and inhalation data. Engineering Controls: "Best Available" grades: Hand and dermal acceptable grades; inhalation grades A,B,C. Hands = 20 replicates; Dermal = 20 to 30 replicates; Inhalation = 9 replicates. High confidence in dermal data, low confidence in inhalation data. PHED data used for PPE scenario. The following protection factors (PFs) were used for the PPE scenario: 50% for coveralls, 90% for chemical resistant headgear, and a 10 fold PF for the addition of an organic vapor removing cartridge. No PFs were used for the engineering controls.
Hot plate/pan	No data	3.5 lb naled/day	PPE: No data Engineering Controls: No data
Flagger			
Liquids	PHED V1.1	350 acres	PPE: "Best Available" grades: Hand, dermal, and inhalation acceptable grades. Hands = 16 replicates; Dermal = 16 to 18 replicates; Inhalation = 18 replicates. High confidence in dermal and inhalation data. PHED data used for PPE scenario. The following protection factors (PFs) were used for the PPE scenario: 50% to estimate the use of coveralls, 90% to estimate the use of chemical resistant gloves, and a 10 fold PF for the addition of an organic vapor removing cartridge. A 98% PF was necessary for the Engineering Controls scenario to estimate an enclosed truck.

[1]Standard Assumptions based on an 8-hour work day as estimated by HED. Data from the Biological and Economics Analysis Division were not available.
[2]"Best Available" grades are defined for meeting Subdivision U Guidelines. Best available grades are assigned as follows: matrices with grades A and B data and a minimum of 15 replicates; if not available, then grades A, B, and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality and number of replicates. Data confidence are assigned as follows:
High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = grades A, B, C, D, and E or any combination of grades with less than 15 replicates

Appendix A

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DP Barcode: D260129
HED DOC Number: 013791
Toxicology Branch: RRB4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

March 26, 2002

MEMORANDUM

SUBJECT: Revised Human Health Risk Assessment for Dichlorvos
PC Code 084001, Reregistration Case No. 0310
DP Barcode D281889, SBarcode S612765

FROM: Susan V. Hummel, Branch Senior Scientist
Reregistration Branch 4
Health Effects Division (7509C)

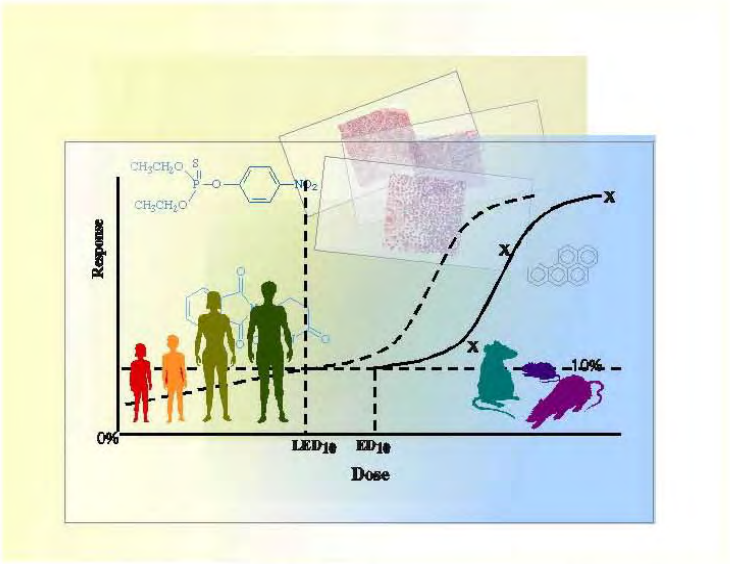
TO: Eric Olson, Chemical Review Manager
Special Review Branch
Special Review and Reregistration Division (7508W)

Attached please find the Revised Risk Assessment for Dichlorvos, also known as DDVP (PC Code 084001), revised per Public Comments submitted under Phase 3 of the OP Pilot Process, in response to the August 9, 2000 Preliminary Human Health Risk Assessment. Revisions also have been made to use the NAFTA breathing rate of 1.0 m^3/hr instead of the default PHED breathing rate of 1.5 m^3/hr, and Residential SOP recommended breathing rate of 1.7 m^3/hr. This change increases the inhalation MOEs, and therefore decreases the estimated risk to occupational and residential handlers. The risk assessment has been changed to use the recommended body weight of 60 kg instead of 70 kg for the short term risk assessments, because the endpoint used is from a developmental study. This slightly increases the estimated exposure and decreases the MOEs. Additional risk assessments for alternative uses, along with additional explanatory text has been added to the Occupational and Residential Exposure Sections. This chapter incorporates information from the toxicology assessment from Sanjivani Diwan, Ghazi Dannan and Joycelyn Stewart, the assessments of human incidence data from Jerry Blondell and Monica Spann, the residue chemistry assessment from Susan Hummel, the occupational and residential exposure assessments from Dave Jaquith, and the dietary risk analyses from David Hrdy, Mohsen Sahafayen, and Susan Hummel. Bill Sette, Jess Rowland, Ray Kent, and Steve Knizner also contributed to this risk assessment.

cc: Jack Housenger, Ray Kent, Dave Jaquith, Sue Hummel, Sanju Diwan

HUMAN HEALTH RISK ASSESSMENT

Dichlorvos (DDVP)



U.S. Environmental Protection Agency
Office of Pesticide Programs
Health Effects Division (7509C)

Susan V. Hummel, Risk Assessor
Date: June 25, 2001

HUMAN HEALTH RISK ASSESSMENT

Dichlorvos (DDVP)

Phase 4

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I. EXECUTIVE SUMMARY

The Health Effects Division (HED) has conducted a human health risk assessment for the active ingredient Dichlorvos (2,2-dichlorovinyl dimethyl phosphate), also known as DDVP, for the purposes of making a reregistration eligibility decision. Cumulative risk assessment considering risks from other pesticides or chemical compounds having a common mechanism of toxicity is not addressed in this document. This risk assessment updates the August 9, 2000 Preliminary Human Health Risk Assessment and addresses the Public Comments submitted in accordance with Phase 3 of the Tolerance Reassessment Advisory Committee (TRAC) Organophosphate (OP) Pilot Process.

A. Use and Major Formulations

Dichlorvos is an organophosphate insecticide and fumigant registered for use in controlling flies, mosquitos, gnats, cockroaches, fleas, and other insect pests. Formulations of Dichlorvos include pressurized liquids, granulars, emulsifiable concentrates, total release aerosols, and impregnated materials. Dichlorvos is applied with aerosols and fogging equipment, with ground spray equipment, and through slow release from impregnated materials, such as resin strips and pet collars.

Dichlorvos is registered to control insect pests on agricultural sites; commercial, institutional and industrial sites; and for domestic use in and around homes (i.e., resin strips, crack & crevice treatment, home lawns) and on pets. Dichlorvos is used in mushroom houses, storage areas for bulk, packaged and bagged raw and processed agricultural commodities, food manufacturing/processing plants, animal premises, and non-food areas of food-handling establishments. It is also registered for direct dermal pour-on treatment of cattle and poultry.

The mechanism of pesticidal action of Dichlorvos is inhibition of cholinesterase. The Agency has determined that the adverse effects caused by Dichlorvos that are of primary concern to human health are neurological effects related to inhibition of cholinesterase activity.

B. Regulatory History

The Agency initiated a Special Review (PD 1) for pesticide products containing Dichlorvos on February 24, 1988. At that time, the Agency was concerned that exposure to Dichlorvos from registered uses posed an unreasonable carcinogenic risk and that there were inadequate margins of exposure for cholinesterase inhibition and liver effects to exposed individuals. After evaluation of information submitted through the Special Review Process, the Agency conducted another risk assessment for Dichlorvos. In 1995, the Agency concluded that Dichlorvos posed carcinogenic risks of concern to the general population from dietary exposure. The Agency also concluded in 1995 that Dichlorvos posed risks of concern for cholinesterase inhibition to residents and to individuals mixing, loading, and applying this pesticide, as well as to those reentering treated areas. Subsequently, the Agency issued a Preliminary Determination to Cancel Certain Registrations and Draft Notice of Intent to Cancel the Dichlorvos uses which

posed the greatest risks, also called Position Document 2/3 or PD 2/3 (60 FR 50338, September 28, 1995). In its 1995 Preliminary Determination (PD 2/3), the Agency concluded that the risks outweighed the benefits for most uses of Dichlorvos and, therefore, recommended a variety of measures to reduce those risks. The Agency proposed cancellation of certain uses of Dichlorvos and cancellation of other uses unless certain labeling modifications were made to reduce risk.

The PD 2/3 Federal Register Notice provided for a formal comment period, which closed on December 28, 1995. Comments were received, and are contained in a public docket identified as "OPP-30000/56." Major comments to the PD 2/3 were submitted to the Agency by Amvac Chemical Corporation, the Japanese Resin Strip Manufacturer's Association, grower groups, and the general public. Some of the comments contained additional data pertaining to the risks posed by Dichlorvos.

The Agency has also identified newer exposure and toxicity data pertaining to Dichlorvos that have become available since publication of the Notice of Preliminary Determination to Cancel certain Registrations and Draft Notice of Intent to Cancel (PD 2/3). In addition to the newer data and information described above, the Food Quality Protection Act of 1996 has effectively modified the considerations the Agency uses to assess the risks of pesticides. Therefore, the Agency has recently re-evaluated the toxicology and exposure databases for Dichlorvos to make a determination of potential special susceptibility of infants and children, as mandated by FQPA. In addition, the Agency has reviewed new information pertaining to dietary exposure and performed a refined dietary exposure assessment. The Agency has also refined the occupational and residential exposure assessment for Dichlorvos with new information and new methodologies that were previously unavailable.

The following issues pertaining to the ongoing Dichlorvos risk assessment were presented to the FIFRA Science Advisory Panel (SAP) on July 28, 1998: (1) the selection of a 3X FQPA safety factor for Dichlorvos and (2) the resin strip exposure assessment.

The Agency has revised the Dichlorvos risk assessment to incorporate new information received to date, to the extent appropriate. This preliminary risk assessment has been conducted for Dichlorvos in conjunction with the public review and comment process for all of the organophosphate pesticides. In Phase 2 of the OP pilot process, error correction comments from the registrant were incorporated. This revision incorporates the public comments submitted in Phase 3 of the OP pilot process. Comments on the Dichlorvos Preliminary Risk Assessment were received from Amvac, NRDC, and Dichlorvos users. Additional exposure analyses were conducted for different sizes of resin strips and for pet collars.

C. Hazard Identification and Dose-Response Assessment

The toxicology database for Dichlorvos is complete with respect to the OPPTS Guideline requirements. There is a new data requirement for a developmental neurotoxicity (DNT) study in rats. For acute toxicity, technical Dichlorvos was placed in Toxicity Categories II, I and II, respectively for the oral, dermal and inhalation routes and in Toxicity Category III and IV for

eye and dermal irritation, respectively. Dichlorvos did not cause organophosphate induced delayed neurotoxicity (OPIDN) in the hen following single or multiple (28 days) exposures. Following a single oral dose to rats, Dichlorvos was associated with a variety of neurological and physiological changes. Subchronic and chronic oral exposures in rats and dogs as well as chronic inhalation exposure in rats resulted in significant decreases in plasma, red blood cell and/or brain cholinesterase activity. The Carcinogenic potential of Dichlorvos has been classified as "suggestive" under the 1999 Draft Agency Cancer Guidelines and no quantitative assessment of cancer risk is required. Dichlorvos has been shown to be a direct acting mutagen by common *in vitro* bacterial genetic toxicity assays. In addition, Dichlorvos is a direct acting mutagen in *in vitro* mammalian test systems. Dichlorvos seems to also have clastogenic activity in Chinese Hamster Ovary (CHO) cells *in vitro* with or without metabolic activation. On the other hand, studies showed that Dichlorvos was not clastogenic in *in vivo* micronucleus tests. There was no evidence of increased susceptibility following *in utero* exposures to rats and rabbits as well as pre/post natal exposure to rats. Also, there was no evidence of abnormalities in the development of the fetal nervous system in the studies submitted to the Agency. However, a study in the open literature (Mehl et al. 1994), which reported decreased total brain weight in two litters of guinea pig pups produced by dams which had been exposed to Dichlorvos twice daily, raised the concern for potential increased susceptibility of infants and children. The Mehl, et. al., study has many limitations, but the concern raised by the study is supported by other literature studies reporting that the pesticide Trichlorfon affects brain development in pigs. Since Trichlorfon metabolizes to Dichlorvos, there is a concern that Dichlorvos may affect brain development , and that it may do so in ways not measured in standard developmental toxicity tests. Therefore, a rat developmental neurotoxicity (DNT) study for Dichlorvos has been required to determine Dichlorvos's effects on brain development.

The toxicity endpoints used in this document to assess hazards include acute dietary and chronic dietary reference doses (RfDs), and short-, intermediate- and long-term dermal and inhalation no observed adverse affect levels (NOAELs). In light of the developing Agency policy on use of toxicology studies employing human subjects, HED selected doses and endpoints for risk assessment based solely on animal studies.

Inhibition of cholinesterase activity was the toxicity endpoint selected for acute and chronic dietary, as well as intermediate term and long term (chronic) occupational and residential risk assessments. Decrease in body weight gain and mortality was the basis for the endpoint selected for short term occupational and residential risk assessment, although cholinergic signs were seen at higher doses. The Uncertainty Factor(s) ranged from 100 to 300 depending on the type of exposure scenario (acute, short term, intermediate term or long term; oral, dermal, or inhalation) and the type of exposure assessment (occupational vs. residential).

The Food Quality Protection Act (FQPA) Safety Factor Committee evaluated the hazard and exposure data to determine if the 10x safety factor should be retained. The committee determined that the FQPA safety factor could be reduced to 3x. The FQPA safety factor is applicable to acute and chronic dietary risk assessments and residential and other non-occupational risk assessments of all durations. The FQPA safety factor was retained based on the

data gap for the developmental neurotoxicity study in rats, but reduced to 3x because: 1) the standard developmental and reproductive toxicity studies submitted to the Agency showed no indication of increased susceptibility of rats, or rabbits to *in utero* and/or postnatal exposure to Dichlorvos; and 2) the dietary (food and drinking water) and non-dietary (residential) risk assessments do not underestimate the potential exposures for infants and children from the use of Dichlorvos.

D. Exposure Assessment

Dietary exposure to Dichlorvos residues may occur as a result of use of Dichlorvos on or at a variety of sites, including mushroom houses, bulk-stored and packaged or bagged nonperishable processed and raw food, commercial food processing plants, direct dermal pour-on treatment to livestock, and livestock premises treatment. Two other pesticides, Naled and Trichlorfon, degrade to Dichlorvos through plant and animal metabolism and other processes. Residues of Dichlorvos from the use of Naled are included in the Dietary Exposure Assessment. All Trichlorfon field crop food uses have been canceled and associated tolerances revoked, therefore, the Agency does not expect measurable Dichlorvos residues from use of Trichlorfon on field crops. The Trichlorfon tolerances on livestock commodities remain; dermal use on beef cattle is supported as an import use. Non-detectable Dichlorvos residues in livestock commodities are expected as a result of Trichlorfon use, and Dichlorvos was not a significant metabolite in the Trichlorfon dermal metabolism study.. Therefore, dietary exposure to Dichlorvos residues resulting from use of Trichlorfon are considered negligible for the purposes of this Risk Assessment.

Most product and residue chemistry data requirements for Dichlorvos have been fulfilled. However, the Reregistration data requirements for storage stability (Guideline 860.1380), for meat, milk, poultry, and egg studies (Guideline 860.1480), crop field trials (Guideline 860.1500) on tomatoes, processing studies (Guideline 860.1520) on tomatoes, and directions for use (Guideline 860.1200) have not been fulfilled. The tomato use was not being supported for reregistration, but one registrant has indicated willingness to support this use.

Dietary exposure estimates for Dichlorvos have been refined with residue data from USDA's Pesticide Data Program (PDP), FDA surveillance monitoring data and FDA Total Diet Study (TDS) data. Anticipated residues for Dichlorvos have been revised to incorporate these residue data.

The Environmental Fate and Effects Division (EFED) evaluated the potential for Dichlorvos to contaminate water from the use of Dichlorvos, Naled and Trichlorfon. EFED has limited ground water monitoring data for Dichlorvos, Naled, and Trichlorfon from the states of California and Hawaii in the "Pesticides in Groundwater" database. These data indicate that Naled, Dichlorvos, or Trichlorfon have not been detected in groundwater; however, these data were not targeted to the pesticide use area. The SCIGROW model was used to estimate concentrations of Dichlorvos, Naled, and Trichlorfon in groundwater. OPP does not have any surface monitoring data on the concentrations of Dichlorvos, Naled, or Trichlorfon at the present

time. Therefore, the Tier I screening model GENEEC was used to estimate surface water concentrations for Dichlorvos resulting from the use of Naled, Trichlorfon and Dichlorvos. Use of the Tier II model (PRZM) was not possible because the use scenario with the highest application rate was Trichlorfon application to turf, and PRZM can only be used for agricultural sites.

Occupational and residential exposure scenarios can be described as short term (1-7 days), intermediate term (7 days to several months), and long term or chronic (several months to a lifetime). Most of the Dichlorvos residential exposure scenarios are appropriately described as short term, exceptions are resin pest strips and pet flea collars which are long term exposure scenarios.

Exposure assessments for a number of occupational and residential scenarios were derived from limited data from the scientific literature, textbooks, knowledge of cultural practices, and the Residential SOPs. Other estimates, particularly in the residential environment, were derived from chemical specific monitoring data, including biomonitoring of a urinary metabolite, in combination with models and literature studies. The Agency considers the Dichlorvos occupational and residential exposure estimates to be the best available with current methodologies.

Residential and occupational exposures to Dichlorvos may also result from uses of Naled and Trichlorfon, but are expected to be negligible with the exception of the use of Trichlorfon on turf. An exposure model used in the Trichlorfon RED suggests that Dichlorvos exposures from turf use of Trichlorfon may be of concern; however, predicted exposures to Dichlorvos do not exceed our exposure estimates for the direct use of Dichlorvos on turf. The only Naled residential use is a mosquitocide public health use. For this use the application rate of Naled is very low, and any Dichlorvos formed dissipates rapidly. Further discussion is found in the exposure assessment section of this document.

E. Risk Assessment/Characterization

Dietary (food source). The Agency has refined the dietary risk estimates using new anticipated residues and a revised acute dietary endpoint. Residues of Dichlorvos in food from the use of Dichlorvos, Naled, and Trichlorfon were considered in this risk assessment.

In both acute and chronic risk assessments, exposure was compared to a population adjusted dose, (PAD), which is the reference dose (RfD) reduced by the FQPA 3x safety factor. HED considers dietary residue contributions greater than 100% of the PAD to be of concern. The acute and chronic PADs are 0.0005 mg/kg/day and 0.00017 mg/kg/day, respectively.

Acute Dietary (Food). The acute dietary analysis for Dichlorvos (including contribution from Naled and negligible contribution from Trichlorfon) was conducted using the Dietary Exposure Evaluation Model (DEEM™) software. Results are reported as a percentage of the acute Population Adjusted Dose (aPAD) for the 99.9th percentile of the population. The most

highly exposed subpopulation was children (1-6) with estimated exposure of 67% of the aPAD, followed by infants (<1) at 62% of the aPAD. Acute dietary exposure to Dichlorvos from all potential sources did not exceed 100% of the aPAD for any subpopulation. and therefore is not of acute dietary exposure concern.

Chronic Dietary (Food). The chronic dietary analysis for Dichlorvos (including contribution from Naled and Trichlorfon) was conducted using the DEEM™ software. Chronic dietary exposure to Dichlorvos , which was calculated using mean residues and mean consumption, was compared to the cPAD. Chronic dietary exposure did not exceed 2% of the cPAD for all subpopulations, which is below the Agency's level of concern of 100%.

Dietary (Water). Monitoring data were not available for the drinking water risk assessment. Therefore, estimated environmental concentrations (EECs) of Dichlorvos from the use of Dichlorvos, Naled, and Trichlorfon in water were compared with Drinking Water Levels of Comparison (DWLOCs) for acute or chronic systemic toxicity. EECs of Dichlorvos in ground and surface water were derived from conservative screening level models. A DWLOC is a theoretical upper limit on a pesticide's concentration in drinking water in light of total aggregate exposure to a pesticide in food, drinking water, and through residential uses.

Acute Drinking Water. The estimated surface water concentration of 194 µg/L Dichlorvos from the use of Trichlorfon on turf, exceeded the $DWLOC_{acute}$ of 12 µg/L for the US population and the $DWLOC_{acute}$ of 2 µg/L for infants and children. This indicates a potential concern and a need to refine the surface water exposure estimates. However, no scenario is available for the Tier 2 model for turf use. The modeled groundwater concentrations of 0.0002 to 0.015 µg/L did not exceed the $DWLOC_{acute}$ for any subpopulation.

Chronic Drinking Water. For chronic drinking water exposure, no $DWLOC_{chronic}$ was calculated because the Margins of Exposure (MOE s) for chronic residential inhalation exposure to Dichlorvos from resin strips were less than the target MOE, and therefore exceed the Agency's level of concern, resulting in a DWLOC of zero. The modeled groundwater concentrations were 0.0002 to 0.015 µg/L. The modeled surface water concentrations of Dichlorvos and of Naled and Trichlorfon-derived Dichlorvos were 0.06, 2.2 and 26 µg/L, respectively. Food and water exposure to Dichlorvos from the use of Dichlorvos, Naled, and Trichlorfon, is minimal compared with residential exposure. Therefore, any drinking water exposure will add minimally to exposures and risks of concern.

Residential Risk Estimates. Residential risks are estimated for the uses of Dichlorvos only. The residential exposure to Dichlorvos from the uses of Naled and Trichlorfon are considered negligible, except from the use of Trichlorfon on turf, which is discussed in the Trichlorfon RED. The Agency has refined residential risk estimates using new information, including the Pesticide Handlers Exposure Database (PHED, version 1.1), chemical specific data included in the ORETF database, the Residential SOPs, and the toxicological endpoints chosen by OPP's Hazard Identification Assessment Review Committee. The FQPA 3x safety factor was applied to the residential risk assessments. Resulting risk estimates are reported as Margins of

Exposure (MOEs). The MOEs are compared to the target MOE, which is 300 for all residential exposure scenarios. The exposure and resulting risk is of concern when the MOE is less than the target MOE.

Application with Pressurized Aerosol Spray Can. The Agency estimated the short term risk to residents applying the insecticide as an aerosol spray. Pressurized aerosol products containing Dichlorvos do not list any clothing requirements, therefore the Agency is assuming that Dichlorvos is applied during hot weather when an individual will be wearing the least amount of clothing (i.e., shorts and shoes). The MOE of 59 indicates a risk concern; the MOE is less than the target MOE is 300.

Indoor Residential Post-application: All Products, Short Term Exposure. Indoor post application exposures for short term exposure scenarios were derived from a single study measuring the exposures of individuals performing defined activity patterns following the activation of a total release fogger. This study provides a conservative estimate for short term exposure scenarios from indoor applications of Dichlorvos. The total exposure from the biomonitoring phase, plus amount of Dichlorvos measured on the hands in the passive dosimetry phase, was compared to the short term dermal endpoint. The passive dosimetry dose on the hands had to be added because the Jazzercise® routine does not include hand-to-mouth activity. The resulting MOE for this short term exposure was 6.7, indicating a risk concern; the target MOE is 300. The Agency considers this to be a conservative estimate for other Dichlorvos short term exposure scenarios such as directed applications (crack and crevice treatments).

Resin Strips. Respiratory exposures resulting from the use of resin pest strips were estimated using a scientific literature study (Collins and DeVries, 1973). This is a chronic exposure scenario because the resin pest strips are efficacious for 3 - 4 months, and are expected to be replaced as needed. Exposure estimates have been revised to incorporate the recommendations of the July 30, 1998 FIFRA Science Advisory Panel. Exposure estimates and MOEs were calculated for 4 population groups; adult males, adult females, children (age 1-4) years; and children (age 5-11 years). The MOEs for a 16 hour per day exposure time ranged from 9 to 27, all well below the target MOE of 300. Therefore, these MOEs are all of concern. The MOEs for a 2 hour per day exposure time ranged from 70 to 210, also below the target MOE of 300. Therefore, these MOEs are all of concern. Additional assessments were conducted for smaller size resin strips. MOEs for the cupboard size resin strip (5.25 g) were 130 for toddlers, 260 for children 5-11, 310 for adult females, and 360 for adult males. The MOEs for toddlers and children 5-11 are less than our target MOE of 300, and still of concern.

