Note to Reader
February 22, 2000

This document replaces the one placed on EPA's website and in the OPP Docket for Acephate. It contains text that was not included in the previous version. The following text has been added:

On page 5, fourth paragraph: "Following the application of acephate in indoor environments, chemical-specific studies addressing potential post-application exposures to acephate and methamidophos for children and adults in residential and other structural environments are also needed. These studies should address applications made by both homeowners and professional pesticide applicators to carpeted and smooth flooring in the indoor environment."

On page 65, last item: "Chemical-specific studies addressing potential post-application exposures to acephate and methamidophos for children and adults in residential and other structural environments. These studies should address applications made by both homeowners and professional pesticide applicators to carpeted and smooth flooring in the indoor environment."

No other changes were made to this document.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PREVENTION, PESTICIDES, AND TOXIC SUBSTANCES
WASHINGTON, D.C. 20460

January 20, 2000

MEMORANDUM

SUBJECT: **Acephate:** Revised Occupational and Non-Occupational Exposure and Risk Assessments for the Reregistration Eligibility Decision (RED) Document
[Case # 819371, PC Code 103301, DP Barcode D262573]

FROM: Catherine Bodurow Joseph, MSPH, Industrial Hygienist
Reregistration Branch I
Health Effects Division (7509C)

THROUGH: Jeff Dawson, Chemist
AND
Whang Phang, PhD, Branch Senior Scientist
Reregistration Branch I
Health Effects Division (7509C)

TO: Felecia Fort, Risk Assessor
Reregistration Branch I
Health Effects Division (7509C)

The occupational and non-occupational exposure and risk assessments contain significant revisions/modifications from and supercedes the previous chapters submitted for acephate (K. Boyle, D238153; C. Joseph, 09/30/99, D259628; C. Joseph, 12/15/99, D261602). Since the first chapter was made available for public comment, the registrant submitted four dislodgeable foliar residue (DFR) studies for succulent beans, cauliflower, greenhouse roses and tobacco as well as a turf transferable residue (TTR) study for turfgrass. These studies quantified DFRs and TTRs for both acephate and methamidophos, a degradate of acephate. The studies have been reviewed and incorporated into the revised risk assessment. Therefore, the post-application worker risk assessment has dramatically changed. Crop-specific and task-specific re-entry intervals (REIs) have been calculated for succulent beans, cauliflower, greenhouse roses, tobacco and turf. The assessment also incorporates a post-application recreational assessment for adult and 13+ year-old golfers, and the TTR study submitted by the registrant was used for the post-application recreational assessment as

well as the post-application residential assessment. Revisions to the document also reflect changes in the dermal short-term and intermediate-term NOAELs for methamidophos to be used in this risk assessment (NOAEL = 0.75 mg/kg/day) as stated by HIARC memorandum (N. McCarroll, dated 07/28/99, D256737). The change in the methamidophos NOAEL impacts the post-application worker, post-application residential and post-application recreational risk assessments. The residential post-application risk assessments also reflect proposed changes in the Agency's SOPs for Residential Exposure Assessment, which were presented at the FIFRA SAP meeting held on September 21, 1999. Comments from the public have been incorporated into the document. The document is intended to support the development of the Acephate Reregistration Eligibility Decision (RED) document and includes the results for HED's revised review of the potential human health effects associated with occupational and non-occupational exposures to acephate. The document reflects current HED policy.

EPA Registration #s: 3404-694, 51036-262, 59639-28, 51036-238, 59639-33, 59639-86, 51036-236, 59639-88, 59639-89, 59639-26, 59639-27, 51036-252, 239-2406, 59369-85, 51036-237, 59639-31, 499-230, 499-373, 59636-29, 59639-30, 6401-1, 37979-1, 239-2461, 239-2436, 239-2427, 239-2476, 59639-75, 239-2472, 239-2472, 499-373, 499-210, 499-380, 239-2440

EPA MRID #s: 405048-23, 405048-27, 405048-21, 410235-01, 447639-02, 447639-04, 447639-03, 447639-01, 448064-01

PHED: Yes, Version 1.1 (August 1998, Surrogate Table)

Required Data:

No PHED data were available for the following scenarios; therefore, both dermal (GLN 875.2400) and inhalation (GLN 875.2500) data are required:

Applying in transplanting water
Applying in seed treatment hopper box
Applying as a seed treatment in a slurry tank
Loading/applying using aerosol generator
Loading/applying with PCO injector
Loading/applying tree injection

cc: Jeff Dawson; Whang Phang, Ph.D.; Michael Metzger; Felecia Fort; Monica Alvarez
7509C: RRB1: CBJoseph: CBJ: CM#2: Room 722A: 308-1829: 01/20/00
RDI: Michael Metzger (01/20/00)

TABLE OF CONTENTS

1. Occupational and Non-Occupational Executive Summary for Acephate 1

2. Background Information 6

3. Occupational and Non-Occupational Exposure and Risk Characterization 8
   - 3.a. Summary of Acephate Use Patterns and Formulations 8
     - 3.a.i End-Use Products 8
     - 3.a.ii. Mode of Action and Targets Controlled 9
     - 3.a.iii. Occupational-Use Sites 9
     - 3.a.iv. Formulation Types and Percent Active Ingredient 10
     - 3.a.v. Application Rates 10
     - 3.a.vi. Methods and Types of Equipment For Mixing, Loading, and Application 11
     - 3.a.vii. Timing and Frequency of Applications 12
     - 3.a.viii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 14
   - 3.b. Occupational and Non-Occupational Exposure and Risk Assessments 14
     - 3.b.i. Endpoints and Calculations Used in the Exposure and Risk Assessments 14
     - 3.b.ii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 24
     - 3.b.iii. Risk Assessment Assumptions and Factors 25
     - 3.b.iv. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 28
     - 3.b.v. Occupational and Residential Applicator Exposure Data Sources 29
     - 3.b.vi. Mitigation Summary 31
     - 3.b.vii. Occupational Handler Risk Assessment 31
     - 3.b.viii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 33
     - 3.b.ix. Data Sources for Post-Application Worker Risk Assessment 34
     - 3.b.x. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 43
     - 3.b.xi. Post-Application Worker Risk Assessment 44
     - 3.b.xii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 45
     - 3.b.xiii. Non-Occupational (Residential Applicator) Risk Assessment 45
     - 3.b.xiv. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 47
     - 3.b.xv. Non-Occupational (Post-Application Residential) Risk Assessment 47
     - 3.b.xvi. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 48
     - 3.b.xvii. Non-Occupational (Post-Application Recreational) Risk Assessment 48
     - 3.b.xviii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 49
   - 3.c. Occupational and Non-Occupational Risk Assessment and Characterization 49
     - 3.c.i. General Risk Characterization Considerations 49
     - 3.c.ii. Individual and Professional Pesticide Applicator Risk Characterization Results 50
     - 3.c.iii. Modifications Based upon Agency's Revisions, Public Comments,

and/or Registrants' Comments 58
3.c.iv. Post-Application Worker Risk Characterization Results 58
3.c.v. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 59
3.c.vi. Non-Occupational (Residential Applicator) Risk Characterization Results 59
3.c.vii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 60
3.c.viii. Non-Occupational (Post-Application Residential) Risk Characterization Results 61
3.c.ix. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 61
3.c.x. Non-Occupational (Post-Application Recreational) Risk Characterization Results 61
3.c.xi. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments 62
3.d. Incident Reports 62
3.d.i. General Summary 62
3.d.ii. IDS Data 62
3.d.iii. AAPCC Data 63
3.d.iv. CDPR Data 64
3.d.v. NPTN Data 65
3.d.vi. Incident Data Conclusions 65
3.d.vii. Incident Data Recommendations 65
3.e. Data Needs 65

Appendices 66

1. Occupational and Non-Occupational Executive Summary for Acephate

Summary Description for Acephate:

Acephate (O,S-dimethyl acetylphosphoramidothioate) is an organophosphate insecticide used to control insects on a variety of field, fruit, and vegetable crops. Pesticidal properties and toxicity are due to inhibition of acetylcholinesterase enzyme. Another registered pesticide, methamidophos (O,S-dimethyl phosphoramidothioate), is a degradate of acephate and is a potent cholinesterase inhibitor by all routes of exposure. As well as quantifying risk to acephate exposures, the assessments in this document will address methamidophos exposures and risks following the application of acephate products.

Acephate is currently formulated as manufacturing products (75, 97, and 98.9 % active ingredient [ai]), granulars (1.5 and 15 % ai), emulsifiable concentrates (4 and 8 % ai), wettable powders (75, 80, and 90 % ai), a pelleted/tableted product (97 % ai), pressurized liquids (0.25, 1, 3 and 12 % ai), a ready-to-use product (75 % ai), soluble-concentrate liquids (4, 8, 9.4, 15.6, 50, 75, 90, 96 and 97 % ai), and a dust product (75 % ai). Some wettable powder formulations are contained in water-soluble packaging.

Products of acephate have been registered for both occupational and residential uses. Acephate is registered for use on the following crops: alfalfa, almonds, apples, apricots, beans (snap, dry and lima), brussels sprouts, carrots/radishes, cauliflower, celery, non-bearing citrus, cotton, cranberries, grapefruit, grapes, head lettuce, dry onions, oranges, peanuts, pepper (non-bell and sweet), peppermint/spearmint, potatoes, soybeans, tobacco, walnuts. It is also used on field-grown ornamentals (i.e., trees, shrubs), pasture, rangeland, and on sod and golf course turf. In addition, acephate has registered indoor and outdoor residential uses.

Based upon available pesticide survey usage information for the years 1988-1997, total annual domestic usage of acephate is approximately 4 to 5 million pounds active ingredient (ai). In terms of lb ai used per year, acephate usage is as follows: cotton (23%), tobacco (21%), residential outdoors by consumers (20% or less), horticulture nurseries (8%), golf courses (4%) and other sites. Crops with over 25 percent of acres treated include: tobacco (61%), celery (49%), head lettuce (47%), lima beans (41%), snap beans for processing (35%), cranberries (34%), mint (31%) and fresh snap beans (29%). Most of the usage is in Arizona, California, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Texas and Virginia. Per-acre rates are generally less than 2.5 lb ai per application and less than 4.5 lb ai per year.

Occupational applications for granular and liquid acephate formulations can be made in numerous ways. Granular acephate applications can be made by belly grinder, hand, tractor-drawn spreader, push-type spreader, and shaker can. Liquid acephate applications can be made by aircraft, airblast sprayer, backpack sprayer, chemigation, groundboom spray, hand/handtool/shaker can, handgun (hydraulic sprayer), high-pressure sprayer, hopper box (seed treatment), low-pressure handwand, seed slurry treatment, sprinkler can, and transplanting in water (tobacco).

Residential acephate applications can also be made by several methods. Applications can be made by aerosol can, shaker can, backpack sprayer, hand/handtool/shaker can, hose-end sprayer, low-pressure handwand, and sprinkler can.

Toxicological NOAELs of Concern for Assessments:

For ACEPHATE:
NOAEL $_{ST,dermal}$ and NOAEL $_{IT,dermal}$ = 12 mg/kg/day
NOAEL $_{ST,inhalation}$ and NOAEL $_{IT,inhalation}$ = 0.14 mg/kg/day
NOAEL $_{Acute\ oral}$ = 0.5 mg/kg/day

HIARC and FQPA SFC determined that MOEs greater than 100 do not exceed HED's level of concern for acephate occupational and residential exposures.

For METHAMIDOPHOS:
NOAEL $_{ST,dermal}$ and NOAEL $_{IT,dermal}$ = 0.75 mg/kg/day
NOAEL $_{ST,inhalation}$ and NOAEL $_{IT,inhalation}$ = 0.27 mg/kg/day
NOAEL $_{Acute\ oral}$ = 0.3 mg/kg/day

HIARC and FQPA SFC determined that MOEs greater than 100 and 300 do not exceed HED's level of concern for methamidophos occupational and residential exposures, respectively.

As methamidophos is anticipated to be present following the application of acephate, the occupational and residential applicator assessments only consider potential acephate exposures while the occupational, residential and recreational post-application assessments address both potential acephate and methamidophos exposures.

Individual and Professional Pesticide Applicator Risk Assessment:

HED has determined that individual and professional pesticide applicators (i.e. mixers, loaders, applicators, flaggers) are likely to be exposed during acephate use. Due to the frequency and duration of acephate uses, it was determined that uses of acephate by individual and professional pesticide applicators result in short-term and intermediate-term exposures. However, the frequency and duration of these exposures do not exhibit a chronic exposure pattern (i.e., daily exposures which occur for a minimum of several months). The anticipated use patterns and current labeling indicate more than 25 exposure scenarios based upon the types of equipment that potentially can be used to make acephate applications.

Two chemical-specific exposure monitoring studies were submitted in support of the reregistration of acephate. Because minimal chemical-specific individual and professional pesticide applicator exposure data were available for the assessment, the majority of analyses for both individual and professional short-term exposures and intermediate-term exposures were performed using the Pesticide Handlers Exposure Database (PHED), Version 1.1 (August 1998). Numerous

mixer/loader, applicator, mixer/loader/applicator and flagger scenarios were evaluated.

The calculations of individual and professional acephate applicators' combined dermal and inhalation risks indicate that numerous exposure scenarios exceed 100 for baseline, PPE and engineering controls assessment levels. However, at the highest level of mitigation available and/or feasible for a specific scenario, thirteen of the scenarios do not exceed 100. There are also five scenarios for which no exposure data are available and four scenarios for which surrogate data from similar PHED scenarios were used. The range of combined dermal and inhalation MOEs for the individual and professional pesticide acephate applicators' scenarios was 0.065 to 28,000.

Post-Application Worker Risk Assessment:

HED has determined that workers may be exposed to acephate and methamidophos upon entering occupational areas which have been previously treated with acephate to perform specific work activities in these areas (e.g., scouting, staking/tieing, irrigating, harvesting). Due to the frequency and duration of post-application worker exposures coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that occupational acephate uses result in potential short-term and intermediate-term dermal acephate and methamidophos post-application worker exposures. Potential inhalation exposures are not anticipated for post-application worker exposures, and HED currently has no policy/method for evaluating non-dietary ingestion by workers due to poor hygiene practices or smoking. As a result, only dermal exposures were evaluated in the post-application worker assessment. Valent submitted four dislodgeable foliar residue studies (DFRs) and one turf transferable residue study (TTR) which address the dissipation of acephate and methamidophos in fields/greenhouses of succulent beans, cauliflower, greenhouse roses, tobacco, and turfgrass. These studies were used to evaluate potential post-application worker risks.

Re-entry intervals (REIs) were calculated for specific tasks. Calculated REIs for succulent beans while performing harvest by hand, stake/tie, scout, and irrigate were 5 days. Calculated REIs for cauliflower while performing scout, irrigate, and harvest by hand were 0 days. Calculated REIs for greenhouse roses while sorting and packing was 6 days and while pruning and harvesting by hand was 12 days. Calculated REIs for tobacco while performing stake/tie, scout and irrigate was 8 days and while harvesting by hand was 19 days. Calculated REIs for turfgrass while mowing with tractor or push-type mower was 0 days and while harvesting sod was 1 day. It should be noted that the default REI of 24 hours will still apply to cauliflower and turf under the Worker Protection Standard.

Non-Occupational (Residential Applicator) Risk Assessment:

HED has determined that residential pesticide applicators are likely to be exposed during acephate use. Due to the frequency and duration of acephate uses, it was determined that uses of acephate by residential pesticide applicators result in short-term exposures to these applicators. The anticipated use patterns and current labeling indicate several exposure scenarios based upon the types

of equipment that potentially can be used to make acephate applications in the residential environment.

The calculations of residential acephate applicators' combined dermal and inhalation risks indicate that two exposure scenarios exceed 100 while six scenarios do not. There are also two scenarios for which surrogate data from similar PHED scenarios were used. The range of combined dermal and inhalation MOEs for the residential acephate applicators' scenarios was 2.9 to 7,100.

Non-Occupational (Post-Application Residential) Risk Assessment:

HED has determined that the public may be exposed to acephate and methamidophos upon entering residential areas which have been previously treated with acephate. Due to the frequency and duration of potential post-application residential exposures coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that residential acephate uses result in potential short-term dermal and oral acephate and methamidophos post-application residential exposures to the public. Potential inhalation exposures are not anticipated for post-application residential exposures.

It is anticipated that adults and children may primarily be exposed to acephate and methamidophos through their contact with turfgrass. Acephate and methamidophos exposures may also occur from contact (i.e., pruning, cutting and weeding) with treated ornamentals, flowers, trees, and shrubs. However, it is anticipated that these exposures would not be as significant as turfgrass exposures because of lower contact rates and the frequency and duration of potential contacts. Therefore, these potential exposures are not addressed in this assessment.

Although the residential SOPs specify that the residential exposure calculations are to be used as screening tools, the following acephate post-application residential exposure scenarios exceed HED's level of concern: dermal exposures to children (MOE = 86) and children's hand-to-mouth exposures (MOE = 94). None of the methamidophos post-application residential exposure scenarios exceed HED's level of concern (MOE range = 1,500 - 500,000).

Non-Occupational (Post-Application Recreational) Risk Assessment:

HED has determined that the public may be exposed to acephate and methamidophos upon entering recreational areas which have been previously treated with acephate. The recreational areas addressed in this assessment are golf courses. Due to the frequency and duration of potential post-application recreational exposures at golf courses coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that occupational acephate uses at golf courses result in potential short-term dermal acephate and methamidophos post-application recreational exposures to adults and 13+ year-olds. Potential inhalation exposures are not anticipated for post-application recreational exposures. No potential hand-to-mouth exposures were estimated for recreational exposures.

It is important to note that potential post-application recreational exposures were assessed on the same day acephate would be applied to the golf course. The assessment was completed in this manner, because it is assumed that the public could be exposed immediately following an acephate treatment. As a result, the average of chemical-specific TTRs measured following the second application in the turf study submitted by the registrant were used in the post-application recreational assessment.

HED is not concerned regarding adult and 13+ year-old golfers' risks to acephate and methamidophos following an acephate treatment of golf course turf. The calculated MOEs for adult golfers' risks to acephate and methamidophos were 7,500 and 125,000, respectively while the calculated MOEs for 13+ year-old golfers' risks to acephate and methamidophos were 4,620 and 78,100, respectively.

Incident Reports:

When both Poison Control Center and California data were considered, acephate generally had a lower hazard than other organophosphate and carbamate insecticides. There have been two accidental deaths reported associated with exposure. Both deaths involved misuse and in one case use of a particulate mask may have increased the risk of inhaling acephate. Minor and moderate symptoms of exposure have often been associated with inhalation indoors. Outdoor agricultural use are associated with lower risks of illness and poisoning than most other organophosphate and carbamate insecticides.

Data Needs:

Several areas of the risk assessment and characterization would improve with more data. Valent recently completed several DFR and TTR studies. The Agency commends these submissions and would encourage the registrant to conduct and submit additional exposure monitoring studies. In particular, applicator scenarios for which no data are currently available to the Agency for assessment purposes are encouraged. Specific data on typical use, types of mixing and loading completed for application equipment, types of packaging available to individual and professional pesticide applicators, types of potential engineering controls, additional information on slit-placement techniques for turf applications of granules, and information on post-application techniques for all crops would also improve the risk assessment. Following the application of acephate in indoor environments, chemical-specific studies addressing potential post-application exposures to acephate and methamidophos for children and adults in residential and other structural environments are also needed. These studies should address applications made by both homeowners and professional pesticide applicators to carpeted and smooth flooring in the indoor environment.

2. Background Information

This revised document is based upon the following referenced documents.

Acephate Hazard Identification Committee Report; Author: George Ghali, PhD; Chapter directed to Tina Levina, IRB/RD/OPP (01/15/98) [HED Doc. No. 012453].

Acephate HED Risk Assessment and Disciplinary Chapters for the Reregistration Eligibility Decision (RED) Document. List A Reregistration Case 0042. Chemical No. 103301. DP Barcode: D245803. (10/30/98).

Acephate Labels.

Acephate: Occupational and Residential Exposure (ORE) Assessment for the Reregistration Eligibility Decision (RED) document; Author: Kathryn Boyle, Chemist, RRB1/HED/OPP; Chapter directed to Felecia Fort, Chemist and Risk Assessor RRB1/HED/OPP (06/16/98) [PC Code 103301, DP Barcode D238153].

Acephate: Support for the Toxicology Endpoint Selection for Dermal Risk Assessments; Author: Nancy McCarroll, Toxicologist, TB1/HED/OPP; Chapter directed to Felecia Fort, Chemist and Risk Assessor RRB1/HED/OPP (06/20/99) [PC Code 103301, DP Barcode D245164].

FQPA Safety Factor Recommendations for the Organophosphates: A Combined Report of the Hazard Identification Assessment Review Committee and the FQPA Safety Factor Committee; Authors: Brenda Tarplee and Jess Rowland; Chapter directed to Margaret Stasikowski, Division Director (08/06/98).

HED Science Advisory Council for Exposure, Policy 003, "Agricultural Default Transfer Coefficients" Health Effect Division, Office of Pesticide Programs. May, 1998.

HED Science Advisory Council for Exposure, Policy 005, "Use of PHED data for Application by Rotary Wing Aircraft." Health Effect Division, Office of Pesticide Programs. May, 1998.

HED Science Advisory Council for Exposure, Policy 006, "The Use of PHED Aerial Application Data" Health Effect Division, Office of Pesticide Programs. August, 1998.

HED Science Advisory Council for Exposure, Policy.007, “Use of Values from the PHED Surrogate Table and Chemical-Specific Data.” Health Effects Division, Office of Pesticide Programs. January, 1999.

Methamidophos: Report of Hazard Identification Assessment Review Committee; Author: Jess Rowland; Chapter directed to Alberto Protzel, TB2/HED/OPP (02/12/98) [HED Doc. No. 012477].

Methamidophos: Support for the Toxicology Endpoint Selection for Dermal Risk Assessments; Author: Nancy McCarroll, Toxicologist, TB1/HED/OPP; Chapter directed to Felecia Fort, Chemist and Risk Assessor RRB1/HED/OPP (07/28/99) [HED Doc. No. 013672].

Methamidophos: Toxicology Endpoint Selection for Short- and Intermediate-Term Dermal Risk Assessments; Author: Jess Rowland; Chapter directed to Felecia Fort, RRB1/HED/OPP (10/27/98) [HED Doc. No. 012921].

Overview of Issues Related to the *Standard Operating Procedures for Residential Exposure Assessment*. Prepared by The Residential Exposure Assessment Work Group (headed by Jeff Evans). Office of Pesticide Programs, Health Effects Division. August 1999.

Review of Methamidophos Incident Reports; Authors: Jerome Blondell, PhD, MPH and Monica Spann, MPH (Signed 09/09/99); Chapter directed to Susan Hanley of RRBI/HED/OPP (09/09/99) [PC Code 101201, DP Barcode D258608].

PHED Surrogate Exposure Guide, V1.1. Health Effects Division, Office of Pesticide Program. August, 1998."

Review of Acephate Incident Reports; Authors: Ruth Allen, PhD, MPH and Jerome Blondell, PhD, MPH (Signed 09/08/99); Chapter directed to Felecia Fort of RRBI/HED/OPP (09/08/99) [PC Code 103301, Case #0042, DP Barcode D247487].

Standard Operating Procedures (SOPs) for Residential Exposure Assessments. Prepared by The Residential Exposure Assessment Work Group. Office of Pesticide Programs, Health Effects Division and Versar, Inc. December 1997.

U.S. EPA 1999. LUIS Report (Quantitative Usage Analysis) for Acephate dated 06/08/99.

EPA MRID #s:
405048-23, 405048-27, 405048-21, 410235-01, 447639-02, 447639-04, 447639-03, 447639-01, 448064-01.

3. Occupational and Non-Occupational Exposure and Risk Characterization

Occupational and non-occupational exposure and risk assessments are required for an active ingredient if: (1) certain toxicological criteria are triggered **and** (2) there is potential exposure to handlers (i.e., mixers, loaders, applicators, etc.) during use or to persons entering treated areas after application is completed. Acephate (O,S-dimethyl acetylphosphoramidothioate) meets both criteria. Acephate is a cholinesterase inhibitor in acute toxicity category II by the oral route and acute toxicity category IV by the dermal and inhalation routes. There is potential exposure from both agricultural and residential uses of acephate. In addition, the general public may be exposed to acephate from golfing following acephate treatment of a golf course.

Another registered pesticide, methamidophos (O,S-dimethyl phosphoramidothioate), is a degradate of acephate and is a potent cholinesterase inhibitor in acute toxicity category I by all routes of exposure. Therefore, the potential exposure to methamidophos is also assessed in this document. As methamidophos is anticipated to be present following the application of acephate, the occupational and residential handler assessments only consider potential acephate exposures while the occupational, residential and recreational post-application assessments address both potential acephate and methamidophos exposures.

3.a. Summary of Acephate Use Patterns and Formulations

3.a.i End-Use Products

There are registered products of acephate (O,S-dimethyl acetylphosphoramidothioate) intended for both occupational and residential uses. Occupational uses include acephate treatment of terrestrial food and feed crops, indoor food crops, terrestrial non-food crops, and commercial (industrial) and golf course turf. Acephate is registered for use on the following crops: alfalfa, almonds, apples, apricots, beans (snap, dry and lima), brussels sprouts, carrots/radishes, cauliflower, celery, non-bearing citrus, cotton, cranberries, grapefruit, grapes, head lettuce, dry onions, oranges, peanuts, pepper (non-bell and sweet), peppermint/spearmint, potatoes, soybeans, tobacco, walnuts. It is also used on field-grown ornamentals (i.e., trees, shrubs), pasture, rangeland, and on sod and golf course turf. In addition, acephate has registered indoor and outdoor residential uses.

Based upon available pesticide survey usage information for the years 1988-1997, total annual domestic usage of acephate is approximately 4 to 5 million pounds active ingredient (ai). In terms of lb ai used per year, acephate usage is as follows: cotton (23%), tobacco (21%), residential outdoors by consumers (20% or less), horticulture nurseries (8%), golf courses (4%) and other sites. Crops with over 25 percent of acres treated include: tobacco (61%), celery (49%), head lettuce (47%), lima beans (41%), snap beans for processing (35%), cranberries (34%), mint (31%) and fresh snap beans (29%). Most of the usage is in Arizona, California, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Texas and Virginia. Per-acre rates are generally less than 2.5 lb ai per application and less than 4.5 lb ai per year.

3.a.ii. Mode of Action and Targets Controlled

Acephate is an organophosphate and broad spectrum, systemic insecticide. Examples of the pests that acephate is used to control include, but are not limited to, the following:

- Thrips, Plantbugs, Fleahoppers, Armyworms, Cotton aphids, Bollworms, Budworm, and Stinkbugs (on cotton);

- Fleahoppers, Grasshoppers, Aphids, Bean leaf beetles, Bean leaf rollers, Cabbage loopers, Cutworms, Cloverworms, Leafhoppers, Plantbugs, Soybean looper, Corn earworms, Green peach aphids, and Imported cabbage worms (on vegetable crops);

- Grasshoppers, Mormon crickets, Black grassbugs, and Imported fire ants (on pasture, rangeland, and wastelands);

- Fall armyworms, Yellow striped armyworms, Cutworms, Cinch bugs, Fleas, Sod webworms, Leafhoppers, Mole crickets (except CA), Greenbug, and Imported fire ants (on sod and turf);

- Wasps, Cockroaches, Ants, Pillbugs, and Earwigs (perimeter treatment);

- Aphids, Armyworms, Bagworms, Budworms, Cankerworms, Cuban laural thrips, Web worms, Gypsy moths, Lace bugs, Leafhopper, Leaf beetles, Loopers, Maple shoot moth, Plant bugs, Sawflies, Spittlebugs, Tent caterpillars, Oak web worms and Whiteflys (on deciduous shade trees and ornamentals);

- Aphids, Cutworms, Grasshoppers, Soybean loppers, Velvetbean caterpillars, Mexican bean beetle, Silver spotted skipper, Stink bugs, and thrips (on field crops); and

- Fireworms, Spanworms, Sparganothis (on fruit crops including cranberries).

3.a.iii. Occupational-Use Sites

Acephate is registered for occupational use on terrestrial food and feed crops, indoor food crops, and terrestrial non-food crops. For ease and brevity, the occupational crop use sites in this document have been grouped as follows:

- Fruit trees (non-bearing citrus only);

- Field, Forage, Fiber, Small Fruit, and Vegetable Crops (including cranberries, cotton, tobacco, beans [fresh and dry], mint, peanuts, brussels sprouts, cauliflower, celery, head lettuce, non-bell peppers and sweet peppers);

- Cotton Seed Treatment (including slurry and hopper box);

- Non-Crop Areas (including field margins [perimeter treatments], pastures, and wastelands);

- Evergreens in Large Stands (including Christmas tree plantations and various types of pine tree forests);

- Commercial Ornamentals Grown in Greenhouses (including ornamental bedding plants);

- Commercial Outdoor Ornamental Applications (not necessarily being grown for commercial use) [including deciduous shade trees, flowering trees and shrubs, evergreens, and roses];

- Commercial Turf (including sod farms and golf courses);

- Spot Treatment (including indoor and outdoor spot treatments);

- Indoor and Outdoor Applications by commercial applicators at residential sites (Pest Control Operator [PCO] uses and use to control pests on turf, ornamentals, or fruit/ vegetables); and

- Indoor and Outdoor Applications by commercial applicators at non-residential sites (PCO uses at restaurants, meatpacking houses, and other food storage sites; PCO uses on turfgrass and ornamentals in parks, malls, atriums, and recreational areas).

3.a.iv. Formulation Types and Percent Active Ingredient

Acephate is currently formulated as manufacturing products (75, 97, and 98.9 % active ingredient [ai]), granulars (1.5 and 15 % ai), emulsifiable concentrates (4 and 8 % ai), wettable powders (75, 80, and 90 % ai), a pelleted/tableted product (97 % ai), pressurized liquids (0.25, 1, 3 and 12 % ai), a ready-to-use product (75 % ai), soluble-concentrate liquids (4, 8, 9.4, 15.6, 50, 75, 90, 96 and 97 % ai), and a dust product (75 % ai). Some wettable powder formulations are contained in water-soluble packaging.

3.a.v. Application Rates

The crop groupings described previously have the following maximum application rates:

- Fruit Tree (non-bearing citrus) at 0.5 lb ai per acre;

- Field, Forage, Fiber, Small Fruit, and Vegetable Crops (including cranberries, cotton,

tobacco, beans [fresh and dry], mint, peanuts, brussels sprouts, cauliflower, celery, head lettuce, non-bell peppers and sweet peppers) at 0.5 to 1.0 lb ai per acre;

- Cotton Seed Treatment (including slurry and hopper box) at 0.04 lb ai per 100 pounds of seed (when mixed before application) and 0.1875 lb ai per acre (when mixed at time of application using a drop-type spreader);

- Non Crop Areas (including field margins, pastures and wastelands) at 0.125 lb ai per acre;

- Evergreens in Large Stands (including Christmas tree plantations and various types of pine tree forests) at 0.5 to 1.0 lb ai per acre;

- Commercial Ornamentals Grown in Greenhouses at 0.5 to 1.0 lb ai per 100 gallons of water;

- Commercial Outdoor Ornamental Applications (not necessarily being grown for commercial use) [including deciduous shade trees, flowering trees and shrubs, evergreens, and roses] at 0.5 to 1.0 lb ai per 100 gallons of water;

- Commercial turf (including sod farms and golf courses) at 5.0 lb ai per acre;

- Ornamentals at residences and other public areas (including shade trees, evergreens, and roses) at 0.0076 to 0.035 lb ai per gallon, 1.5 tablespoon per mound of wettable powder for fire ant mounds, and 2 cans of 1 to 3 % ai aerosol cans for residential uses;

- Turf at residences and other public areas at 0.035 lb ai per gallon; and

- Spot Treatment at commercial and residential sites at 0.075 lb ai per gallon.

3.a.vi. Methods and Types of Equipment For Mixing, Loading, and Application

The following mixing, loading and application methods are used for the previously described crop groupings:

- Fruit Trees (non-bearing citrus only) -- equipment used for commercial use includes airblast sprayer and high pressure handwand for trees;

- Field, Forage, Fiber, Small Fruit, and Vegetable Crops -- equipment used commercially includes groundboom, aerial, chemigation, and tractor-drawn drop-type spreader;

- Cotton Seed Treatment -- equipment used for commercial use includes slurry, hopper box application, and tractor-drawn drop-type spreader;

- Non-Crop Areas -- equipment used includes groundboom, handgun sprayer and aerial applications;

- Evergreens in Large Stands -- equipment used for commercial use includes airblast sprayer, aerial, and high pressure handwand;

- Commercial Ornamentals Grown in Greenhouses -- equipment used for commercial use includes low pressure handwand, backpack sprayer, high pressure handwand (mixing/loading separate), and applying soluble powder/granular by hand/handtool/shaker can;

- Commercial Outdoor Ornamental Applications -- equipment used for commercial use includes low pressure handwand, backpack sprayer, high pressure handwand (mixing/loading separate), airblast sprayer, and applying soluble powder/granular by hand/handtool/shaker can;

- Ornamentals at Residences -- equipment used for homeowner includes backpack sprayer, low pressure handwand, applying soluble powder/granular by hand/handtool/shaker can, hose-end sprayer, and aerosol can;

- Commercial Turf -- equipment used for application to turf includes aerial application, groundboom, and handgun sprayer;

- Residential Turf -- equipment used for application to residential turf includes low pressure handwand, backpack sprayer, hose-end sprayer, and sprinkling can; and

- Spot Treatment -- equipment used for spot treatment is Pest Control Operator (PCO) injector, low pressure handwand and aerosol can.

3.a.vii. Timing and Frequency of Applications

- Fruit Tree -- applications are typically made as the insects begin to appear; reapply at 7-10 day intervals;

- Field, Forage, Fiber, Small Fruit, and Vegetable Crops -- apply when eggs or insects appear; current labels state: repeat at 7-10 day intervals, do not exceed 7 applications per season; **however, the Acephate Use Closure Memo lists the following maximum application rates for food crops treated with acephate**:

  Beans (snap, dry, lima), 2 lb ai per acre per crop cycle
  Brussels sprouts, 2 lb ai per acre per crop cycle
  Cauliflower, 2 lb ai per acre per crop cycle
  Celery, 2 lb ai per acre per crop cycle
  Cotton, 6 lb ai per acre per crop cycle
  Cranberries, 1 lb ai per acre per crop cycle

Head lettuce, 2 lb ai per acre per crop cycle
Peanuts, 4 lb ai per acre per crop cycle
Pepper (non-bell), 1 lb ai per acre per crop cycle
Pepper (bell), 2 lb ai per acre per crop cycle
Peppermint/Spearmint, 2 lb ai per acre per crop cycle
Soybean, 1.5 lb ai per acre per crop cycle and
Tobacco, 4 lb ai per acre per crop cycle;

- Cotton Seed Treatment -- treat seeds in slurry tank or hopper box once before planting seeds (label does not specify that mechanical treatment is required);

- Non-Crop Areas -- for fire ant control apply in the morning or late afternoon; do not apply more than once per year; for other insects thoroughly spray foliage and soil; begin application in mid-June and make 3 or more applications at three week intervals;

- Evergreens in Large Stands -- apply when foliage expansion and insect hatch has occurred; reapply as needed to control infestation;

- Commercial Ornamental Grown in Greenhouses -- apply when insects are present or feeding injury is first noticed; spray 2-3 times about 7-10 days apart; additional sprays may be necessary if plants become re-infested; using granulars apply twice in the spring (6 weeks apart), at the first sign of growth, and one additional application in the fall; do not exceed 3 applications per year;

- Commercial Outdoor Ornamental Applications -- apply when insects are present or feeding injury is first noticed; spray 2-3 times about 7-10 days apart; additional sprays may be necessary if plants become re-infested; using granulars apply twice in the spring (6 weeks apart), at the first sign of growth, and one additional application in the fall; do not exceed 3 applications per year;

- Commercial turf -- applying for fire ant control apply in the morning or late afternoon; do not apply more than once per year; for other insects thoroughly spray foliage and soil; begin application in mid-June and make 3 more applications at three week intervals; and

- Spot Treatment -- on an as needed basis for control of insects.

3.a.viii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

Minor HED-based modifications (regarding application rates and/or acreage treated) are included in this section of the assessment. A registrant provided the Agency additional information on residential application rates which should be addressed during label modification. The suggested changes by the registrant have been included in this assessment. HED has also modified the occupational acreage treated for cranberries to 30 acres. This information was provided by public comment. HED requests additional information from the registrant regarding the application methods/equipment, cultural practices and exposure monitoring data for acephate treatment of cranberries. Please note that acreage changes should be addressed during label modification.

3.b. Occupational and Non-Occupational Exposure and Risk Assessments

HED has determined that there is potential for exposure in occupational settings from handling acephate products during the application process (i.e., mixer/loader, applicator and mixer/loader/applicator) and from entering previously treated areas. In addition, HED has determined that there is potential for exposure to the public from handling acephate products during the application process in the residential environment and from entering previously treated residential areas. Finally, golfers who enter golf courses following acephate treatment may also have potential exposure. HED has also determined that there is potential for exposure to methamidophos, a degradate of acephate, following acephate application in both occupational and residential environments.

As a result, acephate risk assessments have been completed for individual and professional pesticide applicator scenarios, worker post-application scenarios, residential handler and post-application scenarios, and recreational scenarios for both adult and 13+ year-old golfers. Because methamidophos is a degradate of acephate, risk assessments have also been completed for worker, residential, and recreational post-application exposures to methamidophos.

3.b.i. Endpoints and Calculations Used in the Exposure and Risk Assessments

A series of toxicological endpoints and calculations were used to complete the individual and professional pesticide applicator risk assessments, worker post-application assessments and non-occupational (e.g., residential and recreational) assessments. The endpoints and equations which have been used are presented in this section. All endpoints were selected by the Hazard Identification Assessment Review Committee (HIARC). HIARC and the Food Quality Protection Act Safety Factor Committee (FQPA SFC) determined the uncertainty factors (UF) for both acephate and methamidophos.

The toxicological database for acephate (O,S-dimethyl acetylphosphoramidothioate) is adequate and will support reregistration. Table 1 summarizes the acute toxicity studies for acephate and the toxicity categories for the different routes of administration. Table 2 summarizes the toxicological endpoints, No Observable Adverse Effect Levels (NOAELs), and uncertainty factors (UF) for acephate which serve as the basis for the risk assessments.

Table 1. Acute Toxicity Categories for Acephate.

Test	Results	Toxicity Category
Acute Oral Toxicity (Rat)	LD_{50} =945 mg/kg males LD_{50} = 866 mg/kg females	II
Acute Dermal Toxicity (Rabbit)	LD_{50} > 10 g/kg females	IV
Acute Inhalation Toxicity (Rat)	LD_{50} > 61.7 mg/L	IV
Primary Eye Irritation (Rabbit)	Mild irritant	III
Primary Dermal Irritation (Rabbit)	PIS = 0.1 (Intact and abraded skin)	IV
Dermal Sensitization (Guinea Pig)	Negative	----

Table 2. Endpoints for Assessing Risks to Acephate Exposure.

Test	Study	Dose	Endpoint	UF
Dermal – Any Duration	21-Day Dermal Toxicity (Rat)	NOAEL = 12 mg/kg/day	Brain cholinesterase inhibition	100 for occupational and residential exposures
Inhalation -- Any Duration	4-week Inhalation (Rat)	NOAEL = 0.0005 mg/L (0.14 mg/kg/day)	Brain cholinesterase inhibition	100 for occupational and residential exposures
Oral – Acute	Acute Neurotoxicity Range Finding (Rat)	NOAEL = 0.5 mg/kg/day	Brain cholinesterase inhibition	100 for residential exposures
Carcinogenic		Acephate has been classified as a Group C (possible human carcinogen). Per F. Fort (e-mail message 04/06/98), the RfD approach will be used.		

NOAEL = No Observable Adverse Effect Level; UF = Uncertainty Factor

The inhalation NOAEL of 0.14 mg/kg/day was calculated from the inhalation endpoint of 0.0005 mg/L in Fischer 344 rats. The inhalation endpoint for inhalation risks was converted to an oral equivalent dose as presented below:

$$Inhalation\ NOAEL\ (mg/kg/day) = \frac{NOAEL\ (mg/L)\ x\ RV\left(\frac{L}{hr}\right)\ x\ D\ (hr) x\ A\ x\ AF}{BW(kg)}$$

where:

RV/BW = respiratory volume (mean liters of air respired per hour at rest) divided by body weight (for Fischer 344 Rats is 47 L/kg/hr)

D(hr) = duration of daily animal exposure (based on a 6-hour/day)

A = absorption - the ratio of deposition and absorption in the respiratory tract compared to absorption by the

oral route (assumed to be 1)
AF = activity factor (animal default is 1)

Table 3 summarizes the acute toxicity studies for methamidophos (O,S-dimethyl phosphoramidothioate) and the toxicity categories for the different routes of administration. Table 4 summarizes the toxicological endpoints, NOAELs, and UFs for methamidophos which are used in this document. HIARC classified methamidophos as a "not likely" human carcinogen. Therefore, a cancer risk assessment is not required.

Table 3. Acute Toxicity Categories for Methamidophos.

Test	Results	Toxicity Category
Acute Oral Toxicity (Rat)	LD_{50} = 15.6 mg/kg males LD_{50} = 13.0 mg/kg females	I
Acute Dermal Toxicity (Rabbit)	LD_{50} > 118 mg/kg males	I
Acute Inhalation Toxicity (Rat)	LC_{50} = 0.052-0.079 mg/L males LC_{50} = 0.062-0.128 mg/L females	I
Primary Eye Irritation (Rabbit)	Corneal opacity and pannus present in 2/6 rabbits for 10 days post-treatment; one death occurred 30 minutes after dosing	I
Primary Dermal Irritation (Rabbit)	PIS = 0.6; but test material was lethal to 5/9 animals within 24 hours of treatment	I
Dermal Sensitization (Guinea Pig)	Negative	----

Table 4. Endpoints for Assessing Risks to Methamidophos Exposure.

Test	Study	Dose	Endpoint	UF
Dermal – Any Duration	21-Day Dermal Toxicity (Rat)	NOAEL = 0.75 mg/kg/day	Plasma, red blood cell and brain cholinesterase inhibition	100 for occupational and 300 for residential exposures
Inhalation -- Any Duration	90-Day Inhalation (Rat)	NOAEL = 0.001 mg/L (0.27 mg/kg/day)	Plasma, red blood cell and brain cholinesterase inhibition	100 for occupational and 300 for residential exposures
Oral – Acute	Acute Neurotoxicity (Rat)	NOAEL = 0.3 mg/kg/day	Brain cholinesterase inhibition	300 for residential exposures

The inhalation NOAEL of 0.27 mg/kg/day was calculated from the inhalation endpoint of 0.001 mg/L in Wistar rats. The inhalation endpoint for inhalation risks was converted to an oral

equivalent dose as presented below:

$$Inhalation\ NOAEL\ (mg/kg/day) = \frac{NOAEL\ (mg/L)\ x\ RV\left(\frac{L}{hr}\right)\ x\ D\ (hr) x\ A\ x\ AF}{BW(kg)}$$

where:

RV = respiratory volume (mean liters of air respired per hour at rest) for Wistar Rats is 8.46 L/hr
D(hr) = duration of daily animal exposure (based on a 6-hour/day)
BW(kg) = mean body weight in kg of Wistar rat (0.187 kg) for subchronic studies
A = absorption - the ratio of deposition and absorption in the respiratory tract compared to absorption by the oral route (assumed to be 1)
AF = activity factor (animal default is 1)

Since the short-term and intermediate-term dermal NOAELs for both acephate and methamidophos were selected based upon 21-day dermal rat studies, no dermal absorption adjustment is required for these assessments.

Toxicological Endpoints/NOAELs of Concern

Short-term exposures are defined as daily exposures for durations of 1-7 days, intermediate-term exposures are defined as daily exposures for durations of several weeks, and chronic exposures are defined as daily exposures for a minimum of several months. During the exposure assessment process, it was determined that uses of acephate by individual and professional pesticide applicators result in short-term and intermediate-term dermal and inhalation exposures to acephate of these applicators. However, the frequency and duration of these exposures do not exhibit a chronic exposure pattern. Therefore, performing a chronic occupational assessment and a carcinogenic (RfD approach) assessment are not appropriate and toxicological endpoints of a chronic nature will not be discussed in this document. In addition, it is anticipated that post-application workers will have short-term and intermediate-term dermal exposures to acephate and methamidophos. Inhalation exposures are not anticipated for occupational post-application scenarios.

Residential applicators are anticipated to have short-term dermal and inhalation exposures to acephate while post-application residential exposures are anticipated to be short-term dermal and oral for both acephate and methamidophos. Recreational exposures are anticipated to be short-term dermal for both acephate and methamidophos. Negligible inhalation exposures for residential and recreational post-application scenarios.

Exposure and Risk Equations for Individual, Professional and Residential Applicators' Assessments

Daily dermal and inhalation exposures, absorbed daily doses, and risks are calculated as described below. These calculations are used for individual, professional and residential pesticide applicators. The first step is to calculate daily dermal and inhalation exposures.

Daily dermal exposure is calculated:

Daily dermal exposure (mg / day) =

Unit exposure (mg / lb ai) x Application rate (lb ai/A) x Daily treatment (A/day)

Where:

Daily dermal exposure = amount deposited on the surface of the skin that is available for dermal absorption, also referred to as potential dose (mg/day);
Unit exposure = normalized exposure value derived from August, 1998 PHED Surrogate Exposure Table or December, 1997 Residential SOPs when no chemical-specific data are available for assessment (mg/lb ai applied);
Application rate = normalized application rate based on a logical unit treatment such as acres, a maximum value is generally used (lb ai/A); and
Daily treatment = normalized application area based on a logical unit treatment such as acres (A/day).

[Note: (lb ai/acre) and (A/day) are replaced, respectively, with (lb ai/gal) and (gal/day) when appropriate.]

Daily inhalation exposure is calculated:

Daily inhalation exposure (mg / day) =

[Unit exposure (μg/lb ai) x Application rate (lb ai/A) x Daily treatment (A/day)] / (1000 μg/mg)

Where:

Daily inhalation exposure = amount available for absorption, also referred to as potential dose (mg/day);
Unit exposure = normalized exposure value derived from August, 1998 PHED Surrogate Exposure Table or December, 1997 Residential SOPs when no chemical-specific handler data were available for this assessment (μg/lb ai applied);
Application rate = normalized rate based on a logical unit treatment such as acres, a maximum value is generally used (lb ai/A); and
Daily treatment = normalized area based on a logical unit treatment such as acres (A/day).

Absorbed daily dermal and inhalation doses are then calculated by normalizing the daily dermal and inhalation exposures by body weight. For individual, professional and residential pesticide applicators using acephate, a body weight of 70 kg (default adult body weight) was used for all exposure scenarios because the effects observed in the toxicological studies were not sex-specific.

Since the toxicity endpoint is based upon a 21-day dermal study, use of a dermal absorption factor is not needed. Daily inhalation exposure levels were calculated for inclusion into the PHED surrogate exposure tables and presented as (μg/lb ai) based on a human inhalation rate of 29 L/minute and an 8-hour working day. The absorbed dermal and inhalation doses for short- and intermediate-term scenarios were calculated using the following equation.

Absorbed Daily Dose is calculated:

Absorbed daily dermal or inhalation dose (mg/kg/day) =
Daily dermal or inhalation exposure (mg/day) / body weight

[Note: 70 kg human assumed for short-term and intermediate-term individual, professional and residential applicator exposures; calculates a potential biologically-available dose resulting from dermal or inhalation exposure.]

Once the route-specific absorbed daily doses are calculated, the dermal and inhalation Margins of Exposure (MOEs) are calculated as follows.

Margin of Exposure is calculated:

MOE (unitless) = NOAEL (mg/kg/day) / Absorbed Daily Dose (mg/kg/day)

[Note: NOAEL and absorbed daily dose are for the same route of exposure and exposure duration (e.g., both dermal or both inhalation and both short-term or both intermediate-term).]

Because exposures from both the dermal and inhalation routes have the same toxicological effect (i.e., brain cholinesterase inhibition), the route-specific MOEs can be combined to express a total risk from acephate exposure to individual, professional and residential pesticide applicators. That is, once $MOE_{ST,dermal}$, $MOE_{ST,inhalation}$, $MOE_{IT,dermal}$ and $MOE_{IT,inhalation}$ have been calculated for each exposure scenario, the short-term (ST) MOEs and intermediate-term (IT) MOEs can be combined using the following equations. Combined MOEs of 100 are considered acceptable for individual, professional and residential pesticide applicator exposures to acephate.

Combined Dermal and Inhalation Margin of Exposures are calculated:

$$MOE_{ST,Combined} = 1 / (1/MOE_{ST,dermal} + 1/MOE_{ST,inhalation})$$

$$MOE_{IT,Combined} = 1 / (1/MOE_{IT,dermal} + 1/MOE_{IT,inhalation})$$

Exposure and Risk Calculations for Post-Application Worker Assessments

HED is concerned about potential occupational post-application exposure to acephate and methamidophos from entering treated agricultural fields, greenhouses, sod farms, and golf courses. Due to the nature of activities in these areas, it is anticipated that workers will have exposure to acephate and methamidophos following acephate treatment. Valent submitted four dislodgeable foliar residue studies (DFRs) and one turf transferable residue study (TTR) which address the dissipation of acephate and methamidophos in fields/greenhouses of succulent beans, cauliflower, greenhouse roses, tobacco, and turfgrass. Brief summaries and reviews of the DFR and TTR studies may be found in Section 3.b.ix.

The calculations used to estimate daily dermal dose and MOE for the dermal post-application scenarios are similar to those described previously for the individual, professional and residential applicator scenarios. The only significant differences are: (1) the manner in which daily dermal dose is calculated using a transfer coefficient, transferable residues, and accounting for the dissipation of acephate and methamidophos over time and (2) inhalation exposures were not calculated for the post-application scenarios (i.e. absorbed daily dose and MOE calculations only represent dose levels from dermal exposures, because inhalation exposures have been shown to account for a negligible percentage of the overall body burden).

Chemical-specific dislodgeable foliar residue (DFR) and turf transferable residue (TTR) dissipation data were used to complete the post-application risk assessments. Best fit transferable residue levels (i.e., DFRs and TTRs) were calculated based on empirical data using the equation D2-16 from *Series 875-Occupational and Residential Test Guidelines: Group B-Post-application Exposure Monitoring Test Guidelines*. The factors for this equation were developed based on a semi-log regression of actual acephate and methamidophos dissipation data following the application of acephate to succulent beans, cauliflower, greenhouse roses, tobacco and turfgrass.

$$C_{envir(t)} = C_{envir(0)} e^{PAI_{(t)} * M}$$

Where:

$C_{envir(t)}$ = transferable residue concentration (µg/cm^2) that represents the amount of residue on the surface of a contacted leaf surface that is available for dermal exposure at time (t);
$C_{envir(o)}$ = transferable residue concentration (µg/cm^2) that represents the amount of residue on the surface of a contacted leaf surface that is available for dermal exposure at time (0);
e =natural logarithms base function;
PAI_t = post-application interval or dissipation time (e.g., day after treatment [DAT]); and
M = slope of line generated during linear regression of data [ln(C_{envir}) versus post-application interval (PAI)].

The following equation was used to calculate dermal doses for acephate and methamidophos on each post-application exposure day.

Post-Application Dermal dose is calculated:

Dermal dose (mg/kg/day) =

(TR(t) [μg/cm^2] x Tc (cm^2/hr) x DA x 0.001 mg/μg conversion x # hours worked/day) / body weight (kg)

Where:

Dermal dose (t) = dermal dose attributable to exposure at time (t) when engaged in a specific mechanical activity or job function (mg/kg/day);
Transferable residue (TR) = transferable residue that represents the amount of residue which is available for dermal exposure at time (t) [μg/cm^2];
Tc = transfer coefficient or measure of the relationship of exposure to transferable residue concentrations

while engaged in a specific mechanical activity or job function;
DA = dermal absorption (%); 21-day dermal study;
Hours worked/day = exposure duration or hours engaged in specific mechanical activity (hrs/day); and
Body weight = body weight (kg).

[Note: no chemical-specific transfer coefficients were available; default transfer coefficients are presented later in text; 100% dermal absorption was assumed (as previously described in this document); 70 kg human assumed.]

Once the post-application dermal doses are calculated, the dermal Margins of Exposure (MOEs) can be calculated. MOEs of 100 are considered acceptable for post-application worker exposure to both acephate and methamidophos.

Margin of Exposure is calculated:

MOE (unitless) = NOAEL (mg/kg/day) / Dermal Dose (mg/kg/day)

Exposure and Risk Calculations for Post-Application Residential Assessments

HED is concerned about potential acephate and methamidophos exposure to the public from entering residential areas treated with acephate. Due to the nature of activities in residential areas, it is anticipated that adults and children will have exposure to acephate and methamidophos following acephate treatments in the residential environment. It is also anticipated that these exposures may include: dermal exposure for both adults and children, hand-to-mouth exposure for children, and turfgrass ingestion exposure for children. Incidental soil ingestion is not anticipated to be of concern, and inhalation exposures are not anticipated for post-application residential scenarios. To perform an assessment of these potential residential exposures, HED used chemical-specific data from the turf transferable residue study (TTR) which Valent submitted to the Agency. Acephate and methamidophos TTRs were averaged from actual field measurements made following the second application of acephate during the registrant's study. Acephate and methamidophos TTRs were then adjusted to reflect the difference in application rate used in the TTR study and in residential environments (e.g., 5.0 lb ai/A versus 3.5 lb ai/A).

The screening level equations used to quantify the potential residential exposures are from the Agency's *Standard Operating Procedures for Residential Exposure Assessments (December 1997).* In addition, since the September 21, 1999, FIFRA SAP panel meeting on residential exposures, changes to standard Agency assumptions for transfer coefficients, hand-to-mouth activities and extraction of residues from the hand by saliva have been proposed. These new standard assumptions are incorporated into this assessment.

Potential Dermal Dose is calculated:

Dermal dose (mg/kg/day) =
(TTR(t) [μg/cm^2] x Tc (cm^2/hr) x DA x 0.001 mg/μg conversion x ED) / body weight (kg)

Where:

Dermal dose (t) = dermal dose attributable to exposure at time (t) when engaged in a specific mechanical activity or job function (mg/kg/day);
Turf transferable residue (TTR) = transferable residue that represents the amount of residue which is available for dermal exposure at time (t) [μg/cm^2];
Tc = transfer coefficient or measure of the relationship of exposure to transferable residue concentrations while engaged in a specific mechanical activity;
DA = dermal absorption (%);
ED = exposure duration or hours engaged in specific mechanical activity (hrs/day); and
Body weight = body weight (kg).

[Note: no chemical-specific transfer coefficients were available; standard transfer coefficients of 14,500 and 5,200 were used for short-term adult and child calculations, respectively; standard exposure time is 2 hours/day; 100% dermal absorption was assumed (as previously described in this document); 70 kg human assumed for adult and 15 kg human assumed for child.]

Once the post-application residential dermal doses are calculated, the dermal Margins of Exposure (MOEs) can be calculated. MOEs of 100 are considered acceptable for exposures to acephate of all population subgroups. MOEs of 300 are considered acceptable for exposures to methamidophos of all population subgroups.

Margin of Exposure is calculated:

MOE (unitless) = Dermal NOAEL (mg/kg/day) / Dermal Dose (mg/kg/day)

Hand-to-mouth Exposure is calculated:

$ADD = (TTR_t \times SA \times FQ \times SE \times ET \times CF1) / BW$

Where:

ADD = average daily dose (mg/kg/day)
TTR_t = dislodgeable foliar residue on day "t" (μg/cm^2 turf)
SA = surface area of the hands (cm^2/event)
FQ = frequency of hand-to-mouth activity (events/hr)
SE = saliva extraction (% expressed as x/100)
ET = exposure time (hr/day)
CF1 = conversion factor to convert μg units in the DFR value to mg for the daily exposure (0.001 mg/μg)
BW = body weight (kg)

[Note: standard surface area for one hand-to-mouth event is assumed to be 20 cm^2 (palmar surface area of 3 fingers) for a toddler of age 3 years; replenishment of the fingers with pesticide residues was assumed to be implicit; 50% saliva extraction of residues from the fingers was assumed; standard rate of hand-to-mouth activity is 20 events/hour for toddlers of ages 3-5 years; standard exposure time is 2 hours/day; 15 kg human assumed for child.]

Once the hand-to-mouth doses are calculated, the hand-to-mouth Margins of Exposure (MOEs) can be calculated. MOEs of 100 are considered acceptable for child exposures to acephate. MOEs of 300 are considered acceptable for child exposures to methamidophos.

Margin of Exposure is calculated:

MOE (unitless) = Oral NOAEL (mg/kg/day) / Hand-to-mouth Dose (mg/kg/day)

It was assumed that the TTRs from the submitted study would represent the potential, available residues for turfgrass ingestion. Therefore, the average TTRs for acephate and methamidophos were used to calculate children's turfgrass ingestion risks.

Turfgrass Ingestion is calculated:

$ADD = (GR_t \times IgR \times SE \times CF1) / BW$

Where:

ADD = average daily dose (mg/kg/day)
GR_t = grass residue on day "t" ($\mu g/cm^2$)
IgR = ingestion rate of grass (cm^2/day)
SE = saliva extraction (% expressed as x/100)
CF1 = weight unit conversion factor to convert the μg of residues on the grass to mg to provide units of mg/day (1 mg/1000 μg)
BW = body weight (kg)

[Note: grass residues were assumed to be equivalent to TTRs; ingestion rate for grass for toddlers (age 3 years) is assumed to be 25 cm^2/day (i.e., 2 x 2 inches or 4 in^2); this value is intended to represent the approximate area from which a child may grasp a handful of grass; 50% saliva extraction of residues from the turfgrass was assumed; 15 kg human assumed for child.]

Once the turfgrass ingestion doses are calculated, the respective Margins of Exposure (MOEs) can be calculated. MOEs of 100 and 300 are considered acceptable for exposures to acephate and methamidophos, respectively.

Margin of Exposure is calculated:

MOE (unitless) = Oral NOAEL (mg/kg/day) / Dose (mg/kg/day)

<u>Exposure and Risk Calculations for Post-Application Recreational Assessments</u>

HED is concerned about potential acephate and methamidophos exposure to the public from entering recreational areas treated with acephate. The only recreational area addressed in this risk assessment is the golf course. Due to the nature of activities on golf courses, it is anticipated that adults and 13+ year-olds may have dermal exposure to acephate and methamidophos while golfing following acephate treatment to golf courses. Inhalation exposures are not anticipated for golf course post-application exposures. To perform an assessment of these potential recreational exposures, HED used chemical-specific data from the turf transferable residue study (TTR) which Valent submitted to the Agency. Acephate and methamidophos TTRs were averaged from actual field measurements made following the second application of acephate during the registrant's study.

The calculations used to estimate dermal dose and MOEs for the dermal recreational scenarios are similar to those described previously for the post-application worker scenarios. The only differences in calculating the dermal dose of golfers were: (1) the duration of golfing 18 holes was estimated at 4 hours, (2) the use of 100 as a transfer coefficient; golfers' dermal exposure is anticipated to be significantly lower than post-application workers, and golfers' exposures are anticipated to occur through minimal hand contact with the golf ball and dermal exposure to the lower legs; as a result, a transfer coefficient of 100 is consistent with low potential for dermal transfer, and (3) a body weight of a 70 kg was used for adults and 44 kg for 13+ year-olds in the calculations. No potential hand-to-mouth exposures were estimated for recreational exposures.

3.b.ii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

Since the previous acephate RED document was available for public comment, the registrant of methamidophos submitted a supplemental report on its 21-day dermal rat toxicity study. This supplemental report corrected the actual concentration of active ingredient used in the study. HIARC determined that the corrected dose level must be used as the dermal NOAEL in risk assessments for methamidophos. The dermal NOAEL for methamidophos is 0.75 mg/kg/day rather than 1.0 mg/kg/day.

Valent submitted four dislodgeable foliar residue studies (DFRs) and one turf transferable residue (TTR) study to the Agency. The Agency has reviewed each of these studies and found them to be acceptable. Data from these DFRs and TTR are used in the following assessments within this document: post-application worker, post-application residential and post-application recreational.

EPA presented a document entitled Overview of Issues Related to the Standard Operating Procedures (SOPs) for Residential Exposure Assessment (dated August 05,1999) to the FIFRA SAP panel on September 21, 1999. As a result, the Agency will be revising the residential SOPs in early 2000 to reflect comments from the 1999 SAP panel. The current assessment incorporates the proposed changes to standard Agency assumptions for dermal transfer coefficients, hand-to-mouth activities, and extraction of residues by saliva.

Calculations for the post-application residential risks use dermal NOAELs for acephate and methamidophos when assessing acephate and methamidophos dermal exposures. However, calculations for the post-application residential risks use oral NOAELs for acephate and methamidophos when assessing acephate and methamidophos hand-to-mouth, and turfgrass ingestion exposures. Grass residues have been assumed to be equivalent to the submitted study TTRs, and potential soil ingestion has been removed from the assessment because it is not anticipated. In addition, this document incorporates a post-application recreational assessment for golfers.

3.b.iii. Risk Assessment Assumptions and Factors

The following assumptions and factors were used in order to complete the exposure and risk assessments contained in this document:

- Average work day interval for individual and professional pesticide applicators and post-application workers represents an 8-hour workday (e.g., the acres treated, volume of spray solution prepared in a day or number of hours involved in post-application activity [e.g., stake/tie, irrigate, harvest]).

- Daily acreage or volumes to be treated in each individual and professional pesticide applicator scenario include:

Granules by belly grinder:	trees/shrubs – 2 acres
Granules by hand:	fire ant – 1 acre
	trees/shrubs -- 0.025 acre
Granules by tractor-drawn spreader:	agricultural -- 80 acres
	sod farm – 80 acres
	golf course turf -- 40 acres
Granules by push-type spreader:	turf -- 5 acres
Granules by shaker can:	trees/shrubs – 0.25 acre
Liquids by aerial:	agricultural – 350 acres
	forest – 350 or 800 acres
Liquids by airblast sprayer:	non-bearing citrus – 40 acres
	trees/shrubs/floral – 1000 gallons
Liquids by backpack sprayer:	trees/shrubs/floral – 40 gallons
	wasps/fire ant – 5 gallons
	PCO – 40 gallons
Liquids by chemigation:	agricultural -- 350 acres
	agricultural -- 80 acres
	cranberries -- 30 acres
Liquids by groundboom spray:	agricultural -- 80 acres
	sod farm – 80 acres
	golf course turf – 40 acres
Liquids by hand/handtool/shaker can:	fire ant – 1 acre
Liquids by handgun (hydraulic sprayer)	tobacco – 13 gal/A for 6 acres
	trees/shrubs/floral – 1000 gallons
	turf – 5 acres
Liquids by high-pressure sprayer:	trees/shrubs/floral – 1000 gallons
Liquids by hopper box (seed treatment):	cotton – 80 acres
Liquids by low-pressure handwand:	trees/shrubs/floral – 40 gallons
	wasps/fire ant – 5 gallons
	PCO – 40 gallons
Liquids by seed slurry treatment:	cotton seed -- 200,000 lbs (100 tons)
Liquids by sprinkler can:	fire ant – 1 acre

Liquids by transplanting in water:	tobacco -- 20 acres

- Daily acreage or volumes to be treated in each residential applicator scenario include:

Aerosol can:	crack & crevice – 0.02 lb
	ornamentals – 0.06 lb
Granules by shaker can:	ornamentals – 0.05 lb
	roses – 0.05 lb
Liquids by backpack sprayer:	roses/trees/shrubs/floral – 2 gallons
	turf – 2 gallons
Liquids by hand/handtool/shaker can:	fire ant – 0.05 lb
Liquids by hose-end sprayer:	roses/trees/shrubs/floral – 50 gallons
	shade trees – 50 gallons
	turf – 50 gallons and 0.5 acre
Liquids by low-pressure handwand:	roses/trees/shrubs/floral – 2 gallons
	turf – 2 gallons
Liquids by sprinkler can:	roses/trees/shrubs/floral – 5 gallons
	turf – 5 gallons

- To evaluate occupational and residential risk levels associated with the various use patterns, calculations are completed for a range of maximum application rates to various agricultural crops/treatments (i.e., low-range, mid-range and high-range are maximum rates for specific crop types, ornamentals or turf) as listed on current, available acephate labels and the Acephate Use Closure memo.

- Due to a lack of scenario-specific data, HED often calculates unit exposure values using generic protection factors (PF) that are applied to represent various risk mitigation options (i.e., the use of personal protective equipment [PPE] and engineering controls). PPE protection factors include those representing a double layer of clothing (50% PF), chemically-resistant gloves (90% PF), and appropriate respiratory protection (80 to 90% PF, depending upon the type of respirator used). Engineering controls are generally assigned a protection factor of 90 to 98 percent, depending upon the type of engineering controls selected. Engineering controls may include: closed mixing/loading systems, closed cabs/cockpits, and water-soluble packaging. When protection factors are used in estimating exposure, it is noted in the footnotes and/or tables.

- For the individual, professional and residential pesticide applicator assessments a body weight of 70 kg was assumed. This body weight is used since the endpoint of concern is not sex-specific (i.e., cholinesterase inhibition can be assumed to occur in both males and females).

- For the post-application worker assessments several assumptions were made: default

transfer coefficients were used; 100% dermal absorption was assumed; and a body weight of 70 kg was assumed. The default transfer coefficients used in the post-application worker assessment are as follows: succulent beans (4,000 cm^2/hr for bean harvest by hand, stake/tie, scout and irrigate); cauliflower (1000 cm^2/hr for cauliflower scouting/irrigating and 2,500 cm^2/hr for cauliflower harvest by hand); greenhouse roses (2,500 cm^2/hr for roses sorting/packing and 10,000 cm^2/hr for roses pruning/harvest by hand); tobacco (4,000 cm^2/hr for tobacco stake/tie, scouting & irrigating and 10,000 cm^2/hr for tobacco harvest by hand); and turf (500 cm^2/hr for tractor mowing, 1,000 cm^2/hr for push-type mowing and 10,000 cm^2/hr for sod harvesting).

- For the non-occupational (post-application residential) assessments numerous assumptions were made: TTRs were averaged from actual field measurements made following the second application in Valent's study and used as day 0 data; no dissipation was assumed; default transfer coefficients of 14,500 cm^2/hour and 5,200 cm^2/hour were used for adult and child dermal dose calculations, respectively; 100% dermal absorption was assumed; default exposure time was 2 hours/day; default surface area for one hand-to-mouth event is assumed to be 20 cm^2 (palmar surface area of 3 fingers) for a toddler of 3 years; replenishment of the fingers with pesticide residues was assumed to be implicit; 50% saliva extraction of residues from fingers was assumed; default rate of hand-to-mouth activity is 20 events/hour for toddlers of ages 3-5 years; grass residues were assumed be equivalent to TTRs; ingestion rate for toddlers (age 3 years) was assumed to be 25 cm^2/day; and body weights of 70 and 15 kg were used for adults and children, respectively.