Pet Flea Collars. The assessment for flea collar exposure was derived from a registrant submitted study. Respiratory exposures but not dermal exposures were measured in the study. Respiratory exposures were estimated for 7 population groups; adult males; adult females; and children in various age ranges. The MOEs ranged from 14 to 38 and were all less than the target MOE of 300. Therefore, the MOEs are all of concern. There are no data with which to estimate dermal exposure from contact with pets, and dermal exposure was not included in the initial exposure assessment. An alternative assessment was done for the flea collars, treating the

flea collars as a "mobile resin strip." In this assessment, dermal exposure was included as per draft ExpoSAC policy, and hand-to-mouth exposure was included. The MOEs ranged from 26 to 130, which are all of concern, compared to the target MOE of 300.

Lawns, Turf and Ornamental Plants - Post-Application Exposure. Dichlorvos can be used on home lawns and ornamental plants; however, the product can only be applied by a commercial applicator, not the homeowner, so no resident applicator assessment is needed. The post-application assessment was obtained by using dislodgeable foliar residue information from three foliar residue studies submitted by the registrant, the above mentioned carpet study, and the residential Standard Operating Procedures (SOPs). The MOEs, which include both dermal and hand-to-mouth exposures, range from 83 to 2800, with an average of 210. One of these MOEs and the average MOE exceed the Agency's level of concern, although the estimates are conservative because they are based on the initial transferable residue at the reentry time, and the rapid dissipation of Dichlorvos from turf.

Lawns, Turf and Ornamental Plants - Post-Application Exposure from use of Trichlorfon. Exposure to Dichlorvos from the use of Trichlorfon on lawns was assessed. Dichlorvos residues were modeled using the half-lives from the Dichlorvos turf study. MOEs for adults ranged from 230 to 770. Toddler exposures ranged from 100 to 357, including hand-to-mouth exposure. The MOEs from the high end exposures exceed our level of concern, although it should be noted that the assessment is conservative, and Dichlorvos residues dissipate rapidly from grass.

Occupational Risk Estimates. The Agency has refined occupational and residential risk estimates using new information, including the Pesticide Handlers Exposure Database (PHED, version 1.1), surrogate data and chemical specific data from the literature, additional information on cultural practices in mushrooms and greenhouses, ExpoSAC policies, and the toxicological endpoints chosen by OPP's Hazard Identification Assessment Committee. The FQPA uncertainty factor of 3x is not applicable to occupational risk assessments. Resulting risk estimates are reported as Margins of Exposure (MOEs), and compared to the target MOE, which is 100 for all Dichlorvos occupational exposure scenarios.

Crack and Crevice Treatment. Occupational exposure estimates for certified pesticide applicators conducting crack and crevice treatment with Dichlorvos were obtained from PHED (V1.1) for this short term exposure scenario. The MOE for crack and crevice treatment in homes (by certified pest control operators) of 5 is considered to be of concern when compared to the target MOE of 100.

Mushroom House Application and Re-entry. The Agency has a risk concern for Dichlorvos application scenarios involving use of a hand-held fogger (short term exposure, MOE 1.4) , hand-held sprayer (intermediate term exposure, MOE 35), backpack sprayer (intermediate term exposure, MOE 26 to 28), and a portable sprayer on a cart (intermediate term exposure, MOE 10), when compared to the target MOE of 100. The MOE for re-entry at 24 hours after treatment was 32 (Target MOE 100) and is considered to be of concern, as well.

MOEs for re-entry intervals longer than 24 hours cannot be calculated, because no data were provided for reentry intervals longer than 24 hours, and no decline in Dichlorvos air concentrations was demonstrated.

Greenhouse Application and Re-entry. Labeled uses permit application of Dichlorvos to greenhouse plants by hand-held foggers, total release foggers, and by smoke generators. The registrant has recently submitted a request for voluntary deletion of the hand-held fogger use under FIFRA Section 6(f). However, the request has not been processed, because clarifications were needed on the use patterns being supported. The MOE of 0.66 for this short term exposure is of concern, compared to the target MOE of 100, even after addition of personal protective equipment (PPE). Total release foggers and smoke generators are considered to result in negligible exposure since the applicator vacates the premises immediately upon activation of the foggers. For re-entry to Dichlorvos treated greenhouses (short term exposure) , the MOE for total exposure (with re-entry at 10 hours) is 130, which is not considered to be of concern compared to the target MOE of 100.

Animal Premises Treatment, Direct Animal Sprays, Feedlots, Manure Treatment, Garbage Dumps, and Baits. Exposure assessments for direct application to dairy cattle using handheld sprayers were conducted using PHED V1.1. Inhalation MOEs for this intermediate term exposure are not considered to be of concern; dermal MOEs and total MOEs for the backpack sprayer (MOE = 120 to 1000) are not of concern, compared to the target MOE of 100. Total MOEs for Hand Held Sprayer (MOE = 2000) and Portable Sprayer on a cart (MOE = 600) do not indicate a risk concern. There are no data addressing potential reentry into animal facilities, but the Agency does not expect reentry into animal facilities to be of concern in outdoor facilities, because Dichlorvos is expected to dissipate rapidly, and minimal dermal contact is expected.

Application to Lawns, Turf, and Ornamentals. There are products registered for use on home lawns, but not for use by homeowners. The reentry to home lawns after treatment is provided above under residential uses. The material is usually applied in tank mixtures with Chlorpyrifos. We note that the use of Chlorpyrifos on lawns has been canceled. Data from the Outdoor Residential Exposure Task Force (ORETF) were used for the assessment. Several clothing scenarios were evaluated. Applicator exposure is not of concern for applicators of granular formulations wearing coveralls and gloves (MOE = 140) compared to the target MOE of 100. Applicator exposure is of potential concern for applicators of liquid formulations wearing coveralls and gloves (MOE = 90) compared to the target MOE of 100. Reentry to residential lawns is of concern (minimum MOE 25, average MOE 61), compared to the target MOE of 300.

Food Manufacturing Plant Treatment and Re-entry. Dichlorvos can be applied to food manufacturing plants with wall-mounted automatic foggers. Short term exposure to mixer/loaders through automatic application is expected to be negligible; however, there would still be reentry exposure. EPA assumed 24 hours elapsed before reentry is allowed, and that

workers spend 8 hours per day in the treated area for the next 3 days. The MOE of 5.3 exceeds the level of concern, when compared to the target MOE of 100.

Warehouse Treatment and Re-entry. Dichlorvos can be applied to warehouses with wall-mounted automatic foggers. Short term exposure to mixer/loaders through automatic application is expected to be negligible; however, there would still be reentry exposure. EPA assumed 24 hours elapsed before reentry is allowed, and that workers spend 60 minutes in the treated area. The MOE of 53 is of concern, compared to the target MOE of 100.

Insect Traps. Exposure is believed to be negligible since the pesticide is in the form of an impregnated strip and the traps are placed in outdoor areas (such as forests) where there is no human exposure. They are not used in residential settings.

Aggregate Exposure and Risk. The Agency considered aggregate exposure and risk estimates for residents who might be exposed to Dichlorvos from multiple sources, such as residential use, food, and water. Residential exposure and risk to Dichlorvos from the use of Dichlorvos was included; Dichlorvos contributions from the use of Naled and Trichlorfon were considered negligible, except for Trichlorfon use on turf. (Dichlorvos exposure for this use will be considered in the Trichlorfon RED). Food exposure from Dichlorvos from the use of Dichlorvos, Naled and negligible contribution from use of Trichlorfon was included. Water exposure from the use of Dichlorvos, Naled and Trichlorfon was included. As noted below, the chronic exposures from food and the conservative water modeling estimates are negligible compared to the exposure from residential use. Nonetheless, the aggregate exposure and risk estimates suggest potential drinking water concerns.

Aggregate Acute Dietary (Food and Water) Exposure and Risk. Acute dietary risk estimates include risk from Dichlorvos resulting from the use of Dichlorvos, Naled, and Trichlorfon. Acute dietary risk estimates for food alone do not exceed the Agency's level of concern. The aggregate acute dietary risk estimate for food and water does, however, exceed the Agency's level of concern for the U. S. Population and subpopulations, when Dichlorvos from all three pesticides (Dichlorvos, Naled, and Trichlorfon) is considered.

The $DWLOC_{acute}$ for Dichlorvos, resulting from the use of Dichlorvos, Naled, and Trichlorfon, is 12 µg/L for the total US Population, 1.9 µg/L for all infants, 1.7 µg/L for children (1-6 years), and 12 µg/L for females (13-50 years). The estimated environmental concentrations (EECs) were determined separately for acute exposure and for chronic exposure, and separately for Dichlorvos resulting from the use of Dichlorvos, Naled, and Trichlorfon.

The conservative Tier I estimates of ground water concentration provided by the SCI-GROW model are not of risk concern. For acute drinking water exposure, both the modeled groundwater concentrations of 0.0002 to 0.015 µg/L for Dichlorvos resulting from the use of Dichlorvos, Naled, and Trichlorfon, are less than the $DWLOC_{acute}$ of 12 µg/L for the U. S. population and females (13-50), the $DWLOC_{acute}$ of 1.9 µg/L for all infants, and the $DWLOC_{acute}$ of 1.7 µg/L for children (1-6 years). However, the estimated environmental concentration of

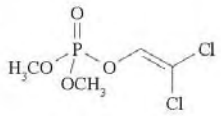
Dichlorvos in surface water, resulting from the use of Trichlorfon on turf, of 81.7 µg/L and the estimated environmental concentration of Dichlorvos in surface water, resulting from the Agricultural uses of Naled of 2.2 µg/L, from the GENEEC models indicates a potential risk concern. This indicates a need to refine the Agency's Tier I surface water EECs. However, there is no Tier II scenario for turf, so the surface water estimates cannot be further refined at this time. There is no risk concern from the estimated environmental concentration of Dichlorvos in surface water, of 0.060 µg/L, resulting from the use of Dichlorvos.

Aggregate Short and Intermediate Term Dietary and Residential Exposure and Risk. DWLOCs were not calculated for aggregate short or intermediate term exposure, because the short and intermediate term residential exposure scenarios are associated with risks of concern, therefore, the DWLOCs would effectively be zero. However, both the food and water exposure that would go into this calculation are negligible compared to the residential exposure.

Aggregate Chronic Dietary (Food and Water) and Residential Exposure and Risk. Chronic dietary exposure and risk estimates from food do not exceed the Agency's level of concern. However, the chronic residential inhalation exposure estimates from resin strips exceed the Agency's level of concern. Therefore, the $DWLOC_{chronic}$ value is effectively zero. The $DWLOC_{chronic}$ value is driven by the chronic residential inhalation exposure to Dichlorvos from resin pest strips, for which the chronic exposure exceeds our level of concern without considering water exposure. Food and water exposure to Dichlorvos is minimal compared with residential exposure. Therefore, any water exposure will add mimimally to exposures and risks of concern.

II. Physical and Chemical Properties

The chemical structure and physical properties of Dichlorvos are given below.



CAS Registry No.:	62-73-7
PC Code No.:	084001
Empirical Formula:	$C_4H_7Cl_2O_4P$
Molecular Weight:	221.0
Physical State	liquid
Water Solubility	slightly soluble
Vapor Pressure	0.032 mm Hg at 32°C
Specific Gravity	1.42 at 25°C

III. Hazard assessment

A. Toxicology Assessment

I. Overview

Based on available information to date, the Agency has determined that the adverse effects of primary concern for Dichlorvos are those related to inhibition of cholinesterase activity.

Organophosphate pesticides, such as Dichlorvos, are known to inhibit cholinesterase activity and some cause delayed neurotoxic effects. Inhibition of cholinesterase activity can result in a number of clinical signs and symptoms, including headaches, dizziness, nausea, vomiting, diarrhea and increased urination, blurred vision, pinpoint pupils, increased salivation, labored breathing, muscle paralysis, slow heart rate, respiratory depression, convulsions, coma and even death. Numerous toxicological studies using laboratory animals are available addressing most of these toxicological endpoints for Dichlorvos.

The Carcinogenic potential of Dichlorvos has been classified as "suggestive" under the 1999 Draft Agency Cancer Guidelines and no quantitative assessment of cancer risk is required.

ii. FIFRA Guideline Studies

The acute toxicity studies for Dichlorvos are summarized in Table 1, and the toxicology profile for Dichlorvos is summarized in Table 2. The toxicology database required to support the Reregistration of Dichlorvos is essentially complete. All required toxicology studies have been submitted and reviewed by Agency scientists, with the exception of a developmental neurotoxicity study is rats, which is now being required. In addition to the required studies, the registrant recently conducted a voluntary (non-guideline) study in human volunteers. The EPA will not rely on these types of studies in making final regulatory decisions until the Agency has in place a robust policy that will ensure any such studies meet the highest scientific and ethical standards.

Table 1. Guideline Acute Toxicity Studies for Dichlorvos

Study Type	MRID No.	Results	Toxicity Category
Acute Oral - Rat	00005467	LD_{50} = 80 mg/kg (M) 56 mg/kg (F)	II
Acute Dermal - Rat	00005467	LD_{50} = 107 mg/kg (M) 75 mg/kg (F)	I
Acute Inhalation - Rat	00137239	LC_{50} = > 0.198 mg/L	II
Primary Eye Irritation	00146921	Mild irritant	III
Primary Skin Irritation	00146920	Mild-irritant	IV
Dermal Sensitization	none	No study available	NA
Acute Delayed Neurotoxicity - Hen	41004702	Negative for acute delayed neurotoxicity	NA
Acute Neurotoxicity - Rat	42655301	NOAEL = 0.5 mg/kg; LOAEL = 35 mg/kg (Changes in FOB, motor activity) No neuropathology	NA

Table 2. Guideline Toxicology Studies for Dichlorvos in Experimental Animals

Study Type	MRID No.	Results
28-Day Delayed Neurotoxicity- Hen	43433501	Cholinesterase inhibition (ChEI) NOAEL = 0.1 mg/kg/day LOAEL = 0.3 mg/kg/day (brain ChEI) No neuropathology.
90-Day Subchronic Toxicity - Rat	41004701	NOAEL = 0.1 mg/kg/day LOAEL = 1.5 mg/kg/day (plasma and RBC ChEi)
90-Day Neurotoxicity - Rat	42958101	NOAEL = 0.1 mg/day LOAEL = 7.5 mg/kg/day (plasma, red blood cell (RBC) and brain ChEI).
Chronic-Feeding-Dog	41593101	NOAEL = 0.05 mg/kg/day LOAEL = 1.0 mg/kg/day (plasma and RBC ChEI in both sexes and brain ChEI in males).

Study Type	MRID No.	Results
Chronic toxicity/ Carcinogenicity-F344 Rats (NTP study)	40299401	NOAEL = Not established LOAEL = 4.0mg/kg/day (plasma and RBC ChEI) **Suggestive evidence of carcinogenicity (mononuclear cell leukemia in male rats)**
Carcinogenicity-Mouse	40299401	NOAEL = Not established LOAEL = 10 mg/kg/day (plasma and RBC ChEI in males)
Developmental Toxicity-Rat	41951501	Maternal toxicity NOAEL = 3 mg/kg/day LOAEL = 21 mg/kg/day (clinical signs, decreased body weight gain and reductions in food consumption and efficiency) Developmental toxicity NOAEL = $\geq$ 21 mg/kg/day (HDT) ChEI was not measured.
Developmental Toxicity-Rabbit	41802401	Maternal toxicity NOAEL = 0.1 mg/kg/day LOAEL = 2.5 mg/kg/day (mortality, decreased body weight gain and mortality at LOAEL; cholinergic signs at 7 mg/kg/day) Developmental toxicity NOAEL= $\geq$ 7 mg/kg/day (HDT) ChEI was not measured.
Reproductive Toxicity - Rat	42483901	Parental/Systemic NOAEL = 2.3 mg/kg/day LOAEL = 8.3 mg/kg/day (decreased % of females with estrous cycle and increased % of females with abnormal cycling. Offspring NOAEL= 2.3 mg/kg/day; LOAEL = 8.3 mg/kg/day (reduced # dams bearing litter, fertility index, pregnancy index and pup weight).
Mutagenicity		Dichlorvos has been shown to be a direct acting mutagen by common *in vitro* bacterial genetic toxicity assays and in *in vitro* mammalian test systems. Conflicting evidence was seen for clastogenic activity *in vivo*.
Metabolism-Rat	41228701 41839901	The overall metabolic profile suggests the involvement of the one-carbon pool biosynthetic pathway as evidenced by the presence of a relatively large amount of radioactivity in the form of expired $^{14}CO_2$ and the presence of dehalogenated metabolites as well as urea and hippuric acid.

iii. Literature Studies (Non-guideline)

In addition to the developmental and reproduction studies submitted to the Agency to fulfill the OPPTS Guidelines, HED's Hazard Identification Assessment Review Committee (HIARC) evaluated a prenatal developmental toxicity study in guinea pigs that was published in the open literature (Mehl et al. 1994). In this study Trichlorfon (125 mg/kg), Dichlorvos (15 mg/kg, once or twice/day) and several other organophosphates (Dimethoate, TOCP, Soman, and Ethyl Trichlorfon) were administered subcutaneously to pregnant outbred albino guinea pigs (Ssc: AL, MOI:DHF) between day 42 and 46 of gestation. A dose of 15 mg/kg Dichlorvos was considered the largest dose that could be given without causing cholinergic symptoms in the pregnant dams, but it was noted that the mother of the litter that received 15 mg/kg once in 24 hours had slight symptoms. Offspring were born between day 69 and 72 of gestation. Brain weights of pups were determined within 24 hours of birth. Dichlorvos, in both groups dosed twice/day produced significant decreases in total brain weight (12-14%) and significant decreases in cerebellum, medulla, thalamus/hypothalamus, and the colliculi. In the group given Dichlorvos 15 mg/kg once daily, total brain weight decreases (6%) were not statistically significantly decreased, and only the thalamus/hypothalamus (19%) was significantly decreased. For dams given Trichlorfon, red blood cell (RBC) cholinesterase inhibition (ChEI). was 64% at 1 hour, with recovery at 24 hours. There were no significant decreases in brain AChEI, glutamate decarboxylase, or choline acetyltransferase at either time interval.

The HIARC reviewed additional open literature data on Trichlorfon, which metabolizes to Dichlorvos. The HIARC noted that the decreased brain weight effects in guinea pigs and mini-pigs were seen following oral exposure of Trichlorfon (Berge, GN. et al. 1986; 1987a and b; Hjelde, T; et al.1998; Knox, B. et al. 1978; Mehl, N. et al.1994 and Pope, A. et al. 1986). Together, these studies show that mid- to late-gestational exposures to pigs (or guinea pigs) to Trichlorfon in the dose range of 50-100 mg/kg for 1-5 days, results in cerebellar and sometimes cerebral hypoplasia that is poorly correlated with body weight loss but well correlated with total brain weight loss. The Berge study repeatedly reports Purkinje cell loss and other histopathological findings, but the Pope study failed to confirm this. The Berge study also found decreases in cholinergic and GABA-ergic marker enzymes. After reviewing the open literature studies, the Agency concluded that, although the Mehl study had limitations which raised doubts about its reliability, the open literature findings could not be dismissed and that additional developmental neurotoxicity data in the rat are needed to further assess the developmental toxicity potential of Dichlorvos (Diwan, S., et. al., 1999).

The registrant, AMVAC, provided a list of about 60 studies primarily from the open literature on the toxicity and effects of Dichlorvos. These studies were, for the most part, published more than 30 years ago, had no supporting data to verify the toxicity endpoints, and were not designed for dose-response assessment. While a variety of species (including man) were tested, none of the submitted studies had a comparative assessment of man to other species, and most human studies lacked the essential quantitative exposure and toxicity assessments needed to quantify and characterize the risk.

The studies do not add any new information to the relevant database for animal studies with Dichlorvos and cannot be used to quantify and characterize the risk; however, together as a whole, they suggest (but do not prove) that humans may be less sensitive by the inhalation route of exposure to Dichlorvos vapors than the animal models for ChEI. The current inhalation risk assessment for Dichlorvos was based on a two-year rat inhalation study (MRID No. 0057695, 00632569) where THE NOAEL was 0.00005 mg/L (0.05 mg/kg/day) based on plasma, RBC, and brain ChE inhibition at the next higher dose of 0.00048 mg/L (0.5 mg/kg/day) (HIARC reports: Ghali, G., 12/19/97; Rowland, J., 6/3/98; Rowland, J., 6/2/99; Diwan, S., 6/8/99; and Khasawinah, A. and Diwan, S., 9/10/99). For the short-term inhalation exposure risk assessment in humans, this NOAEL value may be too conservative, especially after adding the 10-fold uncertainty factor (UF) for intra-species variability. The Arizona III human exposure monitoring study, with repeated measurements of air concentrations of Dichlorvos and of plasma and RBC ChE levels, might be a more suitable study for the short-term (one month or less) inhalation exposure risk assessment. In this study, where residents spent nearly 50% of their time inside the house, the actual NOAEL for human plasma and RBC ChE inhibition seems to be in the range of 0.0001 mg/L (0.1 mg/m^3 or 0.01 mg/kg/day) which is an average of the one air concentration measurement in each of the homes in the study. Each home had one 20% Dichlorvos resin strip/1000 cubic feet/month, in accordance with the Dichlorvos label (citation 11, also reviewed by J. Stewart and H. Spencer on 4/8/93, HED Document no. 010157). Based on this study, and after accounting for the average time spent (~ 50%) at home, the NOAEL in humans would be approximately equal to the NOAEL in the two-year rat inhalation study (0.00005 mg/L). The study was classified core-Supplementary because "as a journal article it was not presented in enough detail for complete assessment of the information to be made, although it provides valuable information" (J. Stewart and H. Spencer, HED Document no. 010157 dated 4/8/93). Additional information on the study pertaining to exposure was submitted, in addition to cholinesterase measurements for the participants.

B. Dose Response Assessment

I. Determination of Susceptibility

The HIARC evaluated the toxicology database with regard to increased susceptibility to infants and children and concluded that there was no indication of increased susceptibility to rat or rabbit fetuses following *in utero* exposure or to the offspring after pre/post natal exposures to Dichlorvos (Ghali 1997, Rowland 1998, Rowland 1999). In all these studies, maternal or parental NOAELs were less than or equivalent to the developmental or offspring NOAELs. However, based on the published data discussed above, on the effects of Trichlorfon on pig and guinea pig brain development, the HIARC recommended that a developmental neurotoxicity study in rats should be conducted with protocol modifications which included examination of brain weight.

The FQPA Safety Factor Committee met on January 18, 2000, and reviewed both the hazard and exposure data to determine if the retention of the additional 10x factor is warranted

(Tarplee 2000). After carefully considering all the factors, the Committee concluded that a safety factor is required for Dichlorvos based on the data gap for the developmental neurotoxicity (DNT) study in rats required. However, it was determined that the10x FQPA safety factor can be reduced to 3x because: 1) the standard developmental and reproductive toxicity studies submitted to the Agency showed no indication of increased susceptibility of rats, or rabbits to *in utero* and/or postnatal exposure to Dichlorvos; and 2) the dietary (food and drinking water) and non-dietary (residential) risk assessments will not underestimate the potential exposures for infants and children from the use of Dichlorvos.

ii. Cancer Classification

Dichlorvos has been the subject of several cancer peer reviews by the OPP Carcinogenicity Peer Review Committee, the Agency Cancer Risk Assessment and Verification Endeavor (CRAVE) Workgroup, and the FIFRA Science Advisory Panel (SAP). The Carcinogenic potential of Dichlorvos has been classified as "suggestive" under the 1999 Draft Agency Cancer Guidelines and no quantitative assessment of cancer risk is required. The 6th Cancer Assessment Review Committee (CARC) meeting for Dichlorvos was held on August 18, 1999. During the meeting and in followup discussions, it was determined that:

1) Mononuclear cell leukemia (MCL) in the male Fischer rat has certain properties in terms of variability and reliability which limit its usefulness for human risk assessment.

2) Forestomach tumors in mice, observed at gavage doses causing inhibition of plasma and red blood cell cholinesterase and cholinergic signs, are also limited in their use for human risk assessment.

3) The fact that Dichlorvos is only positive by the gavage route and negative by the inhalation route, which is the major route of human exposure, indicates that any classification by the oral route may be limited since localized effects in the forestomach may not be applicable to human risk assessment.

iii. Toxicology Endpoint Selection

The Hazard Identification Committee (HIARC) met on November 13 and 18, 1997, May 7, 1998, February 18, 1999, May 27, 1999, and August 5, 1999 to evaluate the existing toxicology database for Dichlorvos, identify toxicological endpoints and dose levels of concern appropriate for use in risk assessments for different exposure routes and durations, and assess/reassess the reference dose (RfD). A group of HED Branch Chiefs and Toxicologists met on November 19, 1998 and on February 18, 1999, to revisit the inhalation endpoints for Dichlorvos. Reports on Dichlorvos (Ghali 1997, Rowland 1998, Rowland 1999, Diwan 1999, Khasawinah and Diwan 2000) discussed issues relating to acute and chronic dietary exposures and Reference Doses (RfDs), dermal and inhalation exposures, susceptibility (FQPA) issues, and the selection of uncertainty factors (UF). The conclusions and toxicology endpoints selected for dietary and non-dietary risk assessments are presented in Table 3 below.

In addition to the HIARC discussions of Dichlorvos, the Agency received oral comments regarding the cholinesterase inhibition endpoint at the July 1998 FIFRA SAP Meeting. The Registrant convened a Blue Ribbon Panel on cholinesterase inhibition, and presented the findings of that panel at the July SAP meeting. The Agency has informally reviewed the Blue Ribbon Panel Report and determined that it pertains to the generic issue of cholinesterase endpoints.

The Agency has reviewed the body of data concerning the toxicology of Dichlorvos. Toxicity endpoints and doses were selected, uncertainty factors were assigned, and Reference Doses (RfDs) and Population Adjusted Doses (PADs) were calculated based on animal NOAELs.

The EPA will not rely on oral dosing human studies in making final regulatory decisions under FQPA until the Agency has in place a robust policy that will ensure any such studies meet the highest scientific and ethical standards. Therefore, the Agency selected doses and endpoints to calculate dietary and non-dietary risk in the current assessment based solely on animal studies.

Table 3. Doses and Toxicological Endpoints Selected for Risk Assessment of Dichlorvos

EXPOSURE SCENARIO	DOSE (mg/kg/day) UF	ENDPOINT Target MOE	STUDY
Acute Dietary (animal)	NOAEL = 0.5	Alterations in Functional Observation Battery (FOB) at 35 mg/kg (LOAEL)	Acute Neurotoxicity - Rat
	UF = 300[a] FQPA = 3		
	Acute RfD = 0.0017 mg/kg/day Acute aPAD = 0.0005 mg/kg/day		
Chronic Dietary	NOAEL = 0.05	Plasma and RBC cholinesterase inhibition in both sexes and brain cholinesterase inhibition in males (LOAEL = 0.1 mg/kg/day)	1-Year Dog
	UF = 100 FQPA=3		
	Chronic RfD = 0.0005 mg/kg/day Chronic cPAD = 0.00017 mg/kg/day		
Short-Term Inhalation and Dermal[b] (Animal)	Oral NOAEL = 0.1	Decreases in body weight gain and maternal mortality at 2.5 mg/kg/day (LOAEL); cholinergic signs at 7 mg/kg/day	Developmental - Rabbit
	UF = 100 FQPA = 3 for residential exposure	Target MOE = 100 Occupational Target MOE = 300 Residential	
Intermediate-Term Inhalation and Dermal[b] (Animal)	Oral NOAEL = 0.05	Inhibition of plasma and red blood cell cholinesterase activity at 0.1 mg/kg/day (LOAEL) at the 12 day measurement.	Chronic Toxicity-Dog
	UF= 100 for occupational exposure	Target MOE = 100 Occupational	
Chronic Dermal	None	Use pattern indicates no potential Long-Term dermal exposure; risk assessment not required	None
Chronic Inhalation	0.05 (0.00005 mg/L)	Plasma, RBC and Brain cholinesterase inhibition (LOAEL = 0.5 mg/kg/day)	2-Year Rat Inhalation Study
	UF=100[c] FQPA=3	Target MOE = 100 Occupational Target MOE = 300 Residential	

[a] The UF includes 10x for inter-species variation, 10x for intra-species extrapolation, and 3x for the lack of cholinesterase measurement. [b] Since an oral NOAEL was selected for these exposure periods, a dermal absorption factor of 11% should be used. [c] The UF includes 10x for intraspecies variation and 10x interspecies variation.

The critical toxicology study for acute dietary risk assessment is the acute neurotoxicity study in rats. Sprague Dawley rats (12/sex/dose) received a single oral dose of Dichlorvos (97.8%) at doses of 0, 0.5, 35 or 70 mg/kg. Behavioral Testing (Functional Observation Battery (FOB) and Motor Activity) was conducted pretest, 15 minutes after treatment, and on study days 7 and 14. Cholinesterase measurements were not performed. The NOAEL was 0.5 mg/kg and the LOAEL was 35 mg/kg based on alterations in FOB (gait changes, whole body tremors, clonic convulsions, absent forelimb/hind limb grasp, constricted pupils and exophthalmus), decreased motor activity, catalepsy and reduction in body temperature. The Uncertainty Factor includes 10x for inter-species extrapolation, 10x for

intra-species variation, and 3x for the lack of cholinesterase measurement. The FQPA safety factor is reduced to 3x. **Therefore, the acute Population Adjusted Dose (aPAD) is 0.0005 mg/kg/day (NOAEL of 0.5 mg/kg/day ÷ (UF of 300 x FQPA factor of 3).**

The critical toxicology study for chronic noncancer dietary risk assessment is the chronic one-year feeding study in dogs (Guideline 83-1b, MRID No. 41593101). Groups of beagle dogs were administered Dichlorvos by capsule for 52 weeks at dose levels of 0, 0.1, 1.0 and 3.0 mg/kg/day. The 0.1 mg/kg/day dose was lowered to 0.05 mg/kg/day on day 22 due to the inhibition of plasma cholinesterase noted after 12 days. Plasma cholinesterase was decreased in males (21.1%) and females (25.7%) at week 2 in the 0.1 mg/kg/day which was then reduced to 0.05 mg/kg/day. After week 2, plasma cholinesterase activity was only significantly reduced in males (39.1 to 59.2%) and females (41.0 to 56.7%) in the mid-dose group and in males (65.1 to 74.3%) and females (61.1 to 74.2%)in the high dose group at all other later time intervals. RBC cholinesterase activity was reduced in males (23.6%) and females (50.1%) at week 6 in the low-dose group. This was believed to be a residual effect on RBC cholinesterase of the higher dose of 0.1 mg/kg/day, because much less inhibition was observed in this group after week 6. After week 6, RBC cholinesterase activity was only significantly decreased in males (43.0 to 53.9%) and females (38.0 to 51.9%) in the mid-dose group and in males (81.2 to 86.9%) and females 79.2 to 82.5%) in the high-dose groups at all other later time intervals. Brain cholinesterase activity was significantly reduced in males (22%) in the mid-dose group and in males (47%) and females (29%) in the high dose group. The NOAEL and LOAEL selected for chronic dietary risk assessment are 0.05 and 0.1 mg/kg/day, respectively, based on plasma and RBC cholinesterase inhibition in males and females as early as the first time point measure and brain cholinesterase in males. An uncertainty factor of 300 is required to account for interspecies extrapolation (10x), intraspecies variation (10x), and the FQPA safety factor (3x). **Therefore, the chronic Population Adjusted Dose (cPAD) was determined to be 0.00017 mg/kg/day (NOAEL of 0.05 mg/kg/day ÷ (UF of 100 x FQPA of 3).**

For occupational and residential risk assessment, the dermal absorption rate for Dichlorvos was estimated to be approximately 11% in 10 hours of exposure. This was based on the findings of a dermal absorption study in rats (85-2), MRID No. 41435201.

The critical study selected for short term dermal risk assessment was the Developmental Study in Rabbits. Groups of New Zealand White rabbits (16/dose) received oral administration of Dichlorvos (97%) in distilled water at dose levels of 0, 0.1, 2.5 or 7.0 mg/kg/day during gestation days 7 through 19, inclusive. For Maternal Toxicity, the NOAEL was 0.1 mg/kg/day and the LOAEL was 2.5 mg/kg/day based on decreases in maternal body weight gain during gestation days 7-19 (approximately 12 days). Although the decreased body weight gain was not statistically significant, it was considered to be biologically significant. A dose-related increase in maternal mortality also was noted at 2.5 and 7 mg/kg/day. Cholinergic signs were observed at 7 mg/kg/day. For Developmental Toxicity, the NOAEL was > 7 mg/kg/day (highest dose tested) a LOAEL was not achieved. The target MOE is 100 (10x for interspecies variation and 10x for intraspecies variation) for occupational exposure and 300 for residential exposure (includes the additional 3x FQPA safety factor).

The critical study selected for risk assessment for intermediate-term dermal exposure was the Chronic One-Year Toxicity Study in Dogs, which is discussed above. The NOAEL is 0.05 mg/kg/day based on inhibition of plasma cholinesterase at 0.1 mg/kg at 12 days and inhibition of plasma and red blood cell cholinesterase activity at 1 mg/kg/day at the 13 week measurement. The target MOE is 100 (10x for interspecies variation and 10x for intraspecies variation) for occupational exposure. No residential exposure of this duration is expected.

The HIARC did not select a toxicology endpoint for long term dermal exposure to Dichlorvos. The available information on the Dichlorvos use pattern and exposure profile indicate that long term dermal exposure will not occur. Therefore, the HIARC determined that this type of risk assessment is not required.

The critical study for inhalation risk assessment for Dichlorvos is an inhalation carcinogenicity study in rats (83-2a), MRID No. 0057695, 00632569). Groups of 50/sex/group Carworth rats were exposed to atmospheres containing Dichlorvos vapor for 23 hours/day, 7 days/week at concentrations of 0, 0.05, 0.5, and 5 mg/m^3 equivalent to 0.055, 0.5, and 5.0 mg/kg/day for 2 years. Animals were observed for clinical signs of toxicity, hematology, and clinical chemistry. Plasma, RBC and brain cholinesterase activity were determined at study termination. There were no toxic signs, and no organ weight or organ to body weight changes, or hematological changes attributable to administration of Dichlorvos. Body weights were significantly decreased in mid and high dose males up to study termination, and in high dose females throughout the study. Plasma, RBC, and brain cholinesterase activity were significantly reduced in the mid and high dose groups (76, 72, and 90 and 83, 68, and 90 percent of control in mid dose males and females, and to 38, 4, and 21, and 22, 5, and 16 percent of control in the high dose male and female groups, respectively). RBC cholinesterase activity was reduced to 88 percent of control in the low dose females. The NOAEL for cholinesterase inhibition was 0.055 mg/kg/day and the LOAEL was 0.5 mg/kg/day. This is the same inhalation study which has been used by the Agency RfD/RfC Work Group in deriving the Reference Concentration (RfC) for Dichlorvos. An Agency RfC document is available on IRIS.

The study NOAEL of 0.05 mg/m^3 (or 0.00005 mg/L) was selected for chronic inhalation risk assessment scenarios. For inhalation risk assessments for occupational exposure, the target MOE is 100 (10x for intraspecies variation and 10x for interspecies variation). For inhalation risk assessments for residential exposure, the target MOE is 300 (10x for intraspecies variation, 10x for interspecies variation, and 3x for the FQPA safety factor).

iv. Endocrine Disruptor Effects

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific bases for including, as part of

the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and/or testing protocols being considered under the Agency's EDSP have been developed, Dichlorvos may be subjected to additional screening and/or testing to better characterize effects related to endocrine disruption.

v. Incident Reports

The Agency has conducted a review of reported poisoning incidents associated with human exposure to Dichlorvos. The Agency has consulted the following data bases for the poisoning incident data on the active ingredient Dichlorvos: (1) the OPP Incident Data System, which contains anecdotal reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992, (2) Poison Control Center Data for 28 organophosphate and carbamate chemicals for the years 1985 through 1992, (3) California Department of Food and Agriculture reports (superceded by the Department of Pesticide Regulation), which contain uniform data on suspected pesticide poisonings collected since 1982, and (4) National Pesticide Telecommunications Network (NPTN), which is a toll-free information service supported by OPP. In addition, the Agency has received public comments regarding poisoning incidences associated with Dichlorvos as comments to the Proposed Notice of Intent to Cancel (PD 2/3). Specific comments on incidences were received from Amvac Chemical Corporation, the Japanese Resin Strip Manufacturer's association, and two private citizens, Arturo Haran and Eric Levine.

Exposure to Dichlorvos has resulted in poisoning incidents. Dichlorvos has widespread use patterns in the home and agricultural environments. Many of these uses (e.g., poultry houses) are atypical of most organophosphates, which makes it difficult to compare the risk. According to California data, it appears that a majority of cases involved illnesses to workers indoors that entered a facility previously fumigated with Dichlorvos. Often exposure results from inadequate ventilation before persons are allowed in or near the treated area or lack of proper personal protective equipment (PPE).

Dichlorvos can cause systemic illness, including respiratory effects, to individuals who are exposed after fumigation.

I. Agency Review of Incident Reports

Incident Data System. The Agency's incident data system has 6 reports of poisoning incidences associated with Dichlorvos use between 1992 and 1998; the majority of these incidences were associated with misuse. These cases do not have documentation confirming exposure or health effects unless otherwise noted.

Poison Control Center Data. Dichlorvos was one of 28 organophosphate chemicals for which Poison Control Center (PCC) data were requested. There was a total of 19,666 Dichlorvos cases in the Poison Control Center (PCC) data base from 1985 to 1992. Of these, 316 cases were occupational exposure; 259 (82.0%) involved exposure to Dichlorvos alone and 57 (18.0%) involved exposure to multiple chemical products including Dichlorvos. There were a total of 9043 adult non-occupational exposures; 8575 (94.8%) involved this chemical alone and 468 (5.2%) were attributed to multiple chemical products. Workers who were indirectly exposed (not handlers) were usually classified as non-occupational cases. In this analysis, four measures of hazard were developed based on the Poison Control Center data, as listed below:

1. Percent of all accidental cases that were seen in or referred to a health care facility (HCF).

2. Percent of these cases (seen in or referred to HCF) that were admitted for medical care.

3. Percent of cases reporting symptoms based on just those cases where the medical outcome could be determined.

4. Percent of those cases that had a major medical outcome which could be defined as life-threatening or resulting in permanent disability.

Exposure to Dichlorvos alone or in combination with other chemicals was evaluated for each of these categories, giving a total of 8 measures. A ranking of the 28 chemicals was done based on these measures with the lowest number being the most frequently implicated in adverse effects. Dichlorvos did not rank in the top 7 for any category. Table 4 presents the analyses for occupational and non-occupational exposures.

Dichlorvos had average or below average evidence of effects compared to other organophosphate insecticides (Blondell 1994). For non-occupational exposure, six life-threatening cases were reported for exposure to Dichlorvos alone and eight life-threatening cases were reported which involved exposure to Dichlorvos and other products (Table 5 below). Among cases seen in a health care facility, Dichlorvos cases were much less likely to be hospitalized than the other insecticides. On other measures of hazard (percent seen in a health care facility or percent with symptoms), Dichlorvos had percents similar to the median for other cholinesterase inhibitors (Blondell 1994).

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For Dichlorvos, there were 10307 incidents; 10070 involved exposure to Dichlorvos alone and 237 involved other pesticide products as well. Compared to 14 other organophosphates and carbamates that 25 or more children were exposed to, Dichlorvos cases were less than half as likely to be seen in a health care facility or require hospitalization. Symptoms, however, occurred just as often for Dichlorvos and there were four life-threatening cases reported in children under age six.

Table 4. Measures of Risk From Occupational and Non-occupational Exposure to Dichlorvos Using Poison Control Center Data from 1985-1992[a]

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single chemical exposure	51.4 (68.2)	24.0 (44.0)
Multiple chemical exposure	50.3 (69.8)	24.9 (46.1)
Percent Hospitalized		
Single chemical exposure	9.8 (12.2)	5.4 (9.9)
Multiple chemical exposure	10.7 (14.3)	6.0 (12.6)
Percent with Symptoms		
Single chemical exposure	81.8 (85.8)	69.5 (74.0)
Multiple chemical exposure	84.4 (85.8)	70.3 (75.2)
Percent with Life-threatening Symptoms		
Single chemical exposure	0.6[b] (0.0)	0.1[b] (0.0)
Multiple chemical exposure	0.5[b](0.5)	0.1[b] (0.05)

[a] Extracted from Blondell 1994; number in parentheses is median score for that category.
[b] The percent calculated here is based on a single case for a single chemical exposure. The percent calculated here is based on between 6 to 8 cases for multiple chemical exposures.

California Pesticide Illness Surveillance Data (1982 to 1995). Detailed descriptions of 227 cases submitted to the California Pesticide Illness Surveillance Program (1982-1995) were reviewed. In 62 of these cases, Dichlorvos alone was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Dichlorvos ranked 27th as a cause of systemic poisoning in California. One individual was hospitalized between 1982 and 1995. Table 5 presents the types of illnesses reported by year. A total of 51 of 62 people had systemic illnesses (82.3%).

Table 6 gives the total number of workers who took time off work as a result of their illness, the total number of these workers who were hospitalized, and the length of hospitalization. A variety of worker activities were associated with exposure to Dichlorvos as illustrated in Table 7 below.

Table 5. Cases Due to Dichlorvos Exposure in California , 1982-1995.

Year	Illness Type					
	Systemic[a]	Eye	Skin	Respiratory	Combination[b]	Total
1982	8	1	2	-	-	11
1983	6	1	2	-	-	9
1984	2	-	-	-	-	2
1985	6	1	-	-	-	7
1986	2	-	-	-	-	2
1987	-	-	-	-	-	-
1988	2	-	-	-	-	2
1989	1	-	-	-	-	1
1990	2	-	-	1	-	3
1991	1	-	-	-	-	1
1992	5	-	-	-	-	5
1993	4	-	-	-	-	4
1994	11	-	-	2	1	14
1995	1	-	-	-	-	1
Total	51	3	4	3	1	62

[a] Category includes cases where skin, eye, or respiratory effects were also reported. [b] Category includes combined irritative effects to eye, skin, and respiratory system

Table 6. Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Dichlorvos Exposure in California, 1982-1995.

	Number of Persons Disabled	Number of Persons Hospitalized
1 day	5	-
2 days	2	1
3-5 days	4	-
6-10 days	-	-
> 10 days	2	-
Unknown	4	2

Table 7. Illnesses by Activity Categories for Dichlorvos Exposure in California, 1982-1995

Activity Category[a]	Illness Category					
	Systemic[b]	Eye	Skin	Respiratory	Combination[c]	Total
Applicator	6	1	1	-	-	8
Mixer/loader	1	-	-	-	-	1
Clean/Fix	-	-	-	1	-	1
Coincidental	2	-	-	-	-	2
Spray Drift Exposure	3	-	-	-	1	4
Pesticide Handling between Packaging and End Use	9	-	-	-	-	9
Chamber Fumigation	1	-	-	-	-	1
Manufacturing/ Formulation Plant Workers	1	-	-	-	-	1
Field Worker	2	-	1	-	-	3
Structural Treatment	15	-	-	2	-	17
Miscellaneous Nonoccupational Exposure	11	2	2	-	-	15
Total	51	3	4	3	1	62

[a] Clean/Fix= clean and/or repairing pesticide contaminated equipment; Coincidental= coincidental; Spray drift exposure = exposure to pesticide that has drifted from intended targets; Persons handling pesticide products between packaging and end-use, self explanatory; Chamber fumigation and manufacturing/formulation plant workers are self explanatory; Mixer/loader = mixing and/or loader of pesticide concentrates and dilute pesticides; Miscellaneous = non-occupational miscellaneous exposure; field worker and structural treatment are self explanatory.

[b] Category includes cases where skin, eye, or respiratory effects were also reported

[c] Category includes combined irritative effects to eye, skin, and respiratory system

According to the above activity categories, workers exposed to residue of structural treatment and miscellaneous non-occupational exposure were associated with the majority of the exposures. Most such cases involve indoor workers exposed to residues from a fogger or spray-type application. A number of cases resulted due to faulty equipment. Structural treatment with Dichlorvos was associated with illnesses that included symptoms of shortness of breath, difficulty breathing, chest tightness and pain, loss of concentration, headaches, dizziness, and several other symptoms. The miscellaneous nonoccupational exposure category was associated with illnesses that included symptoms of difficulty breathing, contact dermatitis on the face and nose, chemical conjunctivitis of the eyes, headaches, nausea, and several other symptoms.

National Pesticide Telecommunications Network (NPTN). As stated previously, NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984 to 1991 has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others. On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, Dichlorvos was ranked 18th with 188 incidents reported in humans and 32 incidents reported in animals (mostly pets).

ii. Public Comments on Incidents

The Agency received additional information on poisoning incidences associated with Dichlorvos as comments to the PD 2/3. Specific comments on incidences were received from Amvac Chemical Corporation, the Japanese Resin Strip Manufacturer's Association, and two private citizens, Arturo Haran and Eric Levine. Amvac submitted a review of human incident data for Dichlorvos (Feiler 1995), and the Japanese Resin Strip Manufacturer's Association submitted data on poisoning incidences involving Dichlorvos resin strips. Arturo Haran submitted an anecdotal report of health effects and Eric Levine submitted a comment about the potential carcinogenicity of Dichlorvos. The Agency has reviewed this new information (Blondell 1996). The Agency's conclusions are summarized below.

Data reported by the American Association of Poison Control Centers (AAPCC) concerning exposure to single products with Dichlorvos often contain other active ingredients. AAPCC reported 21,006 exposures to single products containing Dichlorvos. Most of these exposures involve homeowner use products that contained Dichlorvos in combination with other insecticides such as propoxur, pyrethrins, or piperonyl butoxide. In these cases involving Dichlorvos in combination with other pesticides it is incorrect to attribute any resulting toxicity solely to Dichlorvos.

Dichlorvos resin strips account for a very small proportion of total incidences, about 33 cases per year (1% of total incidences). Incidence reports involving exposure to resin strips usually do not involve any significant acute symptoms that would require medical treatment (Blondell 1996).

Eric Levine commented on epidemiological evidence linking use of Dichlorvos resin strips with childhood cancer. Two epidemiologic studies have reported an association between exposure to Dichlorvos resin strips and childhood cancer. These studies by Liess and Savitz (1995) and Davis et al (1993) have been reviewed by the Agency (Blondell 1996). Reviews of these studies have identified biases and confounders that could explain the observed associations. The Agency concludes that the biases are a more likely explanation for the findings of increased cancer than exposure to resin strips. Additional studies that correct for the control of potential biases and problems of exposure determination are needed before an association between Dichlorvos and childhood cancer can be established.

IV. Exposure and Risk Assessment

A. Dietary Exposure (Food Sources)

I. Background

Dietary (food) exposure to a pesticide depends on two components: the amount of pesticide residue on a commodity and how much of that commodity is consumed. In estimating Dichlorvos residues on food for the PD 2/3, the Agency relied on a variety of data for Dichlorvos, including tolerance levels (the legal maximum residue) and field trial data (measured residues resulting from actual pesticide application). These estimated residues can be further refined by taking into account the effects of processing and cooking on treated foods, and by estimating the percent of the crop that is treated. The current dietary (food) exposure and risk assessment is based primarily on monitoring data (both regulatory enforcement data and statistically based sampling data) and dietary intake surveys. Both the acute and chronic dietary exposure assessments are highly refined.