- For the non-occupational (post-application recreational) assessment several assumptions were made: TTRs were averaged from actual field measurements made following the second application in Valent's study and used as day 0 data; it was assumed that golfers would only have dermal exposure (no inhalation exposure); it was assumed that the duration of golfing 18 holes is estimated at 4 hours; 100 was used as a transfer coefficient for golfers; and body weights of 70 and 44 kg were used for adults and 13+ year-olds, respectively.

- For the individual, professional and residential pesticide applicator assessments, a Margin of Exposure (MOE) of 100 was assigned for acephate by HIARC; for the post-application worker, post-application residential and post-application recreational assessments, a MOE of 100 was assigned for acephate by HIARC; for the post-application worker assessment, a MOE of 100 was assigned for methamidophos by HIARC; and for the post-application residential and post-application recreational assessments, methamidophos MOEs of 300 were assigned by HIARC/FQPA SFC for all population subgroups.

3.b.iv. Modifications Based upon Agency's Revisions, Public Comments, and/or

Registrants' Comments

Several HED-based modifications (e.g., acreage treated, transfer coefficients and DFR/TTR data usage) are included in this section of the assessment. HED has also modified the occupational acreage treated for cranberries to 30 acres based upon information provided by public comment. HED requests additional information from the registrant regarding the application methods/equipment, cultural practices and exposure monitoring data for acephate treatment of cranberries. Please note that acreage changes should be addressed during label modification. In addition, the registrant provided input for three residential applicator scenarios regarding acreage treated or volume used. These include: 2 gallons for the use of a low pressure hand wand, 2 gallons for the use of a backpack sprayer, and 0.5 lb/1000 ft^2 for the use of a shaker can. These changes should be addressed during label modification.

HED does not agree with the registrant's use of respirator protection factors. The protection factors which the registrant cited are very conservative and are only used for negative-pressure half-face or full-face respirators. The protection factors the Agency uses for this assessment reflects the use of dust/mist respirators and are in concurrence with other occupational-based agencies.

HED agrees with the registrant that aerial turf application of acephate at 5 lb ai/A is infeasible; however, this potential exposure scenario remains on current labels. As a result, it is maintained in this assessment. This should be addressed during label modification.

PHED data for wettable powders have been used due to the lack of data for soluble powders in this assessment. This is the best available information the Agency currently has to it to conduct an assessment. The Agency would encourage the registrants to conduct appropriate exposure monitoring studies to determine occupational and residential exposures to soluble powder formulations. The Agency would like to work together with the registrants to develop appropriate protocols for such studies.

The Agency's modifications to post-application residential assumptions have already been previously discussed.

3.b.v. Occupational and Residential Applicator Exposure Data Sources

<u>Acephate Pest Control Operator Study (Occupational Study)</u>

The registrant submitted a study entitled *Potential Exposure to Acephate During and After Application of Orthene PCO Spray Concentrate by Commercial Pest Control Operators* (March 27, 1988; MRID # 405048-23). This study was previously reviewed and used in the assessment. A summary of the study may be found subsequently.

A total of nine PCO replicates were monitored in which acephate was spot-treated around baseboards, under counters, and behind equipment in commercial establishments. An additional nine replicates were conducted for PCOs treating residential establishments. Each PCO mixed one gallon of finished spray by tearing open one package (39.7 g acephate) of wettable powder and adding the acephate to one gallon of water. Each PCO sprayed one quart of finished spray. (The remaining three quarts of spray were removed by individuals other than the PCO). The PCO then mixed a second package but did not spray this mixture.

Inhalation exposures were monitored using personal air samplers with two polyurethane foam plugs. Dermal exposures were monitored using single and multi-layered dosimeters. Hand exposures were monitored using white cotton gloves. Quality control procedures were used. The limits of detection were 2 ug for the polyethylene plugs, 0.01 ug/cm^2 for the patches, and 100 ug for the cotton gloves.

The PCOs wore long-sleeved shirts, long pants, and no gloves. The dermal exposure at a residential site was estimated to be 160 mg/lb ai while the dermal exposure at a commercial site was estimated to be 170 mg/lb ai. Residential and commercial inhalation exposures were estimated to be 2.8 mg/lb ai.

Acephate Residential Handler Exposure Study (Residential Study)

The registrant submitted a homeowner exposure study (MRID # 405048-27). This study was previously reviewed and used in the assessment. A summary of the study may be found subsequently.

The study was conducted to assess dermal and inhalation exposures to homeowners applying acephate outdoors by hose-end sprayers. A total of five homeowners were monitored as they mixed and sprayed 4 gallons of finished spray, re-mixed and sprayed another 4 gallons of finished product, and then cleaned out the hose-end sprayer by back flushing.

Inhalation exposures were monitored using personal air samplers with two polyurethane foam plugs. Dermal exposures were monitored using dosimeters. Hand exposures were monitored using white cotton gloves. Quality assurance sampling was conducted in the field during the study. The laboratory detection limits were 1.0 ug/foam plug, 0.01 ug/cm^2 for the patches, and 2.0 ug per pair of gloves.

The number of replicates was low but still sufficient to demonstrate a dermal exposure range of 120 to 1,500 mg/lb ai. The dermal exposure to homeowners applying liquid formulations of acephate to bushes and shrubs by hose-end sprayer was estimated to be 480 mg/lb ai when wearing shorts and short-sleeved shirts. The hands accounted for the majority of the dermal exposure. The inhalation exposure was estimated to be less than 0.15 mg/lb ai.

Occupational and Residential Pesticide Applicator Exposure Databases

The chemical-specific data from the two afore-mentioned studies were the only data submitted to the Agency for assessing human exposures during pesticide handling activities and in support of the reregistration of acephate. When chemical-specific exposure data are unavailable, it is HED's policy to use data from the Pesticide Handlers Exposure Database (PHED) Version 1.1 (August 1998) and Standard Operating Procedures for Residential Exposure Assessments (December 1997) to assess occupational and residential applicator exposures for regulatory actions.

PHED was designed by a task force of representatives from the US 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 upon the central assumption that the magnitude of handler exposures to pesticides are primarily a function of task (e.g., mixing/loading/applying), formulation type (e.g., wettable powders, granulars), application method (e.g., aerial, groundboom), and levels of personal protective clothing worn by the individual and professional pesticide applicator (e.g., gloves, double layer of clothing).

Once the data for a given exposure scenario have 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.

The unit exposure values calculated by PHED generally range from the geometric mean to the median of the selected data set. To add consistency and quality control to the values produced from this system, the PHED Task Force has evaluated all data within the system and has developed a set of grading criteria to characterize the quality of the original study data. The assessment of data quality is based upon the number of observations and the available quality control data. These evaluation criteria and the caveats specific to each exposure scenario are summarized in Table 5 of Appendix A. While data from PHED provide the best available information on handler exposures, it should be noted that some aspects of the included studies (e.g., duration, acres treated, pounds of active ingredient handled) may not accurately represent labeled uses in all cases. HED has developed a series of tables of standard unit exposures for many occupational scenarios that can be used to ensure consistency in exposure assessments.

3.b.vi. Mitigation Summary

Two common risk mitigation approaches HED considers for reducing occupational exposures are the use of personal protective equipment [PPE] (i.e., chemically-resistant gloves, double layer of clothing) and the use of engineering controls (i.e., closed tractor cabs, closed mixing/loading/tranfer systems, and water-soluble packets). Occupational exposure assessments are completed by HED through a tiered approach using a baseline exposure scenario and, if required, increasing the levels of risk mitigation (use of PPE and engineering controls) to achieve an acceptable margin of exposure or cancer risk. [Note: administrative controls are generally not considered in exposure assessments, because exposure assessments are conducted with respect to the current registered labels.]

The baseline clothing/PPE outfit for occupational exposure scenarios is generally an individual wearing long pants, a long-sleeved shirt, no chemically-resistant gloves and no respiratory protection (exceptions are otherwise noted). The first level of mitigation generally considered in the exposure assessment is the use of PPE. As is used in this exposure assessment, PPE involves the use of an additional layer of clothing, chemically-resistant gloves and appropriate respiratory protection beyond the baseline outfit (i.e., long pants and long-sleeved shirt). The next level of mitigation considered in the assessment is the use of engineering controls (when feasible for the application method).

3.b.vii. Occupational Handler Risk Assessment

HED has determined that individual and professional pesticide applicators (i.e. mixers, loaders, applicators, flaggers) are likely to be exposed during acephate use. Due to the frequency and duration of acephate uses, it was determined that uses of acephate by individual and professional pesticide applicators result in short-term and intermediate-term exposures to these applicators. However, the frequency and duration of these exposures do not exhibit a chronic exposure pattern (i.e., daily exposures which occur for a minimum of several months). The anticipated use patterns and current labeling indicate numerous exposure scenarios based upon the types of equipment that potentially can be used to make acephate applications. These scenarios serve as the basis for the quantitative exposure and risk assessments. The following major occupational exposure scenarios were identified for acephate:

- (1a) mixing/loading soluble powder for aerial application;
- (1b) mixing/loading soluble powder for chemigation application;
- (1c) mixing/loading soluble powder for groundboom application;
- (1d) mixing/loading soluble powder for airblast application;
- (1e) mixing/loading soluble powder for handgun (hydraulic sprayer) application;
- (1f) mixing/loading soluble powder for transplanting water application;
- (1g) mixing/loading soluble powder for slurry seed treatment;
- (1h) loading soluble powder for hopper box application;
- (2) mixing/loading dry flowable for slurry seed treatment;
- (3a) mixing/loading liquids for aerial application;
- (3b) mixing/loading liquids for slurry seed treatment;

- (4) loading granular in tractor-drawn drop-type spreader;
- (5) applying spray with fixed-wing aircraft;
- (6) applying spray using groundboom sprayer;
- (7) applying spray with airblast sprayer;
- (8) applying spray with handgun sprayer;
- (9) applying in transplanting water;
- (10) applying as a seed treatment in a hopper box;
- (11) applying as a seed treatment in a slurry tank;
- (12) applying granular with tractor-drawn drop-type spreader;
- (13a) mixing/loading/applying soluble powder using low-pressure hand wand;
- (13b) mixing/loading/applying wettable powder using low-pressure hand wand (MRID # 405048-23);
- (14) mixing/loading/applying using backpack sprayer;
- (15) mixing/loading/applying using high-pressure sprayer;
- (16) loading/applying using aerosol generator;
- (17) loading/applying with Pest Control Operator (PCO) injector;
- (18) loading/applying soluble powder (dry) by hand/hand tool/shaker can;
- (19) mixing/loading/applying soluble powder using sprinkling can;
- (20) loading/applying tree injections;
- (21) loading/applying granules with push-type granular spreader;
- (22) loading/applying granules with belly grinder;
- (23) loading/applying granules with shaker can;
- (24) loading/applying granules by hand; and
- (25) flagging for aerial spray applications.

For several scenarios either no data were available to perform an assessment or similar PHED data were used as surrogate data in the assessment. The scenarios for which no data are available have been classified in the tables of Appendix A as *No Data*. The scenarios which use surrogate data from PHED are specified in Table 5 of Appendix A. A brief summary of these scenarios also follows. In addition, PHED data for wettable powders have been used in this assessment due to a lack of data for soluble powders.

The following scenarios have no submitted data or PHED data available to perform an assessment: 10, 11, 16, 17 and 20. Surrogate data from PHED were used for the following scenarios: (9) PHED data for groundboom were used (which may over-estimate transplant water application for tobacco); (18) PHED data for granular bait dispersed by hand scenario were used; (19) PHED data for the garden hose-end sprayer were used; and (23) PHED data for granular bait dispersed by hand scenario were used.

The occupational risk assessment has been completed based upon the exposure data available to HED. The individual and professional pesticide applicator exposure and risk calculations are presented in the tables contained in Appendix A entitled *Acephate Occupational Handler Exposure and Risk Assessment Tables (Short-Term and Intermediate-Term Exposures)*. These results are for

both individual and professional pesticide applicators. The exposure factors (i.e., scenario descriptors, application rates, and daily treatment) and unit exposure values at varying levels of mitigation used in the assessment are presented in Table 1 of Appendix A. The calculations of daily exposure in milligrams/day (mg/day) at the baseline risk mitigation level, absorbed daily dose (mg/kg/day), individual dermal and inhalation MOEs using ST and IT NOAELs, and combined dermal and inhalation MOEs are presented in Table 2. Tables 3 and 4 contain similar calculations for increased levels of risk mitigation -- use of additional mitigation in the form of personal protective equipment (PPE) are presented in Table 3 and use of engineering controls are presented in Table 4. The format of these tables is similar to Table 2. The only differences are the unit exposure values taken from Table 1 which represent different levels of risk mitigation. All equations used in these tables are summarized at the end of the tables and in *Section 3.b.i* of this document.

Table 5 of Appendix A summarizes the parameters and caveats specific to the PHED exposure data used for each exposure scenario and corresponding exposure/risk assessment. These caveats include the descriptions of the source of the data and an assessment of the overall quality of the data. Generally, the assessment of the data is based upon the number of observations and the available quality control data. Quality control data are assessed based upon a grading criteria established by the PHED Task Force. Additionally, it should be noted that all calculations were completed based on current HED policies pertaining to the completion of occupational and residential exposure/risk assessments (e.g., rounding, exposure factors and acceptable data sources).

3.b.viii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

Numerous HED-based modifications were made to this section of the assessment. The exposure scenario for helicopter application was removed from the assessment. HED determined that PHED contains insufficient data for evaluation of a helicopter scenario. HED added an exposure scenario for a push-type granular spreader. A few minor changes were made to PHED values. Numerous corrections were made in the exposure and risk calculations from the previous assessment. Finally, as has been previously mentioned, minor changes occurred in HED-based default daily acreages treated and a change in the daily treated acreage for cranberries was made based upon the receipt of public comment.

3.b.ix. Data Sources for Post-Application Worker Risk Assessment

HED is concerned about and has addressed post-application worker exposure scenarios in this risk assessment. Five new chemical-specific studies were submitted to support the reregistration of acephate. These studies quantify dislodgeable foliar residues (DFRs) and turf transferable residues (TTRs) on succulent beans, cauliflower, greenhouse roses, tobacco and turfgrass. DFRs or TTRs have been quantified for both acephate and methamidophos, a degradate of acephate, in each of these studies. Along with the chemical-specific data, guidance provided in *Series 875-Occupational and Residential Test Guidelines: Group B--Post-Application Exposure Monitoring Test Guidelines* were used to complete various aspects of this risk assessment. The use of specific data sources is noted

as appropriate.

Two previously-submitted chemical-specific DFR studies for cauliflower are also mentioned. These studies were previously reviewed and discussed in the previous assessment. A summary of these studies may be found subsequently, but these studies were not used in this assessment.

Chemical-specific DFR exposure data were submitted by the registrant in support of reregistration of acephate (MRID #s 405048-21 and 410235-01).

Acephate was applied using ground equipment (ground rig sprayer) to a field plot of cauliflower located in Fresno, CA. Acephate was applied six times at 1 lb ai/acre at one week intervals between April 28 and June 2, 1987. The total application of acephate was 6 lb ai/acre. Samples were collected using a leaf punch (2.54 cm in diameter) on day 0 after each application and on days 2, 3, 7, 10, 14, 21, 28, and 35 after the sixth application. The samples were washed with a detergent solution. The solution was then extracted and analyzed for both acephate and methamidophos. Quality control samples were acceptable.

The review of MRID #s 405048-21 and 410235-01 (P. Perreault, memo July 26, 1990) indicated that the cauliflower studies were unacceptable. The irrigation data presented in the addendum to the cauliflower DFR studies indicates that irrigation practices during the study, specifically the use of sprinkler irrigation, may have increased foliar residue dissipation significantly and prevented the accumulation of DFRs from one application to the next.

The cauliflower DFR studies were conducted using 6 applications each at a rate of 1 lb ai, seven days apart. However, as a result of discussions with the registrant, the maximum application permitted on cauliflower is 2 lb ai/acre/crop cycle. Thus, data from the cauliflower DFR study after application 1 could be used to estimate the 1 lb ai rate, the data after application 2 could be used to estimate the 2 lb ai rate.

On Day 0 after application 1, the dislodgeable residues of acephate found on cauliflower leaf punches were 0.395, 0.155, and 0.290 ug/cm^2. The average of these is 0.280 ug/cm^2. On Day 0 after application 2, the dislodgeable residues of acephate found on cauliflower leaf punches were 0.733, 0.184, and 0.186 ug/cm^2. The average acephate DFR is 0.368 ug/cm^2. Residues of methamidophos were also analyzed. On Day 0 after application 1, the residues of methamidophos were 0.0064, 0.0035, and 0.0058 ug/cm^2. The average methamidophos DFR is 0.0052 ug/cm^2. On Day 0 after application 2, the residues of methamidophos were 0.0257, 0.179, and 0.0165 ug/cm^2. The average methamidophos DFR is 0.0200 ug/cm^2.

Using the acephate residue data after application 6 from Day 0, 2, 3, 7, 10, 14, 21, 28, and 35, the slope of the decline curve was estimated using regression techniques. The slope was 0.09218831, with an r value of 0.97233. A decline curve for methamidophos was not performed.

HED will not use this data for risk calculations due to deficiencies in the execution of these

studies and the submission of a new, acceptable cauliflower DFR study. These studies have been presented for comparison purposes only.

The following recently-completed chemical-specific DFR and TTR studies were submitted to support the reregistration of acephate:

MRID # 447639-02: *Determination of Dislodgeable Foliar Residues in Succulent Beans Treated with Acephate*; Submitted by Valent U.S.A. Corporation; Study Completion Date: 09/23/98; Report Date: 02/11/99; Author J.C. Lai; DP Barcode: D254036.

MRID # 447639-04: *Determination of Dislodgeable Foliar Residues in Cauliflower Treated with Acephate*; Submitted by Valent U.S.A. Corporation; Study Completion Date: 08/24/98; Report Date: 02/18/99; Author: J.C. Lai; DP Barcode: D254039.

MRID # 447639-03: *Determination of Dislodgeable Foliar Residues in Roses Treated with ORTHENE™ Turf, Tree & Ornamental Spray (OTTO)*; Submitted by Valent U.S.A. Corporation; Study Completion Date: 09/29/98; Report Date: 02/12/99; Author: J.C. Lai; DP Barcode: D254038.

MRID # 447639-01: *Determination of Dislodgeable Foliar Residues in Tobacco Treated with ORTHENE™ 75 WSP*; Submitted by Valent U.S.A Corporation; Study Completion Date: 09/17/98; Report Date: 02/11/99; Author: J.C. Lai; DP Barcode: D253888.

MRID # 448064-01: *Determination of Turf Transferable Residues on Grass Treated with Acephate*; Submitted by Valent U.S.A. Corporation; Study Completion Date: 10/14/98; Report Date: 03/15/99; Author: J.C. Lai; DP Barcode: D255789.

The data generated from the recently-submitted DFR and TTR studies are summarized in Tables 1-5 of Appendix B. A brief summary of each DFR and TTR study follows.

MRID # 447639-02: Dislodgeable foliar residues (DFRs) of acephate in ORTHENE® 75 SP and one of its degradate, methamidophos, were quantified from succulent beans in Benton County, Oregon (near Corvallis). This study evaluated a treated plot, divided into three replicate subplots, and a control plot situated at least 100 feet away. Two applications of ORTHENE® 75 SP were made, seven days apart, at a rate of 1.0 lb a.i. per acre (maximum label rate) in 20 gallons/acre (minimum volume) with a tractor-mounted boom sprayer. Field studies were conducted between June 30 and August 04, 1998.

Leaf punch samples were collected at the following intervals: just prior to application 1, just after application 1 when the spray had dried, 1 day before application 2, just after application 2, and day 1, 2, 3, 5, 7, 10, 14, 21, 28, 35 after the second application. At each interval, three replicate samples were collected from the treated plot and one sample was collected from the control plot. At intervals, when field fortification samples were prepared, six more samples were collected from the control plot.

Sample replicates each consisted of forty 1- inch (2.54 cm) diameter leaf punches collected at each interval, representing a total of 405 cm^2 surface area. (Leaf punches were collected only from leaves which had also been present at the first application). Residues were dislodged by extracting twice with 100 mL of 0.01% Triton X-100 solution. The extraction was performed by mechanically shaking the leaf punches in the Triton solution for ten minutes. All the samples were dislodged within 1.5 hours of collection. The dislodged samples were stored frozen until shipment.

The proprietary analytical method used was validated prior to initiation of the study. It involved extraction of residues with ethyl acetate and analysis by gas chromatography with flame photometric detection. The laboratory fortification recoveries averaged 84.9 percent for acephate and 98.0 percent for methamidophos. For this study, the limit of detection (LOD) was 0.125 µg (0.0003 µg /cm^2) for acephate and 0.05 µg (0.0001 µg /cm^2) for methamidophos. The limit of quantification (LOQ) for both acephate and methamidophos was 0.0025 µg /cm^2.

Field fortification samples were prepared in three replicates at two spiking levels at six sampling intervals. The field spike samples were analyzed with field DFR samples collected at the same interval to assure the quality of the samples. The overall average recovery was 88.4 percent ± 12 percent CV for acephate and 86.4 percent ± 15 percent CV for methamidophos. A storage stability study was also conducted and results suggested that the residues were stable during the period of sample storage.

This study met **most** of the criteria contained in Subdivision K of the Pesticide Assessment Guidelines and will be used in the acephate risk assessment. Pertinent omissions and flaws of the study include: (1) The study was conducted in only one location. The guideline specifies DFR studies be conducted in three geographically different locations; (2) It is unclear whether DFR data were corrected for either laboratory or field fortification recovery; and (3) Predicted foliar residues according to a first-order kinetics equation deviated significantly from the actual measured DFR values obtained.

MRID # 447639-04: Dislodgeable foliar residues (DFRs) of acephate in ORTHENE® 75 SP and one of its degradates, methamidophos, were quantified from cauliflower in Santa Cruz County, California (Watsonville). The study evaluated a treated plot, divided into three replicate subplots, and a control plot situated at least 100 feet away. Two applications of ORTHENE® 75 SP were made, 10 days apart, using 1.0 lb ai/A (maximum application rate) with a tractor-mounted boom sprayer. During the period of the DFR study, there was a total rainfall of 0.04 inches. No rain events occurred within 24 hours after the application of the pesticide. The cauliflower was maintained by normal agricultural practices, which included in-furrow irrigation. Water was not applied to plant leaves. The study was conducted between July 10, 1998 and August 24, 1998.

Leaf punch samples were collected at the following intervals: prior to application #1, just after application #1 when the spray had dried, just before application #2, after application #2, and on Day 1, 2, 3, 5, 7, 10, 14, 21, 28, 35 after the second application. At each interval, three sample replicates

were collected from the treated plot and one sample from the control plot. At the intervals when field fortification samples were prepared, six more samples were collected from the control plot.

Sample replicates each consisted of forty 1-inch (2.54 cm) diameter leaf punches collected at each interval, representing a total of 405 cm^2 surface area (counting both sides of leaf punches). The leaf punches were collected only from leaves which had also received the first application. Residues were dislodged from samples by extracting twice with 100 mL of 0.01% Triton X-100 solution. The extraction was performed by shaking the leaf punches in the Triton solution for ten minutes. The dislodged samples were stored frozen until shipment. All the samples were dislodged within 4 hours of collection.

A proprietary analytical method (i.e. Method RM-12HE-2) was used to quantify acephate and methamidophos DFRs. The method was validated before the study was initiated. The limit of detection was 0.125 µg (0.0003 µg/cm^2) for acephate and 0.05 µg (0.0001 µg/cm^2) for methamidophos. The limit of quantitation for both acephate and methamidophos was 0.0025 µg/cm^2.

Laboratory fortification samples were prepared as follows: (1) acephate: at 1.0, 10, 20, 200, 800 µg per 100 mL 0.01% Triton solution and (2) methamidophos: 1.0 10, 40 µg per 100 mL of the 0.01% Triton solution. These lab fortified samples were analyzed with each set of samples to evaluate the performance of the analytical method. Laboratory fortification recoveries averaged 87.0 percent ± 14% CV for acephate and 96.1 percent ± 19% CV for methamidophos. Field fortification samples were prepared in three replicates at two spiking levels at six sampling intervals. Field fortification levels were: (1) acephate - 2.0, 20, 40, and 400 µg per 200 mL of the Triton solution and (2) methamidophos - 2.0 and 20 µg per 200 of the Triton solution. These QC samples were analyzed with the samples collected at the same interval to assure the quality of the samples. The overall average recovery was 83.4 percent ± 11% CV for acephate and 89.6 percent ± 20% CV for methamidophos. A storage stability study was also conducted by determining the residues in laboratory fortified samples at different intervals. The results suggested that the residues were stable during the period of sample storage.

This study met **most** of the criteria contained in Subdivision K of the Pesticide Assessment Guidelines and will be used in the acephate risk assessment. Pertinent omissions and flaws of the study include: (1) The study was conducted in only one location. The guideline specifies DFR studies be conducted in three geographically different locations; (2) It is unclear whether DFR data were corrected for either laboratory or field fortification recovery; (3) The reproducibility and the representativeness of the replicate samples collected at the sampling interval was poor; and (4) Predicted foliar residues according to a first-order kinetics equation deviated significantly from the actual measured DFR values obtained. The highest foliar acephate residue of 0.464 µg/cm^2 occurred at Day 3 after the second application. The Day 0 average DFR value was 0.2 µg/cm^2, which is significantly lower. Yet, the acephate calculated half-life was calculated from Day 0. The sampling procedure may have been flawed, in that it did not yield truly representative samples, or there may have been a climatic influence (e.g., dryness). Rainfall was extremely light during the study; the first

rainfall (only 0.01 inches) after the second application was recorded 14 days afterwards. Two in-furrow irrigation events occurred on Day 3 and Day 6 after the second application.

MRID # 447639-03: Dislodgeable foliar residues (DFRs) of acephate in ORTHENE® Turf, Tree & Ornamental (OTTO) spray and its degradate, methamidophos, were quantified from rose foliage in one greenhouse test plot located in Monterey County, California (Pajaro). The study evaluated a treated plot, divided into three replicate subplots, and a control plot situated at least 100 feet away. Two applications of ORTHENE® Turf, Tree and Ornamental spray were made with a backpack sprayer with a handheld boom, seven days apart, using 2.15 lb a.i. per acre (maximum label rate) in 215 to 214 gallons of water per acre. The trial was conducted in a glass commercial greenhouse between June 15, 1998 (planting date) and September 17, 1998 (last DFR sampling date).

Leaf punch samples were collected at the following intervals: just prior to application #1, just after application #1 when the spray had dried, 1 day before application #2, just after application #2, and on Day 1, 2, 3, 5, 7, 10, 14, 21, 28, 35 after the second application. At each interval, three replicate samples were collected from the treated plot and one sample was collected from the control plot.

Sample replicates each consisted of forty 1- inch (2.54 cm) diameter leaf punches collected at each interval, representing a total of 405 cm^2 surface area. (Leaf punches were collected only from leaves which had also been present at the first application). Residues were dislodged by extracting twice with 100 mL of 0.01% Triton X-100 solution. The extraction was performed by mechanically shaking the leaf punches in the Triton solution for ten minutes. All the samples were dislodged within 4 hours of collection. The dislodged samples were stored frozen until shipment.

Validation of the analytical method was not mentioned in the study. Laboratory fortification recoveries averaged: (1) for acephate - 87.5 $\pm$ 12 percent (n=7) and (2) for methamidophos - 91.7 $\pm$ 23 percent (n=7). The limit of detection (LOD) was 0.125 µg (0.0003 µg /cm^2) for acephate and 0.05 µg (0.0001 µg /cm^2) for methamidophos. The limit of quantitation (LOQ) for both acephate and methamidophos was 0.0025 µg /cm^2.

Field fortification samples were prepared in triplicate at two spiking levels. Field spikes were analyzed with field DFR samples collected at the same interval to assure the quality of the samples. The overall average (all fortification levels) recovery was 91.3 ± 12 percent for acephate and 93.4 ± 23 percent for methamidophos. A storage stability study was also conducted and results suggested that the residues were stable during the period of sample storage.

This study met **most** of the criteria contained in Subdivision K of the Pesticide Assessment Guidelines and will be used in the acephate risk assessment. Pertinent omissions and flaws of the study include: (1) The study was conducted in only one location. The guidelines recommend that DFR studies be conducted in three geographically different locations per crop treated. There are no specific guidelines governing greenhouse studies concerning the acceptable number of trial locations even though greenhouse environments are controlled and should not differ from one to the next

significantly; (2) It is unclear whether DFR data were corrected for either laboratory or field recovery losses; and (3) Predicted foliar residues according to a first-order kinetics equation deviated significantly from the actual measured DFR values obtained. It should also be noted that the study report (see pp. 18-19) may contain a typographical error, since with regard to use of curve-fitting software, two 50 percent dissipation values were given. For acephate, 50 percent dissipation was calculated to occur at either 1.60 days (R^2 = unknown) or 2.03 days (R^2 = 0.961); for methamidophos the calculated value was either 1.03 days (R^2 = unknown) or 1.38 (R^2 = 0.924).

MRID # 447639-01: Dislodgeable foliar residues (DFRs) of acephate in ORTHENE® 75 SP and one of its degradates, methamidophos, were quantified from tobacco in Martin County, North Carolina. The study evaluated a treated plot, divided into three replicate subplots, and a control plot situated at least 100 feet away. Three applications of ORTHENE® 75 SP were made, seven days apart, using 0.77, 0.75, and 0.77 lb ai/A. (maximum label rate), in 10.2 to 10.5 gallons per acre (the minimum recommended volume) with a tractor-mounted boom sprayer, equipped with 8 nozzles. The effective swath was 15 feet and was directed 12 inches above the canopy. No irrigation was performed throughout the study. Field studies were conducted between June 12 and July 31, 1998.

Leaf punch samples were collected at the following intervals: just prior to application 1, just after application 1 when the spray had dried, 1 day before application 2, just after application 2, just before application 3, just after application 3, and day 1, 2, 3, 5, 7, 10, 14, 21, 28, 35 after the third application. The leaf punches were collected from the areas of the plants expected to receive the highest amount of spray during applications. At each interval, three replicate samples were collected from the each of the treated subplots and one sample was collected from the control plot. At intervals, when field fortification samples were prepared, six more samples were collected from the control plot.

Sample replicates each consisted of forty 1- inch (2.54 cm) diameter leaf punches collected at each interval, representing a total of 405 cm^2 surface area. (Leaf punches were collected only from leaves which had also been present at the first application). Residues were dislodged by extracting twice with 100 mL of 0.01 percent Triton X-100 solution. The extraction was performed by mechanically shaking the leaf punches in the Triton solution for ten minutes. All samples were dislodged within 4 hours of collection. The dislodged samples were stored frozen until shipment.

The analytical method was validated prior to analysis. The LOD was 0.125 µg (0.0003 µg/cm^2) for acephate and 0.05 µg (0.0001 µg /cm^2) for methamidophos. The LOQ for both acephate and methamidophos was 0.0025 µg/cm^2. Fortification levels ranged from the LOD to concentrations above those found in the samples; that is, from 1 to 800 μg acephate and from 1 to 40 μg methamidophos. Recoveries averaged 98 percent for acephate and 112 percent for methamidophos.

Fortified field fortification recovery for acephate (all levels) averaged 93.4 +/-10 percent (C.V.; N=34). The mean recovery for methamidophos (both levels) was 95.9 percent +/- 18 percent (C.V.; N=34).

Storage stability of acephate and methamidophos residues stored frozen or refrigerated in 0.01 percent Triton X-100 was evaluated. Laboratory solutions of 0.01 percent Triton X-100 were fortified with between 12.5 μg acephate or between 5.0 μg methamidophos, and samples were analyzed at Days 1,7, 14, and 43. (Samples were analyzed up to 67 days after collection). The overall results show that acephate and methamidophos are stable in detergent solutions stored at -20ºC to 5ºC. However, the study authors also state: "Several field fortified samples were extracted after 60 and 67 days of freezer storage and recoveries ranged from 78.5 percent to 99.5 percent for acephate and 67.5 percent to 89.0 percent for methamidophos."

This study met **most** of the criteria contained in Subdivision K of the Pesticide Assessment Guidelines and will be used in the acephate risk assessment. Pertinent omissions and flaws of the study include: (1) The study was conducted in only one location. The guidelines recommend that DFR studies be conducted in three geographically different locations per crop treated; (2) It is unclear whether DFR data were corrected for storage stability recovery; and (3) Predicted foliar residues according to a first-order kinetics equation deviated significantly from the actual measured DFR values obtained.

MRID # 448064-01: Turf transferable residues (TTRs) of acephate in ORTHENE® 75 WSP and one of its degradates, methamidophos, were quantified from Bahia turfgrass in Putnam County, Florida (Melrose). The study evaluated a treated plot, divided into three replicate subplots, and a control plot at least 100 feet away. Two applications of ORTHENE® 75 WSP were made, 14 days apart, using 5.0 lb a.i./A (maximum label rate), with a CO_2 backpack sprayer and hand-held boom, equipped with 8 nozzles. The nozzles were positioned 12 inches above the turf during the applications. The applications were originally scheduled to be made 7 days apart but due to rain events the second application was postponed to 14 days after the first application. The turf was maintained according to normal cultural practices and irrigated using overhead sprinklers (used twice prior to the first application). A single application of the maintenance insecticide Amdro (0.73percent Bait at 0.016 a.i./A) was made on July 29, 1998 (28 days prior to the first application of the test substance). During the study period, there were 16 rain events and 13.09 total inches of precipitation. No rain events occurred within 24 hours after the applications of ORTHENE® 75 WSP. Samples were collected between August 26 and October 14, 1998.