For the acute and chronic dietary exposure analyses, the Agency used the Dietary Exposure Evaluation Model (DEEM™), which incorporates consumption data generated in USDA's Continuing Surveys of Food Intakes by Individuals (CSFII), 1989-1992. For acute dietary risk assessments, the entire distribution of single day food consumption events is combined with either a single residue level (deterministic analysis) or a distribution of residues (probabilistic analysis, referred to as "Monte Carlo," risk at the 99.9th percentile of exposure reported) to obtain a distribution of exposures in mg/kg bw/day. For chronic dietary exposure analysis, the three day average daily consumption for each subpopulation is multiplied by an average residue estimate (either a tolerance level or anticipated (mean) residue) for each commodity to obtain the average dietary (food) exposure in mg/kg/day.

ii. Sources of Dichlorvos Residues on Foods

Dietary exposure to Dichlorvos residues may occur as a result of use on or at a variety of sites, including mushroom houses, warehouses containing bulk-stored and packaged or bagged nonperishable processed and raw food, commercial food processing plants, groceries, direct animal treatment, and livestock premise treatment. As a result, Dichlorvos residues may be found in bulk stored and packaged or bagged non perishable processed or raw food. Dichlorvos residues may also be found in mushrooms and in livestock commodities, such as meat, milk, meat byproducts, poultry, and eggs. In addition, a Dichlorvos registrant has expressed interest in supporting use on tomatoes.

Two other pesticides, Naled and Trichlorfon, degrade to Dichlorvos through plant and livestock metabolism, and non-biological reactions. The Agency does not expect measurable Dichlorvos residues from Trichlorfon because all Trichlorfon food uses on field crops have been canceled and associated tolerances revoked, and non-detectable residues were found in livestock dermal studies.

Three factors will significantly affect dietary exposure to Dichlorvos from registered uses of Naled; these include, the pre-harvest interval (PHI), the condition and length of storage, and cooking and processing. Plant metabolism studies show that Dichlorvos residues are formed 1 to 3 days after treatment with Naled; however, Dichlorvos residues decline to less than the limit of detection (0.01 to 0.05 ppm) 7 days after treatment. In general, registered uses of Naled have PHIs of less than 7 days. Because of the short PHIs for Naled products, measurable residues of Dichlorvos may be present in the diet from Naled treated food. As a result, the dietary (food) exposure assessment for Dichlorvos includes residues of Dichlorvos resulting from the application of Naled.

Dietary exposure estimates for acute and chronic dietary exposure assessments have been refined with residue data from USDA's Pesticide Data Program (PDP), FDA surveillance monitoring data, and FDA Total Diet Study (TDS) data, processing and cooking studies, and percent of crop treated information.

iii. Residue Chemistry Studies for Dichlorvos

Residue chemistry studies for Dichlorvos provide valuable information on Dichlorvos residues in foods. These studies are submitted to satisfy FIFRA guidelines for pesticide registration as described in the OPPTS Test Guidelines, Series 860. Key studies on the nature and magnitude of Dichlorvos residues in food are summarized below. Similar studies have been conducted for Naled and Trichlorfon.

Nature of the Residue - Plants (GLN 860.1300): The reregistration requirements for plant metabolism are fulfilled. The Agency determined that the available data depicting the metabolism of Naled in plants are sufficient to delineate the metabolism of Dichlorvos in plants because Dichlorvos is the initial metabolite of Naled. In plants, Naled is metabolized to Dichlorvos which is hydrolyzed to dimethyl phosphate or dichloroacetaldehyde. Dimethyl phosphate is sequentially degraded to monomethyl phosphate and inorganic phosphates, and dichloroacetaldehyde is converted to 2,2-dichloroethanol which is then conjugated and/or incorporated into naturally occurring plant components. The residue of concern in plant commodities is Dichlorvos.

Nature of the Residue - Animals (GLN 860.1300): The reregistration requirements for animal metabolism are fulfilled. Acceptable studies depicting the qualitative nature of the residue in ruminants and poultry following dermal treatment with Dichlorvos have been submitted and evaluated. Because Dichlorvos is the initial metabolite of Naled, the available metabolism studies reflecting oral dosing of ruminants and hens with Naled are sufficient to delineate the metabolism of orally dosed Dichlorvos in animals. The residue of concern in animal commodities is Dichlorvos.

Residue Analytical Methods (GLN 860.1340): Adequate methods are available for tolerance enforcement. The Pesticide Analytical Manual (PAM) Vol. II lists a GC method (with flame photometric detection; Method I) for the determination of Dichlorvos in plant and

animal commodities. An additional GC method (Method II) using electron capture detection is listed for the determination of Dichlorvos and Naled in plant and animal commodities; this method is also an enforcement method for Naled. A GC method using microcoulometric detection is listed as Method A. This method determines total residues of Dichlorvos and Naled via hydrolysis of Naled residues to Dichlorvos; however, the method can be modified to determine Naled and Dichlorvos separately.

Adequate methods are also available for data collection. In general, GC methods similar to the enforcement methods (using a variety of detectors capable of measurement of Dichlorvos), enzyme inhibition colorimetric methods, or methods based on measurement of small changes in pH (in the presence of an enzyme inhibitor) were used for data collection. Adequate method validation data have been submitted for the data collection methods.

Multiresidue Methods (GLN 860.1360): The reregistration requirements for Multiresidue Method data are satisfied. The 2/97 FDA PESTDATA database (PAM Volume I, Appendix I) indicates that Dichlorvos is completely recovered (>80%) using Multiresidue Method Section 302 (Luke Method; Protocol D). Dichlorvos is not recovered using Multiresidue Method Sections 303 (Mills, Onley, Gaither Method; Protocol E, non-fatty foods) and 304 (Mills Method; Protocol E, fatty foods). However, Dichlorvos is an 'early eluter' and requires low temperature chromatographic conditions. Consequently, fewer samples are analyzed by FDA for Dichlorvos than are typically analyzed by the Luke multiresidue method.

Storage Stability Data (GLN 860.1380): The reregistration requirements for storage stability data are not fulfilled. Information pertaining to the storage intervals and conditions of samples of the following commodities, from studies that were reviewed in the Residue Chemistry Chapter of the Guidance Document, must be submitted: packaged and bagged raw agricultural commodities and processed food; bulk stored raw agricultural commodities; milk; eggs; and meat, fat, and meat byproducts of dairy cows and poultry. Alternatively, the registrant may demonstrate that there are sufficient residue data which are supported by storage stability data to support all registered uses of Dichlorvos.

The available storage stability data indicate that residues of Dichlorvos are stable under frozen storage conditions for up to 90 days in/on plant commodities, up to 4.5 months in/on peanuts, and up to 8 weeks in animal commodities.

Crop Field Trials (GLN 860.1500): The reregistration requirements for magnitude of the residue in/on mushrooms are fulfilled. The only crop use of Dichlorvos that the registrant is supporting for reregistration is use in mushroom houses. Therefore, the previously required data for cucumbers, lettuce, radishes, tomatoes, and tobacco are no longer required, provided these uses are removed from all Dichlorvos labels. However, a registrant has expressed interest in supporting use on tomatoes. This triggers the requirement for crop field trials on tomatoes.

Adequate magnitude of the residue data are available for the aspirated grain fractions of corn, rice, and wheat, and data for soybean aspirated grain fractions can be translated from the available grain dust data. These data indicate that a tolerance for aspirated grain fractions is required.

Processed Food/Feed (GLN 860.1520): The reregistration requirements for magnitude of the residue in the processed commodities of the following crops have been fulfilled: field corn, cottonseed, peanuts, rice, soybeans, and wheat. The available data indicate that a tolerance for soybean hulls is required. Because the registrant is not supporting pre- or post-harvest use of Dichlorvos on tomatoes, data for tomato processed commodities are no longer required. However, another registrant has expressed interest in supporting use on tomatoes, which triggers the requirement for processing data

Milk and the fat, meat, and meat byproducts of cattle, goats, hogs, horses, and sheep (GLN 860.1480): **Direct Dermal uses:** Cattle, goat, hogs, horses, and sheep may be both dermally treated, through direct pour on treatment and/or treatment of their premises, and orally exposed to Dichlorvos. Adequate dermal magnitude of the residue studies have been submitted and evaluated for cattle. Residues were nondetectable (<0.01 ppm) in tissues and milk following treatment at 1x the maximum registered rate. **Livestock Premise Treatment:** Applications are made as a mist or fog to livestock premises, while the livestock are present, thus, direct livestock contact is occurring.

Secondary Residues: The maximum theoretical dietary burdens of Dichlorvos to beef and dairy cattle are 7.0 and 6.5 ppm, respectively (see Table 8 below).

Table 8. Calculation of maximum ruminant dietary burden for Dichlorvos.

Feed Commodity	Reassessed Tolerance (ppm)	% Dry Matter	Beef Cattle		Dairy Cattle	
			% of Diet	Burden (ppm)	% of Diet	Burden (ppm)
Wheat, grain	4.0	89	50	2.25	40	1.80
Wheat, aspirated grain fractions	20	85	20	4.71	20	4.71
		TOTAL	70	6.96	60	6.51

An adequate feeding study, reflecting dosing of dairy cattle at 2, 6, and 20 ppm, has been submitted and evaluated. Residues were nondetectable (<0.01 ppm) in tissues and milk at all dosing levels. It was concluded that the cattle feeding study could be translated to swine because the metabolism of Dichlorvos in swine was not expected to be different than the metabolism of Dichlorvos in cattle and poultry, which were similar. The ruminant feeding studies support the classification of category 3 of 40 CFR §180.6(a), having no reasonable expectation of finite residues in livestock tissues from consumption of Dichlorvos treated feeds.

Eggs and the fat, meat, and meat byproducts of poultry: **Direct Dermal Treatment:** Poultry may be both dermally, through direct pour on treatment and/or treatment of their premises, and orally exposed to Dichlorvos. Adequate dermal magnitude of the residue studies have been submitted and evaluated for poultry. Residues were nondetectable (<0.02-<0.05 ppm) in poultry tissues and egg, following treatment at levels 0.1-6.6x the maximum registered rate; detectable residues of up to 0.08 ppm were only observed in poultry skin samples from the 6.6x rate. **Premise Treatment:** Applications are made as a mist or fog to livestock premises, while the livestock are present; thus, direct livestock contact is occurring.

Secondary Residues: The maximum theoretical dietary burden of Dichlorvos to poultry is calculated to be 6.20 ppm based on a diet consisting of 20% soybeans hulls (15-ppm reassessed tolerance) and 80% wheat grain. An adequate feeding study, reflecting dosing of laying hens at 2, 6, and 20 ppm, has been submitted and evaluated. Residues were nondetectable (<0.01 ppm) in tissues and eggs at all dosing levels. The poultry feeding study supports the classification of category 3 of 40 CFR §180.6(a), having no reasonable expectation of finite residues in poultry tissues from the consumption of Dichlorvos treated feed.

Reduction of Residue Studies. The Reregistration requirements for reduction of residue studies are fulfilled. Adequate cooking studies with meat, egg, milk, dried beans, cocoa beans, coffee beans, and tomatoes have been submitted and evaluated. These studies indicate that Dichlorvos residues decrease during cooking, and that the loss is correlated with time and temperature of cooking. The available cooking data can be translated to similar food products cooked under similar conditions.

Adequate degradation studies with bulk stored raw and processed commodities of dried beans, field corn, flour, oats, peanuts, soybeans, sugar, and walnuts also have been submitted. A decline in the level of Dichlorvos residues was observed in all commodities except peanuts. Walnuts had no detectable residues. Adequate degradation studies with similar packaged and bagged raw and processed commodities were additionally submitted. A decline in the level of Dichlorvos residues was reported for packaged dried beans and sugar. Some information was provided of typical total storage times, frequency of applications, and rates of application (g/1000 cu. ft.).

B. Dietary Exposure Estimates

I. Sources of Residue Data for Estimating Dietary Exposure to Dichlorvos

Sources of data to estimate the levels of residues of pesticides in food include the following: tolerances (legal limits), controlled field trial data, Food and Drug Administration (FDA) surveillance and compliance monitoring data, FDA Total Diet Study data (market basket survey based on a random sampling of residues on food in grocery stores), US Department of Agriculture (USDA) Pesticide Data Program (PDP), and USDA/FSIS (Food Safety Inspection Service) livestock monitoring data (Hummel, 1998a, Hummel 2000). The estimated levels of

residues can then be adjusted for the effects of processing using processing studies, including commercial processing studies, washing studies, cooking studies, and residue degradation studies. Of these sources, the Agency relied on tolerance levels and field trial data (adjusted for the effects of processing and cooking) to estimate dietary exposure to Dichlorvos in the PD 2/3. At the time of the PD 2/3, the monitoring data available for Dichlorvos were very limited. In this updated assessment, anticipated residues based on some tolerances plus field trial and monitoring data were used. No monitoring data were available for livestock commodities except milk.

(a). ***Field Trial Data.*** Data from controlled field trials which reflect currently registered uses are available for mushrooms. Data from direct dermal pour-on treatments to cattle and poultry are discussed in the Dichlorvos Registration Standard. Field trial data are available for packaged or bagged food, use in food manufacturing and processing facilities, and for secondary residues in livestock commodities. Adequate field trial data are not available for tomatoes.

(b). ***FDA Surveillance and Compliance Monitoring Data.*** The FDA Surveillance and Compliance Monitoring Program is designed to ensure that pesticide residues do not exceed established tolerances. Naled and Dichlorvos are included in the FDA surveillance and compliance monitoring programs. However, Dichlorvos is only detected using the Luke method on non-fatty foods, and only when "early eluter" column conditions are used (low column temperature). Thus, the number of samples analyzed for Dichlorvos is low compared to the samples analyzed for other pesticides, although the number of analyses done by FDA that will detect Dichlorvos have increased significantly in the last few years. FDA Surveillance and Compliance monitoring data were obtained from FDA for 1990 through 1998. From 1994 through 1998, FDA analyzed over 3000 surveillance monitoring samples for Dichlorvos. The limit of quantitation (LOQ) for Dichlorvos in fruits and vegetables is approximately 0.01 ppm, and the limit of detection (LOD), approximately 0.003 ppm.

All residues of Dichlorvos reported were non-detectable, with the following exceptions: three samples of strawberries (which had low levels of detectable residues of Dichlorvos), one sample of red raspberries (0.08 ppm Dichlorvos); one tomato sample from Mexico with a trace residue (> LOD, but <LOQ); one sample of garbanzo beans from S. Korea with a trace residue; and 0.03 ppm on one sample of cantaloupe from Honduras. All residues of Naled reported were non-detectable, with the following exceptions: 3 samples of strawberries with residues of 0.1, 0.2, and 0.43 ppm Naled .

(c). ***FDA Total Diet Study Data (TDS).*** The FDA Total Diet Study Program is designed to measure trends in pesticide residues. Since 1982, approximately four market baskets per year have been collected in a large city in one of four regions of the country. The region of the country in which the market basket samples are collected rotates so that samples are collected in all four regions over one year. FDA summarizes the data expressed as daily intakes for 8 age-sex groups (infants, young children, male and female teenagers, male and female adults, and male and female older persons). Each market basket has consisted of 234-

265 individual food items prepared as ready to eat foods (washed and cooked). Individual foods are analyzed separately. Although the TDS includes sampling of meats and poultry, Dichlorvos could not be analyzed in these commodities using the TDS analytical methods.

Historically, the Agency has not used FDA Total Diet Study data for exposure assessment purposes because the number of samples is limited (approximately four samples per year of each of 234 - 265 individual food items since 1982), samples are only collected in large cities, and the treatment history is unknown. The TDS does not include minor crops. However, a total of 43 market basket surveys are now available for 1982 - 1996. Among the commodities collected in the TDS, there were approximately 35 non-fatty commodities analyzed which were similar to crackers and cereals, approximately 11 baked goods which were made from flour, sugar, and dried eggs, 4 coffee and 1 tea commodities, plus raisins, prunes, and cooked eggs. These are commodities that are or are produced from 'bulk stored' and 'packaged and bagged' commodities, and may have been treated with Dichlorvos closer to the point of consumption than the wheat grain samples collected by USDA in their Pesticide Data Program.

By grouping the commodities (generally along crop group classifications), there were more than 100 samples per group of commodities analyzed. The Agency has used extrapolation among members of crop groups in the past when using monitoring data. For example, monitoring data for oranges could be extrapolated to all citrus (tangerines, tangelos, grapefruit, lemons, and limes), provided the use pattern for citrus is the same.

Dichlorvos is not listed specifically as one of the pesticides recovered in the analyses for the FDA Total Diet Study. However, Dichlorvos is known to be detected by the Luke method for non-fatty foods when low column temperatures are used in the analysis ("early eluter" conditions). All of the Total Diet Study samples were analyzed using temperature programming which would allow detection of "early eluters." Therefore, if Dichlorvos is present, it would be detected, and one detectable residue of Dichlorvos was reported. The LOD for Dichlorvos in total diet samples is 0.001 ppm (personal communication, B. McMahon, FDA).

(d). ***USDA Pesticide Data Program Data.*** The USDA Pesticide Data Program (PDP) collects residue data primarily for fresh fruits and vegetables, plus wheat grain and milk. A few canned and frozen commodities have been tested. Samples are collected in terminal markets and large distribution centers. The commodities included in the PDP changes annually. Sampling dates and sites are selected at random following a statistically designed sampling plan. Participating laboratories meet rigorous quality assurance/quality control (QA/QC) criteria including following good laboratory practices (GLP), a check sample program, and confirmation of residue findings. Sampling and analyses are done through a cooperative agreement with nine states and two USDA laboratories. These states represent about 50% of the population of the US and a large percentage of the fresh fruits and vegetables grown in the US. Food commodities collected in the PDP are prepared as normally would be done for consumption, washed and peeled, although not cooked. Canned and frozen commodities are not further cooked before analysis, although they may have been blanched or cooked in the canning or freezing process.

The USDA PDP analyzes for Dichlorvos, which would include Dichlorvos resulting from Naled since the analytical method used generally converts Naled to Dichlorvos prior to or during the analysis. The LOD for the analyses varied, depending on the laboratory conducting the analyses, and ranged from 3 ppb to 280 ppb. All samples analyzed for Dichlorvos had non-detectable residues, except for (1) one peach sample analyzed in 1992, which had a Dichlorvos residue of 0.059 ppm; (2) one green bean sample analyzed in 1994, which had a Dichlorvos residue of 0.012 ppm; (3) one grape sample analyzed in 1996, which had a Dichlorvos residue of 0.003 ppm, which was below the LOQ; (4) one milk sample analyzed in 1996, which had a Dichlorvos residue of 0.003 ppm, which was below the LOQ; (5) one pear sample analyzed in 1997, which had a Dichlorvos residue of 0.005 ppm, which was below the LOQ; and (5) 15 strawberry samples in 1998, on which the maximum Dichlorvos residue was 0.02 ppm. PDP data were used in the Dichlorvos dietary exposure assessment for commodities which could be treated with Naled, and for milk. The PDP data on wheat grain were not used, because packaged and bagged commodities made from wheat grain could have been treated again with Dichlorvos after the PDP samples would have been collected. The PDP does not analyze for Naled because initial method validation indicated that Naled is converted to Dichlorvos during the analysis. The PDP does, however, identify unknown residues, and would report a residue of Naled if found.

(e). ***Processing and Cooking Study Data.*** Residues for raw commodities can be modified by processing factors to account for changes during commercial or other processing and cooking. Processing, cooking and decline (half-life) studies were available for cocoa beans, dry pinto beans, tomato juice, ground roasted coffee beans, raw hamburger meat, raw eggs, and raw whole milk. The resulting cooking factors were used to reduce the Agency's estimate of residues for these commodities and were translated to other commodities based on similarity of cooking time and temperature. Additional cooking studies were available and discussed in the Residue Chemistry Chapter of the Registration Standard. Half-lives of Dichlorvos in various commodities ranged from 0 to over 1,000 hours. The reduction of Dichlorvos upon cooking appeared to be related to the length of time and temperature used in cooking. Residues were adjusted based on these cooking factors to obtain the Anticipated Residue Estimate for the cooked commodity.

(f). ***Percent of crop treated data.*** OPP has refined its estimates of dietary exposure for various commodities based on percent of crop treated. The Biological and Economic Analysis Division (BEAD) of OPP provided updated percent of crop treated (% CT) information that were incorporated into the acute dietary (food) exposure analysis as appropriate (Hummel, et. al. 2000). Where a range of percent crop treated estimates are supplied for this analysis, the upper end of that range is assumed for acute dietary (food) exposure analysis, and the typical or average % CT is used for the chronic dietary (food) exposure analysis.

ii. Anticipated Residues for Dietary (Food) Exposure

Anticipated residues are a realistic estimate of actual pesticide residues in foods based on available data. Reliable data are available for Dichlorvos, including the USDA's PDP data, the FDA Total Diet Study and the FDA monitoring data. These data were not available at the time of the PD 2/3, Notice of Intent to Cancel, published in 1995. Anticipated residues used in the dietary risk assessment are presented in separate memo (Hummel S, Hrdy D, and Sahafayen M, 2000). The methods for deriving anticipated residues for Dichlorvos are described below.

(a) ***From Use of Dichlorvos***. All Dichlorvos tolerances in 40 *CFR* §180.235 were evaluated as potential sources of Dichlorvos residues. For the updated Dichlorvos dietary exposure assessment, FDA Total Diet Study data were used for residues resulting from the use of Dichlorvos per se, where appropriate, by grouping similar commodities made from grain products, sugar, dried eggs, coffee and tea, and dried fruits. These are summarized below.

Raw Agricultural Commodities. The following uses have been canceled: tomatoes, cucumbers, lettuce, and radishes, and the associated tolerances recommended for revocation. Therefore, these uses are not included in the exposure assessment. One Dichlorvos registrant has proposed supporting use on tomatoes. No detectable residues of Dichlorvos were detected on tomatoes in 1996-1998 in the PDP or from 1994-1998 in the FDA Surveillance Monitoring Program.

Meat, Milk, Poultry and Eggs. Residues in livestock tissues, including milk and eggs, may result from consumption of Dichlorvos treated livestock feeds, direct dermal treatments, livestock premise treatments, or from use as a drug in swine. Livestock metabolism studies done at exaggerated rates in ruminants and poultry have demonstrated that oral ingestion of Dichlorvos, Naled, and Trichlorfon by cattle and poultry will not result in detectable residues. This conclusion can be translated to the drug use of Dichlorvos in swine. Secondary residues in livestock and poultry from consumption of treated feed fall under category 3 of 40 CFR §180.6(a), having no reasonable expectation of finite residues. Data reflecting Dichlorvos direct livestock treatments are discussed in the Residue Chemistry Chapter of the Dichlorvos Registration Standard. Data from direct dermal studies indicate that detectable residues are not expected, except in skin. Residues are non-detectable (<0.01 ppm) in cattle tissue and milk, and non-detectable (<0.05 ppm) in poultry tissues and eggs. For the PD 2/3 dietary exposure assessment, the Agency used one-half the limit of detection as the residue estimate in both cases.

There were no monitoring data available for meat commodities, but PDP data were available for milk. Ratios of Dichlorvos residues found in livestock tissues in dermal metabolism studies to residues of Dichlorvos found in milk in the livestock dermal metabolism studies were calculated. These ratios were then used with the PDP monitoring data in milk to estimate residues of Dichlorvos in livestock tissues. The dietary exposure estimates in poultry commodities are based on the non-detectable residues (<0.05 ppm) reported after poultry were

dermally treated with Dichlorvos. A cooking factor of 0.3x was then applied. The dietary exposure estimate for eggs was the non-detectable residue found in cooked eggs in the FDA Total Diet Study.

Bulk Stored, Packaged or Bagged Commodities, Food and Feed Handling Uses. The anticipated residues used in the Dichlorvos PD 2/3 exposure assessment for packaged, bagged or bulk stored food were based on field studies submitted by Amvac (Hummel 1994b). Residue data were submitted for many commodities. For those commodities where data were not submitted, the Agency translated residue data from similar commodities. For example, data on dry beans are translated to other legumes; data on wheat flour are translated to all flours and meals, etc. In addition, residue data were provided for corn and oats at various points during processing, and for flour, sugar, dried milk, dried eggs, shortening, and baking mix from a treated manufacturing facility. Bulk stored commodities are assumed to be uncovered when treated. Although pesticide labels state that bulk or unpackaged foods should be covered or removed before spraying, it is not possible to assess the effect of covering food since the type of material used in the cover is not specified and the manner in which food is covered would vary considerably. Therefore, food is assumed to be uncovered, which is likely to overestimate residues. Since the proportion of commodities stored in bulk vs. packaged/bagged is unknown, the anticipated residues are based the residues found in packaged/bagged food, because foods are expected to be packaged/bagged closer to the time of consumption.

FDA TDS data were used for the Dichlorvos dietary exposure assessment on grain products and sugar, eggs, coffee and tea. In the 43 samples of 126 commodities in which Dichlorvos would be detected, only one sample had a detectable residue, one sample of rye bread at 0.01 ppm, which is below the LOQ of 0.03 ppm.

The Food Additive Regulation in 40 *CFR* §185.1900 for packaged or bagged nonperishable processed foods and the tolerance in 40 *CFR* §180.235 for nonperishable packaged, bagged or bulk raw food do not refer to specific commodities. Therefore, the Agency has developed a list of commodities likely to be treated with Dichlorvos that are covered by tolerances and/or Food Additive Regulations. Because these tolerances and Food Additive Regulations were established to cover residues resulting from use at different sites (for example, wheat could be treated in its raw form in a silo, later as flour, during processing into cake mixes, and finally as a stored packaged commodity), cancellation of any one of the site-specific uses does not necessarily eliminate the risk of a commodity from Dichlorvos treatment. The Agency did not combine the residues from different sites in creating the anticipated residues, although the cumulative residues from treating a commodity at different sites were considered in the estimation of percent of crop treated for the PD 2/3; however, the Agency position has changed. Now we expect that sufficient time will pass between treatments that only the maximum residue from one type of treatment needs to be considered.

(b) ***From Use of Naled.*** All Naled tolerances in 40 *CFR* §180.215 were evaluated as potential sources of Dichlorvos residues. Anticipated residues are based on either tolerance level equivalents or field trials or monitoring data from FDA (Regulatory monitoring

or Total Diet Study) or USDA (PDP). These data sources were used for both acute and chronic dietary exposure estimates. Naled and Dichlorvos residue estimates were reduced when data were available to account for the effects of washing, cooking, and processing. In addition, wide area application of Naled in mosquito and fly control use could result in residues potentially on all crops in the Agency's DEEM™ software. The Agency did not include all these crops in its estimate of anticipated Dichlorvos residues for the chronic dietary exposure assessment. Although it is possible that Dichlorvos residues could occur on any raw agricultural commodity from this use of Naled, it is unlikely that residues would be found on all commodities. As a result, this inclusion of residues of Dichlorvos from all raw crops would present a possible source of overestimation of dietary exposure. A sensitivity analysis was conducted for Naled and Dichlorvos from Naled, done separately from the Dichlorvos risk assessment, showing that the mosquito and fly control use was not a substantial source of exposure.

(c) ***From Use of Trichlorfon.*** All Trichlorfon tolerances in 40 *CFR* 180.198 were evaluated as a potential source of Dichlorvos residues. All tolerances for Trichlorfon have been revoked, with the exception of tolerances in beef cattle commodities, which are being retained to cover potential residues from imported meat commodities. In Trichlorfon cattle feeding studies, residues of Trichlorfon and Dichlorvos were <0.05 ppm in livestock commodities at pre-slaughter intervals of 1, 3, and 7 days (T. Morton, 1999). This would result in residue estimates of the same order of magnitude as those for Dichlorvos alone and Naled-derived Dichlorvos. Measurable residues of Dichlorvos from the use of Trichlorfon are not expected, because it has no crop tolerances or registered crop food uses (Hummel, 1998b), and non-detectable residues are expected on livestock commodities.

C. Dietary Risk Estimates (Food Sources)

A DEEM™ analysis was performed to estimate acute dietary exposure and risk from Dichlorvos; and to estimate dietary exposures and risks for chronic systemic toxicity from residues of Dichlorvos. Because Dichlorvos residues on food may be derived from use of either Dichlorvos or Naled, the dietary risk analyses included both Dichlorvos and Naled-derived Dichlorvos. Trichlorfon-derived Dichlorvos was considered. All uses of Trichlorfon have been canceled. The Trichlorfon tolerances have been revoked, except for tolerances in livestock commodities. The DEEM™ analyses were done for all commodities supported for Reregistration.

I. Acute Dietary Exposure and Risk Estimates

A Tier III acute dietary analysis was performed, which combined the acute exposure from Dichlorvos residues resulting from the use of Dichlorvos, Naled-derived Dichlorvos (including residues of Naled, which could be converted in the body to Dichlorvos), but excluding the Naled public health mosquito use (Hummel, et. al. 2000). Residues of Dichlorvos from the use of Trichlorfon were estimated not to increase the residues from the use of Dichlorvos. For assessing risk use of Dichlorvos, anticipated residues based on field trials

and monitoring data were used. For assessing risk from Naled-derived Dichlorvos, anticipated residues based on some tolerances, some field trials, and monitoring data were used. The acute probabilistic dietary analyses used individual food consumption as reported by respondents in the USDA 1989-91 Continuing Survey of Food Intake by Individuals (CSFII) in the DEEM™ software. Results are reported as a percentage of the aPAD for the 99.9th percentile of the population. The % aPAD is calculated as the ratio of the exposure to the aPAD (% aPAD = exposure/aPAD x 100%).

Tier III anticipated residues which incorporated percent of crop treated (% CT), monitoring data from the PDP, the FDA Surveillance Monitoring Program, the FDA TDS, field trial data, and a few tolerances were used to estimate acute dietary exposure. The acute exposure/risk estimate did not exceed the HED's level of concern for either the general US population or any of the sub-populations. The sub-population with the highest exposure was children 1-6 with estimated exposure of 67% of the aPAD (0.000334 mg Dichlorvos/kg bwt/day), while the estimated exposure for the U. S. Population was 29% of the aPAD (0.000145 mg Dichlorvos/kg bwt/day) at the 99.9th percentile. The results are provided in Table 9.

Table 9. Acute Dietary (Food Only) Tier 3 Exposure and Risk Estimates for Dichlorvos.

		95th Percentile		99th Percentile		99.9th Percentile	
Population Subgroup[a]	aPAD, mg/kg	Exposure, mg/kg	% aPAD[b]	Exposure, mg/kg	% aPAD[b]	Exposure, mg/kg	% aPAD[b]
U.S. pop - all seasons:	0.0005	0.000018	4	0.000044	9	0.000145	29
All infants (<1 year):		0.000022	4	0.000087	14	0.000308	62
Children (1-6 years):		0.000034	7	0.000076	17	0.000334	67
Children (7-12 years):		0.000022	4	0.000050	10	0.000167	33
Females (13-50 years):		0.000013	3	0.000032	7	0.000085	17

[a] Population subgroups shown include the U.S. general population, and those of infants, children, and women of child-bearing age.
[b] % aPAD = Exposure (mg/kg) ÷ aPAD (mg/kg) × 100

ii. Chronic Dietary Exposure

A refined DEEM™ chronic exposure analysis was conducted using percent crop treated data and anticipated residues to calculate the chronic dietary exposure estimate for the general population and all subgroups (Hummel, et. al. 2000). Anticipated residues were based on monitoring data from the FDA TDS, the FDA Surveillance Monitoring Program, and from the PDP. Therefore, the Agency has high confidence in the residue data used to estimate chronic dietary exposure.

As mentioned above, OPP has refined its estimates of dietary exposure for various commodities based on percent of crop treated. OPP has refined its estimates of dietary exposure for various commodities using processing factors to account for changes in residue levels during commercial or other processing and during cooking.

(a). Chronic Dietary Risk Estimates (% cPAD)

Tier 3 anticipated residues (which also incorporated % CT information, monitoring data from the PDP and the FDA Surveillance Monitoring Program, and field trial data were used to estimate chronic dietary exposure. The chronic exposure/risk estimate did not exceed HED's level of concern for either the general US population or any of the sub-populations. The resulting risk estimate for all sub-populations and the general US population was below 100% of the cPAD. The sub-population with the highest exposure was children 1-6 with 2% of the chronic population adjusted dose (cPAD) (0.000004 mg Dichlorvos/kg bwt/day), while the estimated risk to the U.S. Population was 1% of the aPAD (0.000002 mg residue/kg bwt/day). The results are provided below in Table 10.

Table 10. Chronic Dietary (Food Only) Tier 3 Exposure and Risk Estimates for Dichlorvos.

Population Subgroup[1]	cPAD, mg/kg/day[2]	Exposure, mg/kg/day	% cPAD
U.S. Population (total)	0.00017	0.000002	1
All infants (< 1 year)		0.000003	2
Children 1-6 yrs		0.000004	2
Children 7-12 yrs		0.000002	1
Females 13-50 yrs		0.000001	1

[1] Population subgroups shown include the U.S. general population, and those of infants, children, and women of child-bearing age, and other, representative populations whose exposure exceeds that of the U.S. general population.
[2] % cPAD = Exposure (mg/kg) ÷ cPAD (mg/kg) × 100

(b). Dietary Cancer Risk Estimates

No dietary cancer risks for Dichlorvos were estimated. The Carcinogenic potential of Dichlorvos has been classified as "suggestive" under the 1999 Draft Agency Cancer Guidelines and no quantitative assessment of cancer risk is required. (Stewart J. 2000).

iii. Uncertainties in Dietary Exposure Assessment

The Agency believes the exposure and risk assessment presented in this document is the most refined to date for acute and chronic dietary exposure to Dichlorvos as a result of use of Dichlorvos, Naled, and Trichlorfon. However, there are some uncertainties associated with this exposure assessment as follows:

(a). The consumption database used in the dietary exposure analysis (CSFII, 1989-1992) has a limited number of individuals in the age group infants less than one year old (approximately 100). The USDA is currently conducting the Supplemental Children's Survey (approximately 5000 children).

(b). The dietary exposure analyses relied primarily on monitoring data obtained either "at the farmgate" in the case of FDA surveillance monitoring data or in regional

distribution warehouses for PDP data. Residues potentially present on items purchased at roadside produce stands or farmer's markets are not represented in this analyses. Although cooking data were available and were used, there may be differences in the amount of reduction of Dichlorvos residues as a result of cooking.

(c). Samples collected for the FDA Total Diet Study were collected in supermarkets in only four cities per year. Residues found in food in other locations may be different.

(d). Very little monitoring data are available for fumigated commodities. Extensive translation was done from one fumigated commodity to another.

(e). For the commodities for which field trial data were used, the residues of Dichlorvos are probably over-estimated. Dichlorvos is expected to dissipate fairly rapidly.

D. Drinking Water Exposure

I. Sources of Dichlorvos Residues in Water

Dichlorvos residues can be present as a result of use of three pesticides: Dichlorvos (DDVP), Naled, and Trichlorfon. Dichlorvos is a degradate of Naled and Trichlorfon. The Environmental Fate and Effects Division (EFED) evaluated the potential for Dichlorvos to contaminate water from these sources. The environmental fate properties of Dichlorvos, Naled, and Trichlorfon are indicators of the potentials of these compounds to migrate to ground or surface water. These fate properties are described below.

ii. Fate Properties of Dichlorvos, Naled, and Trichlorfon

(a). Dichlorvos

The major mode of dissipation of Dichlorvos is volatilization from soils because Dichlorvos has a vapor pressure of 1.2×10^{-2} mm Hg under field conditions. Also, acceptable laboratory studies indicate rapid dissipation through volatilization. Dichlorvos appears to degrade through aerobic soil metabolism and abiotic hydrolysis as well, but these processes are secondary to volatilization. Hydrolysis is pH dependent where the half-lives were 11 days at pH 5, 5 days at pH 7 and 21 hours at pH 9. Aerobic soil metabolism data showed a half-life of 10 hours; 2,2-dichloroacetic acid was the major metabolite. However, an acceptable soil TLC study indicates that Dichlorvos is moderately mobile (K_d's ranging 0.3 to 1.2) based on the Heiling and Turner's mobility classification. The potential of Dichlorvos to leach to ground water is mitigated by its rapid degradation. However, Dichlorvos has the potential to contaminate surface waters because of a low K_{oc} value and high water solubility (10×10^3 ppm). Substantial fractions of run-off will more than likely occur via dissolution in run-off water rather

than adsorption to eroding soil. Despite the potential for contamination, Dichlorvos should not be persistent in any surface waters due to its susceptibility to rapid hydrolysis and volatilization.

(b). Naled

Chemical hydrolysis and biodegradation are the major processes involved in the transformation of Naled and its degradates in the environment. Dichlorvos forms from Naled by indirect photolysis in water and soil. In the presence of photosensitizer in water, as much as 20% of the applied dose of Naled can be found as Dichlorvos after 1 day, with rapid decline of Dichlorvos residues afterwards. Under anaerobic aquatic conditions, Dichlorvos can be as high as 15% of the applied Naled dose after 1 day. The degradation of Dichlorvos formed from Naled under anaerobic conditions is slower (half-life 0.9 days) than under aerobic conditions.

(c). Trichlorfon

Dichlorvos is formed from Trichlorfon in soil by aerobic soil metabolism, and in water hydrolysis studies. Environmental fate data indicate that Trichlorfon degrades rapidly in aerobic soil ($t_{1/2}$ ~ 1.8 days) under non-sterile conditions; however, in a sterile soil, Trichlorfon was stable ($t_{1/2}$ > 40 days). Abiotic hydrolysis studies indicate that Trichlorfon degrades rapidly in aqueous media and that the rate of hydrolysis is pH dependent. The estimated hydrolysis half-life of Trichlorfon is 31 minutes at pH 9, and 34 hours at pH 7, and 104 days at pH 5 from the EFGWB 1-liners database. This indicates the stability of Trichlorfon to hydrolysis under acidic conditions. The maximum amount of Dichlorvos formed from Trichlorfon by aerobic aquatic metabolism is approximately 56 percent of the amount of Trichlorfon originally applied at pH 8.5. This value was chosen because it maximizes the application rate for Dichlorvos and provides a conservative estimate for potential groundwater contamination.

iii. Groundwater

EFED has limited monitoring data on the concentrations of Dichlorvos, Naled or Trichlorfon in groundwater. Validated monitoring data for Dichlorvos, Naled, and Trichlorfon are available for the states of California and Hawaii from the Pesticides in Groundwater Database (USEPA 1992). These data indicated that Naled, Dichlorvos, or Trichlorfon have not been detected in groundwater. These data were not targeted to the pesticide use area. These data are presented in Table 11 below.

Table 11. Groundwater monitoring data for Dichlorvos, Naled, and Trichlorfon showing number of wells sampled (number of wells with residues) (USEPA 1992)

	Naled	Dichlorvos	Trichlorfon
California	83 (0)	20(0)	280 (0)
Hawaii	3 (0)	7 (0)	

Because the groundwater monitoring data for Dichlorvos are limited, EFED used the Tier I **SCI-GROW** screening model to estimate concentrations of Dichlorvos in groundwater. This model shows that Dichlorvos, Naled, and Trichlorfon will not be found in significant concentrations in groundwater. Concentrations of these compounds were calculated based on a maximum annual application rate of 0.2 lb a.i./acre for Dichlorvos (turf), 9.375 lb a.i/acre for Naled (the use rate on Cole crops), and 8.17 lb a.i./acre for Trichlorfon (turf). The amount of Dichlorvos formed as a degradate of Naled was estimated to be 20% of Naled. Therefore, a conservative Dichlorvos use rate was estimated by using Naled's use rate multiplied by 0.20. The amount of Dichlorvos formed as a degradate of Trichlorfon was estimated to be 56% of Trichlorfon, which is the maximum percent of Dichlorvos (56%) formed as a Trichlorfon degradate determined from the Trichlorfon aerobic aquatic metabolism at pH 8.5. The amount of Dichlorvos formed as a Trichlorfon degradate was estimated by multiplying the maximum application rate for Trichlorfon (8.17 lb a.i/acre) by 56%. Because groundwater concentrations of Dichlorvos were estimated using a Tier I screening model, EFED has moderate confidence in the groundwater assessment.

Table 12. Estimated Dichlorvos Concentrations in Groundwater.

Source of Dichlorvos Residues	Modeled Groundwater Concentration, µg/L
Dichlorvos Applied 1/week	0.004
Dichlorvos Applied Every Other Day	0.015
Dichlorvos (from Naled)	0.0002
Dichlorvos (from Trichlorfon)	0.01

There may be exceptional circumstances under which groundwater concentrations could exceed the SCI-GROW estimates. However, such exceptions should be quite rare since the SCI-GROW model is based exclusively on maximum groundwater concentrations from studies conducted at sites and under conditions which are most likely to result in groundwater contamination. The groundwater concentrations generated by SCI-GROW are based on the largest 90-day average recorded during the sampling period. Since there is relatively little temporal variation in groundwater concentrations compared to surface water, the concentrations can be considered as appropriate for acute and chronic risk assessment.

iv. Surface Water

Dichlorvos may reach surface water as a result of use of three pesticides: Dichlorvos (DDVP), Naled and Trichlorfon. In the event that all of these pesticides are used in the same use area, then the contribution for each chemical should be incorporated in any risk assessment.

OPP does not have any surface water monitoring data on the concentrations of Dichlorvos, Naled, or Trichlorfon at the present time. Therefore, the GENEEC model was used

to estimate surface water concentrations for Naled, Trichlorfon and Dichlorvos. GENEEC is a Tier I model used to screen pesticides to determine which ones potentially pose risk to warrant higher level modeling (Parker et al. 1995). The GENEEC model provides upper-bound values on the concentration that might be found in ecologically sensitive environments due to the use of pesticides. GENEEC is a single event model that simulates one runoff event, but it can account for spray drift from multiple applications. GENEEC represents a 10 hectare field immediately adjacent to 1 hectare pond that is 2 meters deep with no outlet. The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 10% of the applied pesticide into the pond. This amount can be reduced due to degradation on the field and by soil sorption. Spray drift is estimated at 5% of the application rate.

Turf was used as the site of interest for Trichlorfon. General outdoor uses (including turf) were used as the site of interest for Dichlorvos. Eight crops were simulated for Naled. The modeling results indicate that all these compounds have the potential to contaminate surface waters by runoff, for short periods of time especially in areas with large amounts of annual rainfall. However, based on its environmental fate characteristics, Naled will degrade/dissipate rapidly ($t_{1/2}$ < 1 day), Trichlorfon and Dichlorvos will persist slightly longer ($t_{1/2}$ 1.4 and ~ 5 days, respectively). Mitigation practices that reduce runoff could be effective in reduction of these chemicals transport into surface waters.

Table 13. Estimated Environmental Concentrations (EECs) for Dichlorvos based on GENEEC Model

Source of Dichlorvos Residues	Acute Surface Water Concentration, µg/L (ppb)	Chronic Surface Water Concentration, µg/L (ppb)
Dichlorvos	0.435	0.060
Naled-derived Dichlorvos	16.5	2.2
Trichlorfon-derived Dichlorvos	81.7	11.7

E. Drinking Water Risk Estimates

I. Drinking Water Levels of Comparison

HED has calculated drinking water levels of comparison (DWLOCs) associated with acute and chronic exposure to Dichlorvos in drinking water. These DWLOCs will be compared with the estimated environmental concentrations (EECs) of Dichlorvos in water. The DWLOC is the concentration of a chemical in drinking water that would be acceptable as an upper limit in light of total aggregate exposure to that chemical from food, water, and residential sources. The acute DWLOC for Dichlorvos includes aggregate exposure from food and water only. The chronic DWLOC includes residential exposure.

The $DWLOC_{acute}$ was calculated for the general population, All Infants, Children (1-6 years), who are the most highly exposed population subgroup, and for females (13-50 years). Acute water exposures and DWLOC calculations are summarized in Table 14 below.

$$DWLOC_{acute}\ (\mu g/L) = \frac{\text{acute drinking water exposure (mg/kg/day) x body weight (kg)}}{\text{Water consumption (L/day) x } (10^{-3}\ mg/\mu g)}$$

where body weight is 70 kg for adults, 60 kg for females (13-50) and 10 kg for children and water consumption is 2 L per day for adults and 1 L per day for children. And acute water exposure = aPAD - acute food exposure, where aPAD is 0.0005 mg/kg/day.

Table 14. Summary of $DWLOC_{acute}$ Calculations for Dichlorvos.

DEEM Population Subgroup	Acute Dietary Exposure to Dichlorvos at 99.9th %tile, mg/kg/day	Allowable Water Exposure, mg/kg/day	$DWLOC_{acute}$, µg/L
US Population	0.000145	0.000355	12
All Infants	0.000308	0.000192	1.9
Children (1-6)	0.000334	0.000166	1.7
Females (13-50)	0.000085	0.000415	12

The cPAD of 0.00017 mg/kg/day for Dichlorvos would be used to calculate a $DWLOC_{chronic}$ for Dichlorvos, using the following formulae:

$$DWLOC_{chronic}\ (\mu g/L) = \frac{\text{(chronic water exposure, mg/kg/day)(body weight)}}{\text{(water consumption, L/day)}(10^{-3}\ mg/\mu g)}$$

where body weight and water consumption values are as given above
and chronic water exposure = cPAD - (chronic food + residential exposure).

The calculation cannot be done, since chronic exposure exceeds our level of concern without considering water exposure, due to residential use of resin pest strips alone. The $DWLOC_{chronic}$ would effectively be zero.

DWLOCs were not calculated for short or intermediate term exposure. Because the short and intermediate term residential exposure scenarios are associated with risks of concern, the DWLOCs would effectively be zero. It should be noted that both food and water exposure are negligible compared to the residential exposure.

ii. Drinking Water Risk Estimates

As mentioned above, the acute and chronic DWLOCs are compared with the estimated environmental concentrations (EECs) of Dichlorvos in water to determine if there is a risk concern.

For acute drinking water exposure, the modeled groundwater concentrations of 0.0002 to 0.015 µg/L for Dichlorvos resulting from the use of Dichlorvos, Naled, and Trichlorfon, are less than the $DWLOC_{acute}$ of 12 µg/L for the U. S. population and females (13-50), the $DWLOC_{acute}$ of 1.9 µg/L for all infants, and the $DWLOC_{acute}$ of 1.7 µg/L for children (1-6 years). The conservative Tier I estimates of ground water concentration provided by the SCI-GROW model are not of risk concern. However, the estimated environmental concentration of Dichlorvos in surface water, resulting from the turf use of Trichlorfon, of 81.7 µg/L and the estimated environmental concentration of Dichlorvos in surface water, resulting from the agricultural uses of Naled of 2.2 µg/L, from the GENEEC models indicates a potential risk concern. There is no risk concern from the estimated environmental concentration of Dichlorvos in surface water, resulting from the use of Dichlorvos, of 0.060 µg/L.

For chronic drinking water exposure, the modeled groundwater concentrations of 0.0002 to 0.015 µg/L exceed the $DWLOC_{chronic}$ of zero µg/L. The modeled surface water concentrations of Dichlorvos (0.06 µg/L) and of Naled and Trichlorfon-derived Dichlorvos (2.2 and 26 µg/L, respectively) also exceed the $DWLOC_{chronic}$ of zero µg/L. The $DWLOC_{chronic}$ value is driven by the chronic residential inhalation exposure to Dichlorvos from resin pest strips, for which the chronic exposure exceeds our level of concern without considering water exposure. As mentioned above, food and water exposure to Dichlorvos is minimal compared with residential exposure. Therefore, any water exposure will add mimimally to exposures and risks of concern.

F. Occupational Exposure and Risk Estimates

Pesticide handlers and workers reentering treated areas may be exposed to Dichlorvos during the following scenarios: crack and crevice treatment by certified pest control operators, coarse spray application to mushroom houses and greenhouses, warehouse treatments, food manufacturing and processing facilities, worker re-entry to mushroom houses and greenhouses, worker re-entry into food manufacturing and processing facilities, application to domestic animals, such as cattle or poultry, application to domestic animal premises, such as dairy barns, re-entry into domestic animal premises, application to feedlots, application to manure piles, application to lawns, turf, and ornamental plants, and post-application gardening work with lawns, turf, and ornamental plants. Occupational exposure and risk estimates are presented in Table 15 below.

Risk is expressed as a Margin of Exposure (MOE)

$$MOE = \frac{NOAEL}{Exposure}$$

where both the NOAEL and the Exposure are expressed in mg/kg/day, and the target MOE for all occupational scenarios is 100. Both short term and intermediate term dermal exposures include a dermal absorption factor of 11%, because the exposure is compared to an oral NOAEL.