There is some confusion in the documentation of the acephate containing product used in this study. Originally, the field study protocol specified use of ORTHENE® Turf, Tree & Ornamental Spray. Subsequently, the registrant decided to use ORTHENE® 75 WSP instead. For some unknown reason, no label for the latter product was provided for review. Instead, a ORTHENE® 75 S product label is attached to the study, even though this label does not specify use on turf grass as a registered use. To complicate matters further, a Protocol Amendment (see pg. 57 of the Study Report) changed all field protocol references to ORTHENE® Turf, Tree & Ornamental Spray to read ORTHENE® 75 S. The Amendment stated that ORTHENE® Turf, Tree & Ornamental Spray is the same as ORTHENE® 75 S but notes that the labels are indeed different. The target application rate used appears to be the maximum application rate listed for the use of ORTHENE® Turf, Tree & Ornamental Spray on residential or commercial turf grass. ORTHENE® 75 WSP is formulated as a

water soluble powder containing 75 percent technical grade acephate by weight.

Samples were collected at the following intervals: just prior to application #1, just after application #1 after the spray had dried (20 to 35 minutes after application), 6 days after first application (this sampling period was added due the second application being delayed), 1 day prior to application #2, just after application #2 when the spray had dried (20 to 35 minutes after application), 2 and 8 hours after application #2, and on days 1, 2, 3, 5, 7, 10, 14, 21, 28 and 35 after the second application. At each interval, three replicate samples were collected from each of the three treated sub-plots and one sample from the control plot. Triplicate field fortified samples were generated on six occasions, at two concentration levels.

Each sample replicate consisted of a cotton sheet of known area. The samples were collected using the modified California roller technique. This technique involved attaching a cotton sheet to a sampling frame and securing the frame to the turf subplot area with large spikes. The surface area of the sheet exposed to the turf was 4,026 cm^2. The modified California roller was placed at one end of the frame on a plastic sheet covering the cotton sheet. The roller was guided back and forth inside the frame for five round trips over the sample area. Afterwards, the frame was lifted from the turf and the cotton sheet removed. Any debris on the sheet was removed before the sheet was folded with the exposed sides inward. The folded sheet was then placed in a pre-labeled plastic bag. The sample from the untreated plot was collected prior to the collection of the samples from the treated subplots.

Pesticide residues were extracted from the cotton sheet samples using the proprietary Valent method RM-12A-9. Each sample was placed in a glass jar. The jar was filled with 500 mL HPLC grade water, capped, and placed on a mechanical shaker for 30 minutes. The aqueous extract was decanted into a clean container. A 100 mL aliquot of the water extract was combined with 150 mL of ethyl acetate and blended with sodium sulfate to absorb the liquid. After 5 minutes, the extract was quickly decanted through a bed of sodium sulfate onto a plug of glass wool. This extraction step was repeated twice, and the combined filtrates were evaporated to dryness on a vacuum rotary evaporator. The residue was dissolved in acetone and analyzed by gas chromatography (GC).

Samples were collected into plastic bags, then either immediately frozen or placed in coolers for less than one hour before being frozen or immediately shipped under dry ice to the analytical laboratory. All samples were shipped by overnight delivery service on dry ice to the analytic laboratory. The samples were kept frozen at - 20 ^oC until analysis.

The analytical methodology used was a proprietary Method RM-12HES. It was validated prior to initiation of the turf transfer residue study. The method involved salting the samples with anhydrous sodium sulfate, extraction with ethyl acetate, and analysis via gas chromatography with flame photometric detection. The LOD was 0.125 μg (0.0003 μg /cm^2) for acephate and 0.05 μg (0.00012 μg /cm^2) for methamidophos. The LOQ were 1.25 μg/sample for acephate and 0.50 μg/ sample for methamidophos.

Laboratory fortification samples were analyzed concurrently with each set of samples by

fortifying a cotton sheet. The fortification levels ranged from the LOQ to concentrations in excess of the levels found in the field samples. These laboratory fortification samples were analyzed to evaluate the performance of the analytical method. The overall average recovery was 92.7 percent ± 10.3 percent acephate and 89.6 percent ± 9.99 percent methamidophos.

Six sets of field-fortified samples were prepared in triplicate at two fortification levels. [The Protocol stated that the Day 0 fortification samples were to be placed on the test plot prior to the first application and subjected to the rolling technique used to collect the field samples. The remaining five sets were to consist of unrolled, spiked cotton sheets. However, the Fortification Procedure provided on pages 53 and 54 of the Study Report did not mention the collection/preparation of the Day 0 field fortified sample as being any different from the other field fortified samples.] The Study Report only described the process of applying the field spike solution to pristine cotton sheets. The fortification levels were 20, 200, 400, 2,000, 4,000 and 20,000 μg/mL for acephate and 20, 40, 200, 400, and 2,000 μg/mL for methamidophos. Field fortified samples were stored frozen and treated exactly in the same way as the turf transfer residue samples collected at the same intervals. The field fortified samples were analyzed with the turf transfer residue samples collected at the same sample interval to assure the quality of the turf transfer residue samples. The overall average fortified field sample recovery was 89.6 percent ± 8.4 percent for acephate and 82.6 percent ± 8.59 percent for methamidophos.

The stability of acephate and methamidophos during sample storage was studied by periodically analyzing laboratory fortified cotton sheet samples stored in a freezer. Duplicate fortified samples were analyzed with an untreated control and freshly fortified untreated control The results suggest that the residues of acephate and methamidophos were stable for at least 79 days when frozen. All samples were extracted within 69 days of collection. The recoveries of acephate and methamidophos at each interval are provided in Table 7 of the study report.

This study met **most** of the criteria contained in US EPA's OPPTS Series 875, Occupational and Residential Exposure Test Guidelines Group B: Post-application Exposure Monitoring Test Guidelines, 875.2100, (Transferable Residue Dissipation: Lawn and Turf) and will be used in the acephate risk assessment. Pertinent omissions and flaws of the study include: (1) The study was conducted in only one location. The guidelines recommend that DFR studies be conducted in three geographically different locations per crop treated; (2) It is unclear whether TTR data were corrected for either laboratory or field recovery losses; (3) The reproducibility of replicate samples collected at the same time interval was poor. The coefficient of variance for replicate samples ranged from 7.35 percent to 62.4 percent for acephate residues and from 17.9 percent to 63.3 percent for methamidophos residues; and (4) No product label for ORTHENE® 75 Water Soluble Powder was provided. Instead, a ORTHENE® 75 S label was included. Neither product label references either use on turfgrass or the maximum rate used in this study. However, the study protocol originally specified use of a similar product, ORTHENE® Turf, Tree & Ornamental Spray, which also contains 75 percent a.i. acephate and does reference use on turfgrass at the maximum rate used in this study.

The data for all five studies were analyzed by Versar under HED supervision for use in the

risk assessment by completing a semi-log regression and a pseudo-first order kinetics calculation of half-life as is described in the *Calculations* chapter (Part D, chapter 2) of the draft *Series 875-Occupational and Residential Exposure Test Guidelines, Group B-Post-application Exposure Monitoring Test Guidelines*. Analysis of the data for acephate and methamidophos is summarized in the following table.

Table 5. Summary of DFR and TTR Study Half-lives and Correlation Coefficients for Acephate and Methamidophos.

MRID #	Crop	Acephate		Methamidophos	
		Half-life (days)	Correlation Coeffi. ($R^{2)}$	Half-life (days)	Correlation Coeffi. (R^2)
447639-02	Succulent Beans	3.4	0.83	6.0	0.88
447639-04	Cauliflower	5.7	0.88	12	0.72
447639-03	Greenhouse Roses	3.0	0.94	4.6	0.73
447639-01	Tobacco	5.2	0.87	8.0	0.97
448064-01	Turfgrass	1.3	0.89	5.0	0.29

3.b.x. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

The Agency did not use acceptable chemical-specific DFR and TTR studies to perform post-application exposure and risk assessments in previous versions of this document. The submission of these new, chemical-specific studies by the registrant will greatly improve the risk characterization for post-application worker exposures to acephate and methamidophos.

3.b.xi. Post-Application Worker Risk Assessment

HED has determined that workers may be exposed to acephate and methamidophos upon entering occupational areas which have been previously treated with acephate to perform specific work activities in these areas (e.g., scouting, staking/tieing, irrigating, harvesting). Due to the frequency and duration of post-application worker exposures coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that occupational acephate uses result in potential short-term and intermediate-term dermal acephate and methamidophos post-application worker exposures. Potential inhalation exposures are not anticipated for post-application worker exposures, and HED currently has no policy/method for evaluating non-dietary ingestion by workers due to poor hygiene practices or smoking. As a result, only dermal exposures were evaluated in the post-application worker assessment.

It is important to note that post-application worker exposures were assessed on the same day acephate was applied for cauliflower and turfgrass. The assessments were completed in this manner, because use of the calculated DFRs and TTRs by regression analysis would have significantly underestimated the monitored levels on day 0. As a result, the average of chemical-specific TTRs measured following the second application in the cauliflower and turf studies submitted by the registrant were used in the post-application worker assessments for cauliflower and turf. Calculated DFRs by regression analysis were used in the post-application worker assessments for succulent beans, greenhouse roses and tobacco.

A re-entry interval (REI) is defined as the duration of time which must elapse before residues decline to a level so entry into a previously treated area and engaging in a specific task or activity would not result in exposures which exceed the Agency's level of concern. When chemical-specific data are available, REIs are established on a chemical-, crop-, and activity-specific basis. Chemical-specific DFR and TTR data were available for succulent beans, cauliflower, greenhouse roses, tobacco and turf. However, no chemical-specific transfer coefficients were available for this assessment. As a result, REIs for post-application activities were calculated using default transfer coefficients and equations previously described in Section 3.b.i.

Transfer coefficients are a measure of the relationship between exposure to DFRs and TTRs while engaged in a specific activity or job function (e.g., scouting, irrigating, harvesting). Transfer coefficients and transferable residues are used to estimate potential human exposure. The values assigned by the Science Advisory Council on Exposure for dermal transfer coefficients represent conservative estimates of potential exposure contact during specified tasks. These default transfer coefficients will be in use until the Agriculture Re-entry Task Force (ARTF) provides the Agency activity-specific transfer coefficients. The table on the following page summarizes the default transfer coefficients and activities along with the specific crops and application rates addressed in the post-application worker assessment.

Crop-specific, activity-specific REIs for succulent beans, cauliflower, greenhouse roses, tobacco and turf were calculated. The results are presented in the tables contained in Appendix B entitled *Acephate Post-Application Worker Exposure and Risk Assessment Tables (Short-Term and Intermediate-Term Exposures)*. Table 1 contains post-application risks to workers following two applications of acephate to succulent beans at 1.0 lb ai/A. Table 2 contains post-application risks to workers following two applications of acephate to cauliflower at 1.0 lb ai/A. Table 3 contains post-application risks to workers following two applications of acephate to greenhouse roses at 2.15 lb ai/A. Table 4 contains post-application risks to workers following three applications of acephate to tobacco at 0.77 lb ai/A. Finally, Tables 5 and 6 contain post-application risks to workers following two applications of acephate to turf at 5.0 lb ai/A. All equations used in these tables are summarized at the end of the tables and in *Section 3.b.i* of this document.

Table 6. Post-Application Potential Dermal Transfer Coefficients and Crop Matrix.

Crop Treated	Transfer Coefficient (cm^2/hr)[a]	Activities	Total Application Rate (lb ai/A)
Succulent Beans	4,000	Harvest by hand, stake/tie, scout and irrigate	2.0
Cauliflower	1,000	Scout and irrigate	2.0
	2,500	Harvest by hand	2.0
Greenhouse Roses	2,500	Sort and pack	4.3
	10,000	Prune and harvest by hand	4.3
Tobacco	4,000	Stake/tie, scout and irrigate	2.3
	10,000	Harvest by hand	2.3
Turfgrass	500	Mow with tractor	10
	1,000	Mow with push-type mower	10
	10,000	Harvest sod	10

a Standard values for transfer coefficients are from HED Exposure Science Advisory Council (SAC) Policy #3 dated May 7, 1998.

3.b.xii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

The Agency does not agree with the registrant's default transfer coefficients. This risk assessment uses only HED default transfer coefficients for its calculations.

3.b.xiii. Non-Occupational (Residential Applicator) Risk Assessment

HED has determined that residential pesticide applicators are likely to be exposed during acephate use. Due to the frequency and duration of acephate uses, it was determined that uses of acephate by residential pesticide applicators result in short-term exposures to these applicators. The anticipated use patterns and current labeling indicate several exposure scenarios based upon the types of equipment that potentially can be used to make acephate applications in the residential environment. These scenarios serve as the basis for the quantitative exposure and risk assessments. The following major residential exposure scenarios were identified for acephate:

- (1) mixing/loading/applying wettable powder using a low pressure hand wand;
- (2) mixing/loading/applying using a backpack sprayer;
- (3a) mixing/loading/applying using a hose-end sprayer;
- (3b) mixing/loading/applying using a hose-end sprayer (MRID # 405048-27);
- (4) mixing/loading/applying using a sprinkling can;
- (5) loading/applying soluble powder (dry) concentrate by hand/handtool/shaker can;
- (6) loading/applying granules by shaker can; and
- (7) applying by aerosol can.

Specific PHED data were unavailable for two residential applicator scenarios, so similar PHED data were used as surrogate data in the assessment. These scenarios are specified in Table 3 of Appendix C and summarized as follows. Surrogate data from PHED were used for scenarios (5) and (6). PHED data for granular bait dispersed by hand scenario were used for both of these scenarios.

The residential risk assessment has been completed based upon the exposure data available to HED. The residential pesticide applicator exposure and risk calculations are presented in the tables contained in Appendix C entitled *Acephate Non-Occupational (Residential) Exposure and Risk Assessment Tables (Short-Term Exposures)*. The exposure factors (i.e., scenario descriptors, application rates, and daily treatment) and residential unit exposure values are presented in Table 1 of Appendix C. The calculations of daily exposure in milligrams/day (mg/day), absorbed daily dose (mg/kg/day), individual dermal and inhalation MOEs using ST NOAELs, and combined dermal and inhalation MOEs are presented in Table 2. All equations used in these tables are summarized at the end of the tables and in *Section 3.b.i* of this document.

Table 3 of Appendix C summarizes the parameters and caveats specific to the PHED exposure data used for each exposure scenario and corresponding exposure/risk assessment. These caveats include the descriptions of the source of the data and an assessment of the overall quality of the data. Generally, the assessment of the data is based upon the number of observations and the available quality control data. Quality control data are assessed based upon a grading criteria established by the PHED Task Force. Additionally, it should be noted that all calculations were completed based on current HED policies pertaining to the completion of occupational and residential exposure/risk assessments (e.g., rounding, exposure factors and acceptable data sources).

It is also important to note that residential PHED values represent an applicator wearing typical residential clothing of short-sleeved shirt, short pants and no gloves. In addition, it is assumed that all residential mixing/loading scenarios are performed by open mixing and loading procedures. Homeowner uses are not covered by the Worker Protection Standard. The Agency cannot require the use of PPE and/or engineering controls for residential applicators, because the Agency can only make recommendations to residential applicators. Therefore, the use of PPE and/or engineering controls is not considered in the residential applicator risk assessment.

3.b.xiv. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

As has been previously discussed, the registrant provided the Agency useage information for scenarios 1, 2 and 6 which should be addressed during label modification.

3.b.xv. Non-Occupational (Post-Application Residential) Risk Assessment

HED has determined that the public may be exposed to acephate and methamidophos upon

entering residential areas which have been previously treated with acephate. Due to the frequency and duration of potential post-application residential exposures coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that residential acephate uses result in potential short-term dermal and oral acephate and methamidophos post-application residential exposures to the public. Potential inhalation exposures are not anticipated for post-application residential exposures.

It is anticipated that adults and children may primarily be exposed to acephate and methamidophos through their contact with turfgrass. Acephate and methamidophos exposures may also occur from contact (i.e., pruning, cutting and weeding) with treated ornamentals, flowers, trees, and shrubs. However, it is anticipated that these exposures would not be as significant as turfgrass exposures because of lower contact rates and the frequency and duration of potential contacts. Therefore, these potential exposures are not addressed in this assessment.

The following post-application residential exposures were assessed for both acephate and methamidophos: dermal exposure from residues on turf (adult and child), incidental non-dietary ingestion of residues on grass from hand-to-mouth transfer (child), and ingestion of treated grass (child). The results for acephate and methamidophos risks are presented in Tables 4 and 5, respectively, of Appendix C entitled *Acephate Non-Occupational (Residential) Exposure and Risk Assessment Tables (Short-Term Exposures)*. The screening level equations used to quantify the potential residential exposures are from the Agency's *Standard Operating Procedures for Residential Exposure Assessments (December 1997)* with the addition of standard assumptions incorporated following the 09/21/99 FIFRA SAP meeting. All equations used in these tables are summarized at the end of the tables and in *Section 3.b.i* of this document.

It is important to note that potential post-application residential exposures were assessed on the same day acephate would be applied to the grass. The assessment was completed in this manner, because it is assumed that the public could be exposed immediately following an acephate treatment. As a result, the average of chemical-specific TTRs measured following the second application in the turf study submitted by the registrant were used in the post-application residential assessment. An adjustment for the difference in turf application rates between occupational and residential environments was made. It was assumed that the grass residues were equivalent to the study TTRs.

3.b.xvi. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

TTRs from the turf study submitted by the registrant were used to assess post-application residential exposures and risks in this document. The Agency does not agree with the registrant's use of Day 0 data in its submitted assessment. The registrant has averaged all TTRs from the second application day. The Agency has averaged only the TTRs measured immediately following the second application. This was done to more closely estimate risks for individuals who may have exposures immediately following an acephate treatment in the residential environment. As the registrant also did, the Agency has used an adjustment for the difference in turf application rates between the occupational and residential environments. Standard assumptions have been modified

following the 09/21/99 FIFRA SAP meeting.

The methamidophos dermal and oral NOAELs of 0.75 and 0.3 mg/kg/day, respectively, were used in the assessment.

3.b.xvii. Non-Occupational (Post-Application Recreational) Risk Assessment

HED has determined that the public may be exposed to acephate and methamidophos upon entering recreational areas which have been previously treated with acephate. The recreational areas addressed in this assessment are golf courses. Due to the frequency and duration of potential post-application recreational exposures at golf courses coupled with the dissipation of acephate and methamidophos following acephate treatments, it was determined that occupational acephate uses at golf courses result in potential short-term dermal acephate and methamidophos post-application recreational exposures to adults and 13+ year-olds. Potential inhalation exposures are not anticipated for post-application recreational exposures. No potential hand-to-mouth exposures were estimated for recreational exposures.

Adult and 13+ year-old golfers' exposures are anticipated to be significantly lower than post-application workers' exposures. Golfers' exposures are anticipated to occur through minimal hand contact with the golf ball and dermal exposure to the lower legs. Therefore, a default transfer coefficient of 100 has been used for the post-application recreational assessment. The results of acephate and methamidophos risks for adults and 13+ year-olds are presented in Tables 1 and 2, respectively, of Appendix D entitled *Acephate Non-Occupational (Recreational) Exposure and Risk Assessment Tables (Short-Term Exposures)*. All equations used in these tables are summarized at the end of the tables and in *Section 3.b.i* of this document.

It is important to note that potential post-application recreational exposures were assessed on the same day acephate would be applied to the golf course. The assessment was completed in this manner, because it is assumed that the public could be exposed immediately following an acephate treatment. As a result, the average of chemical-specific TTRs measured following the second application in the turf study submitted by the registrant were used in the post-application recreational assessment.

3.b.xviii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

The Agency did not conduct non-occupational (post-application recreational) exposure and risk assessments in previous versions of the occupational document.

TTRs from the turf study submitted by the registrant were used to assess post-application recreational exposures and risks in this document. The Agency has averaged the TTRs measured immediately following the second application. This was carried out to more closely estimate risks for individuals who may have exposures immediately following an acephate treatment in the

recreational environment would be protected.

The methamidophos dermal NOAEL of 0.75 mg/kg/day was used in the assessment.

3.c. Occupational and Non-Occupational Risk Assessment and Characterization

The occupational and non-occupational risk assessments are summarized herein. Please refer to the appropriate tables as stated in the text. These tables are the basis for the risk assessments.

3.c.i. General Risk Characterization Considerations

Several issues must be considered when interpreting the results of the occupational and non-occupational assessments. These include:

- Minimal chemical-specific individual, professional and residential pesticide applicator exposure data were submitted by the registrant. As a result, nearly all applicator analyses were completed using exposure data from PHED Version 1.1 (August 1998) and default data. Several handler assessments were completed using "low quality" PHED data due to the lack of a more acceptable data set. The PHED unit exposures range between the geometric mean and the median of the available exposure data.
- Several generic protection factors were used to calculate handler exposures. The protection factors used for clothing layers and gloves have not been completed evaluated by HED. The key element being evaluated by HED is the protection factor for clothing. The protection factors used for respiratory protection are based upon NIOSH's *Respirator Decision Logic* and the protection factor for gloves is in the range which OSHA and NIOSH often use.
- In some cases, exposure factors used to calculate daily occupational exposures to handlers are based upon the best professional judgment (due to lack of pertinent data). In other cases, exposure factors have been referenced from the US EPA Exposure Factors Handbook.
- Chemical-specific DFR and TTR studies did not contain specific worker exposure data. As a result, default transfer coefficients were used to estimate potential exposures and doses for workers entering treated fields/areas for specific tasks, the public entering treated residential areas for specific activities and the public golfing on treated golf courses. The default transfer coefficients are based on published empirical data and are generally considered by HED to represent reasonable estimates of dermal exposure.
- DFR and TTR data were only available for succulent beans, cauliflower, greenhouse roses, tobacco and turf. Acephate is applied to many other agricultural crops and ornamentals.

3.c.ii. Individual and Professional Pesticide Applicator Risk Characterization Results

The calculations of individual and professional acephate applicators' combined dermal and inhalation risks indicate that numerous exposure scenarios exceed 100 for baseline, PPE and engineering controls assessment levels. *However, at the highest level of mitigation available and/or feasible for a specific scenario, thirteen of the scenarios do not exceed 100. There are also five scenarios for which no exposure data are available and four scenarios for which surrogate data from similar PHED scenarios were used.*

The following table summarizes the ranges of combined dermal and inhalation MOEs at the baseline, PPE and engineering controls levels for individual and professional acephate applicators.

Table 7. Combined Dermal and Inhalation MOEs for Individual and Professional Acephate Applicators (Short-Term and Intermediate-Term Exposures).

Individual and Professional Acephate Applicators	Short-Term and Intermediate-Term Combined MOE Ranges
Baseline	0.065 - 4500
PPE	0.56 - 5900
Engineering Controls	16 - 28000

A summary of the specific exposure scenarios which exceeded HED's level of concern (i.e. combined dermal and inhalation MOEs less than 100) are presented for each assessment level.

Baseline Exposure Scenarios with MOEs less than 100

(1a) Mixing/loading soluble powder for aerial application with application rates 0.5 lb ai/A for agricultural crops (350 acres; **Combined MOE = 0.65**), 1.0 lb ai/A for agricultural crops (350 acres; **Combined MOE = 0.32**), 5.0 lb ai/A for turf (350 acres; **Combined MOE = 0.065**), and 0.125 lb ai/A for pasture (350 acres; **Combined MOE = 2.6**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1b) Mixing/loading soluble powder for chemigation application with application rate 1.0 lb ai/A for cranberries (30 acres; **Combined MOE = 3.8**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1c) Mixing/loading soluble powder for groundboom application with application rates 0.5 lb ai/A for agricultural crops (80 acres; **Combined MOE = 2.8**), 1.0 lb ai/A for agricultural crops (80 acres; **Combined MOE = 1.4**), 0.125 lb ai/A for pasture (80 acres; **Combined MOE = 12**), 5.0 lb ai/A for turf (sod farm of 80 acres; **Combined MOE = 0.28**), and 5.0 lb ai/A for turf (golf course of 40 acres; **Combined MOE = 0.58**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1d) Mixing/loading soluble powder for airblast application with application rates 0.5 lb ai/A for non-bearing citrus (40 acres; **Combined MOE = 5.8**), 1.0 lb ai/100 gal for trees and shrubs (1000 gal; **Combined MOE = 12**), and 0.5 lb ai/100 gal for outdoor floral (1000 gal;

Combined MOE = 22); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1e) Mixing/loading soluble powder for handgun (hydraulic sprayer) application with application rates 1.0 lb ai/100 gal for trees, shrubs, outdoor floral crops (1000 gal; **Combined MOE = 12**), 0.5 lb ai/100 gal for trees, shrubs, outdoor floral crops (1000 gal; **Combined MOE = 22**), and 5.0 lb ai/A for turf (5 acres; **Combined MOE = 4.5**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1f) Mixing/loading soluble powder for transplanting water application with application rate 0.75 lb ai/A for tobacco (20 acres; **Combined MOE = 7.5**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1g) Mixing/loading soluble powder for slurry seed treatment with application rate 0.04 lb ai/100 lb seed for cotton seed (200,000 lb seed; **Combined MOE = 1.5**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(1h) Loading soluble powder for hopper box application with application rate 0.1875 lb ai/A for cotton seed (80 acres; **Combined MOE = 7.5**); based upon medium confidence in dermal and inhalation data and low confidence in hand data.

(2) Mixing/loading dry flowable for slurry seed treatment with application rate 0.04 lb ai/100 lb seed for cotton seed (200,000 lb seed; **Combined MOE = 80**); based upon high confidence in dermal and inhalation data and low confidence in hand data.

(3a) Mixing/loading liquids for aerial application with application rate 0.75 lb ai/A for pasture/forest (350 acres; **Combined MOE = 1.1**) and 0.75 lb ai/A for forest (800 acres; **Combined MOE = 0.50**); based upon high confidence in hand, dermal and inhalation data.

(3b) Mixing/loading liquids for slurry seed treatment with application rate 0.04 lb ai/100 lb seed for cotton seed (200,000 lb seed; **Combined MOE = 3.6**); based upon high confidence in hand, dermal and inhalation data.

(4) Loading granular in tractor-drawn drop-type spreader with application rates 1.0 lb ai/A for cotton (80 acres; **Combined MOE = 68**), 5.0 lb ai/A for sod (80 acres; **Combined MOE = 13**), and 5.0 lb ai/A for golf course turf (40 acres; **Combined MOE = 28**); based upon high confidence in inhalation data, medium confidence in dermal data and low confidence in hand data.

(6) Applying spray with a groundboom sprayer with application rates 5.0 lb ai/A for sod (80 acres; **Combined MOE = 27**) and 5.0 lb ai/A for golf course turf (40 acres; **Combined MOE = 56**); based upon high confidence in hand, dermal and inhalation data.

(7) Applying spray with airblast sprayer with application rate 0.5 lb ai/A for non-bearing citrus (40 acres; **Combined MOE = 59**); based upon high confidence in dermal and inhalation data and medium confidence in hand data.

(8) Applying spray with handgun sprayer with application rates 1.0 lb ai/100 gal for trees, shrubs, outdoor floral crops (1000 gal; **Combined MOE = 50**) and 5.0 lb ai/A for turf (5 acres; **Combined MOE = 21**); based upon high confidence in dermal and inhalation data and medium confidence in hand data.

(12) Applying granular with tractor-drawn drop-type spreader application rates 1.0 lb ai/A for cotton (80 acres; **Combined MOE = 91**), 5.0 lb ai/A for sod (80 acres; **Combined MOE = 18**), and 5.0 lb ai/A for turf (40 acres; **Combined MOE = 37**); based upon low confidence

in inhalation, dermal and hand data.

(13a) Mixing/loading/applying soluble powder using low pressure hand wand with application rates 0.5 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (40 gal; **Combined MOE = 34**), 1.0 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (40 gal; **Combined MOE = 17**), 0.075 lb ai/gal for wasps (5 gal; **Combined MOE = 18**) and 0.088 lb ai/gal for PCO (40 gal; **Combined MOE = 1.9**); based upon medium confidence in inhalation, dermal and hand data.

(13b) Mixing/loading/applying wettable powder using low pressure hand wand [MRID # 405048-23] with PCO application rates of 0.08745 lb ai/gal (1 gal; **Combined MOE = 24**), 0.08745 lb ai/gal (4 gal; **Combined MOE = 5.9**) and 0.08745 lb ai/gal (40 gal; **Combined MOE = 0.59**); based upon MRID # 405048-23 (9 replicates for residential sites and 9 replicates for commercial sites).

(14) Mixing/loading/applying using backpack sprayer with application rate 0.088 lb ai/gal for PCO (40 gal; **Combined MOE = 48**); based upon low confidence in inhalation, dermal and hand data.

(15) Mixing/loading/applying using high pressure sprayer with application rate 0.5 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (1000 gal; **Combined MOE = 12**) and 1.0 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (1000 gal; **Combined MOE = 6.2**); based upon low confidence in inhalation, dermal and hand data.

(18) Loading/applying soluble powder by hand/handtool/shaker can with application rate 0.00694 lb ai/mound for fire ants (10 mounds/acre; 1 acre; **Combined MOE = 24**); based upon medium confidence in inhalation, dermal and hand data.

(21) Loading/applying granules with push-type granular spreader with application rate 5.0 lb ai/A for turf (5 acres; **Combined MOE = 10**); based upon high confidence in inhalation data and low to medium confidence in dermal and hand data.

(22) Loading/applying granules with belly grinder with application rate 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (87,000 sq ft; **Combined MOE = 5.9**); based upon high confidence in inhalation data and medium confidence in dermal and hand data.

(23) Loading/applying granules with shaker can with application rate 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (10,000 sq ft; **Combined MOE = 5.9**); based upon medium confidence in inhalation, dermal and hand data.

(24) Loading/applying granules by hand with application rates 0.00099 lb per pot up to 12 in diameter (1000 pots; **Combined MOE = 5.9**), 0.008 lb ai/mound for fire ants (10 mounds/A; 1 acre; **Combined MOE = 77**), and 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (1000 sq ft; **Combined MOE = 56**); based upon medium confidence in inhalation, dermal and hand data.

(25) Flagging aerial spray applications with application rates 1.0 lb ai/A for agricultural crops (350 acres; **Combined MOE = 59**), 5.0 lb ai/A for turf (350 acres; **Combined MOE = 12**), 0.75 lb ai/A for forest (350 acres; **Combined MOE = 83**), and 0.75 lb ai/A for forest (80 acres; **Combined MOE = 34**); based upon high confidence in inhalation, dermal and hand data.

PPE Exposure Scenarios with MOEs less than 100

(1a) Mixing/loading soluble powder for aerial application with application rates 0.5 lb ai/A for agricultural crops (350 acres; **Combined MOE = 5.6**), 1.0 lb ai/A for agricultural crops (350 acres; **Combined MOE = 2.7**), 5.0 lb ai/A for turf (350 acres; **Combined MOE = 0.56**), and 0.125 lb ai/A for pasture (350 acres; **Combined MOE = 21**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1b) Mixing/loading soluble powder for chemigation application with application rate 1.0 lb ai/A for cranberries (30 acres; **Combined MOE = 31**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1c) Mixing/loading soluble powder for groundboom application with application rates 0.5 lb ai/A for agricultural crops (80 acres; **Combined MOE = 23**), 1.0 lb ai/A for agricultural crops (80 acres; **Combined MOE = 11**), 0.125 lb ai/A for pasture (80 acres; **Combined MOE = 97**), 5.0 lb ai/A for turf (sod farm of 80 acres; **Combined MOE = 2.3**), and 5.0 lb ai/A for turf (golf course of 40 acres; **Combined MOE = 4.8**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1d) Mixing/loading soluble powder for airblast application with application rates 0.5 lb ai/A for non-bearing citrus (40 acres; **Combined MOE = 48**) and 1.0 lb ai/100 gal for trees and shrubs (1000 gal; **Combined MOE = 97**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1e) Mixing/loading soluble powder for handgun (hydraulic sprayer) application with application rate 5.0 lb ai/A for turf (5 acres; **Combined MOE = 37**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1f) Mixing/loading soluble powder for transplanting water application with application rate 0.75 lb ai/A for tobacco (20 acres; **Combined MOE = 62**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1g) Mixing/loading soluble powder for slurry seed treatment with application rate 0.04 lb ai/100 lb seed for cotton seed (200,000 lb seed; **Combined MOE = 11**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(1h) Loading soluble powder for hopper box application with application rate 0.1875 lb ai/A for cotton seed (80 acres; **Combined MOE = 62**); based upon same dermal data as for baseline; high confidence for hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(3a) Mixing/loading liquids for aerial application with application rate 0.75 lb ai/A for pasture/forest (350 acres; **Combined MOE = 77**) and 0.75 lb ai/A for forest (800 acres; **Combined MOE = 32**); based upon same dermal data as baseline; high confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(4) Loading granular in tractor-drawn drop-type spreader with application rate 5.0 lb ai/A for sod (80 acres; **Combined MOE = 56**); based upon high confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(6) Applying spray with a groundboom sprayer with application rate 5.0 lb ai/A for sod (80 acres; **Combined MOE = 77**); based upon same dermal data as baseline; medium confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(8) Applying spray with handgun sprayer with application rate 5.0 lb ai/A for turf (5 acres; **Combined MOE = 71**); based upon same dermal data as baseline; low confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(12) Applying granular with tractor-drawn drop-type spreader application rate 5.0 lb ai/A for sod (80 acres; **Combined MOE = 77**); based upon same dermal data as baseline; hand data are estimated from no gloves data using 90% protection factor; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(13a) Mixing/loading/applying soluble powder using low pressure hand wand with application rates 1.0 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (40 gal; **Combined MOE = 77**), 0.075 lb ai/gal for wasps (5 gal; **Combined MOE = 83**) and 0.088 lb ai/gal for PCO (40 gal; **Combined MOE = 9.1**); based upon same dermal, hand and inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(14) Mixing/loading/applying using backpack sprayer with application rate 0.088 lb ai/gal for PCO (40 gal; **Combined MOE = 77**); based upon same dermal, hand and inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(15) Mixing/loading/applying using high pressure sprayer with application rate 0.5 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (1000 gal; **Combined MOE = 36**) and 1.0 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (1000 gal; **Combined MOE = 18**); based upon same dermal data as baseline; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(21) Loading/applying granules with push-type granular spreader with application rate 5.0 lb ai/A for turf (5 acres; **Combined MOE = 42**); based upon same dermal and hand data as baseline with a 50% protection factor applied to non-hand dermal data to account for the use of coveralls, 90% protection factor to hand data to account for the use of chemically-resistant gloves, and 90% protection factor applied to account for the use of appropriate respiratory protection (half-face respirator).

(22) Loading/applying granules with belly grinder with application rate 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (87,000 sq ft; **Combined MOE = 4.2**); based upon same dermal data as baseline; medium confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(23) Loading/applying granules with shaker can with application rate 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (10,000 sq ft; **Combined MOE = 9.1**); based upon same dermal data as baseline; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(24) Loading/applying granules by hand with application rates 0.00099 lb per pot up to 12 in

diameter (1000 pots; **Combined MOE = 11**) and 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (1000 sq ft; **Combined MOE = 91**); based upon same dermal data as baseline; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(25) Flagging aerial spray applications with application rates 5.0 lb ai/A for turf (350 acres; **Combined MOE = 30**) and 0.75 lb ai/A for forest (80 acres; **Combined MOE = 91**); based upon same dermal data as baseline; low confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

Engineering Controls Scenarios with MOEs less than 100

(1a) Mixing/loading soluble powder for aerial application with application rates 1.0 lb ai/A for agricultural crops (350 acres; **Combined MOE = 83**) and 5.0 lb ai/A for turf (350 acres; **Combined MOE = 16**); based upon low confidence in inhalation, dermal and hand data; no protection factor was needed to define the unit exposure value; engineering controls are based on water-soluble packaging.

(1c) Mixing/loading soluble powder for groundboom application with application rate 5.0 lb ai/A for turf (sod farm of 80 acres; **Combined MOE = 67**); based upon low confidence in inhalation, dermal and hand data; no protection factor was needed to define the unit exposure value; engineering controls are based on water-soluble packaging.

(3a) Mixing/loading liquids for aerial application with application rate 0.75 lb ai/A for forest (800 acres; **Combined MOE = 91**); high confidence in inhalation data; medium confidence in dermal and hand data; no protection factor was needed to define the unit exposure value; gloves worn during the use of closed mixing/loading systems.

(5) Applying spray with fixed-wing aircraft with application rate 5.0 lb ai/A for turf (350 acres; **Combined MOE = 43**); high confidence in hand data; medium confidence in inhalation and dermal data; no protection factor was needed to define the unit exposure value; engineering controls are based on closed cab.

Individual and/or Professional Pesticide Applicator Scenarios of Concern

The calculations of individual and professional acephate applicators' combined dermal and inhalation risks indicate that, at the highest level of mitigation available and/or feasible for a specific scenario, thirteen of the scenarios do not exceed a MOE of 100. The thirteen scenarios are summarized below.

(1a) Mixing/loading soluble powder for aerial application with application rates 1.0 lb ai/A for agricultural crops (350 acres; **Combined MOE = 83**) and 5.0 lb ai/A for turf (350 acres; **Combined MOE = 16**); based upon low confidence in inhalation, dermal and hand data; no protection factor was needed to define the unit exposure value; engineering controls are based on water-soluble packaging.

(1c) Mixing/loading soluble powder for groundboom application with application rate 5.0 lb ai/A for turf (sod farm of 80 acres; **Combined MOE = 67**); based upon low confidence in inhalation, dermal and hand data; no protection factor was needed to define the unit exposure value; engineering controls are based on water-soluble packaging.

(3a) Mixing/loading liquids for aerial application with application rate 0.75 lb ai/A for forest (800 acres; **Combined MOE = 91**); high confidence in inhalation data; medium confidence in dermal and hand data; no protection factor was needed to define the unit exposure value; gloves worn during the use of closed mixing/loading systems.

(5) Applying spray with fixed-wing aircraft with application rate 5.0 lb ai/A for turf (350 acres; **Combined MOE = 43**); high confidence in hand data; medium confidence in inhalation and dermal data; no protection factor was needed to define the unit exposure value; engineering controls are based on closed cab.

(8) Applying spray with handgun sprayer with application rate 5.0 lb ai/A for turf (5 acres; **Combined MOE = 71**); based upon same dermal data as baseline; low confidence in hand data; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(13a) Mixing/loading/applying soluble powder using low pressure hand wand with application rates 1.0 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (40 gal; **Combined MOE = 77**), 0.075 lb ai/gal for wasps (5 gal; **Combined MOE = 83**) and 0.088 lb ai/gal for PCO (40 gal; **Combined MOE = 9.1**); based upon same dermal, hand and inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(13b) Mixing/loading/applying wettable powder using low pressure hand wand [MRID # 405048-23] with PCO application rates of 0.08745 lb ai/gal (1 gal; **Combined MOE = 24**), 0.08745 lb ai/gal (4 gal; **Combined MOE = 5.9**) and 0.08745 lb ai/gal (40 gal; **Combined MOE = 0.59**); based upon MRID # 405048-23 (9 replicates for residential sites and 9 replicates for commercial sites).

(14) Mixing/loading/applying using backpack sprayer with application rate 0.088 lb ai/gal for PCO (40 gal; **Combined MOE = 77**); based upon same dermal, hand and inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(15) Mixing/loading/applying using high pressure sprayer with application rate 0.5 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (1000 gal; **Combined MOE = 36**) and 1.0 lb ai/100 gal for trees, shrubs, roses, ground cover, floral crops (1000 gal; **Combined MOE = 18**); based upon same dermal data as baseline; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(21) Loading/applying granules with push-type granular spreader with application rate 5.0 lb ai/A for turf (5 acres; **Combined MOE = 42**); based upon same dermal and hand data as baseline with a 50% protection factor applied to non-hand dermal data to account for the use of coveralls, 90% protection factor to hand data to account for the use of chemically-resistant gloves, and 90% protection factor applied to account for the use of appropriate respiratory protection (half-face respirator).

(22) Loading/applying granules with belly grinder with application rate 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (87,000 sq ft; **Combined MOE = 4.2**); based upon same dermal data as baseline; medium confidence in hand data; same inhalation data as baseline with an

80% protection factor to simulate the use of a dust/mist respirator.

(23) Loading/applying granules with shaker can with application rate 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (10,000 sq ft; **Combined MOE = 9.1**); based upon same dermal data as baseline; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

(24) Loading/applying granules by hand with application rates 0.00099 lb per pot up to 12 in diameter (1000 pots; **Combined MOE = 11**) and 0.1125 lb ai/1000 sq ft for trees, shrubs, ornamentals (1000 sq ft; **Combined MOE = 91**); based upon same dermal data as baseline; same inhalation data as baseline with an 80% protection factor to simulate the use of a dust/mist respirator.

Data Gaps for Individual and Professional Pesticide Applicator Scenarios

Data gaps have been identified for the following individual and professional pesticide applicator scenarios:

(10) Applying as a seed treatment in a hopper box (cotton = 0.1875 lb ai/A; 80 acres);

(11) Applying as a seed treatment in a slurry tank (cotton seed = 0.04 lb/100 lb seed; 200,000 lb seed);

(16) Loading/applying using aerosol generator (indoor ornamentals, flowers, trees, shrubs, roses = 10 sec/100 sq ft if 2 ft plants or 1 sec/row-ft when spraying both sides of row; no data);

(17) Loading/applying with PCO injector (PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot; no data); and

(20) Loading/applying tree injections (1.5 cm/injection; dependent on tree size).

Surrogate data from similar PHED scenarios were used for the following four individual and professional pesticide applicator scenarios:

(9) Applying in transplanting water (tobacco = 0.75 lb ai/A; 20 acres); PHED data for groundboom were used (which may over-estimate transplant water application for tobacco);

(18) Loading/applying soluble powder by hand/handtool/shaker can (fire ants = 2 tsp/mound; 10 mounds/A; 1 acre); PHED data for granular bait dispersed by hand scenario were used;

(19) Mixing/loading/applying soluble powder using sprinkler can (fire ants = 0.047 oz/5 gal; 1 gal/mound; 10 mounds/A; 1 A); PHED data for the garden hose-end sprayer were used; and

(23) Loading/applying granules with shaker can (trees, shrubs, ornamentals = 0.1125 lb/1000 sq ft; 10,000 sq ft); PHED data for granular bait dispersed by hand scenario were used.

3.c.iii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

Minor HED-based corrections/modifications were made in this section of the assessment. For example, numerical errors were corrected and a few PHED unit exposure values were updated.

3.c.iv. Post-Application Worker Risk Characterization Results

The following table summarizes the calculated task-specific re-entry intervals (REIs) for succulent beans, cauliflower, greenhouse roses, tobacco and turf. Previously-established pre-harvest intervals (PHIs) are also included in the table for comparison. The current REI for each of these crops is 24 hours (Worker Protection Standard default).

Table 8. Post-Application Calculated Re-Entry Intervals (Crop-specific and Task-specific).

Crop Treated	Total Application Rate (lb ai/A)	Transfer Coefficient (cm^2/hr)[a]	Activities	REI (days) [Crop- and Task-specific]	Current PHI (days) [Crop-specific]
Succulent Beans	2.0	4,000	Harvest by hand, stake/tie, scout and irrigate	5	0 – succulent beans and 14 – succulent lima beans
Cauliflower	2.0	1,000	Scout and irrigate	0	14
	2.0	2,500	Harvest by hand	0	
Greenhouse Roses	4.3	2,500	Sort and pack	6	--
	4.3	10,000	Prune and harvest by hand	12	
Tobacco	2.3	4,000	Stake/tie, scout and irrigate	8	3
	2.3	10,000	Harvest by hand	19	
Turfgrass	10	500	Mow with tractor	0	--
	10	1,000	Mow with push-type mower	0	
	10	10,000	Harvest sod	1	

a Standard values for transfer coefficients are from HED Exposure Science Advisory Council (SAC) Policy #3 dated May 7, 1998.

The calculated REIs represent the duration in days which must elapse before HED would not have concern for a worker, wearing a long-sleeved shirt and long pants, to enter the treated area and perform specific tasks. It should be noted that when calculated REIs for acephate and methamidophos varied for a crop, the REI of the longer duration was chosen to be protective for the worker. It should also be noted that the default REI of 24 hours will still apply to cauliflower and turf under the Worker Protection Standard (WPS).

The Worker Protection Standard for Agricultural Pesticides – 40 CFR Part 170 -- defines crop advisors and scouts as handlers. As such, crop advisors and scouts are permitted to enter treated areas and perform scouting tasks if wearing required PPE. Additionally, the crop advisor exemption permits certified or licensed crop advisors to choose the appropriate PPE to be worn by themselves and their employees while performing crop advising tasks in treated areas. However, crop advisors are still covered under FIFRA – Sections 3, 6, and 12, and Title 40 CFR Part 156.204(b) [labelling] with regard to risk concerns identified through reregistration or other EPA risk

assessment/data evaluation processes.

3.c.v. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

Dramatic modifications/additions have occurred since the previous assessment was available for comment by the public. The registrant's submission of four DFR studies and the TTR study has significantly altered the post-application worker risk assessment.

It should be noted that the Agency does not agree with the registrant's method of calculating REIs. As previously addressed in this document, the Agency also does not agree with the registrant's use of a dermal NOAEL of 50 mg/kg/day.

3.c.vi. Non-Occupational (Residential Applicator) Risk Characterization Results

The calculations of residential acephate applicators' combined dermal and inhalation risks indicate that two exposure scenarios exceed 100 while six scenarios do not. There are also two scenarios for which surrogate data from similar PHED scenarios were used. The range of combined dermal and inhalation MOEs for the residential acephate applicators' scenarios was 2.9 to 7,100.

Residential Pesticide Applicator Scenarios of Concern

(1) Mixing/loading/applying wettable powder using a low pressure hand wand with application rates 0.023 lb ai/gal for ornamentals, flowers, shrubs, trees, fire ants (2 gallons; **Combined MOE = 53**) and 0.035 lb ai/gal for turf (2 gallons; **Combined MOE = 33**); based upon high confidence in hand data and medium confidence in dermal and inhalation data; a 90% protection factor was needed to "back calculate" a no-glove unit exposure value from all non-detects.

(3a) Mixing/loading/applying using a hose-end sprayer with application rates 0.023 lb ai/gal for ornamentals, flowers, shrubs, trees (50 gallons; **Combined MOE = 23**), 0.035 lb ai/gal for turf (50 gallons; **Combined MOE = 16**), 0.0076 lb ai/gal for roses, flowers, shrubs, trees (50 gallons; **Combined MOE = 73**), 0.013 lb ai/gal for shade trees (50 gallons; **Combined MOE = 40**), and 0.058 lb ai/1000 sq ft for ornamentals and turf (20,000 sq ft; **Combined MOE = 23**); based upon low confidence in inhalation, dermal and hand data.

(3b) Mixing/loading/applying using a hose-end sprayer [MRID # 405048-27] with application rate 0.01175 lb ai/gal for shrubbery (50 gallons; **Combined MOE = 2.9**); based upon MRID # 405048-27; 5 replicates.

(5) Loading/applying soluble powder (dry) concentrate by hand/handtool/shaker can with application rate 0.0069 lb ai/mound for fire ants (7 mounds; **Combined MOE = 37**); based upon medium confidence in inhalation, dermal and hand data; a 90% protection factor was needed to "back calculate" a no-glove unit exposure value from all non-detects.

(6) Loading/applying granules by shaker can with application rates 0.5 lb ai/1000 sq ft for ornamentals (100 sq ft; **Combined MOE = 36**) and 0.5 lb ai/1000 sq ft for roses (5 sq ft/rose;

20 roses; **Combined MOE = 36**); based upon medium confidence in inhalation, dermal and hand data; a 90% protection factor was needed to "back calculate" a no-glove unit exposure value from all non-detects.

(7) Applying by aerosol can with application rates 0.01 lb ai/can for crack & crevice (2 cans; **Combined MOE = 97**) and 0.03 lb ai/can for ornamentals (2 cans; **Combined MOE = 33**); based upon high confidence in hand data and medium confidence in dermal and inhalation data.

Data Gaps for Residential Pesticide Applicator Scenarios

Surrogate data from similar PHED scenarios were used for the following two residential pesticide applicator scenarios:

(5) Loading/applying soluble powder (dry) concentrate by hand/handtool/shaker can (fire ants = 0.0069 lb ai/mound; 7 mounds); PHED data for granular bait dispersed by hand scenario were used.

(6) Loading/applying granules by shaker can (ornamentals = 0.5 lb ai/1000 sq ft; 100 sq ft) and (roses = 0.5 lb ai/1000 sq ft; 5 sq ft/rose; 20 roses); PHED data for granular bait dispersed by hand scenario were used.

3.c.vii. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

Minor HED-based corrections/modifications were made in this section of the assessment. For example, numerical errors were corrected and a few PHED unit exposure values were updated. In addition, the registrant provided the Agency residential use information which has been incorporated into the assessment.

3.c.viii. Non-Occupational (Post-Application Residential) Risk Characterization Results

The calculations for post-application residential risks indicate that there are several scenarios which exceed HED's level of concern. For post-application residential acephate risks, MOEs below 100 exceed HED's level of concern. For post-application residential methamidophos risks, MOEs below 300 for all population subgroups exceed HED's level of concern. The following table summarizes dermal risks to adults and children, children's hand-to-mouth risks, and children's turfgrass ingestion risks to both acephate and methamidophos following a residential application of acephate on grass.

Table 9. Post-Application Risks to Public Following Acephate Application to Residential Turf.

Acephate Residential Post-application Scenario	Exposed Individual	Acephate MOE	Methamidophos MOE
Dermal exposure	Adult	140	2,400
	Child	86	1,500
Hand-to-Mouth	Child	94	15,000
Turfgrass ingestion	Child	2,900	500,000

Although the exposure assessment methods outlined in the Residential SOPs are intended to be used as screening tools, the following acephate post-application residential exposure scenarios exceed HED's level of concern: dermal exposures to children and children's hand-to-mouth exposures. None of the methamidophos post-application residential exposure scenarios exceed HED's level of concern.

3.c.ix. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

The use of the registrant's submitted turf study to assess post-application residential risks dramatically changed the results of the post-application residential risk assessment from the previous chapter. However, the Agency does not agree with the registrant's use of a dermal NOAEL of 50 mg/kg/day for acephate in its submitted post-application residential assessment. Nor does the Agency agree with the registrant's use of the dermal NOAEL to calculate hand-to-mouth risks in the assessment.

3.c.x. Non-Occupational (Post-Application Recreational) Risk Characterization Results

HED is not concerned regarding adult and 13+ year-old golfers' risks to acephate and methamidophos following an acephate treatment of golf course turf. The following table summarizes golfers' risks following an acephate treatment.

Table 10. Post-Application Risks to Public Following Acephate Application to Golf Course Turf.

Recreational Scenario	Acephate MOE	Methamidophos MOE
Adult Golfer	7,500	125,000
13+ year-old Golfer	4,620	78,100

3.c.xi. Modifications Based upon Agency's Revisions, Public Comments, and/or Registrants' Comments

A post-application recreational risk assessment for golfers was not included in the previous

document.

3.d. Incident Reports

3.d.i. General Summary

EPA has obtained incident information concerning acephate from four sources: 1) the Office of Pesticide Programs (OPP) Incident Data System (IDS), 2) American Association of Poison Control Centers (AAPCC), 3) the California Department of Pesticide Regulation (CDPR), and 4) the National Pesticide Telecommunications Network (NPTN; a toll-free information service supported by OPP). The IDS contains reports of incidents submitted to OPP since 1992 from various sources, including registrants, other federal and state health and environmental agencies, and individual consumers. AAPCC provides OPP data as a result of Data-Call-Ins issued in 1993. This data covers the years 1985 through 1996 for 28 organophosphate and carbamate chemicals. In addition, EPA purchased data for the time period 1993-1996 for all pesticides. The CDPR data consists of uniform reports, required by statute since 1982, from physicians on suspected pesticide poisonings and all illnesses suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided. The NPTN data consists of a tabulation and ranking of the top 200 categories of human incidents, animal incidents, calls for information, and others.

Two memoranda entitled *Review of Acephate Incident Reports and Review of Methamidophos Incident Reports* are included in Appendix E. A brief summary of the acephate document is contained herein.

3.d.ii. IDS Data

There are two types of incident information on file for acephate: (A) *Report of the Investigation of the Death of (name withheld)* by Sheldon L. Wagner, M.D. Letter to Jerome Blondell, Office of Pesticide Programs, September 3, 1998, and (B) seven incidents of routine reporting to the Incident Data System (IDS). The complete report of the fatality is enclosed herein.

A. *Report of the Investigation of the Death of (name withheld)* by Sheldon L. Wagner, M.D.

A 24 year old male pesticide applicator with no prior history of any cardiac difficulties died suddenly after spraying seven homes with a mixture of acephate and dicofol. A medical review of the applicator's autopsy report, clinical toxicology findings, and results of cholinesterase tests on his tissues were requested by EPA. Dr. Wagner, Professor of Clinical Toxicology at Oregon State University and medical advisor to the Epidemiology Group concluded that "the most probable cause of death was an acute ventricular fibrillation resulting from organophosphate exposure and intoxication."

On the day of his death, the pesticide applicator was mixing and applying organophosphate insecticide without proper protection, and with a particulate mask that would have increased his risk of inhaling increased concentrations of the insecticide. At the seventh home he sprayed, he complained of headaches and collapsed. Attempts to resuscitation failed and he was declared dead one half hour after admission to the emergency room. His stomach contents and urine were negative for drugs and other substances. Dr. Wagner concluded that he had died with documented ventricular fibrillation, the most common type of cardiac arrhythmia occurring with organophosphate insecticides.

Details of the lab assay methods and storage stability of the enzymes were reviewed with three authorities, and these findings and the presence of anticoagulants EDTA was evaluated by Dr. Wagner who concluded that "an abnormally low cholinesterase confirmed significant exposure and /or intoxication from acephate." Dr. Wagner concluded that "the most probable cause of death was an acute ventricular fibrillation resulting from organophosphate exposure and intoxication."

3.d.iii. AAPCC Data

Compared to other organophosphate and carbamate insecticides, acephate is generally similar or somewhat below median levels for health care requirements and occurrence of symptoms. However, for life-threatening or fatal cases, the percents are above the median. The one fatality due to acephate was reported in 1990 involving a 67 year old who was exposed by route of inhalation due to accidental misuse.

For non-occupational cases involving adults and older children or young children, acephate has a similar hazard profile to all other pesticides. In contrast, hazards were noticeably higher for individuals exposed to acephate occupationally. This difference, however, was mostly limited to health care measures. Occupational acephate cases were 74% more likely to require hospitalization and three times more likely to be treated in an intensive care unit.

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For acephate, there were 674 incidents; 575 (85%) involved exposure to acephate alone. Compared to 16 other organophosphates and carbamates that 25 or more children were exposed to acephate cases were less likely to require medical attention. Acephate was also slightly less likely to result in related symptoms and there were no life-threatening or fatal cases in children under six years of age.

3.d.iv. CDPR Data

California accessed medical monitoring records for 542 agricultural pesticide applicators under medical supervision in 1985 for exposure to the more toxic cholinesterase-inhibiting organophosphate and carbamate pesticides (Ames et al. 1987, 1989) . In California, cholinesterase monitoring is required for all pesticide applicators who handle Toxicity Category I or II organophosphate or carbamate pesticides for 30 hours of more in any 30 day period. To be included

in the survey, the worker had to have at least one pre-exposure (baseline) cholinesterase measurement and at least one exposure value (mid-season). A data-call-in was issued by the California Department of Food and Agriculture and local Agricultural Commissioners through pesticide application firms to their medical supervisors. Follow up letters were sent and phone calls made to employers, physicians, and laboratories performing tests, but significant under reporting is likely to have occurred. Therefore, these workers may not be representative of all workers undergoing medical monitoring in California. However, they do represent exposure effects verified by medical laboratories. Cholinesterase activity depression of 20 percent or more below baseline was observed in 127 or 23 percent of the 542 workers. Depression of 20 percent or more below baseline represents strong evidence of exposure (Gallo and Lawryk 1991).

Specific pesticide exposure was available for 94 of the 127 cases, based on usage records for the previous two weeks. Of these, 31 percent had been exposed to mevinphos, 21 percent to methomyl, and 21 percent to parathion, the three leading pesticides responsible for cholinesterase inhibition. **Of the 94 cases with inhibition, 16% had exposure in the past two weeks to acephate.** Note that many of the workers were exposed to two or more pesticides during the two weeks before they had cholinesterase depression of 20% or more. Twelve of the workers in this study were reported to have pesticide-related illnesses by their physicians. These data demonstrate that agricultural workers, who mix, load and apply the more toxic pesticides are subject to significant levels of exposure despite the considerable restrictions in place to prevent exposure.

During the period 1982-1995, 11 cases involving the sole use of acephate were reported. All of these cases were reported in 1989. A total of 8 persons had systemic illnesses from acephate exposure and only 1 person was disabled and hospitalized. Of these 8 persons, one was exposed when performing ground application and the remaining 7 were exposed by drift. Drift was associated with the majority of the illnesses which included symptoms of shortness of breath, asthma, headaches, nausea, diarrhea, and burning eyes. Acephate was ranked 76th as a cause of systemic poisoning in California.

3.d.v. NPTN Data

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, acephate ranked number 13 and was reported to be involved in 254 human incidents and 24 animal incidents.

3.d.vi. Incident Data Conclusions

When both Poison Control Center and California data were considered, acephate generally had a lower hazard than other organophosphate and carbamate insecticides. There have been two accidental deaths reported associated with exposure. Both deaths involved misuse and in one case use of a particulate mask may have increased the risk of inhaling acephate. Minor and moderate symptoms of exposure have often been associated with inhalation indoors. Outdoor agricultural use

are associated with lower risks of illness and poisoning than most other organophosphate and carbamate insecticides.

3.d.vii. Incident Data Recommendations

Indoor use of acephate should be restricted to certified Pest Control Operators. Homeowner products should be limited to only products that are either ready-to-use or mostly diluted product. The one exception to this should be hose-end sprayers and other concentrates that can be used by homeowners without mixing or pouring. Acephate should be sold in non-breakable containers.

3.e. Data Needs

Several areas of the risk assessment and characterization would improve with more data. Areas of data needs include:

- Chemical-specific exposure studies for occupational and non-occupational exposures. Valent recently completed several DFR and TTR studies. The Agency commends these submissions and would encourage the registrant to conduct and submit additional exposure monitoring studies. In particular, applicator scenarios for which no data are currently available to the Agency for assessment purposes are encouraged.

- Specific data on typical use, types of mixing and loading completed for application equipment, types of packaging available to individual and professional pesticide applicators, types of potential engineering controls, additional information on slit-placement techniques for turf applications of granules, and information on post-application techniques for all crops.

- Chemical-specific studies addressing potential post-application exposures to acephate and methamidophos for children and adults in residential and other structural environments. These studies should address applications made by both homeowners and professional pesticide applicators to carpeted and smooth flooring in the indoor environment.

APPENDICES

APPENDIX A

ACEPHATE OCCUPATIONAL HANDLER EXPOSURE AND RISK ASSESSMENT TABLES (SHORT-TERM AND INTERMEDIATE-TERM EXPOSURES)

Table 1: Numerical Inputs for Occupational Handler Exposure to Acephate.

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
Mixer/Loader Exposure								
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	3.7	43	0.17	8.6	0.0098	0.24
	Ag = 1.0	350	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	350	3.7	43	0.17	8.6	0.0098	0.24
	Pasture = 0.125	350	3.7	43	0.17	8.6	0.0098	0.24
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	3.7	43	0.17	8.6	0.0098	0.24
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	3.7	43	0.17	8.6	0.0098	0.24
	Ag = 1.0	80	3.7	43	0.17	8.6	0.0098	0.24
	Pasture = 0.125	80	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	Sod = 80	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	Golf course = 40	3.7	43	0.17	8.6	0.0098	0.24
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	3.7	43	0.17	8.6	0.0098	0.24
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	3.7	43	0.17	8.6	0.0098	0.24

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	3.7	43	0.17	8.6	0.0098	0.24
	Turf = 5.0	5	3.7	43	0.17	8.6	0.0098	0.24
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	3.7	43	0.17	8.6	0.0098	0.24
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	3.7	43	0.17	8.6	0.0098	0.24
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	3.7	43	0.17	8.6	0.0098	0.24
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.066	0.77	0.066	0.15	0.0098	0.24
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	2.9	1.2	0.023	0.24	0.0086	0.083
	Forest = 0.75	800	2.9	1.2	0.023	0.24	0.0086	0.083
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	2.9	1.2	0.023	0.24	0.0086	0.083
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.0084	1.7	0.0069	0.34	0.00017	0.034
	Sod = 5.0	80	0.0084	1.7	0.0069	0.34	0.00017	0.034
	Golf Course Turf = 5.0	40	0.0084	1.7	0.0069	0.34	0.00017	0.034
Applicator Exposure								
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	NF	NF	NF	NF	0.005	0.068

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
	Ag = 1.0	350	NF	NF	NF	NF	0.005	0.068
	Turf = 5.0	350	NF	NF	NF	NF	0.005	0.068
	Pasture = 0.125	350	NF	NF	NF	NF	0.005	0.068
	Forest = 0.75	350	NF	NF	NF	NF	0.005	0.068
	Forest = 0.75	80	NF	NF	NF	NF	0.005	0.068
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.014	0.74	0.014	0.15	0.005	0.043
	Ag = 1.0	80	0.014	0.74	0.014	0.15	0.005	0.043
	Pasture = 0.125	80	0.014	0.74	0.014	0.15	0.005	0.043
	Turf = 5.0	Sod = 80	0.014	0.74	0.014	0.15	0.005	0.043
	Turf = 5.0	Golf course = 40	0.014	0.74	0.014	0.15	0.005	0.043
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	0.36	4.5	0.24	0.90	0.14	0.45
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	0.36	4.5	0.24	0.90	0.14	0.45
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.36	4.5	0.24	0.90	0.14	0.45
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	1.3	3.9	0.39	0.78	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	1.3	3.9	0.39	0.78	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	1.3	3.9	0.39	0.78	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
	Turf = 5.0	5	1.3	3.9	0.39	0.78	NF	NF
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.014	0.74	0.014	0.15	0.005	0.043
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.0099	1.2	0.0072	0.24	0.0021	0.22
	Sod = 5.0	80	0.0099	1.2	0.0072	0.24	0.0021	0.22
	Golf Course Turf = 5.0	40	0.0099	1.2	0.0072	0.24	0.0021	0.22
Mixer/Loader/Applicator Exposure								
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	29	1100	8.6	220	NF	NF
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	29	1100	8.6	220	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	29	1100	8.6	220	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	29	1100	8.6	220	NF	NF
	PCO = 0.088 lb/gal	40 gal	29	1100	8.6	220	NF	NF
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	160	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
	PCO = 0.08745 lb/gal	4 gal	160	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
	PCO = 0.08745 lb/gal	1 gal	170	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
	PCO = 0.08745 lb/gal	40 gal	170	2800	cannot apply PPE to registrant data	cannot apply PPE to registrant data	NF	NF
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
	PCO = 0.088 lb/gal	40 gal	2.5 (gloves)	30	2.5	6.0	NF	NF
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	3.5	120	2.5	24	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	3.5	120	2.5	24	NF	NF
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No Data	No Data	No Data	No Data	No Data	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No Data	No Data	No Data	No Data	No Data	NF	NF
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No Data	No Data	No Data	No Data	No Data	NF	NF
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	100	470	71	94	NF	NF
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	31	9	No Data	No Data	NF	NF
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	No Data	No Data	No Data	No Data	NF	NF
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	2.9	6.3	0.73	0.63	NF	NF
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	10	62	20	12	NF	NF
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	100	470	71	94	NF	NF
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	100	470	71	94	NF	NF
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	100	470	71	94	NF	NF

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Baseline Unit Values		PPE Mitigation Unit Values[e]		Engineering Control Unit Values[f]	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)	Dermal (mg / lb ai handled)	Inhalation (μg / lb ai handled)
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	100	470	71	94	NF	NF
Flagger Exposure								
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Ag = 1.0	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Turf = 5.0	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Pasture = 0.125	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Forest = 0.75	350	0.011	0.35	0.010	0.070	0.0011	0.035
	Forest = 0.75	80	0.011	0.35	0.010	0.070	0.0011	0.035

NF = Not feasible for scenario due to nature of task or equipment (i.e., HED assumes that all agricultural aerial applications are made with enclosed cab aircraft). No Data means no data are available for the scenario.

a Maximum application rates are values found on currently registered labels.
b Amounts of acreage treated per day are from the HED estimates of acreage that could be treated in a single day for each exposure scenario of concern.
c Baseline dermal unit exposure represents a worker's estimated exposure while wearing long pants, long sleeved shirt, no gloves, open mixing/loading, open cab tractor for groundboom applications, and open flagging.
d Baseline inhalation unit exposure represents no use of a respirator.
e PPE: See Table # 5 for full description of PPE assumed for each exposure scenario. PPE generally represents the use of chemically-resistant gloves, an additional layer of clothing, and the use of an appropriate respirator.
f Engineering controls: See Table #5 for full description of engineering controls assumed for each exposure scenario. Engineering controls generally represent the use of closed mixing/loading and closed cab application equipment and a single layer of clothing (exceptions are noted individually).

Note: aerial turf application of 5 lb ai/acre is not feasible; however, it is on current labels and therefore included in this assessment.

Table 2: Baseline Clothing Scenario Exposure and Risks for Occupational Handlers of Acephate, Short- and Intermediate-Term.