The risk assessment has been changed to use the North American Free Trade Agreement (NAFTA) recommended breathing rate rather than the rate recommended in the Occupational and Residential Guidelines, Series 875, Group A, OPPTS 875.1300 and OPPTS 875.1400 (formerly known as Subdivision U Guidelines). The guidelines recommend a breathing rate of 29 L/min (1.7 m^3/hr), whereas the new NAFTA policy recommended breathing rates are 16.7 L/min (1.0 m^3/hr) for moderate activities. The default breathing rate in PHED 1.1 is 25 L/min (1.5 m^3/hr), but the PHED Surrogate Tables used the recommended breathing rate of 29 L/min (1.7 m^3/hr). This change increases the inhalation MOEs, and therefore decreases the estimated risk to occupational and residential handlers. PHED runs for Dichlorvos were done using the PHED default breathing rate and the MOEs have now been corrected to use the NAFTA inhalation rate.

The risk assessment has been changed to use the recommended body weight of 60 kg instead of 70 kg for the short term risk assessments, because the endpoint used is from a developmental study. This slightly increases the estimated exposure and decreases the MOEs. Intermediate term risk assessments use the recommended body weight of 70 kg.

i. Crack and Crevice Treatment in Homes

(a). Application

Exposure and risk analyses were conducted for commercial applicators only (Jaquith 1998g). The registrant, AMVAC, has indicated that they do not intend to market Dichlorvos for homeowner use for this scenario. Information obtained from the National Pest Control Association (NPCA) indicated that Dichlorvos is used only one day per week by PCOs, resulting in a short term exposure scenario (Rambo, 1987). Exposure and risk were calculated by adding inhalation and absorbed dermal dose and comparing the resulting total exposure with the NOAEL.

Exposure estimates for crack and crevice treatment with Dichlorvos, using a hand-held low pressure sprayer, were obtained from PHED (Ver 1.1). The absorbed dermal dose was estimated to be 0.011 mg/kg/day, and the inhalation dose 0.0071 mg/kg/day, with a total exposure of 0.0018 mg/kg/day and a total MOE of 5 (See Table 15, i). The MOE for crack

and crevice treatment in homes (by certified pest control operators) is less than the target MOE of 100, and the exposure exceeds the Agency's level of concern.

(b). Post-application

(See Residential Section.)

ii. Mushroom House

(a). Application

An average mushroom house has a volume of 30,000 ft^3 (Dow, M., 1985). Dichlorvos is applied at a rate of 2.0 grams of active ingredient per 1000 ft^3 or 60 grams per treatment; 16 days per year, 10 houses per day; 4 minutes per house or 40 minutes per day. Protective clothing was slightly different for each application method, long pants, long sleeved shirt and gloves. The label does not specify protective clothing needed.

Application of Dichlorvos to mushroom houses may be made by hand-held fogger, coarse spray and paint-on applications. Exposures using several types of application equipment were evaluated, including the hand-held fogger, a hand-held sprayer, several backpack sprayers, and a portable sprayer on a cart. The registrant has recently submitted a request for voluntary deletion of the hand-held fogger use under FIFRA Section 6(f). However, the request has not been processed because clarifications were needed on the use patterns being supported. The exposures for coarse spray and paint-on applications were derived from PHED (V1.1). Estimates of the surface areas that would be painted or sprayed during Dichlorvos application were derived from mushroom culture textbooks and are considered to be conservative (Jaquith 1998d and n). This application scenario is considered to be intermediate term (one week to several months) because a single individual may treat different mushroom houses on different days due to the cyclic nature of mushroom culture. An applicator is assumed to weigh 70 kg. (Jaquith 1998n)

Hand-held Fogger. The exposures for the hand held fogger application were based on surrogate data from a pulse fogger application. The applicators were wearing chemical resistant protective clothing (coveralls) over long sleeve shirt and long pants, gloves, boots, goggles, and a respirator. Patches were both outside and inside the clothing. The air samples were collected outside the respirator (Nigg, 1987). There were only 3 replicates in the study in which pulse fogging was used. Therefore, this must be considered to be a very low confidence data set. There are no data in the Pesticide Handler Exposure Database (PHED) addressing the use of a hand held fogger, and no chemical specific data. The resulting absorbed dermal exposure, would be 0.071 mg/kg/day. Inhalation exposure is expected to be negligible because of the respiratory protection. The measured air concentrations outside the respirator would result in inhalation exposure estimates two orders of magnitude below the dermal exposure estimates. The dermal and total MOE was 1.4 with a target MOE of 100). These MOEs are of concern. (Jaquith, 1993a, Jaquith, 1998d).

Coarse Spray and Paint-on Applications. For the coarse spray, data from PHED Version 1.1 were used; protective clothing was slightly different for each application method, long pants, long sleeved shirt and gloves. The label does not specify protective clothing needed. The inhalation exposures ranged from 0.0012 to 0.0035 mg/kg/day and absorbed dermal dose ranged from 0.0016 to 0.0068 mg/kg/day, depending on application equipment (Jaquith 1998n). Dermal and inhalation exposure, and total exposure with MOEs of 5 to 18 are considered to be of concern, compared to the target MOE of 100. If an additional layer of protective clothing were added, the absorbed dermal dose would be cut in half, 0.0008 to 0.0034 mg/kg/day, for a total exposure of 0.0020 to 0.0069 mg/kg/day, with MOEs of 7.3 to 25. The most likely application equipment is the portable sprayer on a cart, which has the lowest MOE.

(b). Post-application

For reentry exposure, it was assumed that a worker reenters a ventilated mushroom house 24 hours after treatment and is exposed for 8 hours. The post-application exposures for mushroom houses were derived from information from a textbook on mushroom culture and a study conducted by the California Department of Food and Agriculture (CDFA), now called the California EPA (CalEPA) in which air and surface residues were measured in mushroom houses where Dichlorvos had been applied (Maddy 1981, Jaquith 1998d). The surface residues measured did not decline with time, and there was no clear trend in the air concentrations. Air samples were collected at 30 minutes, and 1, 3, 6, 12, and 24 hours. Only two samples were taken at the 24 hour sampling period. The transfer coefficient was obtained from the ExpoSAC policy 003, to be 2500 cm^2 /hr. Because of the aeration pattern of mushroom houses, the volatility of Dichlorvos, and dissipation of Dichlorvos in mushroom houses, this is considered to be a short-term exposure scenario. Respirators are not worn during reentry. Workers are assumed to weigh 60 kg. The exposures following a 24 hour reentry interval were 0.0010 kg/day and 0.0021 mg/kg/day for the dermal and inhalation routes, respectively, with a total MOE of 32, which is of concern, compared to the target MOE of 100. MOEs for re-entry intervals longer than 24 hours cannot be calculated, because no data were provided for reentry intervals longer than 24 hours, and no decline in Dichlorvos air concentrations was demonstrated.

iii. Greenhouse

(a). Application

Application of Dichlorvos to greenhouse plants was previously allowed by hand-held foggers and by smoke generators. The Registrant has recently submitted a request for voluntary deletion of the hand-held fogger use under FIFRA Section 6(f). However, the request has not been processed, because clarifications were needed on the use patterns being supported. Total release foggers and smoke generators are considered to result in negligible exposure since the applicator vacates the premises immediately upon activation of the foggers. This application

scenario is considered to be short term because treatment would not be expected to occur in a given greenhouse more than once a week.

The specifications for greenhouse applications are slightly different than those for mushroom houses. A typical greenhouse operation consists of seven greenhouses, each with a volume of 85,000 ft^3 (Dow, M., 1985). All seven greenhouses are assumed to be treated in 1 day. Dichlorvos is applied at the rate of 1.4 grams of active ingredient per 1,000 ft^3. Workers were assumed to be wearing coveralls, hood, gloves, apron, boots, goggles, and a respirator. The exposures for the hand held fogger application were based on surrogate data from a pulse fogger application, the same surrogate study used for mushroom houses. (Jaquith, 1998d). The resulting total exposure, would be 0.12 mg/kg/day. This is a short term exposure scenario because dichlorvos would dissipate before another application would be made. The MOE is 0.66 (Target MOE = 100), which is of concern.

(b). Post-application

The dermal exposure for reentry into greenhouses following the use of Dichlorvos was obtained using data from a greenhouse culture textbook, data on turf transferable residues from a Chlorpyrifos/Dichlorvos study (Goh, K. S., et. al. 1986), and a transfer coefficient of 10000 cm^2/hr, from the ExpoSAC Policy 003. Inhalation exposure estimates were modeled assuming the initial concentration at the maximum rate, assuming first order kinetics and an air exchange rate from a textbook (Mastalerz, 1977). Because of the volatile nature of Dichlorvos, this is considered to be a short-term exposure scenario.

The exposures after 10 hours were estimated to be 0.0007 mg/kg/day via the dermal route and 7.6×10^{-5} mg/kg/day by the inhalation route. The MOE for total exposure (with re-entry at 10 hours) is 130, which is not considered to be of concern (target MOE = 100).

iv. Domestic Animal Premises (food and nonfood) and Direct Animal Sprays, Feedlots, Manure Treatment, Garbage Dumps, and Baits

(a). Application

Dairy barn application and direct application to dairy cattle were used as the reference facility for these exposure assessments (Jaquith 1998l). There are no data addressing the use of Dichlorvos in other types of animal facilities. Worker exposure from direct application to animals is based on dairy cattle treatment. Although permitted on product labels, the Agency does not believe that direct application to livestock animals with a handheld sprayer is used. Rather, some type of automated equipment is used to apply Dichlorvos directly to animals. Space and premise treatments also help control insects on animals. Since several registered products provide guidance on use with a handheld sprayer, the exposure and risk are estimated here for that application method, which is expected to result in a much higher exposure than automated methods. While some labels indicate that daily application (probably for direct

application to cattle) is allowable, the use assessment indicates that the material is applied at 2 week intervals (Dow, M., 1985). This assessment assumes daily applications over several months. This is considered to be an intermediate term scenario.

Cattle. Exposure assessments for direct application to dairy cattle using hand-held sprayers were conducted using PHED V1.1. Applicators were assumed to be wearing long sleeved shirt, long pants, and gloves. Gloves are not currently required on the label and must be added. Absorbed dermal doses were estimated to range from 0.000024 to 0.0037 mg/kg/day and respiratory doses from 0.000025 to 0.00010 mg/kg/day, depending on application equipment. These total MOEs would range from 120 to 2000, and are not considered to be of concern.

Poultry. Applicator exposure data for cattle cannot be extrapolated to poultry, because of the different application method and less frequent applications. Individual animals are less likely to be treated directly and the equipment is more likely to be automated. As a result, exposure from applying Dichlorvos to poultry is expected to be much lower than for cattle.

Domestic Animal Premises. Barn sizes were obtained from the Dichlorvos QUA (Dow, M., 1985). Assuming that a worker wears long sleeve shirt, long trousers, shoes and impervious gloves at a minimum, risks from Dichlorvos application to domestic animal premises are lower than the risks from direct application to cattle, with total MOEs from 620 to 4800, and do not exceed the Agency's level of concern, either, except for the use of one type of backpack sprayer (see Table 15). Gloves are not currently required on all Dichlorvos labels and must be added.

Feedlots include stockyards, corrals, holding pens and other areas where large groups of animals are contained. EPA assumes that some type of power sprayer capable of treating a large number of animals in a short time is probably used. A short application time period in an outdoor or partially enclosed area would minimize exposure to less than that of dairy applications.

Manure Treatment. The application equipment used for manure applications may be similar to those used in a dairy barn; however, the application time would probably be less and the treated area would be well ventilated - either outdoors or in a partially enclosed area. The MOE for applicators is expected to be greater than 100 for manure use.

(b). Reentry

There are no data addressing potential reentry into animal facilities. Re-entry exposure to animal premises would not be expected to exceed reentry exposure for greenhouses, and would be expected to be considerably less, since animal premises are usually outdoors or well ventilated, where minimal dermal contact is expected.

v. Lawns, Turf, and Ornamental Plants

(a). Applicator

There are no registered homeowner uses. Dichlorvos is applied only by PCOs in tank mixtures with Chlorpyrifos. We note that the use of Chlorpyrifos on home lawns has been canceled. The types of equipment used and clothing worn by lawn care operators is likely to be long sleeve shirt, long pants, and gloves. Protective clothing is not specified on the label. There are no chemical specific data addressing the potential exposures of commercial lawn care operators to Dichlorvos. The Outdoor Residential Exposure Task Force (ORETF) has recently completed several surrogate mixer/loader/applicator studies addressing lawn care operators (LCOs). (Bangs, 2001; Jaquith, 2001). Applications at 0.5 lb ai/A can be made by hose-end spraygun or by a granular push-type spreader. An applicator is assumed to treat 5 acres per day. This is a short term exposure scenario, because the applicator would not be expected to apply Dichlorvos daily for a long period of time.

If 5 acres are treated with a liquid formulation per day at a rate of 0.5 lb ai/A, the total exposure of would be 0.0023 mg/kg/day, and total MOE of 50, would be of concern, compared to the target MOE of 100. If coveralls were added, the total exposure would be 0.0017 mg/kg/day, and the total MOE, 90, which is of concern, compared to the target MOE of 100.

For a granular formulation, applied with a cyclone spreader, the total exposure would be 0.0011 mg/kg/day, and total MOE would be 83, which is of concern, compared to the target MOE of 100. If coveralls were added, the total exposure would be 0.00069 mg/kg/day, and total MOE, 140, which is not of concern, compared to the target MOE of 100.

(b). Post-Application

The assessment was conducted by using dislodgeable foliar residue information from three foliar residue studies submitted by the registrant, discussed further below under **(d). Lawns, Turf and Ornamental Plants - Post-Application**. The dermal MOEs from the three sites (CA, FL, and Ontario) are 25 to 850 (average MOE 61), compared to a target MOE of 100.

Reentry exposure to commercial turf farms is considered to be negligible because of cultural practices in such facilities. The primary reentry activities in a commercial turf farm are mowing and the cutting of sod. The characteristics of Dichlorvos make it unlikely that such a product would be used immediately preceding such activities.

vi. Food Manufacturing Plant and Warehouse Treatment

(a). Application

Dichlorvos can be applied to warehouses with wall-mounted automatic foggers. Exposure to mixer/loaders through automatic application is expected to be negligible; however, there would still be reentry exposure. For hand held fogger use, see Greenhouses.

(b). Post-application

In estimating reentry exposure, EPA assumed 24 hours elapsed before reentry is allowed, as per recent label changes; and that workers in food manufacturing plants spend 8 hours per day in the treated area for the next 3 days. Dichlorvos is applied at the rate of 2.0 grams active ingredient per 1,000 ft^3 over a period of 125 minutes per application. A Dichlorvos study was conducted. Dichlorvos was applied at the rate of 2.4 grams active ingredient per 1,000 ft^3 in the study. Hand rinses were done and air concentrations were measured at 0, 3, 6, 10, and 22 hours after application. Exposure estimates are for the day following treatment. Absorbed dermal exposure was measured for the hands only and represents an average of the total exposure measured for three work stations, and was considered negligible compared to the inhalation exposure. Inhalation exposure was calculated by integration of the air concentration decline curve over an 8 hour workday, reentering the facility after 24 hours had elapsed. This exposure scenario was considered to be short term due to rapid dissipation of Dichlorvos. (Jaquith, D., 2000a; Jaquith, D, 1993)

For a 24 hour reentry interval to Food Manufacturing plants, the inhalation exposure was 0.019 mg/kg/day. The total MOE of 5.3 is of concern. Re-entry intervals longer than 24 hours are not considered practical.

For a 24 hour reentry interval to Warehouses, assuming the worker spends 60 minutes in the warehouse, the inhalation exposure was 0.0022 mg/kg/day. The total MOE of 53 is still of concern, compared to the target MOE of 100.

vii. Insect Traps

Exposure is believed to be negligible since the pesticide is in the form of an impregnated strip in a sealed package, which is opened and the applicator leaves, and the traps are placed in outdoor areas (such as forests) where there is no human exposure.

G. Residential Exposure and Risk Estimates

Dichlorvos is registered for several residential uses. Resident handlers may be exposed to Dichlorvos during application of Dichlorvos in pressurized aerosol spray cans.

Residential post application exposure may occur after use of the following products containing Dichlorvos: pressurized aerosol spray can, total release fogger, crack and crevice treatment, resin pest strips, and pet flea collars. Residential Exposure and Risk Estimates are summarized in Table 15 below. Information sources and major assumptions for each residential scenario are described below. Additional information is available in the referenced documents (Jaquith 1998a through n). Dichlorvos exposure from the use of Trichlorfon is included in this document. Although exposure could result from the use of Naled, any exposure to Dichlorvos from the use of Naled would be covered by the Naled Risk Assessment.

Residential Scenarios which were evaluated were short term exposure scenarios or long term exposure scenarios. A NOAEL of 0.1 mg/kg/day from a developmental rabbit study is used for short term inhalation and dermal risk assessment. Also, 11% dermal absorption is assumed for the dermal risk assessment. The target MOE for all residential scenarios is 300.

The long-term inhalation NOAEL of 0.05 mg/kg/day from a chronic rat study was used to calculate the risks for the long-term inhalation exposure scenario (resin pest strips) because exposure is expected to occur primarily via inhalation. The target MOE is 300.

i. Residential Handler

(a). Pressurized Aerosol Spray Can

The exposure assessment for pressurized spray cans was derived from data in the Pesticide Handlers Exposure Database (PHED V1.1) and the Residential SOPs for aerosol application. Resident use of pressurized aerosol product is based on application of an entire 16 ounce pressurized aerosol can of 0.5 percent Dichlorvos (Jaquith 2001; Jaquith 1998f). This is a short term exposure scenario.

Pressurized aerosol products containing Dichlorvos do not list any clothing requirements, therefore the Agency is assuming that Dichlorvos is applied during hot weather when an individual will be wearing the least amount of clothing consistent with current HED policy (i.e., shorts, short sleeve shirt, and shoes). Unit dermal exposures were 220 mg/lb ai handled, and 2.4 mg / lb ai handled for inhalation exposure, with a absorbed dermal dose of 0.0017 mg/kg/day. Respiratory exposure was estimated to be negligible compared to the total MOE of 59, which is of concern, compared to the target MOE of 300.

ii. Residential Post-application

(a). Total Release Fogger, Pressurized Aerosol, Crack & Crevice

Post application data from a total release fogger application were used as a surrogate for the post application exposure from pressurized aerosols and crack and crevice

applications. Use of the total release fogger data for the other two scenarios is considered to be conservative.

Indoor residential post-application exposures for short term exposure scenarios were derived from a single study measuring the exposures of individuals performing defined activity patterns (20 minute Jazzercise® routine) following the activation of a total release fogger. This study provides a conservative estimate for short term exposure scenarios from indoor applications of Dichlorvos (Jaquith 1993b). The multi-phase study measured deposition on whole body dosimeters and (in a separate phase) the urinary concentrations of the metabolite dimethyl phosphate (DMP). In order to estimate the potential oral exposure from hand to mouth activity of children, the amount of Dichlorvos measured on the hands in the passive dosimetry phase was considered to be available for ingestion. The passive dosimetry dose on the hands had to be added because the Jazzercise® routine does not include hand-to-mouth activity. The total exposure, including the estimated contribution of hand to mouth ingestion, was 0.017 mg/kg/day (Jaquith 1998k). This is considered to be a short-term exposure scenario. The total exposure from the biomonitoring phase, plus amount of Dichlorvos measured on the hands in the dosimetry phase, was compared to the NOAEL. The resulting MOE for short term exposure was 6.7, which is considered to be of concern. It is recognized that this may be a conservative estimate for other Dichlorvos short term exposure scenarios such as directed applications (pressurized aerosol and crack and crevice treatments). Exposure to children is expected to be the same as that of an adult on a mg/kg basis.

(b). Resin Pest Strips

Several sizes of resin pest strips are marketed. The full size, room size strip is 80 g, containing 14.9 g of Dichlorvos, used to treat 1000 ft^3. Other sizes of resin pest strips are the closet strip, 21 g, containing 3.2 g Dichlorvos; and the cupboard strip, 10.5 g, containing 1.95 g Dichlorvos.

Respiratory exposures resulting from the use of resin pest strips were estimated using a study found in the scientific literature (Collins and DeVries 1973). Fifteen homes were monitored at various time intervals for a period of 91 days. Sampling was done for 20 minutes at the same time on each sampling day. Air monitoring was done in one place in each of the homes, in the same room with the full sized resin pest strip (80 g, containing 14.9 g Dichlorvos). The Dichlorvos measurements declined with time. A decay curve measuring the decline of airborne residues was derived for each of these homes. The resulting equations were integrated over a 120 day period and an average daily concentration was calculated (Jaquith 1998a, 1999d, and 2000). The average air concentration, averaged over this time period was 0.015 mg/m^3. Smaller sized resin strips placed in a closet or cupboard where the door was left open to the room would be expected to have lower concentrations by direct proportion. The 120 day period is the length of time that the resin pest strips remain efficacious. The resin pest strips are replaced as needed. There is no limit to the number of resin strips that can be used in the home. The label suggests that one full sized resin pest strip will treat 1000 ft^3. It was assumed that an individual was present in the home for 16 hours per day, and was exposed for 16 hours, the entire amount

of time spent in the home. This is considered to be a high end estimate and assumes that the Dichlorvos level in the air is the same throughout the home, at any given time. A second calculation was done for a low end exposure estimate, with 2 hours exposure per day. Additional calculations were done for closet sized strips and cupboard sized strips assuming 16 hours of exposure in the room where the closet or cupboard are located.

A more accurate exposure would be possible if air measurements were available from different rooms in the house (i.e., a house profile) . Limited data suggest that the level of Dichlorvos in the air declines with distance from the resin pest strip. There are the data from the Dichlorvos Flea Collar Study that show Dichlorvos levels are lower some distance away from the pet flea collar.

To estimate exposure to Dichlorvos from full sized resin pest strips at the lower end of the range, a second exposure assessment was conducted. Two hours of exposure time was selected as a reasonable estimate of the lower range of potential exposures.

High End exposure estimates from full sized resin pest strips (16 hours exposure per day) and MOEs were calculated for 4 population groups; adult males, adult females, children, age 1-4 years; and children, age 5-11 years. The average exposures were 0.0022 mg/kg/day (MOE = 23), 0.0019 mg/kg/day (MOE = 27), 0.0058 mg/kg/day (MOE = 9), and 0.0039 mg/kg/day (MOE = 13), respectively. These MOEs are all of concern.

Low End exposure estimates from full sized resin pest strips (2 hours exposure per day) and MOEs were calculated for 4 population groups; adult males, adult females, children, age 1-4 years; and children, age 5-11 years. The average exposures were 0.00027 mg/kg/day (MOE = 180), 0.00023 mg/kg/day (MOE = 210), 0.00072 mg/kg/day (MOE = 70), and 0.00049 mg/kg/day (MOE = 102), respectively. These MOEs are all of concern, compared to the target MOE of 300.

AMVAC supports the registration of two smaller sized resin strips in addition to their 80 g full sized resin strip, a 21 g closet sized resin strip, and a 5.25 g cupboard sized resin strip. A full sized (80 g) resin strip in a 1000 ft^3 room will give an average air concentration of 0.015 mg/m^3 over a 90-120 day period. A full sized strip weighing 80 g contains 14.9 g of Dichlorvos (about 19% ai). A smaller strip will give a proportionally smaller average concentration over the same time period. A 21 g strip contains 3.2 g Dichlorvos. In a 1000 ft^3 room, the average air concentration over a 90-120 day period would be 0.015*(3.2/14.9) = 0.0033 mg/m^3. A 5.25 g strip containing 1.0 g Dichlorvos would give an average concentration of 0.0010 mg/m^3. If these small strips were used in closets or cupboards, 0.0033 and 0.0010 mg/m^3 would correspond to the adjoining room concentrations if the closet or cupboard doors were left open.

If the closet or cupboard doors were closed or left open slightly, the adjoining room Dichlorvos concentration would drop, but the concentration inside the closet or cupboard would rise since the air exchange rate inside the closet or cupboard will be lower. Anyone

opening the closet or cupboard would breathe in higher concentrations of Dichlorvos for a brief time. In fact, the average dose inhaled by a resident may not differ by much regardless of whether the closet door is open or closed. Additional analyses for these smaller strips are included in Table 15. Some of the MOEs for the smallest strips are still of concern, compared to the target MOE of 300, 360 for adult males, 310 for adult females, 130 for toddlers, and 260 for children 5-11.