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader Exposure									
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	650	7.5	9.3	0.11	1.3	1.3	0.65
	Ag = 1.0	350	1300	15	19	0.21	0.63	0.67	0.32
	Turf = 5.0	350	6500	75	93	1.1	0.13	0.13	0.065
	Pasture = 0.125	350	160	1.9	2.3	0.027	5.2	5.2	2.6
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	110	1.3	1.6	0.018	7.5	7.8	3.8
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	150	1.7	2.1	0.024	5.7	5.8	2.8
	Ag = 1.0	80	300	3.4	4.3	0.049	2.8	2.9	1.4
	Pasture = 0.125	80	37	0.43	0.53	0.0061	23	23	12
	Turf = 5.0	Sod = 80	1500	17	21	0.24	0.57	0.58	0.28
	Turf = 5.0	Golf course = 40	740	8.6	11	0.12	1.1	1.2	0.58
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	74	0.86	1.1	0.012	11	12	5.8
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	37	0.43	0.53	0.0061	23	23	12
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	19	0.22	0.27	0.0031	44	45	22
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	3.6	0.042	0.051	0.00060	240	230	120
	Trees, Shrubs, Outdoor Floral Crops =	1000 gal	37	0.43	0.53	0.0061	23	23	12
	Trees, Shrubs, Outdoor	1000 gal	19	0.22	0.27	0.0031	44	45	22

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Turf = 5.0	5	93	1.1	1.3	0.016	9.2	8.8	4.5
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	55.5	0.65	0.79	0.0093	15	15	7.5
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	296	3.4	4.3	0.049	2.8	2.9	1.5
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	56	0.65	0.80	0.0093	15	15	7.5
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	5.3	0.062	0.076	0.00089	160	160	80
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	760	0.32	11	0.0046	1.1	30	1.1
	Forest = 0.75	800	1700	0.72	24	0.010	0.50	14	0.50
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	230	0.096	3.3	0.0014	3.6	100	3.6
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.67	0.14	0.0096	0.0020	1300	70	68
	Sod = 5.0	80	3.4	0.68	0.048	0.0097	250	14	13
	Golf Course Turf = 5.0	40	1.7	0.34	0.024	0.0048	500	29	28
Applicator Exposure									
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	NF	NF	NF	NF	NF	NF	NF
	Ag = 1.0	350	NF	NF	NF	NF	NF	NF	NF
	Turf = 5.0	350	NF	NF	NF	NF	NF	NF	NF
	Pasture = 0.125	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	80	NF	NF	NF	NF	NF	NF	NF

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.56	0.030	0.0080	0.00043	1500	330	270
	Ag = 1.0	80	1.1	0.059	0.016	0.00084	750	170	140
	Pasture = 0.125	80	0.14	0.0074	0.0020	0.00011	6000	1300	1100
	Turf = 5.0	Sod = 80	5.6	0.30	0.080	0.0043	150	33	27
	Turf = 5.0	Golf course = 40	2.8	0.15	0.040	0.0021	300	67	56
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	7.2	0.090	0.10	0.0013	120	110	59
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	3.6	0.045	0.051	0.00064	240	220	110
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	1.8	0.023	0.026	0.00033	460	420	220
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	1.3	0.0038	0.019	0.000054	630	2600	500
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	13	0.039	0.19	0.00056	63	250	50
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	6.5	0.020	0.093	0.00029	130	480	100
	Turf = 5.0	5	33	0.098	0.47	0.0014	26	100	21
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.21	0.011	0.003	0.00016	4000	880	710
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data	No Data

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.79	0.096	0.011	0.0014	1100	100	91
	Sod = 5.0	80	4.0	0.48	0.057	0.0068	210	20	18
	Turf = 5.0	40	2.0	0.24	0.028	0.0034	430	41	37
Mixer/Loader/Applicator Exposure									
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	5.8	0.22	0.083	0.0031	140	45	34
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	12	0.44	0.17	0.0063	71	22	17
	Wasps = 0.075 lb/1 gal	5 gal	11	0.41	0.16	0.0059	75	24	18
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	1.4	0.052	0.020	0.00074	600	190	140
	PCO = 0.088 lb/gal	40 gal	100	3.9	1.4	0.056	8.6	2.5	1.9
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	3.4	0.06	0.049	0.00086	250	160	100
	PCO = 0.08745 lb/gal	4 gal	56	0.98	0.8	0.014	15	10	5.9
	PCO = 0.08745 lb/gal	1 gal	15	0.24	0.214	0.00343	56	41	24
	PCO = 0.08745 lb/gal	40 gal	600	9.8	8.57	0.14	1.4	1	0.59
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	0.5	0.0060	0.00714	0.000086	1700	1600	830
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	1	0.012	0.0143	0.00017	840	820	420
	Wasps = 0.075 lb/1 gal	5 gal	0.94	0.011	0.0134	0.00016	890	880	450

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	0.12	0.0014	0.0017	0.000020	7000	7000	3500
	PCO = 0.088 lb/gal	40 gal	8.8	0.11	0.1257	0.0016	95	88	48
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	18	0.60	0.26	0.0086	46	16	12
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	35	1.2	0.50	0.017	24	8.2	6.2
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	6.94	0.0326	0.099	0.0046	120	30	24
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	0.182	0.000053	0.0026	0.0000007	4600	190000	4500
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	725	0.16	1.0	0.0023	12	61	10

BASELINE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	97.9	0.606	1.4	0.0087	9	16	5.9
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	112.5	0.53	1.6	0.0075	8	19	5.9
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	99	0.4653	1.4	0.0066	8	21	5.9
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	8	0.0376	0.11	0.00054	105	260	77
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	11.25	0.0529	0.16	0.00076	75	185	56
Flagger Exposure									
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	1.9	0.061	0.027	0.00087	440	160	120
	Ag = 1.0	350	3.9	0.12	0.056	0.0017	210	82	59
	Turf = 5.0	350	19	0.61	0.27	0.0087	44	16	12
	Pasture = 0.125	350	0.48	0.015	0.0069	0.00021	1700	670	480
	Forest = 0.75	350	2.9	0.092	0.041	0.0013	290	110	83
	Forest = 0.75	80	6.6	0.21	0.094	0.003	130	47	34

NF = Not feasible due to equipment used. HED believes all agricultural aircraft are enclosed cab; helicopter PHED data are insufficient for evaluation. No Data means no data are available for the scenario.

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\frac{1}{\left(\frac{1}{\text{MOE}derm} + \frac{1}{\text{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 3: PPE Mitigation Scenario Exposure and Risks for Occupational Handlers of Acephate, Short- and Intermediate-Term.

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader Exposure									
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	30	1.5	0.43	0.021	28	6.7	5.6
	Ag = 1.0	350	60	3.0	0.86	0.043	14	3.3	2.7
	Turf = 5.0	350	300	15	4.3	0.21	2.8	0.67	0.56
	Pasture = 0.125	350	7.4	0.38	0.11	0.0054	110	26	21
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	5.1	0.26	0.073	0.0037	160	38	31
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	6.8	0.34	0.097	0.0049	120	29	23
	Ag = 1.0	80	14	0.69	0.20	0.0099	60	14	11
	Pasture = 0.125	80	1.7	0.086	0.024	0.0012	500	120	97
	Turf = 5.0	Sod = 80	68	3.4	0.97	0.049	12	2.9	2.3
	Turf = 5.0	Golf course = 40	34	1.7	0.49	0.024	24	5.8	4.8
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	3.4	0.17	0.049	0.0024	240	58	48
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	1.7	0.086	0.024	0.0012	500	120	97
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.85	0.043	0.012	0.00061	1000	230	190
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	0.17	0.0084	0.0024	0.00012	5000	1200	1000

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	1.7	0.086	0.024	0.0012	500	120	100
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	0.85	0.043	0.012	0.00061	1000	230	190
	Turf = 5.0	5	4.3	0.22	0.061	0.0031	200	45	37
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	2.55	0.129	0.0364	0.0018	330	76	62
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	14	0.69	0.20	0.0099	60	14	11
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	2.6	0.13	0.037	0.0019	320	74	62
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	5.3	0.012	0.076	0.00017	160	820	140
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	6.0	0.063	0.086	0.00090	140	160	77
	Forest = 0.75	800	14	0.14	0.20	0.0020	60	70	32
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	1.8	0.019	0.026	0.00027	460	520	240
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.55	0.027	0.0079	0.00039	1500	360	290
	Sod = 5.0	80	2.8	0.14	0.04	0.002	300	70	56
	Turf = 5.0	40	1.4	0.068	0.02	0.00097	600	140	110
Applicator Exposure									
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	NF	NF	NF	NF	NF	NF	NF
	Ag = 1.0	350	NF	NF	NF	NF	NF	NF	NF

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Turf = 5.0	350	NF	NF	NF	NF	NF	NF	NF
	Pasture = 0.125	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	350	NF	NF	NF	NF	NF	NF	NF
	Forest = 0.75	80	NF	NF	NF	NF	NF	NF	NF
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.56	0.0060	0.0080	0.000086	1500	1600	770
	Ag = 1.0	80	1.1	0.012	0.016	0.00017	750	820	400
	Pasture = 0.125	80	0.14	0.0015	0.0020	0.000021	6000	6700	3100
	Turf = 5.0	Sod = 80	5.6	0.060	0.080	0.00086	150	160	77
	Turf = 5.0	Golf course = 40	2.8	0.030	0.040	0.00043	300	330	160
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	4.8	0.018	0.069	0.00026	170	540	130
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	2.4	0.0090	0.034	0.00013	350	1100	270
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	1.2	0.0045	0.017	0.000064	700	2200	560
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	0.38	0.00076	0.0054	0.000011	2200	13000	1900
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	3.9	0.0078	0.056	0.00011	210	1300	178
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	2.0	0.0039	0.028	0.000056	430	2500	370
	Turf = 5.0	5	9.8	0.0020	0.14	0.00029	86	480	71
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.21	0.00225	0.0030	0.000032	4000	4400	2100

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.58	0.019	0.0083	0.00027	1400	520	380
	Sod = 5.0	80	2.9	0.096	0.041	0.0014	290	100	77
	Golf Course Turf = 5.0	40	1.4	0.048	0.020	0.00068	600	200	150
Mixer/Loader/Applicator Exposure									
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	1.7	0.044	0.024	0.00063	500	220	150
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	3.4	0.088	0.048	0.0013	250	110	77
	Wasps = 0.075 lb/1 gal	5 gal	3.2	0.083	0.046	0.0012	260	120	83
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	0.40	0.010	0.0057	0.00014	2100	1000	670
	PCO = 0.088 lb/gal	40 gal	30	0.77	0.43	0.011	28	13	9.1
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
	PCO = 0.08745 lb/gal	4 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	PCO = 0.08745 lb/gal	1 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
	PCO = 0.08745 lb/gal	40 gal	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data	cannot apply PPE to registrant data
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	0.50	0.0012	0.0071	0.000017	1700	8200	1400
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	1.0	0.0024	0.014	0.000034	860	4100	710
	Wasps = 0.075 lb/1 gal	5 gal	0.94	0.0023	0.013	0.000033	920	4200	770
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	0.12	0.00028	0.0017	0.0000040	7000	35000	5900
	PCO = 0.088 lb/gal	40 gal	8.8	0.021	0.13	0.00030	92	470	77
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	13	0.12	0.19	0.0017	63	82	36
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	25	0.24	0.36	0.0034	33	41	18
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	4.9	0.0065	0.070	0.00009	170	1500	150
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	18	0.016	0.26	0.00023	46	610	42
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	196	0.117	2.8	0.0017	4.3	83	4.2
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	80	0.105	1.14	0.0015	10	93	9.1
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	70.3	0.09	1.0	0.0013	12	105	11
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	5.68	0.0075	0.08	0.0001	150	1303	150
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	8.0	0.0105	0.114	0.00015	105	926	91

PPE Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Flagger Exposure									
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	1.8	0.012	0.026	0.00017	460	820	290
	Ag = 1.0	350	3.5	0.025	0.050	0.00036	240	390	150
	Turf = 5.0	350	18	0.12	0.25	0.0017	48	82	30
	Pasture = 0.125	350	0.44	0.0031	NA	NA	NA	NA	NA
	Forest = 0.75	350	2.6	0.018	0.038	0.00026	320	540	200
	Forest = 0.75	80	6.0	0.042	0.086	0.00060	140	230	91

NF = Not Feasible. HED believes all agricultural aircraft are enclosed cab. No Data means no data are available for the exposure scenario.

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\dfrac{1}{\left(\dfrac{1}{\text{MOE}derm} + \dfrac{1}{\text{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 4: Engineering Controls Scenario Exposure and Risks for Occupational Handlers of Acephate, Short- and Intermediate-Term.

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Mixer/Loader Exposure									
(1a) Mixing/Loading Soluble Powder for Aerial Application	Ag = 0.5	350	1.7	0.042	0.025	0.00060	480	230	160
	Ag = 1.0	350	3.4	0.084	0.049	0.0012	240	120	83
	Turf = 5.0	350	17	0.42	0.25	0.0060	48	23	16
	Pasture = 0.125	350	0.43	0.011	0.0061	0.00016	2000	880	620
(1b) Mixing/Loading Soluble Powder for Chemigation Application	Cranberries = 1.0	30	0.29	0.0072	0.0041	0.00010	2900	1400	1000
(1c) Mixing/Loading Soluble Powder for Groundboom Application	Ag = 0.5	80	0.39	0.0096	0.0056	0.00014	2100	1000	670
	Ag = 1.0	80	0.78	0.019	0.011	0.00027	1100	520	360
	Pasture = 0.125	80	0.098	0.0024	0.0014	0.000034	8600	4100	2800
	Turf = 5.0	Sod = 80	3.9	0.096	0.056	0.0014	210	100	67
	Turf = 5.0	Golf course = 40	2.0	0.048	0.029	0.00069	430	200	140
(1d) Mixing/Loading Soluble Powder for Airblast Application	Non-bearing citrus = 0.5	40	0.20	0.0048	0.0029	0.000069	4300	2000	1400
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	0.098	0.0024	0.0014	0.000034	8600	4100	2800
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.049	0.0012	0.00070	0.000017	17000	8200	5600
(1e) Mixing/Loading Soluble Powder for Handgun (Hydraulic Sprayer) Application	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	0.0096	0.00023	0.00014	0.0000032	86000	44000	28000

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	0.098	0.0024	0.0014	0.000034	8600	4100	2800
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	0.049	0.0012	0.0007	0.000017	17000	8200	5600
	Turf = 5.0	5	0.25	0.0060	0.0035	0.000086	3400	1600	1100
(1f) Mixing/Loading Soluble Powder for Transplanting Water Application	Tobacco = 0.75	20	0.147	0.00357	0.0021	0.000051	5700	2700	1800
(1g) Mixing/Loading Soluble Powder for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.78	0.019	0.011	0.00027	1100	520	360
(1h) Loading Soluble Powder for Hopper Box Application	Cotton seed = 0.1875	80	0.15	0.0036	0.0021	0.000051	5700	2700	1800
(2) Mixing/Loading Dry Flowable for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.78	0.019	0.011	0.00027	1100	520	360
(3a) Mixing/Loading Liquids for Aerial Application	Pasture/Forest = 0.75	350	2.3	0.022	0.032	0.00031	380	450	208
	Forest = 0.75	800	5.2	0.050	0.074	0.00071	160	200	91
(3b) Mixing/Loading Liquids for Slurry Seed Treatment	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	0.69	0.0066	0.0098	0.000094	1200	1500	670
(4) Loading Granular in Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.014	0.0027	0.00020	0.000038	60000	3700	3400
	Sod = 5.0	80	0.068	0.014	0.00097	0.0002	12000	700	670
	Golf Course Turf = 5.0	40	0.034	0.0068	0.00048	0.000097	25000	1400	1300
Applicator Exposure									
(5) Applying Sprays with Fixed-Wing Aircraft	Ag = 0.5	350	0.88	0.012	0.013	0.00017	920	820	430
	Ag = 1.0	350	1.8	0.024	0.026	0.00034	480	410	220

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Turf = 5.0	350	8.8	0.12	0.13	0.0017	92	82	43
	Pasture = 0.125	350	0.22	0.0030	0.0031	0.000043	3900	3300	1800
	Forest = 0.75	350	1.3	0.018	0.019	0.00026	630	540	290
	Forest = 0.75	80	3.0	0.041	0.043	0.00059	280	240	130
(6) Applying Spray with a Groundboom Sprayer	Ag = 0.5	80	0.20	0.0017	0.0028	0.000024	4300	5800	2500
	Ag = 1.0	80	0.40	0.0034	0.0057	0.000048	2100	2900	1200
	Pasture = 0.125	80	0.050	0.00043	0.00071	0.0000061	17000	23000	10000
	Turf = 5.0	Sod = 80	2.0	0.017	0.029	0.00024	410	580	240
	Turf = 5.0	Golf course = 40	1.0	0.0086	0.014	0.00012	860	1200	500
(7) Applying Spray with Airblast Sprayer	Non-bearing Citrus = 0.5	40	2.8	0.0090	0.040	0.00013	300	1100	240
	Trees & Shrubs = 1.0 lb/100 gal	1000 gal	1.4	0.0045	0.020	0.000064	600	2200	450
	Outdoor Floral = 0.5 lb/100 gal	1000 gal	0.7	0.0023	0.010	0.000033	1200	4200	910
(8) Applying Spray with Handgun Sprayer	Tobacco (fire ant) = 1.0 lb/80 gal	13 gal/acre; 6 acres	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 1.0 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Outdoor Floral Crops = 0.5 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
	Turf = 5.0	5	NF	NF	NF	NF	NF	NF	NF
(9) Applying in Transplanting Water	Tobacco = 0.75	20	0.75	0.000645	0.011	0.0000092	1100	15000	1000

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(10) Applying as a Seed Treatment in a Hopper Box	Cotton = 0.1875	80	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(11) Applying as a Seed Treatment in a Slurry Tank	Cotton seed = 0.04 lb/100 lb seed	200,000 lb seed	No Data	No Data	No Data	No Data	No Data	No Data	No Data
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	Cotton = 1.0	80	0.17	0.018	0.0024	0.00026	5000	540	500
	Sod = 5.0	80	0.84	0.088	0.012	0.0012	1000	120	110
	Golf Course Turf = 5.0	40	0.42	0.044	0.0060	0.00063	2000	220	200
Mixer/Loader/Applicator Exposure									
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.088 lb/gal	40 gal	NF	NF	NF	NF	NF	NF	NF
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand [MRID # 405048-23]	PCO = 0.08745 lb/gal	0.25 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.08745 lb/gal	4 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.08745 lb/gal	1 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.08745 lb/gal	40 gal	NF	NF	NF	NF	NF	NF	NF
(14) Mixing/Loading/Applying Using Backpack Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	40 gal	NF	NF	NF	NF	NF	NF	NF
	Wasps = 0.075 lb/1 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	Fire Ant (non-crop) = 0.047 lb/5 gal	5 gal	NF	NF	NF	NF	NF	NF	NF
	PCO = 0.088 lb/gal	40 gal	NF	NF	NF	NF	NF	NF	NF
(15) Mixing/Loading/Applying Using High Pressure Sprayer	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 0.5 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
	Trees,Shrubs, Roses, Ground Cover, Floral Crops = 1.0 lb/100 gal	1000 gal	NF	NF	NF	NF	NF	NF	NF
(16) Loading/Applying Using Aerosol Generator	Indoor Ornamentals, Flowers, Trees, Shrubs, Roses = 10 sec/100 sq. ft if 2 ft plants	No data	NF	NF	NF	NF	NF	NF	NF
	Outdoor Ornamentals, Flowers, Trees, Shrubs, Roses = 1 sec/row-foot; spray both sides of row	No data	NF	NF	NF	NF	NF	NF	NF
(17) Loading/Applying with PCO injector	PCO crack & crevice: 1% spray; 1 sec spray per spot; 1 spot/linear foot	No data	NF	NF	NF	NF	NF	NF	NF
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can [label # 00239-02406]	Fire ants = 2 tsp/mound (0.00694 lb/mound)	10 mounds/acre; 1 acre	NF	NF	NF	NF	NF	NF	NF
(19) Mixing/Loading/Applying Soluble Powder Using Sprinkler Can	Fire ants = 0.047 oz/5 gal (0.0029 lb/5 gal)	1 gal/mound; 10 mounds/acre; 1 acre	NF	NF	NF	NF	NF	NF	NF

ENGINEERING CONTROLS Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons/day where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(20) Loading/Applying Tree Injections	1.5 gm/injection	Dependent on tree size	NF	NF	NF	NF	NF	NF	NF
(21) Loading/Applying Granules with Push-Type Granular Spreader	Turf = 5.0	5	NF	NF	NF	NF	NF	NF	NF
(22) Loading/Applying Granules with Belly Grinder	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	87,000 sq ft	NF	NF	NF	NF	NF	NF	NF
(23) Loading/Applying Granules with Shaker Can	Trees, Shrubs, Ornamnetals = 0.1125 lb/1000 sq ft	10,000 sq ft	NF	NF	NF	NF	NF	NF	NF
(24) Loading/Applying Granules by Hand [label # 59639-87]	0.00099 lb per pot up to 12 in diameter	1000 pots	NF	NF	NF	NF	NF	NF	NF
	Fire ants = 2 tsp/mound (0.008 lb/mound)	1 acre; 10 mounds per acre	NF	NF	NF	NF	NF	NF	NF
	Trees, Shrubs, Ornamentals = 0.1125 lb/1000 sq ft	1,000 sq ft	NF	NF	NF	NF	NF	NF	NF
Flagger Exposure									
(25) Flagging Aerial Spray Applications	Ag= 0.5	350	0.19	0.0061	0.0027	0.000087	4400	1600	1200
	Ag = 1.0	350	0.39	0.012	0.0056	0.00017	2100	820	590
	Turf = 5.0	350	1.9	0.061	0.27	0.00874	440	160	120
	Pasture = 0.125	350	0.048	0.0015	0.00068	0.000021	18000	6700	4800
	Forest = 0.75	350	0.29	0.092	0.0041	0.0013	2900	110	110
	Forest = 0.75	80	0.66	0.021	0.0094	0.0003	1300	470	340

NF = Not Feasible; no engineering controls exist or HED does not consider engineering controls an effective approach for mitigating exposure during the use of certain types of equipment. No Data means no data are available for the exposure scenario.

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor

if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\frac{1}{\left(\frac{1}{\mathrm{MOE}derm} + \frac{1}{\mathrm{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 5: Occupational Handler Exposure Scenario Descriptions for the Use of Acephate

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
MIXER/LOADER DESCRIPTORS			
(1a/1b/1c/1d/1e/1f/1g/1h) Mixing/Loading Soluble Powder	PHED V1.1	350 acres for aerial application/ chemigation; 80 acres for groundboom on agricultural; 40 acres for groundboom on golf courses; 40 acres for airblast application (1,000 gallons used for trees&shrubs and outdoor floral); 13 gallons/acre and 6 acres for fire ant control; 1,000 gallons and 5 acres for hydraulic sprayer; 200,000 lb seed for slurry seed treatment; 20 acres for transplanting on a tobacco farm; and 80 acres for hopper box application Note: aerial turf application of 5 lb ai/acre is not feasible; however, it is on current label and therefore included in this assessment Note: Per comments received by the Agency, 30 acres are being used for the treated area of cranberries in this assessment; the Agency requires additional exposure monitoring data, use information and cultural practices with regard to treatment of cranberries; label modifications with regard to the maximum acreage should be made. Note: PHED data for wettable powders have been used due to the lack of data for soluble powders	**Baseline:** Hand and dermal data are ABC grades, and inhalation data are ABC grades. Hand = 7 replicates; dermal = 22 to 45 replicates; and inhalation = 44 replicates. Low confidence in hand data due to the low number of hand replicates. Medium confidence in dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are AB grade with 24 replicates and a high confidence level. The same inhalation data are used as for baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Hands and Dermal =ABC grades; Inhalation=ABC grades. Hands = 5 replicates; Dermal= 6 to 15 replicates; Inhalation = 12 replicates; Low confidence all data. No protection factor was needed to define the unit exposure value. Engineering controls are based on water soluble packets.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(2) Mixing/ Loading Dry Flowable	PHED V1.1	200,000 pounds of seed	**Baseline:** Hand and dermal data are AB grades, and inhalation data are AB grades. Hand = 7 replicates; dermal = 16 to 26 replicates and inhalation = 23 replicates. Low confidence in hand data due to the low number of hand replicates. High confidence in dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are ABC grade with 34 replicates and a medium confidence level. The same inhalation data are used as for baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Hands and Dermal =ABC grades; inhalation = ABC grades. Hands = 5 replicates; Dermal= 6 to 15 replicates; Inhalation = 12 replicates; Low confidence all data. No protection factor was needed to define the unit exposure value. Engineering controls are based on water soluble packets. No additional information was provided by the registrant regarding the use of engineering controls.
(3a/3b) Mixing/Loading Liquids	PHED V1.1	350 acres, for agricultural settings; 800 acres used for forest application; and 200,000 lb of cotton seed.	**Baseline**: Hand and dermal are AB grades, and inhalation are AB grades. Hand replicates =53 replicates; Dermal = 71 to 121 replicates; and inhalation = 85 replicates. High confidence in hand/dermal and inhalation data. No protection factor was needed to define the unit exposure. **PPE** :The same dermal data are used as for baseline. Hands = AB grades, replicates = 59. The same inhalation data are used as for the baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls :** Hand and dermal unit exposure are ABC grades. Hand = 31 replicates; and dermal=30 to 36 replicates. Medium confidence in dermal and hand data. Inhalation are AB grades; replicates = 27. High confidence in inhalation data. Gloves are worn during the use of engineering controls. No protection factor was needed to define the unit exposure value.
(4) Mixing/Loading Granular	PHED V1.1	80 acres for cotton; 80 acres for sod; and 40 acres for golf course turf	**Baseline:** Hand data are all grades, dermal are ABC grades, and inhalation are AB grades. Hand = 10 replicates; dermal = 33 to 78 replicates; and inhalation = 58 replicates. Low confidence in hand data, medium confidence in dermal data, and high confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same inhalation data are used as for baseline coupled with an 80% protection factor to simulate the use of a dust/mist respirator. Hand data are AB grades with 45 replicates, and high confidence level. **Engineering Controls:** The same data are used as for baseline with a 98% protection factor to simulate the use of a closed mixing system.
APPLICATOR DESCRIPTIONS			

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(5) Applying Sprays with Fixed Wing Aircraft	PHED V1.1	350 acres for crops and 800 acres for forest	**Baseline:** No data. **PPE:** No data. **Engineering Controls:** Hands = AB grade, dermal and inhalation=ABC grade. Hands=34 replicates; dermal =24 to 48 replicates, and inhalation =23 replicates. Medium Confidence in dermal and inhalation data; high confidence in hand data. No Protection factor was needed to define the unit exposure value.
(6) Applying with Ground Boom Sprayer	PHED V1.1	80 acres (agriculture) and 40 acres (golf course)	**Baseline:** Hand, dermal, and inhalation data=AB grades. Hand = 29 replicates; dermal = 23 to 42 replicates; and inhalation = 22 replicates. High confidence in hand/dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. The same inhalation data are used as for baseline with an 80% protection factor to simulate the use of a dust/mist respirator. Hand data are ABC grades, with 21 replicates, and medium confidence level. **Engineering Controls:** Hand and dermal data are ABC grades, and inhalation are AB grades. Hand = 16 replicates; dermal =20 to 31 replicates; inhalation = 16 replicates. Medium confidence in hand/dermal data, and high confidence in inhalation data.
(7) Applying with Airblast Sprayer	PHED V1.1	40 acres and 1,000 gallons	**Baseline**: Hands = ABC grades; dermal and inhalation = AB grades. Hands= 31 replicates, dermal = 31 to 48 replicates ; and inhalation= 47 replicates. High confidence in the dermal and inhalation data; medium confidence in hand data; No protection factor was needed to define the unit exposure. **PPE**: The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. Dermal = AB grades with 31 to 48 replicates and high confidence level. Hands= AB grades with 18 replicates, and high confidence level. **Engineering Controls:** Hands and Dermal =AB grade and Inhalation=ABC grade. Hands = 20 replicates (no glove data back calculated from glove data assuming a 90% protection factor for gloves); dermal =20 -30 replicates and inhalation =9 replicates. High confidence in hands and dermal data and low confidence in inhalation data.
(8) Applying Spray with Handgun Sprayer	PHED V1.1	Fire Ants 13 gal/acre and 6 acres gallons; trees & shrubs 1,000 gal; and turf 5 acres	**Baseline:** Hand data are AB grades, dermal data are ABC grades, and inhalation data are A grades. Hand = 16 replicates; dermal = 4 to 20 replicates; and inhalation = 16 replicates. Low confidence in dermal data, and high confidence in hand and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are AB grades with 4 replicates and low confidence level. The same inhalation data are used as for the baseline coupled with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(9) Applying in Transplanting Water	PHED V1.1	20 acres	No PHED data were available for this scenario; therefore, PHED data for groundboom were used (which may over-estimate transplant water application for tobacco). See scenario (7)
(10) Applying in Seed Treatment Hopper Box	No Data	No Data	NA
(11) Applying as a Seed Treatment in a Slurry Tank	No Data	No Data	NA
(12) Applying Granular with Tractor-Drawn Drop-Type Spreader	PHED V1.1	80 acres for cotton; 80 acres for sod; and 40 acres for golf course turf	**Baseline:** Hand and dermal data are AB grade, and inhalation data are AB grade. Hand = 5 replicates; dermal = 1 to 5 replicates; and inhalation = 5 replicates. Low confidence in hand/dermal data, and low confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data (gloved) are estimated from no gloves data using a 90% protection factor. The same inhalation data are used as for the baseline with an 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** Hand, dermal, and inhalation are AB grades. Hand = 24 replicates; dermal = 2-30 replicates; and inhalation = 37 replicates. High confidence in hand, and inhalation data; low confidence in dermal data.
MIXER/LOADER/APPLICATOR			
(13a) Mixing/Loading/Applying Soluble Powders Using Low Pressure Hand Wand	PHED V1.1	40 gallons for floral crops and 5 gallons for Wasps and Fire ants	**Baseline:** Hand data are AB grades, dermal are ABC grades, and inhalation data are ABC grades. Hand = 15 replicates, back calculated from glove data assuming a 90% protection factor from gloves; dermal = 16 replicates; and inhalation = 16 replicates. Medium confidence in hand, dermal and inhalation data. **PPE:** The same dermal, hand, and inhalation data are used as for baseline with an 80% protection factor for inhalation unit exposure to simulate the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(13b) Mixing/Loading/Applying Wettable Powders Using Low Pressure Hand Wand	MRID 405048-23	crack and crevice treatment at residential sites: 1 qt finished product/house; range of 1 to 20 houses/day commercial sites: range of 1 to 20 gallons finished product per day	9 replicates for residential sites 9 replicates for commercial sites

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(14) Mixing/Loading/Applying Using Backpack Sprayer	PHED V1.1	40 gallons; for floral crops; 5 gallons for Wasps and Fire ants	**Baseline:** Hand data are ABC grade, dermal are AB grades, and inhalation data are A grades. Hand = 11 replicates (with gloves); dermal = 9 to 11 replicates; and inhalation = 11 replicates. Low confidence in hand/dermal and inhalation data. **PPE:** The same dermal, hand, and inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(15) Mixing/Loading/Applying using High Pressure Sprayer	PHED V1.1	1,000 gallons	**Baseline:** Hands = ABC grade; dermal = AB grades; and inhalation = A grades. Hands = 13 replicates, back calculated from glove data using a 90% protection factor; dermal = 7 to 13 replicates; and inhalation= 13 replicates. Low confidence in hands, dermal and inhalation data. **PPE:** The same dermal data are used as for baseline couple with a 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(16) Loading/Applying Using Aerosol Generator	No Data	---	No Data
(17) Loading/Applying with PCO injector	No Data	---	See scenario 14(b) for similar scenario for crack and crevice treatment
(18) Loading/Applying Soluble Powder by Hand/Handtool/Shaker Can	PHED V1.1	10 mounds /acre and 1 acre	No PHED data were available for this scenario. Therefore, PHED data for the granular bait dispersed by hand scenario were used. See scenario (24).
(19) Mixing/Loading /Applying Soluble Powder using Sprinkler Can	No Data	1 gal/mound; 10 mound/acre; and 1 acre	No PHED data were available for this scenario. Therefore, PHED data for the garden hose-end sprayer were used. **Baseline:** Dermal and inhalation = ABC grade, hands = E grade; dermal = 8 replicates, hands = 8 replicates, inhalation = 8 replicates; A 50% protection factor was used to simulate long pants and long sleeve shirts.
(20) Loading/Applying Tree Injections	No Data	No Data	NA

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(21) Mixing/Loading/Applying Granular with Push-Type Granular Spreader	PHED V1.1	5 acres for turf	**Baseline:** Hand and dermal = C grade and inhalation = acceptable grades. Hand = 15 replicates; dermal = 0 to 15 replicates; and inhalation = 15 replicates. Low to medium confidence in the dermal and hand data. High confidence in the inhalation data. No protection factor was required to define the unit exposure scenario. **PPE:** Derived by calculation from baseline data. The same dermal data and hand data are used (as for the baseline) with a 50% protection factor applied to non-hand dermal data to account for the use of an additional layer of clothing (coveralls), a 90% protection factor to hand data to account for the use of chemically-resistant gloves, and a 90% PF was applied to account for the use of appropriate respiratory protection. **Engineering Controls:** There are no known engineering controls for this scenario.
(22) Loading/ Applying Granular with Belly Grinder	PHED V1.1	2 acres	**Baseline:** Hand and dermal data are ABC grades, and inhalation data are AB grades. Hand = 23 replicates; dermal = 29 to 45 replicates; and inhalation = 40 replicates. Medium confidence in hand/dermal data, and high confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for baseline. Hand data are ABC grade with 15 replicates and medium confidence level. The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not feasible for this scenario.
(23) Loading/Applying/ Granular with Shaker Can	PHED V1.1	10,000 sq. ft	No PHED data were available for this scenario; therefore, PHED data for the granular bait dispersed by hand scenario were used. See scenario (24)
(24) Loading/Applying Granular by Hand	PHED V1.1	1000 pots	**Baseline:** Hand, dermal and inhalation data are ABC grades. Hands=15 replicates, back calculated from glove data assuming a 90% protection factor; dermal =16 replicates and inhalation =16 replicates. Medium confidence in hand, dermal and inhalation data. **PPE:** The same dermal, hands, and inhalation data are used as for baseline with a 80% protection factor for inhalation unit exposure value to simulate the use of a dust/mist respirator **Engineering Controls**: There is the possibility of mechanical application; however, for this scenario extrapolation is not appropriate.
FLAGGER DESCRIPTORS			

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
(25) Flagging Aerial Applications	PHED V1.1	350 acres agricultural and 800 acres forest	**Baseline:** Hands, dermal and inhalation AB grades. Dermal =18 to 28 replicates; Hands =30 replicates; and inhalation=28 replicates. High confidence in dermal, hands, and inhalation data. **PPE**: The same dermal data are used as for baseline. Hand data are AB grades with 6 replicates and low confidence. The same inhalation data are used as for baseline coupled with a 80% protection factor to simulate the use of a dust/mist respirator. **Engineering Controls:** The same data are used as for baseline with a 90% protection factor to simulate a closed cab.

a Standard Assumptions based on an 8-hour work day as estimated by HED. BEAD data were not available.

b These grades are based on Quality Assurance/Quality Control data provided as part of the exposure studies. A replicate refers to data acquired during one complete work cycle. All handler exposure assessments in this document are based on the "Best Available" data as defined by HED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments.) Best available grades are assigned as follows: matrices with grades A and B data (which is defined as acceptable grade 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 (all grades) regardless of the quality and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection.