(c). Pet Flea Collars

A flea collars is placed on the pet's neck to protect the pet from fleas over the life of the pet flea collar, 90 days. It is expected that the flea collar will be replaced when it is no longer efficacious.

The assessment for flea collar exposure was derived from a registrant submitted study. The study was done in a laboratory larger than a room in a house. There were 15 cats in the study, all in the same laboratory room. The study included air monitoring at different distances from the animal with the flea collar. The study did not include monitoring of dislodgeable residues from the animal fur. However, inhalation exposure is of most concern because of the high vapor pressure of Dichlorvos. There were a number of technical problems with that study and it is considered a weak data set (Jaquith, 1987). It was assumed that an individual spends 1 hour per day in close proximity to an animal wearing a flea collar and 8 hours per day in the general area (Jaquith 1998c). There are no chemical-specific data with which to estimate dermal exposure from contact with pets.

Respiratory exposures were estimated for 7 population groups; adult males; adult females; children, age 1-2; children, age 3-5; children, age 6-8; males, age 9-11; and females, age 9-11. The corresponding exposures were 0.0015 mg/kg/day (MOE = 33), 0.0013 mg/kg/day (MOE = 38), 0.0037 mg/kg/day (MOE = 14), 0.0033 mg/kg/day (MOE = 15), 0.0027 mg/kg/day (MOE = 19), 0.0026 mg/kg/day (MOE = 19), and 0.0023 mg/kg/day (MOE = 22), respectively. These MOEs are all of concern. Adding estimates of absorbed dermal exposure from dermal contact with the pet will increase the estimated exposure and reduce these MOEs which are already of concern, compared to the target MOE of 300.

An alternative analysis was done for the flea collars, considering flea collars to be a mobile resin strip. A dog collar, containing 2.2 g Dichlorvos, would contain (2.2/14.9) or 0.15x of the amount of Dichlorvos contained in a full sized resin strip. The inhalation component of the exposure can be estimated, by determining the air concentration in the room with the pet based on the weight of the flea collar, and assuming that the resident (adult or child) spends 8 hours per day in the room with the pet. The inhalation MOEs from this assessment were 320 for adult males, 270 for adult females, 230 for children 5-11, and 110 for children 1-4.

In addition, a dermal exposure assessment was done, using an assumption of 5 minutes of vigorous petting of the animal each day, and hand-to-mouth exposure was assessed, using draft ExpoSAC policies. Preliminary data from an ISEA presentation (*Exposure to Children and Adults to Transferable Residues of Chlorpyrifos from Dogs Treated with Flea Control Collars*, by JS Boone, JE Chambers, and J Tyler) are available.

Mississippi State University researchers monitored adults and children (ages 3 to 12 years) exposed to dogs (greater than 10 lbs) that were wearing chlorpyrifos treated pet collars (2.54 grams ai per collar EPA Reg. No. 2724-471). Both biological sampling (urine) from children/adults and transferable residues from the dog were monitored in a total of 24

households. In addition to the biological monitoring, transferable residues were collected from the dog by petting an area of 4 x 10 inches (258 cm^2) for 5 minutes using cotton gloves. Areas sampled included the neck area with the collar, the neck area without the collar (collar removed from dog for sampling), and the posterior back. Transferable residue samples were collected prior to applying the collar and 4 hours, 1, 3, 7, 14, 28, 56, 84, 112, 140, and 168 days after treatment.

Only mean transferable residue data at each sampling interval are available at this time. There was not much variability among the sampling intervals, so the average transferable residue for all sampling intervals, excluding the 4 hour measurement, was used. The unit transferable residue from the area around the neck with the collar averaged 124 µg/g ai. Lower unit transferable residues were found by petting around the neck with the collar removed and petting on the back of the animal. This results in a absorbed dermal exposure estimate of 124 µg/g ai x 2.2 g ai, or 270 µg Dichlorvos. Adjusting for body weight, and the 11% dermal absorption, the dermal exposure estimates would be 0.43 µg/kg bw/day for the adult male, 0.50 µg/kg bw/day for the adult female, 2.0 µg/kg bw/day for toddlers, and 1.3 µg/kg bw/day for children.

To estimate hand-to-mouth exposure for this scenario, the same 270 µg was assumed to be available for hand to mouth exposure. The ratio of the surface area of the hand which ends up in the mouth to the total surface area of the hand is 20 cm^2 / 175 cm^2 = 0.11. So, the hand-to-mouth exposure would be 270 µg x 0.11 surface area ratio x 50% saliva extraction factor = 15 µg, which is divided by the body weight of a toddler (15 kg) for an oral exposure estimate of 1.0 µg/kg bw/day.

The total exposure estimated in this alternative analysis is 0.00075 mg/kg/day for an adult male (MOE =130), 0.00078 mg/kg/day for an adult female (MOE=130), 0.0039 mg/kg/day for a toddler (MOE=26), and 0.0019 mg/kg/day for a child 6-10 (MOE=53). The toddler and children's MOEs are of concern compared to the target MOE of 300.

(d). Lawns, Turf and Ornamental Plants - Post-Application

Residues of Dichlorvos may result from the use of Dichlorvos or from the use of Trichlorfon. Both sources of Dichlorvos were assessed using the same study. Residues of Dichlorvos are expected dissipate rapidly from lawns after treatment. This is a short-term exposure scenario. Because of the high vapor pressure of Dichlorvos, only the dermal exposure was assessed.

The assessment for Dichlorvos use used turf transferable residue (TTR) data from three dislodgeable foliar residue studies submitted by the registrant, conducted in California, Florida, and Ontario, the above mentioned carpet study (Jazzercise), and the residential SOPs (Jaquith 1999c). In the TTR studies, Dichlorvos was applied at 0.5 lb ai/A. Two broadcast applications were made 1 week apart. The dermal exposure for Dichlorvos was obtained from the TTR study and the Jazzercise portion of the carpet study where a total release fogger was

used. Duration of contact and hand to mouth activity was obtained from the Residential SOPs. Estimates assumed that an individual performs activities for 2 hours per day, one occurring one hour after application and the other two hours after application. Oral exposure from hand to mouth activity and dermal exposure estimates were obtained for each interval and summed to yield a total daily exposure. The total transferable residues (TTRs), estimates of oral and dermal exposure for each interval, total daily exposures and resulting Margins of Exposure (MOEs) were determined. The target MOE is 300. Inhalation exposure was considered to be negligible due to rapid dissipation of Dichlorvos under these conditions. In an earlier lawn study, Maddy found no detectable residue of Dichlorvos in the air above the lawn 2 hours after application (Jaquith 1998m), thus no inhalation component was added to the risk assessment.

To account for the possibility of oral exposure in children resulting from hand to mouth activity it was assumed that the turf transferable residues would be available for oral exposure (Jaquith 1999c). These were added to the dermal exposure estimates to yield a total exposure. The dermal exposure estimates were derived from the turf transferable residues and a regression equation from a biological monitoring study on carpet (Jazzercise). Calculations were done separately for each hour of exposure, The calculations have been updated to be consistent with the revised Residential SOPs. The estimated exposures in California were 0.00016 mg/kg/day (MOE = 630); in Florida were 0.000036 mg/kg/day (MOE = 2800); and in Ontario were 0.0012 mg/kg/day (MOE=83). The average exposure was 0.00047 mg/kg/day (MOE = 210). The MOE for Ontario and the average MOE are of concern, compared to the target MOE of 300, although it should be noted that residues of Dichlorvos dissipated rapidly from grass, with a half-life of 0.022 days (0.53 hours) to 0.156 days (3.7 hours). Additionally, the estimates are conservative because they are based on the initial transferable residue at the reentry time and 1 hour later.

Dichlorvos from the use of Trichlorfon. In addition to post application exposure from the use of Dichlorvos on lawns, post application exposure to Dichlorvos from the use of Trichlorfon was assessed. (Leighton, T., 2000). A Trichlorfon study was conducted, but Dichlorvos was not measured in that study, instead the Dichlorvos turf transferable residues were modeled using the half-lives of Dichlorvos from a Dichlorvos study. Even though Dichlorvos degrades rapidly, with a vapor pressure of 10^{-2} mm Hg at 20 C, it is transferable from turf. Dichlorvos TTRs are above the detection limit for Dichlorvos up until 24 hours after treatment.

The assessment for Dichlorvos from Trichlorfon use used the Dichlorvos half-lives from the same dislodgeable foliar residue study for Dichlorvos, Trichlorfon total transferable residues (TTR) residues from a Trichlorfon dislodgeable foliar residue study (Dichlorvos residues were not measured in this study), and the Residential SOPs. Trichlorfon was applied at 8.1 lb ai/A. The initial TTR of Trichlorfon was 0.0829 $\mu g/cm^2$. TTRs of Dichlorvos were modeled using the calculated half-lives of Trichlorfon and Dichlorvos. The calculations were done using a spreadsheet-based model developed by EFED to estimate the decay rate of a chemical and its degradate applied to short grass for single or multiple applications. A first order decay assumption is used to determine the concentration at each day after initial application based on the concentration resulting from the initial and additional

applications. The maximum Dichlorvos TTR was found at 11 hours after treatment. A second estimate was made, based on a Trichlorfon application rate of 5.4 lb ai/A. Depending on the half-life and application rate assumed, the Dichlorvos TTR ranged from 0.0028 $\mu g/cm^2$ to 0.0097 $\mu g/cm^2$. Exposure from hand-to-mouth activity for toddlers was added to arrive at total estimated exposure. (Leighton, 2000). Adult exposures ranged from 0.00044 mg/kg/day to 0.00013 mg/kg/day, and MOEs from 230 to 770. Toddler exposures ranged from 0.0010 mg/kg/day to 0.00028 mg/kg/day, and MOEs from 100 to 357, compared to the target MOE of 300. The margins of exposure for the high end exceed our level of concern, although the estimates of exposure are still considered to be conservative, since the starting point was the maximum dislodgeable foliar residue of Trichlorfon of 0.0829 $\mu g/cm^2$, and the next highest TTR was 0.0145 $\mu g/cm^2$, and as pointed out above, Dichlorvos residues dissipate rapidly from grass.

Table 15. Summary of Occupational/Residential Exposure and Risk Estimates for Dichlorvos

USES	NOTES	EXPOSURE PATTERN[1]	Current Exposure (mg/kg/day)			Current MOE
			Dermal	Inhalation	Total	
RESIDENTIAL EXPOSURE All Target MOEs for Residential Scenarios are 300.						
RESIDENTIAL HANDLER	2					
(a) Pressurized aerosol spray can	3	Short-term	0.0017	5.50e-05	0.0017	59
RESIDENTIAL POST-APPLICATION						
(a) Total release fogger Pressurized aerosol Crack and crevice treatment (Adults and children)	4 5 6	Short-term	0.015	Included in the absorbed dermal dose from a biomonitoring study		6.7
(b) Resin pest strips Full size strip 80 g 16 hours exposure/day	7	Long-term, Inhalation Only	N/A	Adult Male 0.0022	0.0022	23
			N/A	Adult Female 0.0019	0.0019	27
			N/A	Child, 1-4 0.0058	0.0058	9
			N/A	Child, 5-11 0.0039	0.0039	13
(b) Resin pest strips Full size strip 80 g 2 hours exposure/day	7	Long-term, Inhalation Only	N/A	Adult Male 0.00027	0.00027	180
			N/A	Adult Female 0.00023	0.00023	210
			N/A	Child, 1-4 0.00072	0.00072	70
			N/A	Child, 5-11 0.00049	0.00049	100
(b) Resin pest strips Closet sized strip 21 g 16 hours exposure/day	7	Long-term, Inhalation Only	N/A	Adult Male 0.00058	0.00058	109
			N/A	Adult Female 0.00050	0.00050	93
			N/A	Child, 1-4 0.0015	0.0015	38
			N/A	Child, 5-11 0.0010	0.0010	78
(b) Resin pest strips Cupboard size strip 5.25 g 16 hours exposure/day	7	Long-term, Inhalation Only	N/A	Adult Male 0.00029	0.00029	360
			N/A	Adult Female 0.00025	0.00025	310
				Child, 1-4 0.0007	0.0007	130
			N/A	Child, 5-11 0.0005	0.0005	260
(c) Pet flea collars	8	Long-term, Inhalation Only	No Data	Adult Male; 0.0015	0.0015	33
				Adult Female; 0.0013	0.0013	38
				Child, 1-2; 0.0037	0.0037	14
				Child 3-5; 0.0033	0.0033	15
				Child 6-8; 0.0027	0.0027	19
				Male 9-11; 0.0026	0.0026	19

Table 15. Summary of Occupational/Residential Exposure and Risk Estimates for Dichlorvos

USES	NOTES	EXPOSURE PATTERN[1]	Current Exposure (mg/kg/day)			Current MOE
			Dermal	Inhalation	Total	
				Female, 9-11; 0.0023	0.0023	22
(c) Pet flea collars - alternative analysis ("mobile pest strip")	7	Long-term, Inhalation & Dermal & Hand to Mouth (toddler only)	0.00043	Adult male: 0.00032	0.00075	130
			0.00050	Adult female: 0.00028	0.00078	130
			0.0030	Child (1-4): 0.00086	0.0039	26
			0.0013	Child (5-11): 0.00058	0.0019	53
(d) Lawns, Turf and Ornamental plants Post-application - Children (Includes hand-to-mouth)	20	Short-term	CA: 0.00016	Negligible	0.00016	630
			FL: 0.000036	Negligible	0.000036	2800
			ONT: 0.0012	Negligible	0.0012	83
			Ave: 0.00047	Negligible	0.00047	210
(d) Lawns, Trichlorfon use Post-application	20					
Adult - high end		Short-term	0.00044	Negligible	0.00044	230
Adult - low end			0.00013	Negligible	0.00013	770
Toddler - high end			0.0010	Negligible	0.0010	100
Toddler - low end			0.00028	Negligible	0.00028	357
OCCUPATIONAL EXPOSURE	9	All Target MOEs for Occupational Scenarios are 100				
i. Crack & crevice treatment in homes	10	Short-term	0.011	0.0071	0.018	5
ii. Mushroom house	11					
Applicator, Hand Held Fogger		Short term	0.071	Negligible	0.071	1.4
Applicator, Coarse Spray		Intermediate term				
Hand Held Sprayer			0.0016	0.0012	0.0028	18
Backpack Sprayer (471)			0.0026	0.0012	0.0038	13
Backpack Sprayer (416)			0.0022	0.0013	0.0035	14
Portable Sprayer on Cart			0.0068	0.0035	0.010	5
Reentry (24-hour REI)		Short-term	0.0010	0.0021	0.0031	32

Table 15. Summary of Occupational/Residential Exposure and Risk Estimates for Dichlorvos

USES	NOTES	EXPOSURE PATTERN[1]	Current Exposure (mg/kg/day)			Current MOE
			Dermal	Inhalation	Total	
iii. Greenhouse	12					
Applicator - hand held fogger		Short-term	0.15	0.00034	0.15	0.66
Applicator - total release fogger		Short-term	total release foggers negligible			
Reentry (10-hour REI)		Short-term	0.0007	0.000076	0.00078	130
iv. Domestic Animal Premises (food and non-food) and Direct Animal sprays, Feedlots, Manure Treatment, Garbage Dumps and Baits (a) Applicator						
Domestic food/nonfood animals (non-poultry)	13	Intermediate term				
Hand Held Sprayer			0.000024	0.000025	0.000049	1000
Backpack Sprayer (471)			0.00037	0.000025	0.00040	120
Backpack Sprayer (416)			0.000039	0.000055	0.000094	780
Portable Sprayer on Cart			0.00010	0.00010	0.00017	290
Domestic food/nonfood animals (poultry)	14	Intermediate term	No data; not expected to exceed dairy barn			
Domestic animal premises (food and non-food) - Dairy barns applicator exposure	15	Short-term				
Hand Held Sprayer			0.000011	0.000010	0.000021	4800
Backpack Sprayer (471)			0.00015	0.000010	0.00015	620
Backpack Sprayer (416)			0.000016	0.000010	0.000026	3800
Portable Sprayer on Cart			0.000042	0.000028	0.000070	1400
Granular and liquid baits		Short-term	No data for liquids, not expected to exceed dairy barns. Granular baits, negligible exposure.			
Feedlots	16	Short-term	No data; not expected to exceed dairy barns			
Manure	17	Short-term	No data; not expected to exceed dairy barns			
Garbage dumps	18	Short-term	No data; not expected to exceed dairy barns			

Table 15. Summary of Occupational/Residential Exposure and Risk Estimates for Dichlorvos

USES	NOTES	EXPOSURE PATTERN[1]	Current Exposure (mg/kg/day)			Current MOE
			Dermal	Inhalation	Total	
(b) Post-application (Reentry)			No data	No Data		N/A
v. Lawns, Turf and Ornamental plants - applicator exposure	19	Short-Term				
Liquids, (single layer, gloves)			0.0023	0.000046	0.0023	50
Liquids, (coveralls, gloves)			0.0013	0.000046	0.0017	90
Granular, (single layer, gloves)			0.0010	0.00019	.0012	83
Granular, (coveralls, gloves)			0.00050	0.00019	.00069	140
Lawns, Turf and Ornamental plants (b) Post-application	20	Short-term	See reentry under residential, ornamental lawns, turf, and plants			
vi. Warehouse treatment						
(a) Applicator		Short-term	Exposure and risk from automatic foggers is negligible			
(b) Reentry (Food Manufacturing Plant)	21	Short-term	0.000034	0.019	0.019	5.3
(c) Reentry (Warehouse)	22	Short-term	0.000034	0.0022	0.0022	45
vii. Insect traps	23	Short-term	Negligible			

NOTES: The following notes define the assumptions used in calculating the margins of exposure.
Risk is expressed as a Margin of Exposure (MOE)

$$MOE = \frac{NOAEL}{Exposure}$$, where both the NOAEL and the Exposure are expressed in mg/kg/day

1. Doses and toxicological endpoints for short term dermal and inhalation occupational and residential risk assessments are based on an oral NOAEL of 0.1 mg/kg/day from a rabbit developmental study. A dermal absorption factor of 11% was used. The applicator is assumed to weigh 60 kg because a developmental endpoint is used. Doses and toxicological endpoints for intermediate term dermal and inhalation occupational and residential risk assessments are based on an oral NOAEL of 0.05 mg/kg/day from a chronic dog study. A dermal absorption factor of 11% was used. The applicator is assumed to weigh 70 kg. Based on the use pattern, long-term dermal risk assessment is not required. The long-term inhalation risk assessment is based on a NOAEL of 0.05 mg/kg/day from a chronic inhalation study in rats. For residential exposure assessments, a toddler is assumed to weigh 15 kg, and a child, 22 kg.

2. An average resident applicator weighs 70 kg (60 kg for the short -term assessments) and has a respiratory volume of 1.0 m^3/hour (NAFTA value for moderate activity). Assumes short pants, short sleeves, and no gloves.

3. Residential use of pressurized aerosol product is based on application of an entire 16 ounce can of 0.5 percent Dichlorvos pressurized aerosol (0.005 lb ai). EPA estimated the risk to residents for different clothing scenarios. Pressurized aerosol products containing Dichlorvos do not have any clothing requirements, therefore EPA is assuming that Dichlorvos is applied during hot weather when an individual will be wearing only shorts, short sleeve shirt, and shoes. Surrogate data tables (scenario 10) from PHED V1.1 and a dermal absorption factor were used to estimate dermal exposure. The risk assessment is based on application by a 60 kg female. (Jaquith, 2001)

4. The assessment is based on biomonitoring data (urinary excretion of DMP from exposure to Dichlorvos) and represents the dose to the individual. An estimate of oral exposure was obtained by assuming that all material on hands (from passive dosimetry data) is available for ingestion. (Jaquith, 1998k) The oral exposure from passive dosimetry is added to the dermal exposure from biomonitoring. (Jaquith, 1993b) Children, performing the same activities as adults were considered to have the same exposure as an adult on a mg per kg basis.

5. Same as for fogger. This is a conservative assumption.

6. Same as for fogger. This is a conservative assumption.

7. Assumes 365 days of exposure per year, 16 hours per day. A time weighted average concentration, derived from integration of decay equations for Dichlorvos in homes, was used to estimate daily exposure (Jaquith 1998h). Smaller strips would yield proportionally smaller exposures. A low end exposure estimate was made, assuming 2 hours of exposure per day. Exposure estimates were made for smaller resin strips, assuming proportionally smaller exposures.

8. Assumes 365 days of exposure per year, 1 hour in close contact to animal, 8 hours casual exposure per day (Jaquith 1998j).

   Alternative assessment assumes that the flea collar is like a mobile resin strip, and the resident spends 8 hours per day in the room with the pet. The air concentration is obtained by ratioing the concentration from a full sized resin strip. Dermal assessment assumes transferable residue from chlorpyrifos petting study, 1875 cm^2 hug per day.
   2.2 g ai x 0.124 mg exposure/g ai x 0.11 dermal absorption / 15 kg bw for toddler = 0.002 mg/kg/day

   Incidental oral exposure from hand-to-mouth activity uses the same chlorpyrifos study, and assumes that 2 fingers (20 cm^2) are placed in the mouth, the transferable residue is on a 175 cm^2 hand, and 50% of the Dichlorvos is extracted by saliva. This is added to the dermal exposure for toddlers only.
   2.2 g ai x 124 µg/g ai x 20 cm^2 / 175 cm^2 x 0.50 saliva extraction = 15 µg dichlorvos
   0.015 mg dichlorvos /15 kg bw for toddler = 0.0010 mg/kg/day
   Summed oral plus absorbed dermal exposure for toddlers is shown in the table under dermal exposure
   0.0020 mg/kg/day + 0.0010 mg/kg/day = 0.0030 mg/kg/day

9. An average worker weighs 60 kg for short term assessments, and 70 kg for intermediate term assessments and has a respiratory volume of 1.0 m^3 /hour (NAFTA Value). Therefore, a variety of scenarios are presented for these three uses. At a minimum, the following protective clothing was used in the exposure scenarios: gloves, long-sleeve shirt, long pants.

10. A 0.5% solution of Dichlorvos is applied using a hand-held low-pressure sprayer. It is assumed that 0.067 lb Dichlorvos is applied by PCO 10 times per day, 1 day a week for 44 weeks. An average commercial applicator wears coveralls, chemical resistant gloves, and shoes. A respirator is not worn. Frequency of use is considered to be short-term (1 application/week) based on use frequency information from the National Pest Control Association. Dermal and inhalation exposures were obtained from PHED V1.1. A respiratory volume of 1.0 m^3 /hour has been used (adjusted from PHED default of 1.5 m^3/hr to account for NAFTA value). The dermal and inhalation MOEs were both calculated using a NOAEL of 0.1 mg/kg/day from the developmental rabbit study and an 11% dermal absorption factor.

11. An average mushroom house has a volume of 30,000 ft^3. Dichlorvos is applied with a hand-held fogger at a rate of 2.0 grams of active ingredient per 1000 ft^3 or 60 grams per treatment; 16 days per year, 10 houses per day; 4 minutes per house or 40 minutes per day, and a 70 kg applicator. Protective clothing was slightly different for each application method. For reentry exposure, it was assumed that a worker reenters a ventilated mushroom house 24 hours after treatment and is exposed for 8 hours. The unit exposures assume workers are wearing coveralls, hood, gloves, apron, boots, goggles, and a respirator.

    For the coarse spray, Dichlorvos is applied at 5.3 lb ai/day (10 houses x 0.53 lb ai per house; 10098 ft2. per house). Applicators are assumed to wear long pants, long sleeve shirt and gloves. The applicator exposure data are from a PHED V1.1 low confidence data set. The exposure values are corrected for a dermal absorption of 11%. Adding an additional layer of clothing (coveralls) is expected to reduce the dermal exposure by 50%, resulting in Total MOEs of 10-35.

Dermal reentry exposure represents the maximum expected at any REI. The inhalation reentry exposure is 0.0085 mg/kg/day and 0.0049 mg/kg/day at 12- and 24-hour reentry intervals, respectively. The MOE for 24-hours is reported in the table.

For reentry exposure, it was assumed that a worker reenters a ventilated mushroom house 24 hours after treatment and is exposed for 8 hours, breathing rate of 1.0 m^3/hr, and 60 kg worker. The post-application exposures for mushroom houses were derived from information from a textbook on mushroom culture and a study conducted by the California Department of Food and Agriculture (CDFA) , now called the California EPA (CalEPA) in which air and surface residues were measured in mushroom houses where Dichlorvos had been applied (Maddy 1981, Jaquith 1998d). This was a limited study measuring surface residues and air concentrations in 2-4 mushroom houses over 24 hours.

12. A typical greenhouse operation consists of seven greenhouses, each with a volume of 85,000 ft^3. All seven greenhouses are assumed to be treated in 1 day. Workers were assumed to be wearing coveralls, hood, gloves, apron, boots, goggles, and a respirator. Dichlorvos is applied at the rate of 1.4 grams of active ingredient per 1,000 ft^3. For reentry, a 1981 CDFA (now Cal/EPA) Dichlorvos study was used rather than translating data from the warehouse assessment as was done for the PD2/3. (Jaquith 1998d).

13. Worker exposure from direct application to animals is based on dairy cattle treatment. A one percent solution of Dichlorvos is applied with a handheld sprayer. An average herd of dairy cattle consists of 65 head, each requiring 24 seconds to spray, two times per day during treatment. Fly control is required from May to October with application expected to be occurring weekly rather than 2 x per day during this time (26 times per year). Although permitted on product labels, EPA does not believe that direct application with a handheld sprayer is used. Rather, some type of automated equipment is used to apply Dichlorvos directly to animals. Space and premise treatments also help control insects on animals. Since several registered products provide guidance on use with a handheld sprayer, the exposure and risk are estimated here for that application method, which is expected to result in a much higher exposure than automated methods. Exposure assessment for direct application to dairy cattle using a handheld sprayer were conducted using PHED V1.1. Applicators were assumed to wear long sleeve shirts, long pants, and gloves.

14. Data for cattle cannot be extrapolated to poultry, because of the different application method and less frequent applications. Individual animals are less likely to be treated directly and the equipment is more likely to be automated. As a result, exposure from applying Dichlorvos to poultry is expected to be much lower than for cattle.

15. An average dairy barn has the dimensions 30 ft x 100 ft x 9 ft (total area covered is 5,340 ft^2). (Dow, M., 1985). Dichlorvos is applied at two week intervals for 22 weeks, one barn per day. A 1.0 percent solution of Dichlorvos is applied using a low pressure hand sprayer at a rate of 0.0115 lb a.i. per 1000 ft^2. A worker wears long sleeve shirt, long trousers, shoes and impervious gloves at a minimum.

16. Feedlots include stockyards, corrals, holding pens and other areas where large groups of animals are contained. EPA assumes that some type of power sprayer capable of treating a large number of animals in a short time is probably used. A short application time period in an outdoor or partially enclosed area would minimize exposure to less than that of dairy applications.

17. MOE is expected to be greater than 100 for manure use. Application equipment may be similar to those used in a dairy barn; however, the application time would probably be less and the treated area would be well ventilated - either outdoors or in a partially enclosed area.

18. Exposure at a garbage dump is believed to be less than dairy exposure.

19. Use on ornamental lawns, turf and plants obtained from ORETF data (G. Bangs, 2001, Jaquith, 2001). Exposures were calculated for two clothing scenarios, a single layer of clothing and gloves, and coveralls and gloves. Applications at 0.5 lb ai/A can be made by hose-end spraygun or by a granular push-type spreader. An applicator is assumed to treat 5 acres per day. This is a short term exposure scenario, because the applicator would not be expected to apply Dichlorvos daily for a long period of time.

The geometric mean dermal exposure for handgun applicators while wearing a single layer of clothing and gloves was 0.5 mg/lb ai. When coveralls were worn the geometric mean dermal exposure was 0.27 mg/lb ai. The arithmetic mean inhalation exposure was 0.0019 mg/lb ai. Assumes that 5 acres are treated per day at a rate of 0.5 lb ai/A (2.5 lb ai handled per day), and that the applicator wears a single layer of clothing and gloves while applying a liquid or granular formulation.

Single layer of clothing:
Dermal Exposure = (2.5 lb ai/day x 0.5 mg/lb ai x 0.11) / 60 kg bw = 0.0023 mg/kg/day
If coveralls are worn the dermal exposure is:
Dermal Exposure = (2.5 lb ai/day x 0.27 mg/lb ai x 0.11)/ 60 kg bw = 0.0013 mg/kg/day
Inhalation Exposure = (2.5 lb ai/day x 0.0019 mg/lb ai x 1.7 NAFTA volume adj.) / 60 kg bw = 0.000046 mg/kg/day
Total Exposure (mg/kg/day) = 0.0023 mg/kg/day + 0.000046 mg/kg/day = 0.0023 mg/kg/day

The dermal exposures for cyclone granular spreaders from the ORETF studies were 0.35 mg/lb ai (single layer no gloves), 0.22 mg/lb ai (single layer, gloves), and 0.11 mg/lb ai (coveralls and gloves). The inhalation exposure was 0.0075 mg/lb ai.

20. Reentry exposure to commercial turf farms is considered to be negligible because of cultural practices is such facilities. The primary reentry activities in a commercial turf farm are mowing and the cutting of sod. The characteristics of Dichlorvos make it unlikely that such a product would be used immediately preceding such activities. (Jaquith, D, 1999c).

The calculations for oral and dermal exposure to children playing on turf have been updated to be consistent with the revised Residential SOPs.

$$\text{Hand to mouth exposure for each hour of exposure} = \frac{\text{TTR (ng/cm}^2\text{)} \times 20\ \text{cm}^2 \times 20\ \text{activities/hr} \times 0.5\ \text{saliva extraction}}{1000\ \text{ng/}\mu\text{g} \times 15\ \text{kg body weight}}$$

$$\text{Dermal Exposure} = \frac{[\text{TTR (ng/cm}^2\text{)} \div 1000\ \text{ng/}\mu\text{g} \times 24400 - 57.3] \times 0.11}{70\ \text{kg}}$$

Activities on the lawn start 1 hour after spraying to allow sprays to dry. Assumes 2 hours of activities per day, with 1 hour of exposure represented by one 20 minute Jazzercise session. Calculations were done separately for each hour of exposure, and are therefore conservative. All calculations include estimate of oral exposure due to hand to mouth activity for children playing on home lawns. Mean TTRs were 4.7 in CA, 1.6 in FL, and 22 ng/cm^2 in ON after 1 hour, and 0.65, 1.15, and 4.5 ng/cm^2 after 2 hours, for the three locations, respectively. The 24400 and -57.3 are coefficients from the regression equation from the Jazzercise study.

The assessment for Dichlorvos from Trichlorfon use used the Dichlorvos half-lives from the same dislodgeable foliar residue study for Dichlorvos, Trichlorfon total transferable residues (TTR) residues from a Trichlorfon dislodgeable foliar residue study (Dichlorvos residues were not measured in this study), and the Residential SOPs. TTRs of Dichlorvos were modeled using the calculated half-lives of Trichlorfon and Dichlorvos. The calculations were done using a spreadsheet-based model developed by EFED to estimate the decay rate of a chemical and its degradate applied to short grass for single or multiple applications. A first order decay assumption is used to determine the concentration at each day after initial application based on the concentration resulting from the initial and additional applications. Exposure from hand-to-mouth activity for toddlers was added to arrive at total estimated exposure. (Leighton, 2000).

21. Dichlorvos can be applied to food processing facilities with wall-mounted automatic foggers. Exposure to mixer/loaders through automatic application is expected to be negligible; however, there would still be reentry exposure. In estimating reentry exposure to food processing facilities, EPA assumed 24 hours elapsed before reentry is allowed, as required on labels; and that workers spend 8 hours per day in the treated area for the next 3 days. Dichlorvos is applied at the rate of 2.0 grams active ingredient per 1,000 ft^3 over a period of 125 minutes per application. Exposure estimates are for the day following treatment. Dermal exposure was measured for the hands only and represents an average of the total exposure measured for three work stations.

22. Dichlorvos can be applied to food warehouses with wall-mounted automatic foggers. In estimating reentry exposure to warehouse facilities, EPA assumed 24 hours elapsed before reentry is allowed, as required on labels; and that workers spend 60 minutes per day in the treated area. Dichlorvos is applied at the rate of 2.0 grams active ingredient per 1,000 ft^3 over a period of 125 minutes per application. Exposure estimates are for the day following treatment. Dermal exposure was measured for the hands only and represents an average of the total exposure measured for three work stations.

23. Exposure is believed to be negligible since the pesticide is in the form of an impregnated strip and the traps are placed in outdoor areas (such as forests) where there is no human exposure.

V. Aggregate and Cumulative Exposure and Risk Characterization

The Food Quality Protection Act amendments to the Federal Food, Drug, and Cosmetic Act (FFDCA, Section 408(b)(2)(A)(ii)) require that for establishing a pesticide tolerance "that there is reasonable certainty that no harm will result from aggregate exposure to pesticide chemical residue, including all anticipated dietary exposures and other exposures for which there are reliable information." Aggregate exposure is the total exposure to a single chemical (or its residues) that may occur from dietary (i.e., food, and drinking water), residential and other non-occupational sources, and from all known or plausible exposure routes (oral, dermal and inhalation). Aggregate risk assessments are typically conducted for acute (1 day), short-term (1-7 days), intermediate-term (7 days to several months), and chronic (several months to lifetime) exposure.

A. Acute Aggregate Risk

The acute aggregate risk estimate to Dichlorvos addresses exposures from food and drinking water. For the highly refined acute probabilistic dietary exposure analysis, PDP and FDA monitoring data and FDA TDS data were used to the greatest extent possible, along with field trial data, cooking and processing factors, and degradation studies to assess dietary exposures. The Dichlorvos acute dietary risk estimates, including all sources of residues of Dichlorvos, range from 17% to 67% of the aPAD at the 99th percentile of the population, with children (1-6 yrs) being the highest exposed population subgroup. Thus, the acute dietary (food) risk estimate associated with Dichlorvos exposure is below the Agency's level of concern.

Using conservative screening-level models, the acute estimated concentrations (EECs) of Dichlorvos in groundwater (SCI-GROW) range from 0.0002 to 0.015 µg/L. The acute surface water EECs, based on upper-bound monitoring data results, are 0.435 µg/L, 2.2 µg/L, and 81.7 µg/L, resulting from the use of Dichlorvos, Naled, and Trichlorfon, respectively. The EECs from the use of Dichlorvos are less than the DWLOCs for all populations (the EEC of 0.060 µg/L is less than the lowest DWLOC of 1.7 µg/L), indicating that acute food and drinking water exposures do not exceed the Agency's level of concern. It should be noted that neither the SCI-GROW model nor the monitoring data reflect concentrations after dilution (from source to treatment to tap) or drinking water treatment. HED concludes that acute aggregate Dichlorvos exposure in food and water from the use of Dichlorvos does not exceed the Agency's level of concern. However, the EEC of Dichlorvos in surface water, resulting from the use of Trichlorfon, of 81.7 µg/L and the EEC of Dichlorvos in surface water, resulting from the use of Naled of 2.2 µg/L, from the GENEEC models indicates a potential risk concern.

B. Short-Term Aggregate Risk

The short-term aggregate risk estimate includes chronic dietary (food and water) from Dichlorvos uses, and short-term non-occupational exposures (i.e., residential/recreational uses). DWLOCs were not calculated for short term exposure. Because the short term residential

exposure scenarios are associated with risks of concern, the DWLOCs would effectively be zero.

C. Intermediate-Term Aggregate Risk

The intermediate-term aggregate risk estimate includes chronic dietary (food and water) from Dichlorvos uses, and intermediate-term non-occupational exposures (i.e., residential/ recreational uses). There are no residential/recreational uses with an intermediate-term exposure scenario. Therefore, an intermediate-term aggregate risk estimate was not evaluated.

D. Chronic Aggregate Risk

The chronic aggregate risk estimate to Dichlorvos addresses exposures from food and drinking water. For the highly refined chronic dietary exposure analysis, PDP and FDA monitoring data, and FDA TDS data were used to the greatest extent possible, along with field trial data, cooking and processing factors, and degradation studies to assess dietary exposures.

The Dichlorvos chronic dietary risk estimates range from 1 to 2% of the cPAD, with children (1-6 yrs) being the highest exposed population subgroup. Thus, the chronic dietary (food) risk estimate associated with Dichlorvos exposure is below the Agency's level of concern. Using conservative screening-level models, the groundwater EECs range from 0.002 to 0.015 μg/L. The upper-bound surface water EEC, based on conservative screening level models, is 0.060 μg/L from the use of Dichlorvos, 2.2 μg/L from the use of Naled and 11.7 μg/L from the use of Trichlorfon.

For chronic drinking water exposure, the modeled groundwater concentrations of 0.0002 to 0.015 μg/L exceed the $DWLOC_{chronic}$ of zero μg/L. The modeled surface water concentrations of Dichlorvos (0.06 μg/L) and of Naled and Trichlorfon-derived Dichlorvos (2.2 and 11.7 μg/L, respectively) also exceed the $DWLOC_{chronic}$ of zero μg/L. The $DWLOC_{chronic}$ value is driven by the chronic residential inhalation exposure to Dichlorvos from resin pest strips, for which the chronic exposure exceeds our level of concern without considering water exposure. As mentioned above, food and water exposure to Dichlorvos is minimal compared with residential exposure. Therefore, any water exposure will add mimimally to exposures and risks of concern.

E. Cumulative Exposure and Risk

The Food Quality Protection Act (1996) stipulates that when determining the safety of a pesticide chemical, EPA shall base its assessment of the risk posed by the chemical on, among other things, available information concerning the cumulative effects to human health that may result from dietary, residential, or other non-occupational exposure to other substances that have a common mechanism of toxicity. The reason for consideration of other substances is due to the possibility that low-level exposures to multiple chemical substances that cause a common toxic effect by a common mechanism could lead to the same adverse health effect as would a higher

level of exposure to any of the other substances individually. A person exposed to a pesticide at a level that is considered safe may in fact experience harm if that person is also exposed to other substances that cause a common toxic effect by a mechanism common with that of the subject pesticide, even if the individual exposure levels to the other substances are also considered safe.

Dichlorvos is a member of the organophosphate (OP) class of pesticides. All pesticides of this class contain phosphorus and other members of this class of pesticides are numerous and include Azinphos Methyl, Chlorpyrifos, Chlorpyrifos-Methyl, Diazinon, Dichlorvos, Dicrotophos, Dimethoate, Disulfoton, Methamidophos, Methidathion, Monocrotophos, Naled Oxydemeton-Methyl, Phorate, Phosmet, Pirimiphos-Methyl, and Trichlorfon to name a few. EPA considers organophosphates to express toxicity through a common biochemical interaction with cholinesterase which may lead to a myriad of cholinergic effects and, consequently the organophosphate pesticides should be considered as a group when performing cumulative risk assessments. HED recently published the final guidance that it now uses for identifying substances that have a common mechanism of toxicity (FR 64(24) 5796-5799, February 5, 1999).

Dichlorvos is more closely related to Naled and Trichlorfon, which are members of the organophosphate class of pesticides. Naled and Trichlorfon can metabolize or degrade to Dichlorvos in food, water, or the environment. Therefore, FQPA requires OPP to estimate cumulative risk from consumption of food and water, containing Dichlorvos derived from Naled and Trichlorfon, and from residential exposure to those pesticides.

HED has recently developed a framework that it proposes to use for conducting cumulative risk assessments on substances that have a common mechanism of toxicity. This framework was presented to the SAP. The SAP was in general agreement with the framework, and made recommendations for improving it. HED plans to release the proposed framework for public comment in March 2000. The framework is available from the Internet at: http://www.epa.gov/scipoly/. In the framework it is stated that a cumulative risk assessment of substances that cause a common toxic effect by a common mechanism will not be conducted until an aggregate exposure assessment of each substance has been completed. The framework is expected to be finalized by the fall of 2000. When the methods are completed and peer reviewed, EPA will proceed with a cumulative assessment of the organophosphates. The current assessment addressed only the risks posed by Dichlorvos, resulting from the uses of Dichlorvos, Naled, and Trichlorfon.

VI. Risk Characterization

The Dichlorvos risk assessment contains strengths, weaknesses, and uncertainties based on the existing toxicological and exposure data, modeling methodologies, data gaps, and gaps in scientific knowledge. This assessment uses standard assumptions regarding human body weight, work life, and other exposure parameters; and interspecies extrapolation to estimate risks.

Additional assumptions were made regarding route to route extrapolation. Strengths and uncertainties of the assessment are described below.

The carcinogenicity of Dichlorvos has been evaluated by internal and external peer review committees: the OPP Carcinogen Assessment Review Committee, the Agency CRAVE Workgroup, and the FIFRA Science Advisory Panel. In addition, the Dichlorvos Registrant, AMVAC, has conducted an independent peer review of the carcinogenicity and mutagenicity of Dichlorvos by a Blue Ribbon Panel. The Agency has classified the Carcinogenic potential of Dichlorvos as "suggestive" under the 1999 Draft Agency Cancer Guidelines and no quantitative assessment of cancer risk is required.

The cholinesterase effect was noted in several species following acute, subchronic, or chronic oral exposure. In the animal studies, the NOAEL for cholinesterase inhibition was within the range of 0.1 to 3 mg/kg/day for all species. In the acute oral human volunteer study, the NOAEL was 1.0 mg/kg in for red blood cell cholinesterase inhibition. Plasma cholinesterase was not measured in the human study. Dichlorvos is also associated with cholinesterase inhibition in a chronic rat inhalation study, with a NOAEL of 0.05 mg/kg/day. The chronic dog feeding study and the chronic rat inhalation study have similar NOAELs, which supports the use of the rat inhalation study for chronic exposure.

The chronic rat inhalation study has been reviewed by OPP's toxicologists and internal peer review committees and by the Agency RfC Committee. This study is the basis for the NOAEL of 0.05 mg/kg/day for this assessment and the basis for the Agency RfC for Dichlorvos cited in the on-line IRIS database.

The Dichlorvos Registrant has conducted an independent peer review of the cholinesterase endpoint for Dichlorvos by a Blue Ribbon Panel of Experts. The conclusions of the Blue Ribbon Panel were presented orally at the July 1998 SAP. The Agency has informally reviewed the Blue Ribbon Panel Report and determined that it pertains to the generic issue of cholinesterase endpoints.

As noted above, most of the toxicology data used to support the cholinesterase endpoint were from oral studies. Occupational and residential exposure to Dichlorvos occurs by dermal and inhalation routes. For the purposes of this risk assessment, the Agency uses 11% dermal absorption (based on animal data) and 100% inhalation absorption (default assumption). Data from a rat dermal absorption study show that Dichlorvos applied to the shaved skin was absorbed at a rate of 11%. Therefore, the Agency has high confidence in the use of 11% dermal absorption.

The Agency has high confidence in the residue data used for dietary exposure estimates. For most commodities, the Agency used residue monitoring data from USDA's PDP, FDA's Surveillance Monitoring and FDA's TDS, which are the best available residue data. These data showed very few detects of Dichlorvos. Therefore, the anticipated residues used in the dietary exposure assessment are primarily based on one-half the level of detection for Dichlorvos. This

is a conservative assumption which is not likely to underestimate dietary exposure and risk. However, very little monitoring data are available for fumigated commodities. Extensive translation of monitoring data was done from one fumigated commodity to another. This may either over or underestimate dietary risk.

Dichlorvos residues may be present in water and food as a result of use of three pesticides: Dichlorvos (DDVP), Naled, and Trichlorfon. Dichlorvos is a degradate of Naled and Trichlorfon. The environmental fate and Effects Division (EFED) evaluated the potential for Dichlorvos to contaminate water from these sources. The environmental fate properties of Dichlorvos, Naled, and Trichlorfon are an indicator of the potential of these compounds to migrate to ground or surface water. EFED has limited monitoring data on the concentrations of Dichlorvos, Naled, or Trichlorfon in groundwater. Validated monitoring data for Dichlorvos, Naled, and Trichlorfon are available for the states of California and Hawaii from the Pesticides in Groundwater Database. These data indicated that neither Naled, Dichlorvos, nor Trichlorfon have been detected in groundwater; however, these data were not targeted to the pesticide use area. OPP does not have any surface water monitoring data on the concentrations of Dichlorvos, Naled, or Trichlorfon at the present time. Therefore, the Tier I screening model GENEEC was used to estimate surface water concentrations for Naled, Trichlorfon and Dichlorvos. The Tier II (PRZM) model could not be used because there is no scenario in the model for turf.

Exposure estimates for a number of occupational and residential scenarios were derived from limited data from the scientific literature, textbooks, and knowledge of cultural practices. Other estimates, particularly in the residential environment, were derived from chemical specific monitoring data, including biomonitoring, in combination with models and literature studies. Any residential exposure assessment conducted by the Agency contains appreciable uncertainty because of limits in scientific knowledge of human behavior patterns. Nonetheless, the Agency considers the occupational and residential exposure estimates to be the best available with current methodologies.

VII. Data Needs

Most of the Reregistration data requirements for Dichlorvos have been fulfilled. The few remaining data requirements are described below.

A. Toxicology Data Requirements

Although the guideline toxicology data requirements for Dichlorvos have been fulfilled, the Agency has requested a developmental neurotoxicity (DNT) study in rats to address the issues of special susceptibility raised by the study by Mehl et. al. The Mehl study is a non-guideline study from the literature which raises numerous questions about the potential special susceptibility of Dichlorvos, which could not be dismissed by the Agency. The concern raised by the study is supported by other literature studies reporting that the pesticide Trichlorfon affects brain development in pigs. Since Trichlorfon metabolizes to Dichlorvos, there is a

concern that Dichlorvos may affect brain development, and that it may do so in ways not measured in standard developmental toxicity tests. The Food Quality Protection Act of 1996 mandates careful consideration of the issue of special susceptibility. The rat developmental neurotoxicity study for Dichlorvos and for other organophosphate pesticides have been required by a September, 1999 Data Call In Notice (DCI). The studies are due to be submitted by September, 2001.

B. Product and Residue Chemistry Data Requirements

GLN 860.1380: Storage Stability Data

The Reregistration requirements for storage stability data are not fulfilled. Information pertaining to the storage intervals and conditions of samples of the following commodities, from studies that were reviewed in the Residue Chemistry Chapter of the Guidance Document, must be submitted: packaged and bagged raw agricultural commodities and processed food; bulk stored raw agricultural commodities; milk; eggs; and meat, fat, and meat byproducts of dairy cows and poultry. Alternatively, the registrant may demonstrate that there are sufficient residue data which are supported by storage stability data to support all registered uses of Dichlorvos.

The available storage stability data indicate that residues of Dichlorvos are stable under frozen storage conditions for up to 90 days in/on plant commodities, up to 4.5 months in/on peanuts, and up to 8 weeks in animal commodities.

GLN 860.1480: Meat, Milk, Poultry, Eggs

The Reregistration requirements for data pertaining to this guideline topic are not completely fulfilled. A dermal magnitude of the residue study must be submitted for swine. No additional data are required for milk and edible tissues of ruminants, and for eggs and edible tissues of poultry.

GLN 860.1500: Crop Field Trials

The Reregistration requirements for crop field trial data on tomatoes are not satisfied, since interest in supporting this tolerance has been indicated.

GLN 860.1520: Processed Food/Feed

The Reregistration requirements for processing data on tomatoes are not satisfied, since interest in supporting this tolerance has been indicated.

C. Occupational and Residential Exposure Data Requirements

Outstanding exposure data requirements exist for greenhouse uses. For the greenhouse use, postapplication data are required. The Dichlorvos Registrant is a member of both the Agricultural Re-entry Task Force (ARTF) and the Outdoor Residential Exposure Task Force (ORETF). These data have been called in under the generic Data Call In (DCI) for Agriculture. The following guideline studies are required:
GDLN 875.2100 Foliar Residue Dissipation Study (replaces GDLN 132-1(a))
GDLN 875.2400 Dermal Exposure (replaces GDLN 133-3, Dermal Passive Dosimetry)
GDLN 875.2500 Inhalation Exposure (replaces GDLN 133-4, Inhalation Passive Dosimetry)

It is the Agency's understanding that the exposure monitoring studies for use of Dichlorvos in greenhouses is being conducted in conjunction with the Agricultural Re-entry Task Force (ARTF). However, the Registrant has not provided an anticipated date for submission of the greenhouse exposure monitoring data.

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