Data confidence as reported in the Table refers to both the quality and the quantity (number of replicates) of data for each PHED run. Each study in PHED has been graded from A to E. A high confidence run yields grades A and B data and 15 or more replicates per body part. Any combination of A and B grade data are listed as acceptable grades data in the tables. A medium confidence run yields grades A, B, and C data and 15 or more replicates per body part. Any combination of A, B, and C grade data are listed as ABC grade data in the tables. A low confidence run yields all grades (any run that includes D or E grade data) or has less than 15 replicates per body part.

Note: PHED data for wettable powders have been used due to the lack of data for soluble powders.

APPENDIX B

ACEPHATE OCCUPATIONAL POST-APPLICATION WORKER EXPOSURE AND RISK ASSESSMENT TABLES (SHORT-TERM AND INTERMEDIATE-TERM EXPOSURES)

Table 1: Post-Application Risks to Workers Following Acephate Application to Beans in OR (1.0 lb ai/acre -- 2 applications).

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Calculated DFR ($\mu g/cm^2$)	S/T, S, I & H Dose (mg/kg/day)	MOE	Calculated DFR ($\mu g/cm^2$)	S/T, S, I & H Dose (mg/kg/day)	MOE
0	0.6063	0.277	43	0.02815	0.013	58
1	0.4961	0.227	53	0.02506	0.011	65
2	0.4059	0.186	65	0.02230	0.010	74
3	0.3321	0.152	79	0.01985	0.009	83
4	0.2718	0.124	97	0.01767	0.008	93
5	**0.2224**	**0.101**	**118**	**0.01573**	**0.007**	**104**

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Dislodgeable Foliar Residue (DFR) calculated by Versar using Excel® Spreadsheet and ANOVA.

S/T, S, I & H = Stake/Tie, Scout, Irrigate & Harvest

S/T, S, I & H Dose (mg/kg/day) = DFR ($\mu g/cm^2$) * Transfer Coefficient (4,000 cm^2/hr for bean harvest by hand, stake/tie, scout and irrigate) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

Table 2: Post-Application Risks to Workers Following Acephate Application to Cauliflower in CA (1.0 lb ai/acre -- 2 applications).

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Average DFR ($\mu g/cm^2$)	Scout/Irrigate Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	Scout/Irr MOE	Harvest MOE	Average DFR ($\mu g/cm^2$)	Scout/Irrigate Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	Scout/Irr MOE	Harvest MOE
0	0.2003	0.023	0.057	522	210	0.0029	0.00033	0.00083	2270	900

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Dislodgeable Foliar Residue (DFR) averaged from actual field measurements made following the second application.

Scout/Irrigate Dose (mg/kg/day) = DFR ($\mu g/cm^2$) * Transfer Coefficient (1,000 cm^2/hr for cauliflower scouting/irrigating) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Harvest Dose (mg/kg/day) = DFR ($\mu g/cm^2$) * Transfer Coefficient (2,500 cm^2/hr for cauliflower harvest by hand) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective scout/irrigate and harvest doses are used to determine the scout/irrigate and harvest MOEs. MOE of 100 is acceptable margin of exposure.

Table 3: Post-Application Risks to Workers Following Acephate Application to Greenhouse Roses in CA (2.15 lb ai/acre -- 2 applications).

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Calculated DFR (μg/cm^2)	Sort/Pack Dose (mg/kg/day)	Prune/Harvest Dose (mg/kg/day)	Sort/Pack MOE	Prune/Harv MOE	Calculated DFR (μg/cm^2)	Sort/Pack Dose (mg/kg/day)	Prune/Harvest Dose (mg/kg/day)	Sort/Pack MOE	Prune/Harv MOE
0	1.517	0.433	1.734	28	7	0.03150	0.009	0.036	83	21
1	1.206	0.344	1.378	35	9	0.02713	0.008	0.031	97	24
2	0.9584	0.274	1.095	44	11	**0.02336**	**0.007**	0.027	**112**	28
3	0.7617	0.218	0.870	55	14	0.02012		0.023		33
4	0.6054	0.173	0.692	69	17	0.01732		0.020		38
5	0.4812	0.137	0.550	87	22	0.01492		0.017		44
6	**0.3824**	**0.109**	0.437	**110**	27	0.01284		0.015		51
7	0.3039		0.347		35	0.01106		0.013		59
8	0.2416		0.276		43	0.009523		0.011		69
9	0.1920		0.219		55	0.0082		0.009		80
10	0.1526		0.174		69	0.007061		0.008		93
11	0.1213		0.139		87	**0.006081**		**0.007**		**108**
12	**0.09639**		**0.110**		**109**					

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Dislodgeable Foliar Residue (DFR) calculated by Versar using Excel® Spreadsheet and ANOVA.

Sort/Pack Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (2,500 cm^2/hr for roses sorting and packing) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Prune/Harvest Dose (mg/kg/day) = DFR (μg/cm^2) * Transfer Coefficient (10,000 cm^2/hr for roses pruning and harvest by hand) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective sort/pack and prune/harvest doses are used to determine the sort/pack and prune/harvest MOEs. MOE of 100 is acceptable margin of exposure.

Table 4: Post-Application Risks to Workers Following Acephate Application to Tobacco in NC (0.77 lb ai/acre -- 3 applications).

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Calculated DFR ($\mu g/cm^2$)	S/T, S & I Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	S/T, S & I MOE	Harvest MOE	Calculated DFR ($\mu g/cm^2$)	S/T, S & I Dose (mg/kg/day)	Harvest Dose (mg/kg/day)	S/T, S & I MOE	Harvest MOE
0	0.3139	0.143	0.359	84	33	0.03145	0.014	0.036	52	21
1	0.2745	0.125	0.314	96	38	0.02884	0.013	0.033	57	23
2	**0.2400**	**0.110**	0.274	**109**	44	0.02644	0.012	0.030	62	25
3	0.2099		0.240		50	0.02425	0.011	0.028	68	27
4	0.1836		0.210		57	0.02224	0.010	0.025	74	30
5	0.1605		0.183		65	0.02040	0.009	0.023	80	32
6	0.1404		0.160		75	0.01870	0.009	0.021	88	35
7	0.1228		0.140		86	0.01715	0.008	0.020	96	38
8	0.1074		0.123		98	**0.01573**	**0.007**	0.018	**104**	42
9	**0.09389**		**0.107**		**112**	0.01442		0.016		45
10						0.01323		0.015		50
11						0.01213		0.014		54
12						0.01112		0.013		59
13						0.01020		0.012		64
14						0.009355		0.011		70
15						0.008579		0.010		76
16						0.007867		0.009		83
17						0.007214		0.008		91
18						0.006616		0.008		99
19						**0.006067**		**0.007**		**108**

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Dislodgeable Foliar Residue (DFR) calculated by Versar using Excel® Spreadsheet and ANOVA.

S/T, S & I = Stake/Tie, Scout & Irrigate

S/T, S & I Dose (mg/kg/day) = DFR ($\mu g/cm^2$) * Transfer Coefficient (4,000 cm^2/hr for tobacco stake/tie, scouting & irrigating) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Harvest Dose (mg/kg/day) = DFR ($\mu g/cm^2$) * Transfer Coefficient (10,000 cm^2/hr for tobacco harvest by hand) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective S/T, S & I and harvest doses are used to determine the S/T, S & I and harvest MOEs. MOE of 100 is acceptable margin of exposure.

Table 5: Post-Application Risks to Workers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications).

Day After Treatment	ACEPHATE					METHAMIDOPHOS				
	Average TTR ($\mu g/cm^2$)	Tractor Mow Dose (mg/kg/day)	Push-type Mow Dose (mg/kg/day)	Tractor Mow MOE	Push-type Mow MOE	Average TTR ($\mu g/cm^2$)	Tractor Mow Dose (mg/kg/day)	Push-type Mow Dose (mg/kg/day)	Tractor Mow MOE	Push-type Mow MOE
0	0.289	0.016	0.033	750	364	0.00106	0.000060	0.00012	12500	6250

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.

Tractor Mow Dose (mg/kg/day) = TTR ($\mu g/cm^2$) * Transfer Coefficient (500 cm^2/hr for tractor mowing) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Push-type Mow Dose (mg/kg/day) = TTR ($\mu g/cm^2$) * Transfer Coefficient (1,000 cm^2/hr for push-type mowing) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. The respective tractor mow and push-type mow doses are used to determine the tractor mow and push-type mow MOEs. MOE of 100 is acceptable margin of exposure.

Table 5 (continued): Post-Application Risks to Workers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications).

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Average TTR (μg/cm^2)	Harvest Dose (mg/kg/day)	MOE	Average TTR (μg/cm^2)	Harvest Dose (mg/kg/day)	MOE
0	0.289	0.33	36	**0.00106**	**0.0012**	**625**
1	**0.0391**	**0.045**	**267**			

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). Workers wearing long pants, long sleeved shirts and no gloves.

Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.

Harvest Dose (mg/kg/day) = TTR (μg/cm^2) * Transfer Coefficient (10,000 cm^2/hr for sod harvesting) * (8 hr/work day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

APPENDIX C

ACEPHATE NON-OCCUPATIONAL (RESIDENTIAL) EXPOSURE AND RISK ASSESSMENT TABLES (SHORT-TERM EXPOSURES)

Table 1: Numerical Inputs for Non-Occupational (Residential) Handler Exposure to Acephate.

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Residential Unit Values	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)
Residential Exposure				
(1) Mixing/Loading/Applying Wettable Powder Using a Low Pressure Hand Wand	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	2 gallons	250	1100
	Turf = 0.035 lb / gal	2 gallons	250	1100
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	250	1100
(2) Mixing/Loading/Applying Using a Backpack Sprayer	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb (4.5 grams) / gal	2 gallons	5.1	30
	Turf = 0.035 lb / gal	2 gallons	5.1	30
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	5.1	30
(3a) Mixing/Loading/Applying Using a Hose-End Sprayer	Ornamentals, Flowers, Shrubs, Trees = 0.023 lb / gal	50 gallons	30	9.5
	Turf = 0.035 lb / gal	50 gallons	30	9.5
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	50 gallons	30	9.5
	Shade Trees = 0.013 lb / gal (LUIS)	50 gallons	30	9.5
	Ornamentals and Turf = 0.058 lb / 1000 sq ft (LUIS)	20,000 sq ft (0.5 A)	30	9.5
(3b) Mixing/Loading/Applying Using a Hose-End Sprayer [MRID # 405048-27]	Shrubbery = 0.01175 lb / gal	50 gallons	480	150
(4) Mixing/Loading/Applying Using a Sprinkling Can	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	5 gallons	30	9.5
	Turf = 0.035 lb / gal	5 gallons	30	9.5

Exposure Scenario	Application Rate[a] (lb ai/A or lb ai/gallons where noted)	Treated Area[b] (A/day or gallons/day where noted)	Residential Unit Values	
			Dermal[c] (mg / lb ai handled)	Inhalation[d] (μg / lb ai handled)
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	5 gallons	30	9.5
(5) Loading/Applying Soluble Powder (dry) Concentrate by Hand/Handtool/Shaker Can	Fire Ants = 0.0069 lb / mound	7 mounds	430	470
(6) Loading/Applying Granules by Shaker Can (NOTE: Label #239-2472 specifies 3 shaker cups of 1.5% / 25 sq ft; 0.5 lb/1000 sq ft used as per registrant)	Ornamentals = 0.5 lb / 1000 sq ft	100 sq ft	430	470
	Roses = 0.1125 lb / 1000 sq ft	5 sq ft / rose; 20 roses	430	470
(7) Applying by Aerosol Can	Crack & Crevice = 0.01 lb / can	2 cans (32 oz)	220	2400
	Ornamentals = 0.03 lb / can	2 cans (32 oz)	220	2400

a Application rates are values found on currently registered labels, through Agency sources (LUIS) and from information provided by the registrant.
b Amounts of acreage treated per day are from the HED estimates of acreage that could be treated in a single day for each exposure scenario of concern, through other Agency sources (LUIS) and from information provided by the registrant.
c Baseline dermal unit exposure represents an individual's estimated exposure while wearing short pants, short sleeved shirt, no gloves, open mixing/loading.
d Baseline inhalation unit exposure represents no use of a respirator.

Table 2: Exposure and Risks for Non-Occupational (Residential) Handlers of Acephate.

RESIDENTIAL Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
Residential Exposure									
(1) Mixing/Loading/Applying Wettable Powder Using a Low Pressure Hand Wand	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	2 gallons	12	0.051	0.17	0.00073	70	190	53
	Turf = 0.035 lb / gal	2 gallons	18	0.077	0.26	0.0011	46	130	33
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	3.8	0.017	0.054	0.00024	220	580	160
(2) Mixing/Loading/Applying Using a Backpack Sprayer	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb (4.5 grams) / gal	2 gallons	0.23	0.0014	0.0033	0.00002	3600	7000	2400
	Turf = 0.035 lb / gal	2 gallons	0.36	0.0021	0.0051	0.00003	2400	4700	1600
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	2 gallons	0.078	0.00046	0.0011	0.0000065	11000	22000	7100
(3a) Mixing/Loading/Applying Using a Hose-End Sprayer	Ornamentals, Flowers, Shrubs, Trees = 0.023 lb / gal	50 gallons	35	0.011	0.50	0.00016	24	880	23
	Turf = 0.035 lb / gal	50 gallons	53	0.017	0.76	0.00024	16	580	16
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	50 gallons	11	0.0036	0.16	0.000051	75	2700	73
	Shade Trees = 0.013 lb / gal (LUIS)	50 gallons	20	0.0062	0.29	0.000088	41	1600	40
	Ornamentals and Turf = 0.058 lb / 1000 sq ft (LUIS)	20,000 sq ft (0.5 A)	35	0.011	0.50	0.00016	24	880	23

RESIDENTIAL Exposure Scenario	Application Rate (lb ai/A or lb ai/gallons where noted)	Treated Area (A/day or gallons where noted)	Daily Exposure (mg/day)[a]		Absorbed Daily Dose (mg/kg/day)[b]		Separate MOEs[c]		Combined MOEs[d]
			Dermal	Inhalation	Dermal	Inhalation	Dermal	Inhalation	
(3b) Mixing/Loading/Applying Using a Hose-End Sprayer [MRID # 405048-27]	Shrubbery = 0.01175 lb / gal	50 gallons	280	0.088	4.0	0.0012	3.0	120	2.9
(4) Mixing/Loading/Applying Using Sprinkling Can	Ornamentals, Flowers, Shrubs, Trees, Fire Ants = 0.023 lb / gal	5 gallons	3.5	0.0011	0.05	0.000016	240	8800	230
	Turf = 0.035 lb / gal	5 gallons	5.3	0.0017	0.076	0.000024	160	5800	160
	Roses, Flowers, Shrubs, Trees = 0.0076 lb / gal (LUIS)	5 gallons	1.1	0.00036	0.016	0.0000051	750	27000	730
(5) Loading/Applying Soluble Powder (dry) Concentrate by Hand/Handtool/Shaker Can	Fire Ants = 0.0069 lb / mound	7 mounds	21	0.022	0.30	0.00031	40	450	37
(6) Loading/Applying Granules by Shaker Can (NOTE: Label #239-2472 specifies 3 shaker cups of 1.5% / 25 sq ft; 0.5 lb/1000 sq ft used as per registrant)	Ornamentals = 0.5 lb / 1000 sq ft	100 sq ft	22	0.024	0.31	0.00034	39	410	36
	Roses = 0.5 lb / 1000 sq ft	5 sq ft / rose; 20 roses	22	0.024	0.31	0.00034	39	410	36
(7) Applying by Aerosol Can	Crack & Crevice = 0.01 lb / can	2 cans (32 oz)	4.4	0.048	0.063	0.00069	190	200	97
	Ornamentals = 0.03 lb / can	2 cans (32 oz)	13	0.14	0.19	0.002	63	70	33

a Daily Exposure (mg/day) = Application Rate (lb ai/A or lb ai/gallon) * Treated Area (A/day or gallons/day) * Unit Exposure Value (mg or μg exposure/ lb ai handled) *[1mg/1000μg (conversion factor if necessary)].

b Absorbed Daily Dose (mg/kg/day) = Daily Exposure (mg/day) * Absorption (1) ÷ Body Weight (70kg).

c MOE (unitless) = NOAEL (mg/kg/day) ÷ Absorbed Daily Dose (mg/kg/day). Where $NOAEL_{dermal}$= 12 mg/kg/day and $NOAEL_{inhalation}$= 0.14 mg/kg/day.

d Combined MOEs = $\dfrac{1}{\left(\dfrac{1}{\text{MOE}derm} + \dfrac{1}{\text{MOE}inhal}\right)}$; MOE of 100 is an acceptable margin of exposure.

Table 3: Non-Occupational (Residential) Exposure Scenario Descriptions for the Use of Acephate

Exposure Scenario (Number)	Data Source	Standard Assumptions[a]	Comments[b, c]
(1) Mixing/Loading /Applying Wettable Powder Using a Low Pressure Hand Wand	PHED V1.1	2 gallons (per registrant; label modification required to reflect such)	**Residential:** Hand data are grade A, dermal data are C grade, and inhalation data are C grade. Hand = 15 replicates; dermal = 16 replicates; and inhalation = 16 replicates. High confidence in hand data . Medium confidence in inhalation and dermal data. A 90% protection factor was needed to "back calculate" a no glove unit exposure value from all non-detects.
(2) Mixing /Loading/Applying Using a Backpack Sprayer	PHED V1.1	2 gallons (per registrant; label modification required to reflect such)	**Residential:** Hand is grade C, dermal data are AB grades, and inhalation data are A grade. Hand = 11 replicates; dermal = 9-11 replicates and inhalation = 11 replicates. Low confidence in hand/dermal/ inhalation data. A 90% protection factor was needed to "back calculate" a no glove unit exposure value from all non-detects.
(3a) Mixing/Loading/Applying Using a Hose-End Sprayer	PHED V1.1	50 gallons of spray solution and 20,000 sq ft (0.5 acre) for turf	**Residential:** Dermal =C grade; Hands =E grade and inhalation =C grade. Hand = 8 replicates; Dermal = 8 replicates; and inhalation = 8 replicates. Low confidence in dermal, hand and inhalation data.
(3b) Mixing/Loading/Applying Using a Hose-End Sprayer	MRID # 405048-27	50 gallons	5 replicates
(4) Mixing/ Loading /Applying Using Sprinkling Can	PHED V1.1	5 gallons	**Residential:** Dermal,=C grade; Hands =E grade and inhalation=C grade. Hand =8 replicates; Dermal = 8 replicates; and inhalation = 8 replicates. Low confidence in dermal, hand and inhalation data.
(5) Loading/Applying Soluble Powder (dry) Concentrate by Hand/Handtool/Shaker Can	PHED V1.1	7 mounds	No PHED data were available for this scenario; therefore, used the PHED data for the granular bait dispersed by hand scenario. **Residential:** Dermal = ABC grades, Hand = ABC grades; dermal/hands = 16 replicates, Inhalation = ABC grades, inhalation = 16 replicates. Medium confidence in dermal and inhalation data.
(6) Loading/Applying Granules by Shaker Can	PHED V1.1	100 sq ft and 5 sq ft/rose for 20 roses NOTE: Label #239-2472 specifies 3 shaker cups of 1.5% / 25 sq ft; 0.5 lb/1000 sq ft used as per registrant; label modification required to reflect such	No PHED data were available for this scenario; therefore, used the PHED data for the granular bait dispersed by hand scenario. **Residential:** Dermal = ABC grades, Hand = ABC grades; dermal/hands = 16 replicates, Inhalation = ABC grades, inhalation = 16 replicates. Medium confidence in dermal and inhalation data.
(7) Applying By Aerosol Can	PHED V1.1	2 cans (32 oz.)	**Residential:** Hands=A grade, dermal/inhalation=ABC . Hand = 15 replicates; dermal/inhalation = 30 replicates. Medium confidence in dermal and inhalation data, high confidence in hand data.

a Some of the assumptions are from Standard Operating Procedures (SOPs) for Residential Exposure Assessment.

b These grades are based on Quality Assurance/Quality Control data provided as part of the exposure studies. A replicate refers to data acquired during one complete work cycle. All handler exposure assessments in this

document are based on the "Best Available" data as defined by HED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments.) Best available grades are assigned as follows: matrices with grades A and B data (which is defined as acceptable grade 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 (all grades) regardless of the quality and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection.

Data confidence as reported in the Table refers to both the quality and the quantity (number of replicates) of data for each PHED run. Each study in PHED has been graded from A to E. A high confidence run is grades A and B data and 15 or more replicates per body part. Any combination of A and B grade data are listed as acceptable grades data in the tables. A medium confidence run is grades A, B, and C data and 15 or more replicates per body part. Any combination of A, B, and C grade data are listed as ABC grade data in the tables. A low confidence run is all grades (any run that includes D or E grade data) or has less than 15 replicates per body part.

c Clothing for residential scenarios is short pants, short-sleeved shirt, no gloves, open mixing/loading. Accounting for the use of PPE is not considered appropriate in residential risk assessments, as the Agency can only make recommendations to residential handlers regarding the use of PPE.

Table 4: Post-Application Risks to Public Following Acephate Application to Turf in FL (5.0 lb ai/A – 2 applications) [ACEPHATE].

	Exposed Individual	Rate Per Treatment (lb ai/A)[a]	(ug/cm^2 [b]	GRt ^{2})	Transfer Coefficient (cm^2	Exposure Time (ET)	Dermal Abs.	Surface Area (cm^2 event)	Freq. (events/ hr)	Extrac. (%)	(cm^2	BW (kg)	(mg/kg/day)[e]	MOE[f]
	Adult	3.5		-	14,500		100	-		-	-		0.083	140
					5,200							15		86
Hand-to-Mouth		3.5	0.20		-	2		20	20		-	15		94
Turfgrass ingestion		3.5	-		-	-		-	-		25	15		2900

a

b Turf transferable residue = 0.289 ^{2} * 3.5 / 5.0 (ratio of application rates) = 0.20 ug/cm ; Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application of registrant's study and corrected for application rate of 3.5 lb ai/A.

Grass residue = TTR (ug/cm); assumed to be equivalent.

d ^{2}/day for grass ingestion

Average daily dose (ADD) (mg/kg/day)
Dermal exposure: ^{2}) * Tc (cm /hr) * mg/1,000 ug * ET (hrs/day) * absorption factor (1.0)] / [BW (kg)];
Hand-to-mouth: ^{2}) * SA (cm /event) * FQ (events/hr) * mg/1,000 ug * ET (2 hrs/day) * SE (0.5)] / [BW (kg)]; and
Turfgrass ingestion: ^{2}) * IgR (cm /day) * SE (0.5) * mg/1,000 ug] / [BW (kg)].

f = NOAEL / ADD where acephate $NOAEL_{dermal}$ 12 mg/kg/day and acephate $NOAEL_{oral}$ = 0.5 mg/kg/day ; the dermal NOAEL is used to calculate the dermal MOE and the acute oral NOAEL is used to calculate the hand-to-

Table 5: Post-Application Risks to Public Following Acephate Application to Turf in FL (5.0 lb ai/A – 2 applications) [METHAMIDOPHOS].

Scenario	Exposed Individual	TTR (ug/cm^2)[a]	GRt (ug/cm^2)[b]	Transfer Coefficient (Tc) (cm^2/hr)	Exposure Time (ET) (hrs/day)	Dermal Abs. (%)	Surface Area (SA) (cm^2/ event)	Freq. (FQ) (events/ hr)	Saliva Extrac. (%)	IgR (cm^2/day)[c]	BW (kg)	ADD (mg/kg/day)[d]	MOE[e]
Dermal exposure	Adult	0.00074	-	14,500	2	100	-	-	-	-	70	0.00031	2400
	Child			5,200							15	0.00051	1500
Hand-to-Mouth	Child	0.00074	-	-	2	-	20	20	50	-	15	0.000020	15000
Turfgrass ingestion	Child	-	0.00074	-	-	-	-	-	50	25	15	0.0000006	500000

a Turf transferable residue = 0.00106 ug/cm^2 * 3.5 / 5.0 (ratio of application rates) = 0.00074 ug/cm^2; Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application of registrant's study and corrected for application rate of 3.5 lb ai/A.

b Grass residue = TTR (ug/cm^2); assumed to be equivalent.

c Ingestion rate: cm^2/day for grass ingestion.

d Average daily dose (ADD) (mg/kg/day)
Dermal exposure: = [TTR (ug/cm^2) * Tc (cm^2/hr) * mg/1,000 ug * ET (hrs/day) * absorption factor (1.0)] / [BW (kg)];
Hand-to-mouth: = [TTR (ug/cm^2) * SA (cm^2/event) * FQ (events/hr) * mg/1,000 ug * SE (0.5) * ET (2 hrs/day)] / [BW (kg)]; and
Turfgrass ingestion: = [GRt (ug/cm^2) * IgR (cm^2/day) * SE (0.5) * mg/1,000 ug] / [BW (kg)].

e MOE = NOAEL / ADD where methamidophos $NOAEL_{dermal}$ = 0.75 mg/kg/day and $NOAEL_{oral}$ = 0.3 mg/kg/day; the dermal NOAEL is used to calculate the dermal MOE and the acute oral NOAEL is used to calculate the hand-to-mouth, and turfgrass ingestion MOEs. MOE of 300 is an acceptable margin of exposure.

APPENDIX D

ACEPHATE NON-OCCUPATIONAL (RECREATIONAL) EXPOSURE AND RISK ASSESSMENT TABLES (SHORT-TERM EXPOSURES)

Table 1: Non-Occupational Risk Assessment for Adult Golfers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications).

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Average TTR ($\mu g/cm^2$)	Adult Golfer Dose (mg/kg/day)	MOE	Average TTR ($\mu g/cm^2$)	Adult Golfer Dose (mg/kg/day)	MOE
0	**0.289**	**0.0016**	**7500**	**0.00106**	**0.000006**	**125000**

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). It is assumed that golfers are wearing long pants, long sleeved shirts and no gloves.

Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.

Adult Golfer Dose (mg/kg/day) = TTR ($\mu g/cm^2$) * Transfer Coefficient (100 cm^2/hr for golfing) * (4 hr/day) * (1mg/1000 μg conversion factor) ÷70 kg Body Weight. NOTE: this does not include possible hand-to-mouth exposures.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

Table 2: Non-Occupational Risk Assessment for 13+ Year-Old Golfers Following Acephate Application to Turf in FL (5.0 lb ai/A -- 2 applications).

Day After Treatment	ACEPHATE			METHAMIDOPHOS		
	Average DFR ($\mu g/cm^2$)	13+ Golfer Dose (mg/kg/day)	MOE	Average DFR ($\mu g/cm^2$)	13+ Golfer Dose (mg/kg/day)	MOE
0	**0.289**	**0.0026**	**4620**	**0.00106**	**0.0000096**	**78100**

NOTE: Values rounded; calculations are based on spreadsheet analyses.

Days After Treatment (DAT). It was assumed that children golfers are wearing long pants, long sleeved shirts and no gloves.

Turf Transferable Residue (TTR) averaged from actual field measurements made following the second application.

13+ Year-Old Golfer Dose (mg/kg/day) = TTR ($\mu g/cm^2$) * Transfer Coefficient (100 cm^2/hr for golfing) * (4 hr/day) * (1mg/1000 μg conversion factor) ÷44 kg Body Weight. NOTE: this does not include possible hand-to-mouth exposures.

Dermal Short-term MOE = $NOAEL_{dermal}$/ Dose; where $NOAEL_{dermal}$ = 12 mg/kg/day for acephate and $NOAEL_{dermal}$ = 0.75 mg/kg/day for methamidophos. MOE of 100 is acceptable margin of exposure.

APPENDIX E

REVIEW OF ACEPHATE INCIDENT REPORTS and REVIEW OF METHAMIDOPHOS INCIDENT REPORTS

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

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

September 8, 1999

MEMORANDUM

SUBJECT: Review of Acephate Incident Reports, DP Barcode 247487, Chemical #103301, Reregistration # 0042

FROM: Ruth H. Allen, Ph.D., M.P.H. Environmental Scientist (Health)
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

Jerome Blondell, Ph.D., M.P.H., Health Statistician
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

THRU: Francis B. Suhre, Senior Scientist
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

TO: Felecia Fort, Chemist
Reregistration Branch 1
Health Effects Division (7509C)

BACKGROUND

In response to the request that Health Effects Division Epidemiology Group review the incident data on acephate, a search of the published epidemiology literature was conducted, and the following data bases were reviewed for the poisoning incident data on the active ingredient acephate:

1) **OPP Incident Data System (IDS)** - reports of incidents from various sources, including registrants (required under Federal Insecticide Fungicide and Rodenticide Act (FIFRA) Section 6(a)(2)), other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) **American Association of Poison Control Centers (AAPCC)** - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 60-70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc. In addition, EPA purchased data for the time period 1993-1996 for all pesticides.

3) **California Department of Pesticide Regulation** - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) **National Pesticide Telecommunications Network (NPTN)** - 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 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

ACEPHATE REVIEW

I. Incident Data System

There are two types of incident information on file for acephate: (A) *Report of the Investigation of the Death of (name withheld)* by Sheldon L. Wagner, M.D. Letter to Jerome Blondell, Office of Pesticide Programs, September 3, 1998, and (B) routine reporting to the Incident Data System (IDS).

A. *Report of the Investigation of the Death of (name withheld)* by Sheldon L. Wagner, M.D.

A 24 year old male pesticide applicator with no prior history of any cardiac difficulties died suddenly after spraying seven homes with a mixture of acephate and dicofol. A medical review of the applicator's autopsy report, clinical toxicology findings, and results of cholinesterase tests on his tissues were requested by EPA. Dr. Wagner, Professor of Clinical Toxicology at Oregon State University and medical advisor to the Epidemiology Group concluded that "the most probable cause of death was an acute ventricular fibrillation resulting from organophosphate exposure and intoxication."

On the day of his death, the pesticide applicator was mixing and applying organophosphate insecticide without proper protection, and with a particulate mask that would have increased his risk of inhaling increased concentrations of the insecticide. At the seventh home he sprayed, he complained of headaches and collapsed. Attempts to resuscitation failed and he was declared dead one half hour after admission to the emergency room. His stomach contents and urine were negative for drugs and other substances. Dr. Wagner concluded that he had died with documented ventricular fibrillation, the most common type of cardiac arrhythmia occurring with organophosphate insecticides.

Details of the lab assay methods and storage stability of the enzymes were reviewed with three authorities, and these findings and the presence of anticoagulants EDTA was evaluated by Dr. Wagner who concluded that "an abnormally low cholinesterase confirmed significant exposure and /or intoxication from acephate." Dr. Wagner concluded that "the most probable cause of death was an acute ventricular fibrillation resulting from organophosphate exposure and intoxication."

B. Incident Data System (IDS) Routine Reporting for Acephate.

Acephate human poisoning incidents are reported for multiple geographic locations, by several companies, and for a variety of uses and formulations. Only those cases involving a moderate, major, or fatal outcome are summarized below. Certain large compilations of cases (e.g., packages numbered 1264, 1827, 3268, 3326, 3380, 3474, 3844, and 4007) that duplicate information collected by Poison Control Centers and covered elsewhere in this review are also excluded from the section below.

Incident #732-1

In September 1992, in Florida a female scout in tomato fields developed dizziness, weight loss, headaches, vomiting, spots before her eyes. She did not seek medical attention immediately, but symptoms persisted and she was hospitalized a few days or weeks later (time not specified). Some of her symptoms have reportedly persisted for months since this incident. No further information on the disposition of this case is available.

Incident #2969-5

In 1995 an incident was reported involving inhalation and respiratory inhalation that was classified as having a moderate outcome. No further information on the disposition of this case is available.

Incident #2969-7

In 1995 an incident occurred where inhalation of acephate reportedly led to headache, difficulty breathing, and pain in the chest. No further information on the disposition of this case is available.

Incident #2969-34

In 1995 an incident occurred when a human was exposed (route of exposure unknown)

and became semi-conscious. No further information on the disposition of this case is available.

Incident #2969-59

In an undescribed incident which led to a lawsuit, an injury was alleged from re-entering a place where acephate had been used. No further information on the disposition of this case is available.

Incident #3599-1

The Minnesota Department of Agriculture surveyed state enforcement agencies to determine what pesticides were involved in spray drift. Among the 32 states responding to the survey, there were a total of 2,681 cases of drift complaint. Acephate was responsible for 19 complaints or about one percent of the total.

Incident #4535-1

An incident occurred in 1996 when dermal exposure to a 62 year old led to lethargy, coughing/choking, pulmonary edema, respiratory irritation, and fever. No further information on the disposition of this case is available.

II. Poison Control Center Data - 1985 through 1992

Acephate was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) ratios of poisonings and hospitalization for PCC cases to estimated number of containers used in U.S. homes; and [C] number and percent of child exposures to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects.

A. Occupational and Non-occupational Exposure

From 1985-1992, there were a total of 3,004 acephate cases in the PCC data base. Of these, 334 cases were occupational exposure; 208 (62%) to acephate alone and 126 (38%) involving exposure to multiple products including acephate. There were a total of 1,996 exposures to adults and children six years old or older; 1,753 (88%) involving acephate alone and 243 (12%) with multiple products.

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 with outcome determined that had a major medical outcome (defined as life-threatening or permanent disability) or death.

Exposure to acephate 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. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1. Measures of Risk From Occupational and Non-occupational Exposure to Acephate Using Poison Control Center Data from 1985-1992[a]

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single product exposure	63.0 (68.2)	27.7 (44.0)
Multiple product exposure	66.5 (69.8)	29.8 (46.1)
Percent Hospitalized		
Single product exposure	12.2 (12.2)	6.0 (9.9)
Multiple product exposure	14.9 (14.3)	6.9 (12.6)
Percent with Symptoms		
Single product exposure	87.9*[7] (85.8)	67.5 (74.0)
Multiple product exposure	87.8 (85.8)	69.8 (75.2)
Percent with Life-threatening Symptoms		
Single product exposure	0.8[b] (0.0)	0.2[b] (0.0)
Multiple product exposure	0.5[b] (0.5)	0.3[b] (0.05)

a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category.

b The percents calculated for the occupational category are based on a single life-threatening case. For non-occupational exposures to a single product, there were 2 life-threatening cases and 1 fatality. The percents calculated for non-occupational exposure to multiple products, included these 3 cases plus 2 more life-threatening cases.

* Top 25% of chemicals are ranked with a superscript of 1 to 7

Compared to other organophosphate and carbamate insecticides, acephate generally similar or somewhat below median levels for health care requirements and occurrence of

symptoms. However, for life-threatening or fatal cases, the percents are above the median. The one fatality due to acephate was reported in 1990 involving a 67 year old who was exposed by route of inhalation due to accidental misuse.

B. Ratios of Poisoning - U.S. Poison Control Data

Active registrations of acephate are include significant residential uses. A comparison was computed for ten pesticides with significant home use between number of non-occupational exposures, poisonings and health care referral and the number of containers reported in U.S. homes. The results for acephate and the median for all 10 residential cholinesterase inhibitors included in the analysis are presented in the Table 2 below.

Table 2. Ratios of acephate exposures, poisonings, and cases referred to a health care facility (PCC Data, 1985-1992) to reported use in U.S. homes in 1990 (children under age six excluded)[a]

Pesticide	Exposure Per Use	Poisonings Per Use	Health Care Referral Per Use
Acephate	.461	.183	.150
Median	.790	.312	.320

a Extracted from Table 9 in the December 5, 1994 memo from Jerome Blondell to Joshua First
* Top 33% of chemicals are ranked with a superscript of 1 to 5

Among pesticides used widely in residential areas, acephate had ratios that were close to half the median (Table 2).

C. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For acephate, there were 674 incidents; 575 (85%) involved exposure to acephate alone. Compared to 16 other organophosphates and carbamates that 25 or more children were exposed to acephate cases were less likely to require medical attention. Acephate was also slightly less likely to result in related symptoms and there were no life-threatening or fatal cases in children under six years of age.

<u>Poison Control Center Data - 1993 through 1996</u>

Results for the years 1993 through 1996 are presented below for occupational cases, non-occupational involving adults and older children, and for children under age six. Unlike the earlier analysis for 1985-1992, cases involving exposures to multiple products are excluded. This is because the earlier analysis showed little difference in rankings and measurement of hazard when multiple exposure cases were included. Tables 3-5 present the hazard information for acephate compared with all other pesticides on six measures: percent with symptoms, percent with moderate, major, or fatal outcome, percent with major or fatal outcome, percent of exposed cases seen in a health care facility, and percent hospitalized and percent seen in a critical care facility. Table 3 presents this information for occupational cases, Table 4 for non-occupational cases involving adults and older children (six years or older), and Table 5 for children under age six.

Table 3. Comparison between acephate and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1996 for occupational cases only.

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Acephate	91.3%	20.3%	0%	46.0%	12.5%	9.38%
All Pesticides	85.9%	18.8%	0.60%	46.8%	7.18%	2.89%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

Table 4. Comparison between acephate and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1996 for non-occupational cases involving adults and older children.

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Acephate	69.5%	9.79%	0.16%	23.2%	9.43%	4.04%
All Pesticides	70.8%	10.8%	0.34%	18.7%	7.62%	3.36%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

Table 5. Comparison between PCP and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) for adults and children six years and older reported to Poison Control Centers, 1993-1996 for children under six years old..

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Acephate	23.5%	1.53%	0%	15.0%	5.56%	1.85%
All Pesticides	22.3%	1.48%	0.13%	17.5%	5.47%	1.61%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

For non-occupational cases involving adults and older children or young children, acephate has a similar hazard profile to all other pesticides. Whether examining the symptomatic measures (SYM, MOD and LIFE-TH in the tables above) or health care-related measures (HCF, HOSP, and ICU) acephate had almost the same degree of hazard or perhaps a bit less hazard (e.g., health measures in Table 5). In contrast, hazards were noticeably higher for individuals exposed to acephate occupationally. This difference, however, was mostly limited to health care measures. Occupational acephate cases were 74% more likely to require hospitalization and three times more likely to be treated in an intensive care unit.

III. California Data - 1982 through 1995

Detailed descriptions of 259 cases involving acephate submitted to the California Pesticide Illness Surveillance Program (1982-1995) were reviewed. In 89 of these cases, acephate was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Acephate ranked 22nd as a cause of systemic poisoning in California. Table 6 presents the types of illnesses reported by year. Table 7 gives the total number of workers that took time off work as a result of their illness and how many were hospitalized and for how long.

Table 6. Cases Due to Acephate Exposure in California Reported by Type of Illness and Year, 1982-1995

Year	Illness Type				
	Systemic[b]	Eye	Skin	Respiratory	Total
1982	5	1	-	-	6
1983	3	2	1	-	6
1984	-	2	1	-	3
1985	2	1	-	-	3
1986	10	4	1	-	15
1987	1	1	-	-	2
1988	20	1	1	-	22
1989	2	1	1	-	4
1990	3	-	2	1	6
1991	8	-	-	-	8
1992	-	2	-	-	2
1993	1	3	-	-	4
1994	3	-	-	-	3
1995	4	-	-	1	5
Total	62	18	7	2	89

[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

A total of 62 persons had systemic illnesses or 70% of 89 persons. A total of 22 workers took time off work as a result of their exposure to acephate, as shown in Table 7 below. A variety of worker activities were associated with exposure to acephate as illustrated in Table 8 below.

Table 7. Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Acephate Exposure in California, 1982-1995.

	Number of Persons Disabled	Number of Persons Hospitalized
One day	10	-
Two days	5	-
3-5 days	5	-
6-10 days	1	-
more than 10 days	1	-
Unknown	2	1

Table 8. Illnesses by Activity Categories for Acephate Exposure in California, 1982-1995

Activity Category	Illness Category				
	Systemic[b]	Eye	Skin	Respiratory	Total
Applicator	14	12	4	-	30
Mixer/Loader	-	3	-	1	4
Coincidental	3	-	-	-	3
Drift exposure	8	1	-	-	9
Field Residue	8	-	1	-	9
Other residue[a]	11	1	1	-	13
Manuf./Formulator	3	-	-	-	3
Other occupational	2	1	1	-	4
Non-occupational	13	-	-	1	14
Total	62	18	7	2	89

[a] Other Residue = worker exposed to residue neither agricultural nor structural.
[b] Category includes cases where skin, eye, or respiratory effects were also reported.

According to the above activity categories, applicators and other handlers accounted for

over a third of the illnesses. Significant number of illnesses were also reported for workers exposed to spray drift and field residue. These illnesses included symptoms of dizziness, nausea, vomiting, chest tightness, eye and skin irritation, skin rashes, and incoordination.

One of the most common causes of acephate poisonings according to the California reports were spills in enclosed spaces, often from broken glass bottles. Approximately, one-third of the systemic illnesses could be ascribed to this cause.

Ratios of poisoning - California Data

The incidence of **systemic poisoning cases** in agricultural workers reported to the California was compared to the number of applications of acephate. Those calculations, along with the median score for a total of 29 pesticides, are presented in the Table 9 below.

Table 9. Systemic Poisonings/1,000 Applications in Selected Agricultural Workers Exposed to Acephate in California, 1982-1989[a]

Pesticide	Number of Applications	Poisonings/1,000 Applications (N) Primary Pesticide Only			Poisonings/1,000 Applications (N) Multiple Pesticide Exposure		
		Handlers	Field Workers	Total	Handlers	Field Workers	Total
Acephate	84,433	.04 (3)	.13 (11)	.17 (14)	.20 (17)	.20 (17)	.40 (34)
Median		.21	.20	.41	.44	.50	1.02

a Extracted from Table A5 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is the observed number of poisoned cases.

Acephate was not among the top five in ratio of field worker poisonings per 1,000 applications in California (see Table 7 in the December 5, 1994 memo.). Generally, the ratio of poisoning per thousand applications was well below the median, 80% lower for handlers and 35% lower for field workers exposures to acephate as the primary pesticide.

California accessed medical monitoring records for 542 agricultural pesticide applicators under medical supervision in 1985 for exposure to the more toxic cholinesterase-inhibiting organophosphate and carbamate pesticides (Ames et al. 1987, 1989) . In California, cholinesterase monitoring is required for all pesticide applicators who handle Toxicity Category I or II organophosphate or carbamate pesticides for 30 hours of more in any 30 day period. To be included in the survey, the worker had to have at least one pre-exposure (baseline) cholinesterase measurement and at least one exposure value (mid-season). A data-call-in was issued by the California Department of Food and Agriculture and local Agricultural Commissioners through pesticide application firms to their medical supervisors. Follow up letters were sent and phone calls made to employers, physicians, and laboratories performing tests, but significant under reporting is

likely to have occurred. Therefore, these workers may not be representative of all workers undergoing medical monitoring in California. However, they do represent exposure effects verified by medical laboratories. Cholinesterase activity depression of 20 percent or more below baseline was observed in 127 or 23 percent of the 542 workers. Depression of 20 percent or more below baseline represents strong evidence of exposure (Gallo and Lawryk 1991).

Specific pesticide exposure was available for 94 of the 127 cases, based on usage records for the previous two weeks. Of these, 31 percent had been exposed to mevinphos, 21 percent to methomyl, and 21 percent to parathion, the three leading pesticides responsible for cholinesterase inhibition. Of the 94 cases with inhibition, 16% had exposure in the past two weeks to acephate. Note that many of the workers were exposed to two or more pesticides during the two weeks before they had cholinesterase depression of 20% or more. Twelve of the workers in this study were reported to have pesticide-related illnesses by their physicians. These data demonstrate that agricultural workers, who mix, load and apply the more toxic pesticides are subject to significant levels of exposure despite the considerable restrictions in place to prevent exposure.

IV. NPTN

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, acephate ranked number 13 and was reported to be involved in 254 human incidents and 24 animal incidents.

V. Summary/Conclusions

When both Poison Control Center and California data were considered, acephate generally had a lower hazard than other organophosphate and carbamate insecticides. There have been two accidental deaths reported associated with exposure. Both deaths involved misuse and in one case use of a particulate mask may have increased the risk of inhaling acephate. Minor and moderate symptoms of exposure have often been associated with inhalation indoors. Outdoor agricultural use are associated with lower risks of illness and poisoning than most other organophosphate and carbamate insecticides.

VI. Recommendations

Indoor use of acephate should be restricted to certified Pest Control Operators. Homeowner products should be limited to only products that are either ready-to-use or mostly diluted product. The one exception to this should be hose-end sprayers and other concentrates that can be used by homeowners without mixing or pouring. Acephate should be sold in non-breakable containers.

References

Ames RG, Mengle DC, Brown SK, Kahn E, Stratton JW, Jackson RJ. 1987. Cholinesterase activity depression among California pesticide applicators: Results from the 1985 cholinesterase monitoring program. California Department of Health Services, Berkeley.

Ames RG, Brown SK, Mengle DC, Kahn E, Stratton JW, Jackson RJ. 1989. Cholinesterase activity depression among California Agricultural Pesticide Applicators. American Journal of Industrial Medicine 15:143-150.

Gallo MA, Lawryk NJ. 1991. Organic Phosphorus Pesticides. Chapter 16, pages 917-1123 in *Handbook of Pesticide Toxicology* edited by W. J. Hayes, Jr. and E.R. Laws, Jr. Academic Press, San Diego.

Wagner SL. 1998. Report of the Investigation of the Death of (name withheld). Oregon State University, Environmental and Molecular Toxicology. Corvallis, Oregon.

cc: Correspondence
Acephate file (chemical no. 103301)
Jack Arthur - 7509C
Monica Alvarez - 7508W

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

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

September 9, 1999

MEMORANDUM

SUBJECT: Review of Methamidophos Incident Reports
DP Barcode D258608, Chemical #101201

FROM: Jerome Blondell, Ph.D., Health Statistician
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

Monica F. Spann, M.P.H., Environmental Health Scientist
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

THRU: Francis B. Suhre, Senior Scientist
Chemistry and Exposure Branch 1
Health Effects Division (7509C)

TO: Susan Hanley, Chemist
Reregistration Branch I
Health Effects Division (7509C)

BACKGROUND

The following data bases have been consulted for the poisoning incident data on the active ingredient Methamidophos (PC Code:101201):

1) OPP Incident Data System (IDS) - reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) Poison Control Centers - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a

national data collection system, the Toxic Exposure Surveillance System which obtains data from about 60-70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc. In addition, as the result of a data purchase by EPA, OPP received Poison Control Center data covering the years 1993 through 1996 for all pesticides.

3) California Department of Pesticide Regulation - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) National Pesticide Telecommunications Network (NPTN) - 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 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

METHAMIDOPHOS REVIEW

I. Incident Data System

Please note that the following cases from the IDS do not have documentation confirming exposure or health effects unless otherwise noted.

Incident#960-1

A pesticide incident occurred in 1994, when an Italian man intentionally swallowed 45.6 grams of methamidophos in a 200 ml solution (estimated dose = 600 mg/kg) in a suicide attempt. He became comatose with cholinesterase level less than 10 percent of normal, which indicates a life-threatening poisoning. With treatment he recovered, however on day 25 weakness developed in his legs. Tests of nerve conduction velocities, evoked potentials, and neuro-toxic esterase confirmed a chronic case of peripheral neuropathy. Other such cases have been reported in the literature.

Incident#2195-4

A pesticide incident occurred in 1995 in California, when twenty-two field workers were weeding an alfalfa field that was treated the day before. Twelve workers experienced nausea and vomiting and sought medical care and two of the workers were admitted to the hospital for twenty-four hours. Enforcement action was taken for not properly posting the field to prevent worker entry. No further information on the disposition of the case was reported.

Incident#4158-1

A pesticide incident occurred in Idaho in 1996 when methamidophos drifted on to a garden. The owner of the garden was told not to eat the vegetables but entered the garden and was exposed by direct contact with the foliage. She was reportedly affected in a manner that persisted for 14 days. However, her symptoms were not reported. No further information on the disposition of this case was reported.

Incident#4215-9

A pesticide incident occurred in 1996, when the chemical got onto a thirty year old's skin and they experienced diarrhea, nausea, and headaches. No further information on the disposition of the case was reported.

Incident#4215-17

A pesticide incident occurred in 1996, when an individual inhaled the chemical and experienced headaches. No further information on the disposition of the case was reported.

Incident#6107-9

A pesticide incident occurred in 1997, when a thirty-eight year old individual experienced ocular irritation and pain. No further information on the disposition of the case was reported.

Incident#6532-4

A pesticide incident occurred in 1997, when an individual experienced agitation, irritation, and uncontrolled anger. No further information on the disposition of the case was reported.

Incident#6869-1

A pesticide incident occurred in 1997, when an aerial applicator applied methamidophos and chlorothalonil to a potato field and thirteen workers were exposed. As a result, one worker is claiming health problems and seeing a doctor daily, and another worker experienced coughing, green phlegm, headaches, and sinus problems. Neither victim reportedly had symptoms typical of organophosphate poisoning. No further information on the disposition of the case was reported.

Incident#7441-1

A pesticide incident occurred in 1998, when ten females were working on an apple field across the road from a potato field that was sprayed with methamidophos and several other chemicals. The workers experienced difficulty breathing, swelling of the tongue, nausea, headaches, vomiting, blurred vision, cough and respiratory irritation. Six of the workers were hospitalized for one night. No further information on the disposition of the case was reported.

Incident#7587-157

A pesticide incident occurred in 1996, when a twenty-two year old male experienced nausea, dizziness, weakness, and throat irritation after methamidophos and chlorothalonil were sprayed aerially about three hundred feet away. No further information on the disposition of the case was reported.

II. Poison Control Center Data - 1985 through 1992

Methamidophos was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) ratios of poisonings and hospitalization for PCC cases to estimated pounds reported in agriculture for pesticides used primarily in agriculture; and [C] number and percent of child exposures to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects.

A. Occupational and Non-occupational Exposure

From 1985-1992, there were a total of 121 methamidophos cases in the PCC data base. Of these, 41 cases were occupational exposure; 33 (80%) to methamidophos alone and 8 (20%) involving exposure to multiple products including methamidophos. There were a total of 74 exposures to adults and children six years old or older; 63 (85%) involving methamidophos alone and 11 (15%) with multiple products.

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 with outcome determined that had a major medical outcome (defined as life-threatening or permanent disability) or death..

Exposure to acephate 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. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1. Measures of Risk From Occupational and Non-occupational Exposure to Methamidophos Using Poison Control Center Data from 1985-1992[a]

	Occupational Exposure	Non-occupational Exposure

Percent Seen in HCF		
Single product exposure	75.8 (68.2)	55.6 (44.0)
Multiple product exposure	80.5*[7] (69.8)	60.8 (46.1)
Percent Hospitalized		
Single product exposure	16.0 (12.2)	14.3 (9.9)
Multiple product exposure	24.2*[7] (14.3)	20.0*[6] (12.6)
Percent with Symptoms		
Single product exposure	95.0*[3] (85.8)	80.0 (74.0)
Multiple product exposure	96.2*[2] (85.8)	80.0 (75.2)
Percent with Life-threatening Symptoms		
Single product exposure	5.0*[2b] (0.0)	0.0 (0.0)
Multiple product exposure	3.8*[2b] (0.5)	0.0 (0.05)

a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category.
b The percents calculated for the occupational category are based on a single life-threatening case.
* Top 25% of chemicals are ranked with a superscript of 1 to 7.

Compared to other organophosphate and carbamate insecticides, methamidophos has a greater hazard in terms of percent developing symptoms, life-threatening symptoms (for the occupationally category only and based on a single case), and greater requirements for health care. In a combined ranking based on all four measures, methamidophos ranked second out of the 28 chemicals (mevinphos ranked first). Similarly, for the non-occupational category methamidophos ranked sixth out of 28 insecticides. The first or highest ranked insecticide was the one associated with the highest combined risk on the various measures.

B. Ratios of Poisoning - U.S. Poison Control Data

Active registrations of methamidophos are used primarily in agricultural settings. A comparison was computed for 15 pesticides with primary agricultural use between number of occupational exposures, poisonings, health care referrals and hospitalizations and the number of pounds active ingredient reported in use for 1989-1991. The results for methamidophos and the median for all 15 agricultural cholinesterase inhibitors included in the analysis are presented in the Table 2 below.

Table 2. Ratios of methamidophos exposures, poisonings, and cases referred to a health care facility (PCC Data, 1985-1992) to thousands of pounds active ingredient reported in use[a]

Pesticide	Exposure Per Use	Poisonings Per Use	Health Care Referral per Use	Hospitalizations Per Use
Methamidophos	.036	.022*[5]	.029	.007*[5]
Median	.033	.013	.027	.004

a Extracted from Table 9 in the December 5, 1994 memorandum from Jerome Blondell to Joshua First.
* Top 33% of chemicals are ranked with a superscript of 1 to 5

Among pesticides used principally in agricultural settings, methamidophos had higher ratios than other cholinesterase-inhibiting insecticides. The ratios of poisonings and hospitalizations per pounds active ingredient reported in use ranked fifth among the 16 insecticides that were compared (Table 2).

C. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For methamidophos, there were 6 incidents; 5 involved exposure to methamidophos alone. Just one of these cases was seen in a health care facility. This number of cases was too small to warrant a more detailed evaluation.

Poison Control Center Data - 1993 through 1996

Results for the years 1993 through 1996 are presented below for occupational cases. Only 12 exposures were reported to be non-occupational in adults and older children, too few to warrant more detailed analysis. Of these 12 cases, six were seen in a health care facility, but none were hospitalized. Only three exposures were reported for children under age six, too few to warrant more extensive analysis. Unlike the earlier analysis for 1985-1992, cases involving exposures to multiple products are excluded. This is because the earlier analysis showed little difference in rankings and measurement of hazard when multiple exposure cases were included. Table 3 presents the occupational hazard information for methamidophos compared with all other pesticides on six measures: percent with symptoms, percent with moderate, major, or fatal outcome, percent with major or fatal outcome, percent of exposed cases seen in a health care facility, and percent hospitalized and percent seen in a critical care facility
.

Table 3. Comparison between methamidophos and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1996 for occupational cases only.

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Methamidophos	90.0%	10.0%	0%	76.0%	10.5%	0%
All Pesticides	85.9%	18.8%	0.60%	46.8%	7.18%	2.89%

* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

For occupational cases, methamidophos had only ten cases where outcome was determined. Therefore, differences in percents given in Table 3 are unlikely to be significant. Of 25 occupational exposures, 19 were seen in a health care facility and 2 of these cases required hospitalization. This suggests a higher requirement for health care but based on relatively few cases.

III. California Data - 1982 through 1994

Detailed descriptions of 158 cases submitted to the California Pesticide Illness Surveillance Program (1982-1994) were reviewed. In 71 of these cases, methamidophos was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Methamidophos ranked 19th as a cause of systemic poisoning in California for this time period and 8th for cases involving only agricultural workers. Table 4 presents the types of illnesses reported by year. Table 5 gives the total number of workers that took time off work as a result of their illness and how many were hospitalized and for how long.

Table 4. Cases Due to Methamidophos Exposure in California Reported by Type of Illness and Year, 1982-1994

Year	Illness Type				
	Systemic[b]	Eye	Skin	Combination[c]	Total
1982	-	-	-	-	-
1983	6	-	1	-	7
1984	5	-	1	-	6
1985	3	-	-	-	3
1986	31	-	-	-	31
1987	-	-	-	-	-
1988	14	-	1	-	15
1989	1	-	-	-	1
1990	1	-	1	-	2
1991	2	-	-	-	2
1992	2	-	-	-	2
1993	-	-	-	-	-
1994	-	-	2	-	2
Total	65	-	6	-	71

[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

Table 5. Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Methamidophos Exposure in California, 1982-1994.

	Number of Persons Disabled	Number of Persons Hospitalized
One day	3	-
Two days	6	1
3-5 days	5	2
6-10 days	15	1
more than 10 days	11	-
Unknown	5	1

A total of 65 persons had systemic illnesses or 91.5% of 71 persons. A variety of worker activities were associated with exposure to methamidophos as illustrated in Table 3 below.

Table 6. Illnesses by Activity Categories for Methamidophos Exposure in California, 1982-1994

Activity Category	Illness Category				
	Systemic[b]	Eye	Skin	Combination[c]	Total
Applicator	1	-	-	-	1
Mixer/Loader	7	-	1	-	8
Drift exposure[a]	19	-	1	-	20
Field residue[a]	32	-	4	-	36
Commodity residue	2	-	-	-	2
Other	4	-	-	-	4
Total	65.00	-	6.00	-	71.00

[a] Drift exposure included 11 school instructors adjacent to a broccoli field being sprayed in 1988. Field residue included 25 workers in a cotton field that had been sprayed that morning.
[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, field residue was associated with the majority (51%) of the exposures. Twenty-five of the cases occurred after a cotton field was sprayed with methamidophos earlier in the morning. Drift exposure was also a problem with methamidophos,

accounting for 28% of the illnesses. The earlier 1994 review (December 5, 1994 memo from Jerome Blondell to Joshua First) found that methamidophos ranked highest for number of field workers poisoned (either by spray drift or field residue) per 1,000 applications from 1982 through 1989.

Weinbaum et al. (1997) analyzed risk factors for systemic illness in California for organophosphates for the time period 1984 through 1988. In their analysis they used the ratio of number of systemic illnesses to the pounds applied. Methamidophos was among five organophosphates that had statistically significant increased risk of poisoning. The estimated increase was 1.6 with a 95 percent confidence interval of 1.2 to 2.0. Only mevinphos, demeton, and oxydemeton-methyl had higher estimated ratios.

IV. National Pesticide Telecommunications Network

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, methamidophos was ranked 91st with 39 incidents in humans reported and 2 incidents in animals (mostly pets).

V. Literature

Rosenstock et al. (1991) performed a retrospective cohort study of agricultural workers in Nicaragua who had been hospitalized with organophosphate poisoning. Of 52 eligible patients hospitalized over a two year period, 38 men were located, and 36 agreed to participate in the study. Of the 36 who agreed to participate, 21 had been previously poisoned by methamidophos. Controls were a close male friend or sibling from the same community who had never been treated for pesticide poisoning and was no more than 5 years different in age from the case participant. Both members of the pair (case and control) were examined during May-June 1989 before the onset of the 4-5 month spraying season. Six of the seven tests from the World Health Organization core neurobehavioral test battery were administered, along with a brief symptom inventory, 6 additional Spanish-translated tests, and a 16 item self-reported symptom inventory. These tests were administered an average of 2 years after the time of hospitalization for poisoning.

Poisoned workers scored significantly worse on five of the six WHO core neurobehavioral tests, 3 of the 6 Spanish-translated tests, and the 16 item self-reported inventory. Deficits were noted in auditory and visual attention, visual memory, visuomotor skills, steadiness and dexterity. These findings replicated, to a large degree, those of Savage et al., which is an important consideration when judging the weight of evidence for a conclusion that OP poisoning is a cause of chronic neurobehavioral effects.

McConnell et al. (1994) evaluated vibration threshold in 36 Nicaraguan workers poisoned by organophosphate insecticides (the same cohort studied by Rosenstock et al. above). All of the

workers had been poisoned and hospitalized from one to three years prior to this study. Of the 36 workers, 21 had been poisoned by methamidophos. The group poisoned by methamidophos had higher mean vibration thresholds than those (n = 15) poisoned by other organophosphates who also had higher mean thresholds than the unexposed control group (each exposed case was matched to a sibling or friend with the same sex and age within five years). These differences were largest in the lower extremities. Testing for suspected confounders (e.g., recent pesticide exposure, history of solvent exposure, and history of work with vibrating machinery) did not alter these results. The authors concluded "These results strongly suggest a chronic sensory impairment resulting from methamidophos poisoning."

Karalliedde et al. (1988) reported on a 22 year old pregnant woman who ingested methamidophos with suicidal intent. It was estimated that she was 36 weeks pregnant at the time. She had severe poisoning and received treatment three hours after the ingestion, including atropine, pralidoxime, and required mechanical ventilation for six days. Forty-four days after the intoxication she delivered a healthy boy with a birth weight of 2.85 kg (6.2 pounds). The authors attribute the healthy baby to prompt and adequate management of the life-threatening phases of the poisoning.

McConnell and Hruska (1993) reported on an epidemic of 548 pesticide poisoning in northwestern Nicaragua during June and July 1987. Of the 548 cases 91% were occupational, 8% involved other accidents, and 1% were suicide attempts. Of the occupational cases, one-third were due to methamidophos.

Senanayake and Karalliedde (1987) reported on a life-threatening sequelae to organophosphate poisoning which they referred to as an intermediate syndrome. They observed 10 patients that had paralysis of the proximal limb muscles , neck flexors, motor cranial nerves, and respiratory muscles 1-3 days after poisoning. One of the ten patients was poisoned by methamidophos (suicide attempt) and required mechanical ventilation. The weakness persisted for 32 days which overlapped the development of a delayed polyneuropathy. In an earlier report of a series of 27 patients with delayed neuropathy (Senanayake 1985), 25 were caused by methamidophos.

Sun et al (1998) reported that methamidophos was responsible for half of the pesticide intoxications and fatality cases in China. A total of 553 intoxications due to dermal exposure to methamidophos and 104 cases by ingestion from 1987 through 1992 among 5 hospitas in rural China. They reviewed the medical records of 104 subjects that had been poisoned by ingestion (mostly attempted suicides) and performed in-person interviews and medical examinations with 100 of these subjects and interviewed relatives of the remaining four. Among the 104 cases, 14 cases of organophosphate-induced delayed polyneuropathy (OPIDP) were identified. Six of the 14 cases had ingested a mixture of methamidophos and dimethoate. In 13 of the 14 OPIDP cases the initial poisoning was severe (12 cases exhibited coma and 3 suffered from urine and feces incontinence). All 14 cases were confirmed by severely inhibited blood cholinesterase. All 14 OPIDP cases complained of paralysis and reeling gait. Most OPIDP cases recovered within two years of their intoxication.

Goh et al. (1990) reported on an outbreak of food poisoning in Singapore which occurred in 1988. A total of 105 cases of illness among those who had consumed gai-lan vegetables were treated at hospitals during the December 3-7 period. Among 68 cases examined at one of the hospitals, 98% exhibited vomiting, 67% reported abdominal cramps, 65% diarrhea, 37% nausea, 63% giddiness, 31% excessive sweating, 30% blurred vision, 19% headache, and 12% muscle twitching. Testing of the suspected vegetables identified 2.4-31.7 ppm methamidophos, 1.1-5.4 ppm profenofos, and 4.1-16.8 ppm dithiocarbamate fungicide. The authors noted "the higher acute toxicity of methamidophos, together with its 5 times higher level of residue detected in the vegetable, would evidence that methamidophos was mainly responsible for the poisoning." The authors go on to estimate the total ingestion by assuming 10% of the highest combined level of methamidophos and profenofos residues remained after cooking and washing and that the average person eats 150 grams, giving an ingestion of 0.56 mg per person. Blood cholinesterase levels were depressed 26-81% below normal in five of the hospitalized patients who were tested.

Chan et al. (1996) reported there were 47 outbreaks of food poisoning in Hong Kong in 1992, all of which were caused by methamidophos. An estimated 329 people were affected. The authors estimated that these food-borne poisoning exceeded the incidence of pesticide poisonings that were not related to dietary intake by five-fold.

VI. Conclusions

Based on Poison Control Center data methamidophos ranked second out of 28 cholinesterase-inhibiting insecticides on combined measures of hazard. Similarly for non-occupational cases (typically bystanders or other workers not directly involved in application), methamidophos ranked sixth. An earlier review of California data found that methamidophos had the highest risk of field worker poisoning per 1,000 applications but that this was influenced by large clusters. For example, in one incident 25 workers were poisoned in a cotton field that had been treated that morning, a clear violation of the required reentry waiting period. Overall combining California and Poison Control Center data rankings, led to methamidophos being ranked third (after mevinphos and carbofuran) for combined measures of hazard.

VII. Recommendations

Methamidophos probably poses one of the highest risks to workers of any organophosphate insecticide currently registered. Significant reductions in hazard to workers would result from cancellation of most uses. Where safer alternatives are not available, a full set of restrictive measures including posting, closed-mixing loading, reentry restrictions, and buffer zones to prevent drift to nearby workers or residential areas should be instituted.

References

Blondell JM. 1994. Memorandum to Joshua First: Review of Poison Control Center Data Call In. December 5, 1994. U.S. Environmental Protection Agency, Washington, D.C.

Chan TYK, Critchley JAJH, Chan AYW. 1996. An estimate of the incidence of pesticide poisoning in Hong Kong. Veterinary and Human Toxicology 38:362-364.

Goh KT, Yew FS, Ong KH, Tan IK. 1990. Acute organophosphorus food poisoning caused by contaminated green leafy vegetables. Archives of Environmental Health 45:180-184.

Karalliedde L, Senanayake N, Ariaratnam A. 1988. Acute organophosphorus insecticide poisoning during pregnancy. Human Toxicology 7:363-364.

McConnell R, Hruska AJ. 1993. An epidemic of pesticide poisoning in Nicaragua: implications for prevention in developing countries. American Journal of Public Health 83:1559-1562.

McConnell R, Keifer M, Rosenstock L. 1994. Elevated quantitative vibrotactile threshold among workers previously poisoned with methamidophos and other organophosphate pesticides. Rosenstock L, Keifer M, Daniell WE, McConnell R, Claypoole K, and The Pesticide Health Effects Study Group. 1991. Chronic central nervous system effects of acute organophosphate pesticide intoxication. Lancet 338:223-227.

Senanayake N, Karalliedde L. 1987. Neurotoxic effects of organophosphorus insecticides: an intermediate syndrome. The New England Journal of Medicine 316:761-763.

Sun DH, Zhou HD, Xue SZ. 1998. Epidemiologic survey on organophosphate-induced delayed polyneuropathy (OPIDP) among patients recovered from methamidophos poisoning. Med Lav 89(suppl. 2):S123-S128.

Weinbaum Z, Schenker MB, Gold EB, Samuels SJ, O'Malley MA. 1997. Risk factors for systemic illnesses following agricultural exposures to restricted organophosphates in California, 1984-1988. American Journal of Industrial Medicine 31:572-579.

cc: Correspondence
Methamidophos file (chemical no. 101201)
Robert McNally, SRRD - (7508C)
Johnathan Becker, HED - (7509C)

RDI: BRSrSci:Francis B. Suhre: