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WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

MEMORANDUM

Date: January 7, 2011

SUBJECT: Review of Agricultural Handler Exposure Task Force (AHETF) Closed Cab Airblast Applicator Exposure Monitoring Studies: AHE55, AHE56, AHE57, AHE58, AHE59

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This memorandum presents the Health Effects Division's primary reviews of the analytical and field phase reports for the following Agricultural Handler Exposure Task Force (AHETF) closed cab airblast applicator studies: AHE55, AHE56, AHE57, AHE58, and AHE59. The closed cab airblast applicator scenario monograph (AHETF, 2010; MRID 48314201), which incorporates these 5 studies as a single dataset and includes statistical analysis based on pre-defined benchmark accuracy objectives, is reviewed separately (Crowley, 2011; D381148).

These studies meet EPA standards for occupational pesticide exposure monitoring and are considered acceptable and appropriate for use in occupational exposure assessments for closed-cab airblast applicators.

1.0 Executive Summary

The Agricultural Handler Exposure Task Force (AHETF) monitored exposure for 24 workers[1] applying liquid spray pesticides using closed cab airblast equipment. Five separate field studies, summarized in Table 1 below, were conducted, each monitoring different workers while spraying tree or trellis crops in 5 different states in the U.S where closed cab airblast equipment is commonly used in production agriculture.

Table 1. Study Summary

Study ID	State	Crop	No. Monitored Workers	Gender	Ages
AHE55	FL	citrus (orange and tangerine)	5	All male	20-70
AHE56	GA	pecan	5	All male	43-68
AHE57	MI	cherry	5	4 male, 1 female	21-58
AHE58	CA	grape	5	All male	27-49
AHE59	WA	apple	4	All male	26-62

Monitored on actual days of work, participants handled from 7 to 90 lbs of active ingredient (carbaryl, malathion, or chlorothalonil), spraying 4 to 30 acres in 2 to 9 hours. Dermal exposure was measured using hand washes, face/neck wipes, and whole body dosimeters (100% cotton union suits) for the remainder of the body (torso, arms, and legs). Inhalation exposure was measured using personal air sampling pumps and OSHA Versatile Samplers (OVS) mounted on the shirt collar. Results represent dermal exposure while wearing a long-sleeved shirt, pants, shoes/socks and chemical-resistant gloves, and inhalation exposure without respiratory protection.

All studies followed the applicable and most up-to-date AHETF standard operating procedures (SOPs) and their corresponding protocols with deviations appropriately recorded with none considered to have compromised the overall research. Field and laboratory fortification samples were acceptable, generally averaging between 70 and 120% recovery, with no systematic deviations. All field samples were appropriately adjusted for the corresponding recovery adjustment factors.

Total dermal exposure, calculated by summing the results for inner dosimeters, hand washes and face/neck wipes, ranged from 9 – 3168 µg, with an average of 377 µg. Normalized to the worker's body weight, dermal exposures ranged from 0.13 – 39.4 µg/kg, with an average of 4.48 µg/kg. Normalized to the amount of active ingredient handled, dermal unit exposures ranged from 0.4 – 76.6 µg/lb ai, with an average of 13.3 µg/lb ai.[2]

Inhalation exposure ranged from 0.1 – 6.39 µg, with an average of 1.6 µg. Normalized to the worker's body weight, inhalation exposures ranged from 0.001 – 0.089 µg/kg, with an average of 0.019 µg/kg. Normalized by the amount of active ingredient handled, inhalation unit exposures ranged from 0.002 – 0.245 µg/lb ai, with an average of 0.0567 µg/lb ai.

[1] One worker enrolled in study AHE59 (WA-apple) was not monitored, reducing the total from 25 to 24. See Section 2.3.

[2] All dermal exposure values reflect a 2X adjustment on hand rinse and face/neck wipe measurements accounting for assumed 50% residue collection method efficiency. See Section 3.3

2.0 Summary of Field Study Characteristics

This section provides summary characteristics of the five closed-cab airblast exposure studies. Attached supplemental tables (Tables S1-26) containing supporting details are cited in each subsection.

2.1 Administrative Summary (Table S - 1)

All studies were sponsored by the AHETF and followed both the study-specific protocols and the AHETF Governing Document (AHETF, 2008-a). Additionally, they were in substantial compliance with Good Laboratory Practice Standards (GLPS) (40 CFR §160)[3] and met EPA Test Guidelines in Series 875 – Occupational and Residential Exposure (875.1100 – dermal exposure; 875.1300 – inhalation exposure). Signed copies of acceptable Quality Assurance and Data Confidentiality statements were provided for each study.

2.2 Test Materials (Table S - 2)

All studies used liquid formulation pesticides containing carbaryl, malathion, or chlorothalonil.

2.3 Sample Size, Monitored Workers, and Locations (Table S - 3)

According to the Closed Cab Airblast Scenario Construction Plan and the AHETF Governing Document, a "5 x 5" configuration was deemed a reasonable approach for the closed cab airblast application scenario. That is, a total of 25 "monitoring units" (MU), obtained by monitoring exposure from 5 spatially distinct study locations across the U.S., each with 5 workers per location would be likely to satisfy pre-defined accuracy benchmarks. Only 24 MUs were collected – Subject A5 in AHE59 (WA-apple) was not monitored due to a series of logistical difficulties[4]. Additionally, due to unknown sampling time, inhalation data for subject A2 in AHE59 (WA-apple) was declared invalid, rendering a total of 23 inhalation exposure measurements.

2.4 Environmental Conditions (Table S - 4)

Temperature (including heat index), humidity, wind speed and direction, cloud cover, and rainfall were all reported. The maximum reported temperature was 93.9° F (AHE58 – CA-grape) and the lowest reported temperature was 35.4° F (AHE57 – MI-apple). In no case did the

[3] Two minor GLP deviations were noted for all studies. 1 – Test substance was not characterized before use. Per protocol, GLP characterization of test substance was conducted at a later date following collection of substance on monitoring day. This was infeasible due to participant selection process. 2 – Scales used to weigh subjects were not maintained and calibrated according to GLPS specifications. Additional study-specific GLP deviations are as follows – AHE57 (MI-cherry): empty substance containers were not retained for study duration and a non-compliant weather station instrument was used to record environmental conditions; AHE58 (CA-grape) & AHE59 (WA-apple): handheld weather monitoring device not maintained as specified. These deviations do not have any substantive impact on the study results.

[4] Fully described in Table S-3, initially a field study team was unavailable on the scheduled day. Attempts at utilizing replacement workers were unsuccessful before the application window of the study's surrogate chemical (carbaryl) passed.

ambient temperature exceed the pre-defined threshold of concern for potential heat-related injury. No significant rainfall was reported.

2.5 Clothing and Personal Protective Equipment (PPE) (Table S - 5)

Per the stated goals of the AHETF, monitoring of closed cab airblast applicators was conducted to represent exposure for workers wearing long-sleeve shirts, pants, shoes/socks, and chemical-resistant gloves when exiting the cabs (gloves are not required when inside the cab), and no respiratory protection. So long as the work clothing met the standards of the EPA Worker Protection Standard (WPS), monitoring was conducted with the clothing worn by the worker on the scheduled monitoring day. In two instances – MUs A3 and A4 in study AHE55 (FL-citrus) – the AHETF supplied workers with replacement shirts prior to study initiation. Per protocol, new chemical-resistant gloves were supplied by the AHETF to all workers at the beginning of the day and were available throughout the day according to WPS requirements. Additionally, due to pesticide label requirements for some of the chemicals used in these studies, some workers wore goggles for eye protection. In another case, though not label-required, a worker elected to wear a dust/mist respirator. In these cases, the exposure measurements were adjusted (according to AHETF SOP 9.K) to extrapolate deposited residue to those portions of the face/head covered by the goggles/eyewear or the respirator.

2.6 Application Characteristics (Table S - 6)

For these studies, only the airblast application activity was monitored – monitoring was not conducted for those workers responsible for mixing and loading the pesticide. The applications were made by trucks or tractors with enclosed cabs hauling airblast sprayers. Rigs were inspected by the study director to ensure compliance with EPA WPS requirements and to verify that the enclosed cabs were equipped with functioning air conditioning systems. Application characteristics including crop height and row spacing, truck/tractor and airblast sprayer brands and models, nozzle characteristics, and driving speed are also reported in Table S-6.

2.7 Application Rates (Table S - 7)

Per the AHETF Governing Document (AHETF, 2008-a) and the CCAB Scenario Construction Plan (AHETF, 2008-b), the total amount of active ingredient applied should be diversified across the scenario and within each study to provide adequate analytical power. Specifically, amounts of active ingredient handled within a study should be separated logarithmically for each MU and span at least an order of magnitude. Table 2 below presents the amount handled for each worker (total amount handled ranged from 7.3 to 90.3 lb active ingredient). The amount handled was slightly out of the range in six instances (italicized in Table 2) – the effects of which are considered only minor and would be reflected in statistical analyses.

Table 2. Summary of Amount Handled (lbs ai)

Desired Stratum of Amount Handled (lbs ai)	Actual Amount Handled (lbs ai) & MU ID				
	AHE55 (FL-citrus)	AHE56 (GA-pecan)	AHE57 (MI-cherry)	AHE58 (CA-grape)	AHE59 (WA-apple)
5-9	8.0 (A1)	7.9 (A1)	*10.8 (A1)*	7.3 (A5)	*9.4 (A2)*

10-17	15 (A2)	15.8 (A2)	16.9 (A2)	*23.0 (A3)*	15.8 (A1)
18-30	24 (A3)	24.6 (A3)	27.6 (A3)	*34.4 (A2)*	*15.9 (A3)*
31-55	40 (A4)	50.5 (A4)	40.7 (A4)	*59.2 (A4)*	34.5 (A4)
56-100	75 (A5)	75.7 (A5)	90.3 (A5)	63.5 (A1)	Not monitored (see Section 2.3)

In order to help achieve the range of amount of active ingredient handled as well as to avoid non-detectable exposures, the study design called for workers to apply at least 3 tank loads and/or work for at least 4 hours per day. In a few cases, work days were less than 4 hours (monitoring durations ranged from 2-9.4 hours); however these instances did not result in failure to capture the desired amount of active ingredient handled or non-detectable exposures.

2.8 Exposure Monitoring and Analytical Methods (Table S - 8)

Passive dosimetry methods were utilized for all monitoring – no biomonitoring samples were collected. Dermal exposure to the hands was measured using a hand rinse method administered at the end of the workday as well as at lunch, restroom breaks, or other instances where workers would otherwise wash their hands as outlined in AHETF SOP 8.B. Dermal exposure to the face/neck was measured using a wipe technique as outlined in AHETF SOP 8.C and extrapolated to non-wiped portions of the head (i.e., those parts covered by goggles or a respirator or covered by hair) according to AHETF SOP 9.K. Dermal exposure to the remainder of the body (torso, arms, legs) was measured using whole body dosimeters (100% cotton union suits), sectioned and analyzed separately as the upper and lower body according to AHETF SOP 8.A. All these measurements combine to reflect dermal exposure underneath a single layer of work clothing (long-sleeve shirt, pants, shoes/socks) and chemical-resistant gloves. Inhalation exposure was measured using OVS tubes mounted on the worker's collar and personal sampling pumps (set at 2 liters per minute) according to AHETF SOP 8.D. The concentrations measured represent the chemical available in each worker's breathing zone.

Validated analytical methods specific to each type of monitoring matrix were used to extract residues followed by quantification with gas chromatography (GC) employing flame photometric detection in phosphorous mode (FPD/P). Modifications to analytical methods are outlined in the submitted analytical reports. Limits of quantification and detection (as defined in AHETF SOP 9.A) are presented in Table 3 below.

Table 3. Analytical Limits (ug/sample) for AHE55-59

Monitoring Matrix		Limit of Detection			Limit of Quantification		
		Carbaryl	Malathion[a]	Chlorothalonil	Carbaryl	Malathion[a]	Chlorothalonil
Inner Dosimeter		0.3	0.3	0.3	1.0	1.0	1.0
Hand Rinse		0.3	0.3	0.3	1.0	1.0	1.0
Face/Neck Wipe		0.3	0.3	0.3	1.0	1.0	1.0
OVS air sampler	AHE55 AHE56 AHE59	0.003	0.003	NA	0.01	0.01	NA
	AHE57 AHE58	NA	0.0015	0.0015	NA	0.005	0.005

NA = not applicable, chemical not used.
[a] Additional validation was performed for malathion for AHE58 (CA-grape), resulting in different LOD/LOQ than other studies using malathion.

3.0 Results

This section provides a discussion of quality assurance and quality control sampling and the actual field monitoring measurements of workers. Attached corresponding supplemental tables providing additional detail are identified.

3.1 Quality Assurance

All phases of each study were subject to appropriate quality assurance processes according to EPA's GLPs and inspected/audited by the AHETF Quality Assurance Unit (QAU) per AHETF SOPs (AHETF SOP Chapter 5: A-K). The inspected phases were: Protocol, Field Phase, Field Data, Draft Report, Analytical Data, Final Report, and Post-Audit Report. Each study contains a signed quality assurance compliance statement as required by GLPs. Protocol amendments or deviations were addressed appropriately under GLP guidance and are described further in Section 4.0.

3.2 Quality Control

AHETF instituted various quality control measures to ensure proper field conduct including calibration of sprayers, preparation and handling of exposure measurement matrices, evaluation of test material, and field observations (AHETF SOP Chapter 10: A-G). Analytical quality control measures for ensuring the integrity of measurements captured in the research were also instituted according to AHETF SOP 9.J. Exposure monitoring matrices (inner whole body dosimeters, hand washes, face/neck wipes, OVS tubes) were fortified with known amounts of active ingredient to assess their stability during field, transit, and storage conditions according to AHETF SOP 8.E. Laboratory control samples were also fortified at the level of quantification and at levels capturing the range of expected field exposures for each matrix. Generally, field fortification samples were collected in triplicate at each of 3 levels (high, middle, and low) on each sampling day. Travel fortifications were generally conducted on each day of sampling in duplicate at the high fortification level only. Untreated control samples were generally conducted in duplicate on each day of sampling. Deviations from this general sampling protocol are specified in the sub-sections below.

The following sections provide results for all quality control sampling across all exposure measurement matrices for all chemicals used. The identified supplemental tables should be referenced for chemical-specific results.

3.2.1 Control Samples (Table S - 9)

As expected, most non-fortified (blank) laboratory and field control samples were below the LOQ. In no instance was an untreated laboratory control found to contain residues. Some field control samples, however, particularly the field control samples for the OVS air samplers, were found to have detectable residues. No summary of these results was provided in the study report. Detected residues in field control samples is a potentially notable finding, since they may impact field fortification recovery estimates, which in turn could alter actual field sample measurements.

Despite the findings in these studies, no action is deemed necessary because only trace amounts were found (most only slightly above the LOQ) which do not significantly impact the results. However, for future AHETF studies, residues found in field control samples should be systematically summarized and reasons for accounting for them (or not) should be described in the study reports.

3.2.2 Laboratory Fortification Recoveries (Table S - 10)

Along with one untreated control, two fortified samples served as additional laboratory recovery samples – one at the LOQ and the other at a level designated to encompass the range of anticipated residues. Average recoveries for each sampling media were > 90% thus no corrections were made to the field sampling measurements based on this aspect of the analytical process.

3.2.3 Field Fortification Recoveries

Field fortification sampling matrices are spiked with known amounts of chemical, then placed in the exposure monitoring area under similar conditions as those in which the actual sampling matrices used on the workers are handled (including drawing air through OVS samplers). Additional samples are fortified to assess degradation of the sample during transit from the field to the lab, but, per AHETF protocol, only analyzed if anomalous field fortification recoveries indicate potential degradation during transport. No storage or transport fortification samples were analyzed.

Field fortifications are conducted at 3 levels to capture the expected range of results, with triplicate samples taken on each day at each fortification level[5]. Once analyzed, the average recovery results (expressed as a percentage of known amount applied) are used as multipliers to adjust, or correct, all measured field samples. As the fortification samples are conducted at levels to capture the range of expected field sample results, adjustments are done using the average percent recovery for the fortification level closest to the measured field sample. The mid-point between each fortification level is used as the threshold in determining the average recovery percentage for use in adjusting the field sample.

With few exceptions, field fortification averages for each fortification level and each monitoring matrix were in the range of 70-120%. A summary of field fortification results for each matrix is provided below in Sections 3.1.3.1 – 3.1.3.4.

3.2.3.1 Inner Dosimeters (Table S - 11 and Table S - 12)

Most results for inner whole body dosimeter (WBD) field fortification samples were acceptable, with recoveries ranging from 78% to 112% and coefficients of variation ranging from 0.43% to 12.3%. Unusually high and low recoveries were observed at the 2200 ug and 5000 ug levels in

[5] AHE58 (CA-grape) reports a deviation from the standard 3-level fortification protocol resulting from dilution errors by the laboratory technician that were not discovered until after the fortification samples were used in the field and analyzed. Despite this difference, the fortifications are still useful to correct field samples and did not compromise the overall research.

AHE58 (CA-grape) – 233% and 42.7%, respectively. However, no results required adjustments using these fortification levels, so the decision to include or exclude these recoveries (as potential outliers) is moot.

3.2.3.2 Face/Neck Wipes (Table S - 13 and Table S - 14)

Results for face/neck wipe field fortification samples were acceptable, with average recoveries ranging from approximately 72.7% to 117% and coefficients of variation ranging from 1.1% to 13.8%.

3.2.3.3 Hand Washes (Table S - 15 and Table S - 16)

Results for hand wash field fortification samples were acceptable, with average recoveries ranging from 62.5% to 122% and coefficients of variation ranged from 1.2% to 13.3%.

3.2.3.4 OVS Air Samplers (Table S - 17, Table S - 18, and Table S - 19)

The results for face/neck wipe field fortification samples were acceptable, with average recoveries ranging from approximately 75% to 129% and coefficients of variation ranging from 1.08% to 25.7%. However, notably anomalous results were observed and are listed in Table 4 below. Additionally, per AHETF standard procedures, samples for the highest fortification level (1000 ug) went unanalyzed as no OVS air sample in the field exceeded 100 ug.

Table 4. Unusual OVS Field Fortification Results

AHE55 (FL-citrus)	Contamination was suspected for the malathion low-level (0.05 ug) fortification since recoveries were abnormally high for the three samples (203%, 157%, and 150%). Field monitoring samples that would have used results for this fortification level instead were adjusted based on the mid-level fortification results.
AHE58 (CA-grape)	Improper fortification sample preparation led to unusually high recovery samples at the low-level on the first two days of sampling. These were excluded from calculation of the low-level recovery average.
	The high-level fortification for the first two days of sampling should have been 100 ug samples but were inadvertently prepared at 250 ug. Additionally, one sample was lost during analysis and the other two were unusually high, indicating improper fortification. These samples were not included in calculation of the high-level fortification average. This had no effect on results, because no AHE58 field sample residue was high enough to justify use of recovery results from either of the high-level fortification samples.
AHE59 (WA-apple)	Described in the study report as resulting from improper vial preparation, an unusually low recovery (11.8%) at the mid-level fortification (0.5 ug) on the first day of sampling was excluded in calculation of average
	Despite being unusually high, recoveries from fourth day of sampling (163% and 184%) at the low-level fortification (0.05 ug) were included in the average calculation due to large recoveries at this fortification level on other sampling days. For this level, the maximum adjustment factor of 1.2 will be used, per AHETF standard procedures, since the factor from the average recovery is 1.29.

3.3 Field Measurements

The following sections summarize the exposure monitoring results, conducted as described in Section 2.8. All measurements were appropriately adjusted for field fortification recoveries. Face/neck wipe measurements were extrapolated to un-wiped portions of the face and head

according to AHETF SOP 9.K. For samples below the LOQ or LOD, ½ LOQ or ½ LOD was used.

Additionally, in order to account for potential residue collection method inefficiencies, EPA has directed the AHETF to make adjustments to hand and face/neck field study measurements as follows[6]:

- if measured exposures from hands, face and neck contribute less than 20% as an average across all workers, no action is required;
- if measured exposure contribution from hands and face/neck represents between 20% and 60% of total, the measurements shall be adjusted upward by 50%, or submission of a validation study to support the residue collection method
- if measured exposure contribution from hands and face/neck represents is greater than 60%, a validation study demonstrating the efficiency of the residue collection methods is required.

3.3.1 Inner Dosimeters (Table S - 20)

After adjusting for field fortification recoveries (see Section 3.1.3.1) and summing the upper and lower body sections, the total dermal exposure underneath the long-sleeve shirt and pants ranged from 0.7 – 1540 µg with an average of 99.8 µg. Out of a total of 48 inner dosimeter samples, 7 were below the LOQ or LOD.

3.3.2 Face/Neck Wipes (Table S - 21)

Because some workers wore label-prescribed eye protection or elected to wear a respirator, and because measurements cannot be easily conducted on hair, extrapolations from those portions of the face/neck that are wiped need to be made to portions of the head that are not measured. Specifics on these adjustment factors can be found in AHETF SOP 9.K. Additionally, to account for potential inefficiencies in residue collection by the wipe technique, the measurements are further adjusted by a factor of 2 (i.e., assuming 50% inefficiency).

After adjusting for field fortification recoveries (see Section 3.1.3.2) and extrapolating to non-wiped portions of the head described above, total head exposure ranged from 0.24 – 7.24 µg with an average of 1.19 µg. Including adjustments for potential method collection inefficiencies, total head exposure ranged from 0.48 – 14.4 µg with an average of 2.36 µg. Out of a total of 24 face/neck wipe samples, 21 were below the LOQ or LOD.

3.3.3 Hand Washes (Table S - 22)

Per protocol, hand washes were collected at the end of each work day and during restroom or lunch breaks. From only one worker – AHE59 (WA-apple) MU3 – were more than 2 hand wash samples collected. As for the face/neck wipe measurements, the hand wash measurements were also adjusted by a factor of 2 to reflect potential inefficiencies in the collection method.

[6] This directive was discussed and presented at a meeting of the Human Studies Review Board (June 2007). The terminology used to describe this are "method efficiency adjusted" (MEA) or "method efficiency corrected" (MEC).

After adjusting for field fortification recoveries (see Section 3.1.3.3) and summing each hand wash, the total hand exposure ranged from 0.65 – 1312 µg with an average of 138 µg. Including adjustments for potential method collection inefficiencies, total hand exposure ranged from 1.3 – 2624 µg with an average of 275 µg. Out of a total of 36 hand wash samples, 4 were below the LOQ or LOD.

3.3.4 OVS Air Samplers/Inhalation Exposure (Table S - 23)

Front and back sections of the OVS tube were analyzed separately. Most back section samples were non-detects, with none above the LOQ. All front section samples had detected residues. Because pump operation time was not recorded, inhalation data for subject A4 in study AHE59 (WA-apple) was considered invalid, and was not analyzed. Thus there were a total of 23 air samples. After adjusting for field fortification recoveries (see Section 3.1.3.4) the total collected chemical amounts ranged from 0.024 – 1.54 µg with an average of 0.386 µg.

To calculate worker inhalation exposure – specifically, "breathing zone" exposure – the measured amounts are adjusted based on the pump flow rate (in liters per minute) and a typical worker's breathing rate for this type of activity. For these studies a breathing rate of 8.3 liters per minute was used, representing sedentary activities, like driving a tractor (NAFTA, 1998). The calculation is as follows:

*Inhalation exposure = Adjusted residue (µg) * [Breathing rate (LPM) ÷ Pump flow rate (LPM)]*

Calculated inhalation exposures ranged from 0.103 – 6.39 µg, with an average of 1.6 µg.

3.4 Exposure Calculations

This section provides total exposures (expressed as mass active ingredient), as well as exposures normalized to (i.e., dividing by) body weight and amount of active ingredient handled (AaiH).

3.4.1 Dermal Exposures (Table S - 24)[7]

Total dermal exposure, calculated by summing the results for inner dosimeters, hand washes and face/neck wipes, ranged from 9 – 3168 µg, with an average of 377 µg. Normalized to the worker's body weight, dermal exposures ranged from 0.13 – 39.4 µg/kg, with an average of 4.48 µg/kg. Normalized by the amount of active ingredient handled, dermal unit exposures ranged from 0.4 – 76.6 µg/lb ai, with an average of 13.3 µg/lb ai.

3.4.2 Inhalation Exposures (Table S - 24)

As shown in Section 3.2.4, inhalation exposure is calculated based on the chemical in air over the monitoring period, the pump flow rate, and the worker's breathing rate. Inhalation exposures

[7] All dermal exposures reflect the 50% method efficiency assumption (i.e., a 2X upward adjustment) for hand rinse and face/neck wipe measurements ("MEA" = method efficiency adjustment). Supplemental Table S-24 presents "Non-MEA" values for reference.

ranged from 0.1 – 6.39 µg, with an average of 1.6 µg. Normalized to the worker's body weight, inhalation exposures ranged from 0.001 – 0.089 µg/kg, with an average of 0.019 µg/kg. Normalized by the amount of active ingredient handled, inhalation unit exposures ranged from 0.002 – 0.245 µg/lb ai, with an average of 0.0567 µg/lb ai.

3.5 Field Observations (Table S - 25)

For all studies, observers were employed to monitor each worker and record their behavior throughout the work day. Much of the observations detailed application procedures (e.g., AHE55 MU A1 @ 1020: "Finishes outside of row 1, N to S, then turns and sprays other side of row 1W and row 2E using all nozzles. Row 1 is shorter than other rows, only 6 to 8 ft. trees."), while others indicated potential impacts on exposure such as when they entered/exited the vehicle and/or instances where they contacted something with a bare hand (e.g., AHE59 MUA4 @ 1144: "Exited cab, walked back to sprayer and with bare hands, turned lever to shut off one side of airblast sprayer to treat end row."). Field observations should be considered when analyzing this data.

4.0 Protocol Amendments and Deviations (Table S - 26)

Field and analytical phase deviations were minor. Reported field phase deviations included failure to collect a handwash sample at a bathroom break (AHE56 – GA-pecan, MUA4) and slight deviations from specified ranges of amount of active ingredient handled and monitoring time requirements. Additionally, workers were observed not wearing chemical-resistant gloves while outside the application equipment (see Table S-25), despite protocols stating that "the use of label-specified PPE (especially the use of gloves outside the cab if contacting contaminated surfaces)" would be enforced during participation. Analytical phase deviations included two instances where a 15% calibration criterion was exceeded as wells as some analytical method deviations. No protocol amendments or deviations were considered to adversely affect the results of exposure monitoring or compromise the overall research.

5.0 Conclusion

As the studies followed their corresponding protocols as well as EPA guidelines for occupational pesticide exposure monitoring, the results are considered useful for assessment of exposure and risk for closed cab airblast applicators. Since these were collected with the intention to populate a generic pesticide exposure database, reviewers are directed to the additional information and statistical analyses in the AHETF Closed Cab Airblast Scenario Monograph (AHETF, 2010; MRID 48314201) and recommendations for use of the data in its corresponding HED review (Crowley, 2011; D381148).

6.0 References

AHETF, (2008-a). Volume IV AHETF Revised Governing Document for a Multi-Year Pesticide Handler Worker Exposure Monitoring Program. Version Number: 1. April 7, 2008. Agricultural Handlers Exposure Task Force (AHETF). [MRID 47172401]

AHETF, (2008-b). Monitoring Unit Selection and Construction Plan for Scenario: Airblast Application of Liquids Sprays to Crops Using Closed Cab Equipment. April 1, 2008. Agricultural Handlers Exposure Task Force (AHETF).

AHETF, (2010). Agricultural Handler Exposure Scenario Monograph: Closed Cab Airblast Application of Liquid Sprays. Report Number AHE1005. December 2, 2010. [MRID 48314201]

Bruce, E. (2010-a). Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in California Trellis Crops. Study Number AHE58. Unpublished study prepared by the Agricultural Handlers Exposure Task Force. 282 p. November 3, 2010. MRID 48289604.

Bruce, E. (2010-b). Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Washington Pome Fruit. Study Number AHE59. Unpublished study prepared by the Agricultural Handlers Exposure Task Force. 220 p. November 3, 2010. MRID 48303502.

Crowley, M., 2011. Memorandum: Review of Agricultural Handler Exposure Task Force (AHETF) Monograph: Closed Cab Airblast Application of Liquid Sprays. D381148. January 7, 2011.

NAFTA - Dept. of Pesticide Regulation (DPR), California EPA, HSM-98014, April 24, 1998.

Smith, L. (2010-a). Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Florida Citrus. Study Number AHE55. Unpublished study prepared by the Agricultural Handlers Exposure Task Force. 377 p. November 3, 2010. MRID 48289601.

Smith, L. (2010-b). Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Georgia Pecans. Study Number AHE56. Unpublished study prepared by the Agricultural Handlers Exposure Task Force. 379 p. November 3, 2010. MRID 48289602.

Smith, L. (2010-c). Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Michigan Stone Fruit. Study Number AHE57. Unpublished study prepared by the Agricultural Handlers Exposure Task Force. 169 p. November 3, 2010. MRID 48303501.

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Table S - 1. Administrative Details						
Study ID		**Title**	**Author**	**Report Date**	**Field Principal Investigator**	**Analytical Facility**
AHE#	**EPA MRID**					
AHE55	48289601	Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Florida Citrus	Larry D. Smith, Ph.D.	11/3/10	Tami I. Belcher	Morse Laboratories, Inc. 1525 Fulton Ave. Sacramento, CA 95825
AHE56	48289602	Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Georgia Pecans	Larry D. Smith, Ph.D.	11/3/10	Aaron Rotondaro	Morse Laboratories, Inc. 1525 Fulton Ave. Sacramento, CA 95825
AHE57	48303501	Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Michigan Stone Fruit	Larry D. Smith, Ph.D.	11/3/10	Aaron Rotondaro	Ricerca Biosciences, LLC 7528 Auburn Road Concord, OH 44077
AHE58	48289604	Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in California Trellis Crops	Eric Bruce	11/3/10	Brian D. Lange	Morse Laboratories, Inc. 1525 Fulton Ave. Sacramento, CA 95825
AHE59	48303502	Determination of Dermal and Inhalation Exposure to Workers During Airblast Applications of Liquid Sprays Using Closed Cab Equipment in Washington Pome Fruit	Eric Bruce	11/3/10	Tami I. Belcher	Morse Laboratories, Inc. 1525 Fulton Ave. Sacramento, CA 95825

Table S - 2. Summary of Pesticides Used									
Study ID	Product Information						Product Purity Analysis		
	Trade Name	Formulation	Manufacturer	Packaging	Active Ingredient	Label % ai	Actual % ai	Lot / Batch #	Laboratory (Date)
AHE55	Sevin® brand XLR Plus	Liquid Flowable	Bayer CropScience	2.5 gallon plastic jug	Carbaryl	44.1% by weight	43.7% by weight	E1H0189-JH122	Morse Laboratories (3/6/09)
	Fyfanon®	Emulsifiable Concentrate	Helena Chemical Company	2.5 gallon plastic jug	Malathion	56.44% by weight	59.6% by weight	CG7L0523	Morse Laboratories (3/6/09)
AHE56	Fyfanon® 5E	Emulsifiable Concentrate	Helena Chemical Company	2.5 gallon plastic jug	Malathion	56.44% by weight	59.3% by weight	CG7L0523	Morse Laboratories (3/16/09)
	Sevin XLR Plus	Aqueous suspension / flowable	Bayer CropScience	2.5 gallon plastic jug	Carbaryl	44.1% by weight	44.5% by weight	208006 JH164	Morse Laboratories (3/6/09)
AHE57	Bravo Weather Stik	Aqueous suspension / flowable	Sygenta Crop Protection, Inc.	2.5 gallon plastic jug	Chlorothalonil	54% by weight	54.2% by weight	GBY8D1601	EPL Bio-Analytical Services (12/2/09)
AHE58	Gowan Malathion 8	Emulsifiable Concentrate	Gowan Company	2.5 gallon wide mouth plastic jug	Malathion	79.5% by weight	75.87% by weight	30AK8003	EPL Bio-Analytical Services (2/26/10)
							72.4% by weight	30AK8002	EPL Bio-Analytical Services (2/26/10)
							68.35% by weight	30AK7005	EPL Bio-Analytical Services (2/26/10)
	Gowan Malathion 8 Flowable	Emulsifiable Concentrate	Gowan Company	2.5 gallon wide mouth plastic jug	Malathion	79.5% by weight	67.52% by weight	30AK8010	EPL Bio-Analytical Services (2/26/10)

Table S - 2. Summary of Pesticides Used									
Study ID	Product Information						Product Purity Analysis		
	Trade Name	Formulation	Manufacturer	Packaging	Active Ingredient	Label % ai	Actual % ai	Lot / Batch #	Laboratory (Date)
							67.18% by weight	30AK8003	EPL Bio-Analytical Services (2/26/10)
	Malathion 8 Aquamul	Emulsifiable Concentrate	Loveland Products, Inc.	2.5 gallon wide mouth plastic jug	Malathion	81.8% by weight	78.2% by weight	531K004A-9	EPL Bio-Analytical Services (2/19/10)
AHE59	Sevin® Brand 4F Carbaryl Insecticide	Aqueous Suspension / flowable	Bayer CropScience	2.5 gallon plastic jug	Carbaryl	43% by weight	41.2% by weight	E160395-JF192	EPL Bio-Analytical Services (12/2/09)
							43% by weight	E160226-JF110	EPL Bio-Analytical Services (12/2/09)
	Carbaryl 4L Insecticide	Aqueous Suspension / flowable	Drexel Chemical Company	2.5 gallon plastic jug	Carbaryl	43.4% by weight	45.4% by weight	7KI211	EPL Bio-Analytical Services (12/2/09)
	Carbaryl 4L Insecticide	Aqueous Suspension / flowable	Loveland Products, Inc.	2.5 gallon plastic jug	Carbaryl	43% by weight	43.4% by weight	E18044-JH345	EPL Bio-Analytical Services (12/2/09)

Table S - 3. Summary of Monitored Workers and Locations											
Study ID	**MU ID**	**Age**	**Gender**	**Height (cm)**	**Weight (kg)**	**Yrs. Experience**	**State**	**County**	**Town**	**Date**	**Crop**
AHE55	A1	70	M	175	112	48	FL	Polk	Babson Park	10/29/08	Orange
	A2	33	M	183	94	8	FL	Polk	Crews Lake	10/30/08	Tangerine
	A3	20	M	188	106	10	FL	Orange	Winter Garden	10/31/08	Orange
	A4	29	M	175	93	9	FL	Polk	Fort Meade	10/27/08	Orange
	A5	30	M	175	92	3	FL	Orange	Labelle	10/28/08	Orange
AHE56	A1	63	M	168	107	10	GA	Tift	Tifton	8/28/08	Pecan
	A2	68	M	173	92	44	GA	Berrien	Alapaha	8/26/08	Pecan
	A3	43	M	193	102	8	GA	Coffee	Douglas	8/27/08	Pecan
	A4	49	M	180	95	7	GA	Irwin	Ocilla	8/25/08	Pecan
	A5	51	M	173	91	8	GA	Irwin	Ocilla	8/25/08	Pecan
AHE57	A1	53	M	165	70	24	MI	Leelanau	Cedar / Lake Leelanau	5/22/09	Cherry
	A2	21	F	161	70	6	MI	Grand Traverse	Williamsburg / Traverse City	5/15/09	Cherry
	A3	58	M	175	103	50	MI	Grand Traverse	Mapleton	5/19/09	Cherry
	A4	48	M	196	143	11	MI	Grand Traverse	Williamsburg / Traverse City	5/15/09	Cherry
	A5	46	M	183	91	30	MI	Leelanau	Cedar / Lake Leelanau	5/22/09	Cherry
AHE58	A1	49	M	168	77	28	CA	Fresno	Selma	6/26/09	Grape
	A2	42	M	168	72	20	CA	Fresno	Firebaugh	7/1/09	Grape
	A3	43	M	165	76	8	CA	Sacramento	Walnut Grove	7/28/09	Grape
	A4	31	M	185	83	5	CA	San Joaquin	Linden	8/7/09	Grape
	A5	27	M	183	108	7	CA	San Joaquin	Lodi	8/10/09	Grape
AHE59	A1	62	M	176	75	40	WA	Yakima	Sunnyside	4/30/09	Apple
	A2	49	M	163	115	29	WA	Yakima	Wapato	5/7/09	Apple
	A3	53	M	180	85	25	WA	Benton	Prosser	5/8/09	Apple
	A4	26	M	175	67	5	WA	Yakima	Sunnyside	5/9/09	Apple
	A5	Worker monitoring planned but not executed because: • On the scheduled monitoring day, only one field studies team was available and already monitoring another worker • A replacement worker from another eligible grower was not monitored because the grower did not need to spray the surrogate chemical (carbaryl) • An identified backup grower did not have a working closed-cab (broken air conditioning) • The application window for surrogate chemical (carbaryl) ended before recruitment was possible.									

Table S - 4. Summary of Meteorological Conditions

Study ID	State	MU ID	Date	Monitoring Period	Humidity (%)		Temp. (° F)		Wind			Cloud Cover (%)	Heat Index[a]	Rainfall (mm)
									Speed (mph)		Direction			
					Max	Min	Max	Min	Max	Min				
AHE55	FL	A1	10/29/08	1012-1449	53.8	26.8	65.7	54.0	7.1	3.7	NW	0-20	<80	0
		A2	10/30/08	1035-1453	54.3	41.3	70.3	59.4	10.0	5.4	N	0-20	<80	0
		A3	10/31/08	0907-1343	76.8	42.3	77.4	63.5	6.6	2.9	N	0-20	<80	0
		A4	10/27/08	0932-1423	84.8	29.3	79.3	60.1	3.3	0.8	N	0-20	<80	0
		A5	10/28/08	1023-1808	45.3	20.8	66.2	55.2	8.3	2.9	NW	0-20	<80	0.01
AHE56	GA	A1	8/28/08	0824-1249	89.0	49.6	88.5	74.7	4.10	0.10	NW	0-20	<120	0
		A2	8/26/08	0955-1443	84.7	61.0	86.2	78.4	8.30	0.30	S	0-40	<120	0
		A3	8/27/08	0958-1553	77.2	47.3	90.5	80.2	5.20	0.00	W	20-60	<120	0.10
		A4	8/25/08	0036-0501	93.8	92.8	72.9	71.6	3.30	0.10	SE	80-100	<120	0
		A5	8/25/08	0548-1216	94.6	68.3	83.3	71.8	5.70	0.20	SE	80-100	<120	2.89
AHE57	MI	A1	5/22/09	1335-1533	49.8	27.7	66.9	62.4	7.6	0.3	SE	0-20	<105	0
		A2	5/15/09	0620-0958	97.5	70.2	52.7	35.4	8.0	0.1	E	20-40	<105	0
		A3	5/19/09	1255-1655	66.4	56.5	62.1	56.3	10.4	0.5	NW	0-20	<105	0
		A4	5/15/09	1419-1834	55.6	37.3	69.4	62.4	13.4	0.3	SE	80-100	<105	0
		A5	5/22/09	0500-0942	96.0	60.1	58.3	47.5	6.2	0.1	NW	80-100	<105	0
AHE58	CA	A1	6/26/09	0801-1346	55.6	12.5	93.9	64.4	3.7	1.0	W	0-20	<105	0
		A2	7/1/09	0650-1149	65.8	25.3	88.3	65.8	3.5	1.1	N	0-20	<105	0
		A3	7/28/09	0641-1056	88.2	55.3	74.5	57.0	5.4	4.5	NR[b]	0-20	<105	0
		A4	8/7/09	0321-0921	88.9	35.0	71.2	53.2	3.2	<0.1	N	0-20	<105	0
		A5	8/10/09	0726-1034	84.7	30.8	87.8	61.9	2.5	0.5	NW	0-20	<105	0
AHE59	WA	A1	4/30/09	0732-1233	43.4	29.2	59.7	51.8	6.1	1.8	N	0-20	<80	0
		A2	5/7/09	0920-1313	39.3	27.8	60.8	55.3	8.3	5.0	W	0-20 20-40	<80	0
		A3	5/8/09	0809-1328	59.3	33.3	60.8	47.5	4.2	2.1	S	0-20	<80	0
		A4	5/9/09	0707-1628	67.8	18.8	71.1	46.1	4.6	0.8	SW	0-20 20-40	<80	0

NR = not reported

[a] Heat index threshold set at 120 in 2008 and is applicable for AHE55 and AHE56. In 2009, it was revised down to 105 and applicable to AHE57, AHE58, and AHE59.

[b] Report indicated that the pin holding the weather vane in place for storage was not removed, so readings are unreliable.

Table S - 5. Summary of Work Clothing and PPE										
Study ID	MU ID	Long-sleeved Shirt		Pants		Gloves[2]	Eye Protection[4]	Shoe type (over socks)	Cap	Respirator Type[4]
		Style	Material	Style	Material					
AHE55	A1	Button-front	Cotton	Work	Cotton/Polyester	Rubber	Goggles	Tennis shoes	--	
	A2	Button-front	Cotton	Denim jeans	Cotton	Rubber	Sunglasses Goggles	Leather shoes	--	
	A3	Button-front[1]	Cotton	Denim jeans	Cotton	Rubber	Sunglasses	Leather boots	Baseball	--
	A4	Button-front[1]	Cotton	Denim jeans	Cotton	Rubber	Goggles	Water-resistant boots	--	
	A5	Button-front	Cotton/Polyester	Work	Cotton/Polyester	Rubber	Goggles	Leather boots	Baseball	--
AHE56	A1	Button-front	Cotton	Denim jeans	Cotton	Latex	--	Leather boots	Baseball	--
	A2	Button-front	Cotton	Denim jeans	Cotton	Latex	Yes	Leather shoes	Baseball	--
	A3	Button-front	Cotton	Denim jeans	Cotton	Latex	--	Leather boots	--	
	A4	Button-front	Cotton	Denim jeans	Cotton	Latex	--	Leather shoes	--	
	A5	Button-front	Cotton	Denim jeans	Cotton	Latex	--	Tennis shoes	Baseball	--
AHE57	A1	Button-front	Cotton	Denim jeans	Cotton	Nitrile	Yes	Leather shoes	Baseball	--
	A2	T-shirt	Cotton	Knit Pull-on	Cotton	Nitrile	Yes	Tennis shoes	--	
	A3	Button-front	Cotton	Work (slacks)	Cotton	Nitrile	--	Leather shoes	Baseball	--
	A4	Sweatshirt	Cotton	Denim jeans	Cotton	Nitrile	--	Leather shoes	--	
	A5	Sweatshirt	Cotton	Denim jeans	Cotton	Nitrile	--	Tennis shoes	--	
AHE58	A1	Button, collar	65% polyester, 35% cotton	Jeans, white	100% cotton	Nitrile	Goggles	Leather boots	Baseball	Dust/mist[5]
	A2	Button, collar	Cotton	Jeans,	100% cotton	Nitrile	Eyeglasses	Leather	Baseball --	--

Table S - 5. Summary of Work Clothing and PPE										
Study ID	**MU ID**	**Long-sleeved Shirt**		**Pants**		**Gloves[2]**	**Eye Protection[4]**	**Shoe type (over socks)**	**Cap**	**Respirator Type[4]**
		Style	**Material**	**Style**	**Material**					
				blue				boots		
	A3	Long-sleeve	100% cotton	Blue jeans	Cotton	Nitrile	Eyeglasses	Leather shoes	Baseball	--
	A4	Button-up	100% cotton	Blue jeans	100% cotton	Nitrile	Eyeglasses	Leather boots	Baseball	--
	A5	Long sleeved T-shirt	Cotton	Jeans	Denim=cotton	Nitrile	Eyeglasses	Leather boots	Baseball	--
AHE59	A1	Button-front	Cotton	Denim jeans	Cotton	Nitrile	Eye/sunglasses	Rubber boots	Baseball	--
	A2	Pull over	Cotton	Denim jeans	Cotton	Rubber	Sunglasses	Leather boots	Baseball	--
	A3	Button-front	Cotton	Denim jeans	Cotton	Rubber and Cloth[3]	Sunglasses	Leather boots	Baseball	--
	A4	Button-front	Cotton	Denim jeans	Cotton	Rubber	--	Tennis shoes	--	

[1] Per study protocol, AHETF replaced a non-WPS compliant shirt worn by worker.
[2] Gloves worn while outside the cab only.
[3] Non-protective, worn while inside the cab.
[4] Per AHETF SOP 9.K, exposure is extrapolated to portions of face covered by eyewear or respiratory protection. --
[5] Though not label-required, worker elected to wear a dust/mist face mask.

Table S - 6. Summary of Application Characteristics														
Study ID	MU ID	Crop				Application Equipment					Speed (mph)	Tank Size (gal)	Application / Exposure Monitoring Time
		Type	Height (ft)	Spacing (ft)		Tractor/truck	Airblast						
				Full	In-row		Brand	Nozzle					
								Type	# used	Pressure (psi)			
AHE55	A1	Orange	8-16	25	15	John Deere 6615	Rears Power Blast	Albuz ATR80	24	NR	NR	500	4.6
	A2	Tan-gerine	12-14	22	8-9	Kubota M9540	Hogan	Hogan ATR80	35	NR	NR	500	4.3
	A3	Orange	5-8	25	12.5	John Deere 7410	Rears Power Blast	Albuz ATR80	16	NR	NR	1000	4.6
	A4	Orange	10-12	30	12-15	John Deere 7330	Rears Power Blast	Albuz	24	NR	NR	1000	4.9
	A5	Orange	8-12	25	15	John Deere 6615	Durand Wayland Super Spray	Ceramic	18	NR	NR	1000	7.8
AHE56	A1	Pecan	30-40	60	60	Massey Ferguson 3630	Savage 5540	Flood jet	8	70	3-4	500	4.4
	A2	Pecan	45-65	40	40	John Deere 7420	Savage 500	NR	7	40	2.5-3	500	4.8
	A3	Pecan	80	60	50	Flatbed truck	NR	NR	14	200	3-5	500	5.9
	A4	Pecan	40-60	50	50	John Deere 5603	Savage 5534	NR	7	40	2.1	500	4.4
	A5	Pecan	40-60	50	50	Flatbed truck	NR	NR	15	200	3	500	6.5
AHE57	A1	Cherry	15	22	16	John Deere 6330	Ag-Tec	NR	12	40	3.5	400	2
	A2	Cherry	18	23	18	John Deere 5525	Ag Superior Spray Blast	NR	8	50	3	300	3.6
	A3	Cherry	14-18	22	20	Case 1394	Speed Sprayer LV500	2.5-3	500	Cone	12	450	4
	A4	Cherry	23	23	23	Massey Ferguson 3435F	John Bean 393CPB	3	500	NR	12	NR	4.25
	A5	Cherry	25	24	20-25	Massey Ferguson 4355	Rears Pul	3	400	Cone	8	200	4.7
AHE58	A1	Grape	5	10-12	6-7	New Holland TS110A	D&M dual-row	Porcelain	20	125	3-3.5	600	5.75
	A2	Grape	7	11	7	John Deere 4430	Int. Man. 256	Plastic	8	~ 90	3-4	600	5
	A3	Grape	7	12	8	John Deere 6715	Aer-O-Fan dual-row	Cone, hollow	16	80	2.8	600	4.25
	A4	Grape	7	11	8	Kubota M8200 Narrow	Lectro Blast dual-row	Air sheer	20	25	3.5	400	6

Table S - 6. Summary of Application Characteristics													
Study ID	**MU ID**	**Crop**				**Application Equipment**					**Speed (mph)**	**Tank Size (gal)**	**Application / Exposure Monitoring**
		Type	**Height (ft)**	**Spacing (ft)**		**Tractor/truck**	**Airblast**						
				Full	**In-**		**Brand**	**Nozzle**					
	A5	Grape	8	10	7	John Deere 5525N	Rears dul-row	Teejet cera-mic, 8's and 5's tip	18	~ 100	3.1	500	3.1
AHE59	A1	Apple	8-14	15-20	10	John Deere 5500N	Rears	NR	14	140	NR	400	5
	A2	Apple	13-15	18	12	New Holland T75F	Rears	NR	16	40	2.6	400	3.9[a]
	A3	Apple	10-12	16	6	John Deere 5510N	Rears	NR	14	150	NR	400	5.3
	A4	Apple	10	13	4	John Deere 5525	Rears	NR	8	145	5.2	400	9.4

NR = not reported

[a] Inhalation monitoring time = 3.4 hrs as pump was not running for up to 36 minutes from 1237 – 1313.

Table S - 7. Summary of Application Rate Information												
Study ID	MU ID	Crop	Active Ingredient (ai)	Product Conc. (lb ai / gallon)	# Loads applied	Area Treated (acres)	Application Amount					
							Spray		Product		Active Ingredient	
							Per Acre (gal)	Total (gal)	Per Acre (gal)	Total (gal)	Per Acre (lb)	Total (lb)
AHE55	A1	Orange	Malathion	5.3	3	12	125	1500	0.125	1.5	0.67	8
	A2	Tangerine	Carbaryl	4.0	3	6	200	1200	0.625	3.75	2.5	15
	A3	Orange	Carbaryl	4.0	3	9	333	3000	0.675	6.0	2.67	24
	A4	Orange	Carbaryl	4.0	4	20+	200	4000	0.5	10.0	2	40
	A5	Orange	Carbaryl	4.0	3	30+	100	3000	0.625	18.75	2.5	75
AHE56	A1	Pecan	Malathion	5.3	3	12	100	1200	0.125	1.5	0.66	7.9
	A2	Pecan	Malathion	5.3	3	18	83.3	1500	0.167	3	0.88	15.8
	A3	Pecan	Malathion	5.3	6	30	100	3000	0.157	4.7	0.82	24.6
	A4	Pecan	Carbaryl	4.0	4	20	100	2000	0.625	12.5	2.53	50.5
	A5	Pecan	Carbaryl	4.0	6	30	100	3000	0.625	18.75	2.53	75.7
AHE57	A1	Cherry	Chlorothalonil	6.0	2	4	40	190	0.448	1.79	2.7	10.8
	A2	Cherry	Chlorothalonil	6.0	3	7.5	60	450	0.373	2.8	2.25	16.9
	A3	Cherry	Chlorothalonil	6.0	3	12	62.5	750	0.383	4.59	2.3	27.6
	A4	Cherry	Chlorothalonil	6.0	3	19.75	100	1500	0.346	6.75	2.1	40.7
	A5	Cherry	Chlorothalonil	6.0	3	24	50	1200	0.625	15	3.76	90.3
AHE58	A1	Grape	Malathion	7.27	4	35	60	2100	0.25	8.73	1.81	63.5
	A2	Grape	Malathion	6.88	4	20	100	2000	0.25	5.0	1.72	34.4
	A3	Grape	Malathion	7.65	3	16	75	1200	0.19	3.0	1.44	23.0
	A4	Grape	Malathion	6.76	5	35	50	1750	0.25	8.75	1.69	59.2
	A5	Grape	Malathion	7.29	3	15	100	1500	0.07	1.0	0.49	7.3
AHE59	A1	Apple	Carbaryl	~ 4	4	8.5	165	1400	0.5-0.625	4.125	1.86	15.8
	A2	Apple	Carbaryl	~ 4	3	6	200	1200	0.625	2.25	1.57	9.4
	A3	Apple	Carbaryl	~ 4	4	12	108	1300	0.35	4.06	1.33	15.9
	A4	Apple	Carbaryl	~ 4	7	23.5	97.2	2285	0.375	8.565	1.47	34.5

Table S - 8. Descriptions of Exposure Monitoring and Analytical Methods				
Exposure Monitoring Method		**Analytical Method**		
Matrix	**Description**	**Active Ingredient**	**Identification**	**Description**
Hand Rinse	Exposure to the hands was measured using a 500 mL aliquot of 0.01% v/v AOT solution. First, 400 mL AOT solution was poured over a worker's hand while rubbing them together over a glass bowl for approximately 30 seconds; the remaining 100 mL was then poured over the worker's hands into the bowl. The bowl of 500 mL solution (now with hand residue) is transferred to a clear glass jar and frozen for storage. Samples are taken at any point a worker would normally wash their hands (e.g., during lunch breaks, before using restroom, etc.) and at the end of monitoring. Samples are analyzed separately, but summed to obtain a total daily hand exposure.	Carbaryl	ARTF-AM-012 ["Determination of Carbaryl in Hand Wash Solutions" (6/98)]	Carbaryl was extracted from hand wash solutions with dichloromethane, using multiple extractions. An aliquot of the extract was evaporated to dryness, reconstituted in acetonitrile:water (50:50 v/v), then submitted to HPLC analysis using post column derivatization/fluorescence detection. The method provided for an optional Florisil SPE purification step that was not needed for this study.
		Malathion	ARTF-AM-006, Revision 3, ["Determination of Diazinon and Malathion in Hand Wash Solutions"]	Malathion residues in AOT hand wash solutions were retained on a conditioned C-18 reverse phase cartridge by passing an aliquot of hand wash sample through the cartridge. The cartridge was washed with water, air-dried, then washed with hexane. Malathion residues were eluted from the C-18 cartridge with dichloromethane. The eluate was evaporated to dryness, redissolved in acetone, then submitted to gas chromatographic (GC) analysis using flame photometric detection in the phosphorous mode (FPD/P).
		Chlorothalonil	ARTF-002 ["Determination of Chlorothalonil in Hand Wash Solutions", 10/17/97)]	Chlorothalonil was extracted from hand wash samples with 500 mL of 0.01% Aerosol®-OT. Each sample was added to separate separatory funnels with together with 10 mL of 20% NaCl, 2 mL of 10N H2SO4 and 50 mL of 1:1 petroleum ether:diethyl ether solution. The sample was shaken for ~2 minutes. The upper organic phase was collected in a evaporation flask. The extraction was repeated, the second organic phase was combined with the first one and then the samples were concentrated to ~2 mL by rotary evaporation and further concentrated to dryness with a stream of nitrogen. The samples were reconstituted with 10 mL of ethyl acetate and diluted depending on the type of sample (field measurement, recovery sample, etc.).

Table S - 8. Descriptions of Exposure Monitoring and Analytical Methods				
Exposure Monitoring Method		**Analytical Method**		
Matrix	**Description**	**Active Ingredient**	**Identification**	**Description**
Face/neck Wipe	The face/neck wipes consisted of two 4" x 4", 100% cotton gauze Kendall Curity sponges moistened with 4 mL of 0.01% (v/v) Aerosol® OT solution (sodium dioctyl sulfosuccinate in distilled water), used sequentially. Face/neck wipes were conducted prior to breaks and at the end of monitoring. Samples were combined for analysis.	Carbaryl	ARTF-AM-014 ["Determination of Carbaryl in Cotton Facial/Neck Wipes" (4/98)]	Carbaryl was extracted from cotton face/neck wipes with acetone. The aluminum foil used to wrap each sample was also rinsed with acetone to remove any residues. An aliquot of the extract was concentrated, subjected to Florisil SPE cleanup (most extracts), then submitted to high performance liquid chromatographic (HPLC) analysis using post column derivatization/fluorescence detection.
		Malathion	ARTF-AM-010, Revision 2, ["Determination of Diazinon and Malathion in Cotton Facial/Neck Wipes"]	Malathion was extracted from cotton facial/neck wipes with an aqueous AOT solution. The aluminum foil used to wrap each sample was also rinsed with aqueous AOT to remove any residues. An aliquot of the extract was subjected to C-18 cleanup. After the sample was passed through the cartridge, retaining the analyte, the cartridge was washed with water, then air-dried. Malathion residues were eluted from the C-18 cartridge with dichloromethane:methanol (50:50, v/v). The eluate was evaporated to dryness and redissolved in acetone.
		Chlorothalonil	ARTF-004 ["Determination of Chlorothalonil in Facial/Neck Wipes", (10/17/97)]	For the concurrent recoveries eight milliliters of 0.01% Aerosol®-OT were added to the gauze pads to simulate field conditions and chlorothalonil residues were extracted with 100 mL ethyl acetate. For field samples the aluminum foil in which the samples were wrapped was placed in 250 mL Teflon® capped jars with the samples and brought to a total volume of 100 mL with ethyl acetate. Samples were shaken for 30 minutes and further diluted depending on the type of sample (field measurement, recovery sample, etc.).
Inner Dosimeters	Whole body dosimeters – white, long underwear, 100% cotton one-piece Carolina Mills, Inc. union suits worn underneath the workers' outer clothing – served to represent the workers' skin on their arms, legs and torso. Following each monitoring period, the inner whole body	Carbaryl	AHETF-AM-031 ["Determination of Carbaryl in Cotton Inner Dosimeters Sectioned into Two Parts" (6/5/08)]	Carbaryl was extracted from cotton inner dosimeter sections (upper and lower) with acetone. Each section was considered one analytical sample. An aliquot of the sample extract was subjected to Florisil SPE cleanup, then submitted to high performance liquid chromatographic analysis using post column derivatization/fluorescence detection. The method,

Table S - 8. Descriptions of Exposure Monitoring and Analytical Methods				
Exposure Monitoring Method		**Analytical Method**		
Matrix	**Description**	**Active Ingredient**	**Identification**	**Description**
	dosimeters were carefully removed and sectioned into two pieces: lower body (below the waist) and upper body (above the waist).			incorporating Florisil cleanup, is applicable to samples containing residue levels ranging from 1.0 µg/sample to 500 µg/sample for inner dosimeters. A provision was made to extend the range of applicability by eliminating the Florisil cleanup.
		Malathion	AHETF-AM-018 ["Determination of Diazinon/Malathion in Cotton Inner Dosimeters Sectioned into Two Parts" Revised, 3/07]	Malathion was extracted from cotton inner dosimeter sections with acetone. The aluminum foil used to wrap each sample was also rinsed with acetone to remove any residues. Following evaporation of the solvent from an aliquot of the extract, the residues were suspended in water, then partitioned into hexane; the hexane was back-extracted against water. An aliquot of the hexane extract was subjected to Florisil Bond Elut cleanup.
		Chlorothalonil	ARTF-0001 ["Determination of Chlorothalonil In Dermal Dosimeters, (10/17/97)"]	Chlorothalonil residues were extracted from individual fabric segments with 2500 mL of hexane. The aluminum foil pieces used to wrap each sample were also rinsed with the solvent to remove any residues. The samples were shaken on a platform shaker for approximately 30 minutes, and then stored ≥ 8 hours at ambient temperature. 500 mL was decanted from each sample disposing of the initial 70 mL. From the remaining 430 mL the samples were processed depending on the type of sample (field measurement, fortification sample, etc.).
OVS tubes	Air sampling was conducted using OSHA Versatile Sampler (OVS) tubes connected by Tygon®-type tubing to a SKC model 110-100 personal air sampling pump set to approximately 2 liters per minute. The sample collector consisted of a glass fiber filter and two sections of XAD-2 sorbent housed in a 13 mm diameter glass tube. The sampler was clipped to the worker's collar (intake facing downward) and the tube attached to their belt. Pump on/off	Carbaryl	AHETF-AM-013 ["Determination of Carbaryl in OVS Air Sampling Tubes" Revision #1 (3/18/04)]	Air sampling tube contents were divided into front and back sections and the sections were analyzed separately. Carbaryl was extracted from the contents of each section of sorbent tube with acetonitrile. An aliquot of the extract was evaporated to dryness, reconstituted in acetonitrile:water (50:50, v/v) then submitted to HPLC analysis using post column derivatization/fluorescence detection. The method provided for an optional Florisil SPE purification step that was not needed for this study.
		Malathion	AHETF-AM-009,	Air sampling tube contents were divided into front

Table S - 8. Descriptions of Exposure Monitoring and Analytical Methods				
Exposure Monitoring Method		**Analytical Method**		
Matrix	**Description**	**Active Ingredient**	**Identification**	**Description**
	times and starting and ending flow rates were recorded.		Revision 4, ["Determination of Diazinon and Malathion in OVS Air Sampling Tubes"]	and back sections and the sections were analyzed separately. Malathion was extracted from the contents of each section of sorbent tube with acetone. An aliquot of the extract was evaporated to dryness, then reconstituted in acetone. Samples were submitted to gas chromatographic (GC) analysis using flame photometric detection in the phosphorous mode (FPD/P).
		Chlorothalonil	ARTF-003 ["Determination of Chlorothalonil in OVS Air Sampling Tubes" (10/17/97)]	Tube contents were divided into front and back sections and analyzed separately. After front and back sections were separated 3.5 mL of toluene was used to rinse the glass portion and extract each sample. The extraction was completed by shaking each sample for ~2 minutes. Aliquots/dilutions were taken/made depending on the type of sample (field measurement, recovery sample, etc.).

Table S - 9. Field Control Samples with Detected Residues						
Study	**Control Sample Type**	**# with detected residues**	**Sample ID**	**Residue Found (ug/sample)**	**LOQ (ug/sample)**	**Comparison to LOQ**
AHE55	OVS tube (front section)	2 of 6	55-F2-03-AR-C1 (F)	0.0363	0.01	3.6X > LOQ
			55-F2-03-AR-C2 (F)	0.0404	0.01	4X > LOQ
AHE57	OVS tube (front section)	4 of 4	57-F1-01-AR-C1 (F)	0.02006	0.005	4X > LOQ
			57-F1-AR-C2 (F)	0.00560	0.005	1X > LOQ
			57-F1-03-AR-C1 (F)	0.01845	0.005	3.7X > LOQ
			57-F1-03-AR-C2 (F)	0.01964	0.005	4X > LOQ
	OVS tube (back section)	2 of 4	57-F1-03-AR-C1 (B)	0.00215	0.005	2.5X < LOQ
			57-F1-03-AR-C2 (B)	0.00855	0.005	1.7X > LOQ
AHE58	Inner Dosimeter	3 of 8	58-FF-02-ID-C1	0.76	1.0	1.3X < LOQ
			58-FF-02-ID-C2	1.2	1.0	1.2X > LOQ
			58-FF-03-ID-C2	0.32	1.0	3X < LOQ
	Inner Dosimeter (confirmatory samples)	5 of 5	58-FF-02-ID-C1	1.2	1.0	1.2X > LOQ
			58-FF-02-ID-C1	1.1	1.0	1.1X > LOQ
			58-FF-02-ID-C2	0.89	1.0	1.1X < LOQ
			58-FF-02-ID-C2	1.3	1.0	1.3X > LOQ
			58-FF-03-ID-C2	0.21	1.0	4.8X < LOQ
	OVS tube (front section)	6 of 8	58-FF-02-AR-C1 (F)	0.0793	0.005	16X > LOQ
			58-FF-02-AR-C2 (F)	0.0634	0.005	13X > LOQ
			58-FF-03-AR-C1 (F)	0.0119	0.005	2.4X > LOQ
			58-FF-03-AR-C2 (F)	0.0019	0.005	2.6X < LOQ
			58-FF-04-AR-C1 (F)	0.0063	0.005	1.3X > LOQ
			58-FF-04-AR-C2 (F)	0.0089	0.005	1.8X > LOQ
	OVS tube (back section)	1 of 8	58-FF-02-AR-C2 (B)	0.001615	0.005	3X < LOQ
AHE59	OVS tube (front section)	5 of 6	59-FF-01-AR-C2 (F)	0.003176	0.01	3.1X < LOQ
			59-FF-02-AR-C1 (F)	0.024228	0.01	2.4X > LOQ
			59-FF-02-AR-C2 (F)	0.015651	0.01	1.6X >LOQ
			59-FF-04-AR-C1 (F)	0.021984	0.01	2.2X >LOQ
			59-FF-04-AR-C2 (F)	0.013675	0.01	1.4X > LOQ
Note: as only negative controls for matrices with detected residues are shown in this table, it follows that all other negative controls for those matrices not presented in this table did not have detected residues (i.e., only a small percentage of all negative controls had detected residues).						

Table S - 10. Summary of Concurrent Laboratory Fortification Samples			
Study ID	**Exposure Matrix**	**Fortification Range**	**Recovery Results (mean ± standard deviation)**
AHE55	Inner Dosimeters	1.0 – 2000 ug/sample	98.9% ± 2.8% (n=6)
	Face/Neck Wipes	1.0 – 2000 ug/sample	92.9% ± 4.6% (n=6)
	Hand Washes	1.0 – 2000 ug/sample	101% ± 6.5% (n=6)
	OVS Air Samplers	0.01 – 100 ug/sample	103% ± 6.2% (n=10)
AHE56[a]	Inner Dosimeters	1.0 – 2000 ug/sample	102% ± 17.8% (n=5)
	Face/Neck Wipes	1.0 – 2000 ug/sample	84.3% ± 6.7% (n=4)
	Hand Washes	1.0 – 2000 ug/sample	90.8% ± 4.3% (n=4)
	OVS Air Samplers	0.01 – 100 ug/sample	92.0% ± 6.7% (n=4)
AHE57	Inner Dosimeters	1.0 – 2500 ug/sample	102.9% ± 13% (n=6)
	Face/Neck Wipes	1.0 – 2500 ug/sample	93.4% ± 11.7% (n=6)
	Hand Washes	1.0 – 2500 ug/sample	108.5% ± 8.2% (n=6)
	OVS Air Samplers	0.01 – 1500 ug/sample	98.1% ± 13.4% (n=9)
AHE58[b]	Inner Dosimeters	1.0 – 2000 ug/sample	104% ± 13.3% (n=13)
	Face/Neck Wipes	1.0 – 2000 ug/sample	102% ± 8.0% (n=8)
	Hand Washes	1.0 – 2000 ug/sample	101% ± 7.9% (n=8)
	OVS Air Samplers	0.005 – 250 ug/sample	104% ± 6.6% (n=10)
AHE59[c]	Inner Dosimeters	1.0 – 2000 ug/sample	108% ± 8.6% (n=13)
	Face/Neck Wipes	1.0 – 2000 ug/sample	103% ± 9.9% (n=10)
	Hand Washes	1.0 – 2000 ug/sample	99.7% ± 9.6% (n=12)
	OVS Air Samplers	0.01 – 100 ug/sample	101% ± 10.2% (n=18)

[a] 1 inner dosimeter (133%), 2 OVS air samplers (318% and 337% - excluded from any analysis due to likely contamination)
[b] 2 OVS air samples (325% and 311% - contamination likely)
[c] 1 inner dosimeter (125%), 1 OVS air sample (125%)

Table S - 11. Inner Whole Body Dosimeter Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**			**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**		
				Low level (5 ug)	**Mid level (100 ug)**	**High level (2000 ug)**	**≤ 52.5 ug**	**> 52.5 ug to ≤ 1050 ug**	**> 1050 ug**
AHE55	Carbaryl	10/28/08		77.0	90.6	90.0	0.778	0.852	1.00
				83.1	89.9	94.1			
				86.0	82.6	106			
		10/30/08		75.2	84.6	97.5			
				73.4	84.0	106			
				72.0	79.6	108			
		Summary Statistics	Mean	77.8	85.2	100			
			SD	5.57	4.28	7.45			
			CV (%)	7.2	5.0	7.5			
	Malathion	10/29/08		108	97.2	101	1.02	0.929	0.973
				97.8	93.0	97.0			
				101	88.6	93.8			
		Summary Statistics	Mean	102	92.9	97.3			
			SD	5.22	4.30	3.61			
			CV (%)	5.1	4.6	3.7			
AHE56	Carbaryl	8/25/08		92.8	81.6	81.4	0.924	0.789	0.877
				92.3	74.6	89.5			
				92.1	80.6	92.3			
		Summary Statistics	Mean	92.4	78.9	87.7			
			SD	0.4	3.8	5.7			
			CV (%)	0.43	4.8	6.5			
	Malathion	8/27/08		87.2	99.8	110	0.871	1.12	1.07
				85.4	111	108			
				88.6	126	103			
		Summary Statistics	Mean	87.1	112	107			
			SD	1.6	13.2	3.8			
			CV (%)	1.8	11.8	3.6			
AHE57	Chloro-thalonil	5/15/09		87.8	86.0	111	0.926	1.01	1.10
				93.0	87.8	107			
				92.3	99.5	105			
		5/29/09		92.8	117	106			
				97.5	101	114			

Table S - 11. Inner Whole Body Dosimeter Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**			**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**		
				Low level (5 ug)	**Mid level (100 ug)**	**High level (2000 ug)**	**≤ 52.5 ug**	**> 52.5 ug to ≤ 1050 ug**	**> 1050 ug**
				92.2	111	116			
		Summary Statistics	Mean	92.6	101	110			
			SD	3.6	12.5	4.4			
			CV (%)	3.9	12.3	4.0			
AHE59	Carbaryl	4/30/09		87.0	101	109	0.897	0.996	1.02
				90.6	99.4	106			
				83.5	95.4	105			
		5/7/09		102	109	96.6			
				91.2	92.6	102			
				100	103	97.6			
		5/9/09		75.3	111	97.0			
				85.1	95.7	106			
				92.9	89.2	99.6			
		Summary Statistics	Mean	89.7	99.6	102			
			SD	8.3	7.3	4.6			
			CV (%)	9.3	7.3	4.5			

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Field sample residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.

Table S - 12. AHE58 – Inner Whole Body Dosimeter Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors

Study ID	Active Ingredient	Monitoring Date		Field Fortification Recovery (%)						Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]					
				Low level (ug)	Mid level (ug)		High level (ug)			≤52.5	>52.5 to ≤175	>175 to ≤1125	>1125 to ≤2100	>2100 to ≤3600	>3600
				5	100	250	2000	2200	5000						
AHE58	Malathion	6/26/09		67.4	--	89.8	--	--	107	1.14	0.966	0.953	1.2	1.2	0.889
				66.4	--	94.9	--	--	117						
				82.8	--	100	--	--	42.7						
		7/1/09		138	--	98.4	--	108	--						
				126	--	101	--	233	--						
				167	--	87.5	--	104	--						
		7/28/09		132	88.2	--	121	--	--						
				112	91.2	--	136	--	--						
				114	102	--	119	--	--						
		8/7/09		119	92.2	--	117	--	--						
				124	105	--	111	--	--						
				123	101	--	124	--	--						
		Summary Statistics	Mean	114	96.6	95.3	121[b]	148	88.9						
			SD	29.3	6.9	5.9	8.4	73.4	40.3						
			CV (%)	26	7.1	6.2	6.9	50	45						

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.
[b] Per standard AHETF procedures, for average recoveries greater than 120%, field measurements are adjusted by a maximum factor of 1.2.

Table S - 13. Face/Neck Wipe Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**			**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**		
				Low level (5 ug)	**Mid level (100 ug)**	**High level (2000 ug)**	**≤ 52.5 ug**	**> 52.5 ug to ≤ 1050 ug**	**> 1050 ug**
AHE55	Carbaryl	10/28/08		72.7	83.3	93.0	0.760	0.841	0.979
				63.3	81.6	92.4			
				79.1	81.7	87.8			
		10/30/08		69.7	88.7	99.8			
				83.9	89.8	104			
				87.3	79.4	110			
		Summary Statistics	Mean	76.0	84.1	97.9			
			SD	9.07	4.20	8.29			
			CV (%)	11.9	5.0	8.5			
	Malathion	10/29/08		118	96.6	107	1.17	1.06	1.08
				116	111	110			
				118	109	107			
		Summary Statistics	Mean	117	106	108			
			SD	1.15	7.8	1.73			
			CV (%)	9.8	7.4	1.6			
AHE56	Carbaryl	8/25/08		86.9	89.3	102	0.877	0.872	0.979
				89.2	79.4	100			
				87.0	92.8	91.6			
		Summary Statistics	Mean	87.7	87.2	97.9			
			SD	1.3	7.0	5.5			
			CV (%)	1.5	8.0	5.6			
	Malathion	8/27/08		105	81.2	81.0	1.04	0.775	0.727
				101	73.4	71.4			
				107	78.0	65.6			
		Summary Statistics	Mean	104	77.5	72.7			
			SD	3.2	3.9	7.8			
			CV (%)	3.1	5.0	10.7			
AHE57	Chloro-thalonil	5/15/09		101	80.3	81.2	0.967	0.773	0.857
				101	79.1	84.1			
				109	79.6	80.0			
		5/29/09		94.7	74.9	88.0			
				92.4	76.0	91.3			

Table S - 13. Face/Neck Wipe Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**			**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**		
				Low level (5 ug)	**Mid level (100 ug)**	**High level (2000 ug)**	**≤ 52.5 ug**	**> 52.5 ug to ≤ 1050 ug**	**> 1050 ug**
				82.3	73.5	89.9			
		Summary Statistics	Mean	96.7	77.3	85.7			
			SD	9.1	2.8	4.7			
			CV (%)	9.4	3.6	5.5			
AHE59	Carbaryl	4/30/09		100	95.8	103	1.01	.994	1.06
				96.8	105	104			
				103	97.9	99.9			
		5/7/09		103	103	86.0			
				101	108	108			
				109	93.9	95.5			
		5/9/09		96.2	100	114			
				97.8	93.6	124			
				98.3	97.6	124			
		Summary Statistics	Mean	101	99.4	106			
			SD	4.0	5.0	12.6			
			CV (%)	4.0	5.0	11.9			

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.

Table S - 14. AHE58 – Face/Neck Wipe Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors														
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**						**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**					
				Low level (ug)	**Mid level (ug)**		**High level (ug)**			**≤52.5**	**>52.5 to ≤175**	**>175 to ≤1125**	**>1125 to ≤2100**	**>2100 to ≤3600**	**>3600**
				5	**100**	**250**	**2000**	**2200**	**5000**						
AHE58	Malathion	6/26/09		95.0	--	96.8	--	--	104	1.04	0.914	0.992	1.09	1.01	1.05
				102	--	100	--	--	104						
				81.8	--	93.3	--	--	106						
		7/1/09		95.0	--	100	--	104	--						
				94.2	--	101	--	99.3	--						
				91.8	--	104	--	100	--						
		7/28/09		124	92.8	--	110	--	--						
				123	94.2	--	115	--	--						
				123	97.8	--	112	--	--						
		8/7/09		105	78.4	--	109	--	--						
				110	94.0	--	102	--	--						
				-- [b]	91.2	--	106	--	--						
		Summary Statistics	Mean	104	91.4	99.2	109	101	105						
			SD	14.4	6.7	3.7	4.6	2.5	1.2						
			CV (%)	13.8	7.3	3.7	4.2	2.5	1.1						

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.
[b] Sample not taken.

Table S - 15. Hand Wash Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**			**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**		
				Low level (5 ug)	**Mid level (100 ug)**	**High level (2000 ug)**	**≤ 52.5 ug**	**> 52.5 ug to ≤ 1050 ug**	**> 1050 ug**
AHE55	Carbaryl	10/28/08		95.4	83.0	108	0.891	0.914	1.04
				89.3	101	107			
				97.3	97.5	106			
		10/30/08		77.4	82.9	106			
				90.3	99.8	105			
				85.2	84.3	90.0			
		Summary Statistics	Mean	89.1	91.4	104			
			SD	7.21	8.87	6.77			
			CV (%)	8.1	9.7	6.5			
	Malathion	10/29/08		85.8	94.4	93.2	0.969	0.987	0.969
				103	98.4	94.4			
				102	103	103			
		Summary Statistics	Mean	96.9	98.7	96.9			
			SD	9.65	4.3	5.35			
			CV (%)	10.0	4.4	5.5			
AHE56	Carbaryl	8/25/08		93.4	94.1	106	0.958	0.952	1.01
				96.5	95.1	85.6			
				97.7	96.2	111			
		Summary Statistics	Mean	95.8	95.2	101			
			SD	2.2	1.1	13.3			
			CV (%)	2.3	1.2	13.2			
	Malathion	8/27/08		96.2	103	89.4	1.02	1.05	0.910
				107	101	90.8			
				105	110	92.8			
		Summary Statistics	Mean	102	105	91.0			
			SD	5.5	4.9	1.7			
			CV (%)	5.4	4.7	1.9			
AHE57	Chloro-thalonil	5/15/09		117	120	105	1.17	1.16	1.07
				115	106	102			
				113	117	110			
		5/29/09		119	121	108			
				119	118	109			

Table S - 15. Hand Wash Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**			**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**		
				Low level (5 ug)	**Mid level (100 ug)**	**High level (2000 ug)**	**≤ 52.5 ug**	**> 52.5 ug to ≤ 1050 ug**	**> 1050 ug**
				118	116	110			
		Summary Statistics	Mean	117	116	107			
			SD	2.2	5.4	3.2			
			CV (%)	1.9	4.7	3.0			
AHE59	Carbaryl	4/30/09		113	109	110	1.08	1.04	1.06
				110	104	107			
				110	99.0	108			
		5/7/09		107	105	98.2			
				109	107	91.4			
				103	107	97.2			
		5/9/09		107	102	109			
				110	109	113			
				104	90.5	120			
		Summary Statistics	Mean	108	104	106			
			SD	3.2	5.9	8.8			
			CV (%)	3.0	5.7	8.3			

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.

Table S - 16. AHE58 – Hand Wash Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors														
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**						**Field Recovery Adjustment Factor by Measured Residue Range (ug)[a]**					
				Low level (ug)	**Mid level (ug)**		**High level (ug)**			**≤52.5**	**>52.5 to ≤175**	**>175 to ≤1125**	**>1125 to ≤2100**	**>2100 to ≤3600**	**>3600**
				5	**100**	**250**	**2000**	**2200**	**5000**						
AHE58	Malathion	6/26/09		103	--	87.8	--	--	62.3	1.11	0.863	0.869	1.03	1.22	0.625
				108	--	90.9	--	--	65.1						
				105	--	82.2	--	--	60.0						
		7/1/09		93.2	--	109	--	119	--						
				122	--	48.6[b]	--	126	--						
				124	--	103	--	120	--						
		7/28/09		89.8	92.2	--	89.8	--	--						
				128	87.4	--	111	--	--						
				126	85.8	--	111	--	--						
		8/7/09		112	85.2	--	107	--	--						
				115	76.2	--	96.8	--	--						
				--[c]	91.0	--	101	--	--						
		Summary Statistics	Mean	111	86.3	86.9	103	122	62.5						
			SD	13.0	5.7	21.2	8.5	3.8	2.6						
			CV (%)	11.7	6.6	24.4	8.3	3.1	4.2						

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.
[b] Sample is unusually low, though without clear explanation – thus, it was included in calculation of the 250 ug level average.
[c] Sample not taken.

Table S - 17. OVS Air Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors										
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**				**Field Recovery Adjustment Factor by Measured Residue Range[a]**		
				Low level (0.05 ug)	**Mid level (0.5 ug)**	**High level (100 ug)**	**Highest level (1000 ug)**	**≤ 0.275 ug**	**> 0.275 ug to ≤ 50.25 ug**	**> 50.25 ug**
AHE55	Carbaryl	10/28/08		112	90.9	106	--	0.99	0.913	1.04
				104	89.9	108	--			
				97.8	91.6	105	--			
		10/30/08		90.6	93.1	111	--			
				94.0	90.8	89.3	--			
				97.8	91.6	104	--			
		Summary Statistics	Mean	99.4	91.3	104	--			
			SD	7.6	1.08	7.56	--			
			CV (%)	7.6	1.2	7.3	--			
	Malathion	10/29/08		203[b]	88.3	99.6	--	--[c]	0.853	0.930
				157[b]	80.8	91.0	--			
				150[b]	86.8	88.3	--			
		Summary Statistics	Mean	--	85.3	93.0	--			
			SD	--	3.97	5.90	--			
			CV (%)	--	4.7	6.3	--			
AHE59	Carbaryl	4/30/09		84.1	110	104	--	1.2	1.07	1.04
				92.7	110	110	--			
				96.7	11.8[d]	105	--			
		5/7/09		134	97.2	94.8	--			
				130	107	108	--			
				141	109	103	--			
		5/9/09		133	115	106	--			
				184	104	101	--			
				163	101	103	--			
		Summary Statistics	Mean	129	107	104	--			
			SD	33.1	5.7	4.4	--			
			CV (%)	25.7	5.3	4.2	--			

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 0.275 is the midpoint between 0.05 and 0.5 ug. Residue results ≤ 0.275 ug would use the adjustment factor corresponding to the low level recovery mean.

[b] Contamination suspected, thus results not used.

Table S - 17. OVS Air Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors									
Study ID	Active Ingredient	Monitoring Date	Field Fortification Recovery (%)				Field Recovery Adjustment Factor by Measured Residue Range[a]		
			Low level (0.05 ug)	Mid level (0.5 ug)	High level (100 ug)	Highest level (1000 ug)	≤ 0.275 ug	> 0.275 ug to ≤ 50.25 ug	> 50.25 ug
[c] Due to suspected contamination of fortification samples, samples ≤ 0.275 ug will be adjusted using the mid-level fortification adjustment factor. [d] Excluded from calculation of average recovery due to improper sample preparation.									

Table S - 18. OVS Air Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors											
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**				**Field Recovery Adjustment Factor by Measured Residue Range[a]**		
				Low level (0.05 ug)	**Mid level (0.5 ug)**	**High level (5 ug)**	**Highest level (1000 ug)**	**≤ 0.275 ug**	**> 0.275 ug to ≤ 2.75 ug**	**> 2.75 ug**
AHE56	Carbaryl	8/25/08		96.0	94.7	78.8	--	0.975	0.914	0.798
				98.0	89.7	86.5	--			
				98.6	89.9	74.1	--			
		Summary Statistics	Mean	97.5	91.4	79.8	--			
			SD	1.4	2.8	6.2	--			
			CV (%)	1.4	3.1	7.8	--			
	Malathion	8/27/08		75.4	93.1	93.6	--	0.784	0.832	0.870
				75.2	72.2	85.5	--			
				84.6	84.3	81.9	--			
		Summary Statistics	Mean	78.4	83.2	87.0	--			
			SD	5.4	10.5	6.0	--			
			CV (%)	6.9	12.6	6.9	--			
AHE57	Chloro-thalonil	5/15/09		120	82.1	96.0	--	0.979	0.803	0.878
				91.1	86.9	91.8	--			
				86.9	79.7	72.9	--			
		5/29/09		94.1	82.8	91.8	--			
				96.7	68.6	98.5	--			
				98.7	81.4	76.1	--			
		Summary Statistics	Mean	97.9	80.3	87.8	--			
			SD	11.6	6.2	10.7	--			
			CV (%)	11.8	7.7	12.2	--			

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 0.275 is the midpoint between 0.05 and 0.5 ug. Residue results ≤ 0.275 ug would use the adjustment factor corresponding to the low level recovery mean.

Table S - 19. AHE58 – OVS Air Samples: Summary of Field Fortification Recovery Samples and Corresponding Adjustment Factors										
Study ID	**Active Ingredient**	**Monitoring Date**		**Field Fortification Recovery (%)**				**Field Recovery Adjustment Factor by Measured Residue Range[a]**			
				Low level (ug)	**Mid level (ug)**	**High level (ug)**		**≤0.275**	**>0.275 to ≤50.25**	**>50.25 to ≤175**	**>175**
				0.05	**0.5**	**100**	**250[b]**				
AHE58	Malathion	6/26/09		683[c]	114	--	91.7	1.11	0.952	1.08	0.895
				272[c]	87.6	--	74.8				
				96.3[c]	86.2	--	102				
		7/1/09		205[c]	100	--	--[d]				
				197[c]	103	--	185[e]				
				236[c]	89.7	--	212[e]				
		7/28/09		106	95.6	109	--				
				115	90.6	90.6	--				
				103	92.7	110	--				
		8/7/09		118	80.6	113	--				
				104	98.5	112	--				
				117	104	111	--				
		Summary Statistics	Mean	111	95.2	108	89.5				
			SD	6.9	9.2	8.4	13.7				
			CV (%)	6.2	9.7	7.8	15.3				

[a] Adjustment factor corresponds to mean recovery percentage for each recovery level. Residue range corresponds to midpoint between each fortification level. Example: 52.5 is the midpoint between 5 and 100 ug. Residue results ≤ 52.5 ug would use the adjustment factor corresponding to the low level recovery mean.
[b] High-level samples prepared with 250 ug, but were supposed to have been prepared with 100 ug. This does not compromise results.
[c] Due to improper fortification sample preparation these results were excluded from calculating the recovery average.
[d] Sample lost during analysis.
[e] Due to improper fortification sample preparation these results were excluded from calculating the recovery average.

Table S - 20. Inner Dosimeter Field Sample Results											
Study ID	MU ID	Active Ingredient	Analytical Method Levels (ug/sample)[a]		Lower Body			Upper Body			Total (ug)[e]
					Raw Exposure (ug)[b]	Field Fortification		Raw Exposure (ug)[b]	Field Fortification		
			LOQ	LOD		Adjustment Factor[c]	Adjusted Exposure (ug)[d]		Adjustment Factor[c]	Adjusted Exposure (ug)[d]	
AHE55	A1	Malathion	1.0	0.3	9.0	1.02	8.824	121	0.929	130.3	139.1
	A2	Carbaryl	1.0	0.3	1.7	0.778	2.185	35.6	0.778	45.76	47.9
	A3				53.0	0.852	62.21	8.9	0.778	11.44	73.7
	A4				< LOQ	--	0.5	< LOQ	--	0.5	1.0
	A5				20.8	0.778	26.74	9.5	0.778	12.21	39.0
AHE56	A1	Malathion	1.0	0.3	34.6	0.871	39.72	< LOQ	--	0.5	40.2
	A2				12.2	0.871	14.01	15.3	0.871	17.57	31.6
	A3				26.6	0.871	30.54	12.3	0.871	14.12	44.7
	A4	Carbaryl	1.0	0.3	7.8	0.924	8.442	2.0	0.924	2.165	10.6
	A5				27.8	0.924	30.09	1324	0.877	1510	1540
AHE57	A1	Chlorothalonil	1.0	0.3	2.749	0.926	2.916	9.113	0.926	9.827	12.7
	A2				6.758	0.926	7.343	< LOD	--	0.15	7.5
	A3				16.83	0.926	18.14	23.8	0.926	25.70	43.8
	A4				11.88	0.926	12.85	4.285	0.926	4.644	17.5
	A5				15.04	0.926	16.20	41.84	0.926	45.14	61.3
AHE58	A1	Malathion	1.0	0.3	1.75	1.14	1.579	48.1	1.14	42.19	43.8
	A2				2.51	1.14	2.193	5.07	1.14	4.474	6.7
	A3				2.93	1.14	2.544	1.96	1.14	1.754	4.3
	A4				1.38	1.14	1.228	9.2	1.14	8.07	9.3
	A5				101.4	0.966	104.6	12.32	1.14	10.79	115.4
AHE59	A1	Carbaryl	1.0	0.3	< LOQ	--	0.5	1.164	0.897	1.338	1.8
	A2				< LOD	--	0.15	< LOQ	--	0.5	0.7
	A3				47.78	0.897	53.29	29.25	0.897	32.55	85.8
	A4				2.318	0.897	2.564	11.81	0.897	13.15	15.7

[a] When < LOQ or < LOD is reported, ½ LOQ or ½ LOD is used.
[b] Calculated from chromatogram peak response (e.g., ug/mL)
[c] From Supplemental Tables K-L.
[d] Adjusted Exposure = Raw exposure ÷ Field Fortification Adjustment Factor
[e] Total = Lower Body Adjusted Exposure + Upper Body Adjusted Exposure

Table S - 21. Face/Neck Wipe Field Sample Results												
Study ID	MU ID	Active Ingredient	Analytical Method Levels (ug/sample)[a]		Raw Exposure (ug)[b]	Face/Neck Exposure Adjustments			Estimated Exposure to Non-Wiped Portion of Head (ug)[f]	Head Exposure (ug)	
			LOQ	LOD		Field Fortification Adjustment Factor[c]	PPE Adjustment Factor[d]	Adjusted Exposure (ug)[e]		Total[g]	Total (MEA)[h]
AHE55	A1	Malathion	1.0	0.3	< LOQ	--	1.1	0.55	0.34	0.89	1.78
	A2	Carbaryl	1.0	0.3	< LOQ	--	1.1	0.55	0.34	0.89	1.78
	A3				3.4	0.760	1.0	4.474	2.7	7.17	14.40
	A4				< LOD	--	1.1	0.17	0.10	0.27	0.54
	A5				< LOQ	--	1.1	0.55	0.34	0.89	1.78
AHE56	A1	Malathion	1.0	0.3	< LOD	--	1.0	0.15	0.09	0.24	0.48
	A2				< LOQ	--	1.0	0.50	0.30	0.8	1.60
	A3				< LOQ	--	1.0	0.50	0.30	0.8	1.60
	A4	Carbaryl	1.0	0.3	< LOD	--	1.0	0.15	0.09	0.24	0.48
	A5				< LOQ	--	1.0	0.50	0.30	0.8	1.60
AHE57	A1	Chlorothalonil	1.0	0.3	< LOD	--	1.0	0.15	0.09	0.24	0.48
	A2				< LOD	--	1.0	0.15	0.09	0.24	0.48
	A3				1.55	0.967	1.0	1.655	1.009	2.66	5.40
	A4				< LOD	--	1.0	0.15	0.09	0.24	0.48
	A5				< LOQ	--	1.0	0.50	0.30	0.8	1.60
AHE58	A1	Malathion	1.0	0.3	2.37	1.04	1.3	2.963	1.83	4.79	9.60
	A2				< LOQ	--	1.0	0.5	0.30	0.80	1.60
	A3				< LOD	--	1.0	0.15	0.09	0.24	0.48
	A4				1.6	1.04	1.0	1.538	0.91	2.45	4.80
	A5				< LOD	--	1.0	0.15	0.09	0.24	0.48
AHE59	A1	Carbaryl	1.0	0.3	< LOD	--	1.0	0.15	0.09	0.24	0.48
	A2				< LOQ	--	1.0	0.5	0.30	0.80	1.60
	A3				< LOQ	--	1.0	0.5	0.30	0.80	1.60
	A4				< LOQ	--	1.0	0.5	0.30	0.80	1.60

[a] When < LOQ or < LOD is reported, ½ LOQ or ½ LOD is used.
[b] Calculated from chromatogram peak response (e.g., ug/mL)
[c] From Supplemental Tables M-N.
[d] PPE characterized in Supplemental Table E. PPE Adjustment Factor discussed in Section 3.2.2.
[e] Adjusted Exposure = Raw Exposure ÷ FF Adjustment Factor * PPE Adjustment Factor
[f] Exposure to non-wiped portion of head = Adjusted Exposure * (2.95/4.84, for males) or (3.05/5.01, for females). MU-specific gender in Supplemental Table C.
[g] Total Head Exposure = Adjusted face/neck wipe exposure + Extrapolated non-wiped head exposure.
[h] MEA = method efficiency adjustment. Total head measurement corrected by a factor of 50% to account for potential collection method inefficiencies.

Table S - 22. Hand Wash Field Sample Results

Study ID	MU ID	Active Ingredient	Analytical Method Levels (ug/sample)[a]		Hand Wash Sample[b]						Hand Exposure	
					# 1		# 2		# 3			
			LOQ	LOD	Raw Exposure (ug)[c]	Field Fort. Adj. Factor[d]	Raw Exposure (ug)[c]	Field Fort. Adj. Factor[d]	Raw Exposure (ug)[c]	Field Fort. Adj. Factor[d]	Total (ug)[e]	Total (MEA)[f]
AHE55	A1	Malathion	1.0	0.3	136	0.987	72.2	0.986	--	--	211.2	422
	A2	Carbaryl	1.0	0.3	34.9	0.891	41.0	0.892	--	--	85.09	170
	A3				13.2	0.891	354	0.914	--	--	402.1	804
	A4				1.5	0.891	9.1	0.892	--	--	11.88	23.8
	A5				1.3	0.891	43.9	0.892	--	--	50.67	101
AHE56	A1	Malathion	1.0	0.3	1.2	1.03	< LOQ	--	--	--	1.67	3.4
	A2				19.5	1.03	--	--	--	--	18.93	37.8
	A3				< LOQ	--	7.2	1.03	--	--	7.49	15
	A4	Carbaryl	1.0	0.3	30.0	0.958	--	--	--	--	31.28	62.6
	A5				773	0.952	--	--	--	--	812.8	1626
AHE57	A1	Chlorothalonil	1.0	0.3	8.383	1.17	--	--	--	--	7.16	14.4
	A2				< LOD	--	< LOQ	--	--	--	0.65	1.3
	A3				10.865	1.17	--	--	--	--	9.29	18.6
	A4				19.751	1.17	--	--	--	--	16.88	33.8
	A5				24.126	1.17	--	--	--	--	20.62	41.2
AHE58	A1	Malathion	1.0	0.3	79.3	0.863	--	--	--	--	91.89	184
	A2				32.85	1.11	--	--	--	--	29.59	59.2
	A3				2.92	1.11	--	--	--	--	2.63	5.2
	A4				11.84	1.11	--	--	--	--	10.67	21.2
	A5				23.65	1.11	--	--	--	--	21.31	42.8
AHE59	A1	Carbaryl	1.0	0.3	9.301	1.08	--	--	--	--	8.61	17.2
	A2				20.33	1.08	3.807	1.08	--	--	22.35	44.6
	A3				5.909	1.08	4.90	1.08	109.1	1.04	114.9	230
	A4				28.09	1.08	1363	1.06	--	--	1312	2624

[a] When < LOQ or < LOD is reported, ½ LOQ or ½ LOD is used.
[b] Hand washes were conducted prior to lunch or bathroom breaks and at the end of the day.
[c] Calculated from chromatogram peak response (e.g., ug/mL)
[d] From Supplemental Tables O-P.
[e] Total Hand Exposure = [Hand Wash #1 ÷ FF Adjustment Factor] + [Hand Wash #2 ÷ FF Adjustment Factor] + [Hand Wash #3 ÷ FF Adjustment Factor]
[f] MEA = method efficiency adjustment. Total hand measurement corrected by a factor of 50% to account for potential collection method inefficiencies.

Table S - 23. OVS Air Sample Field Results and Inhalation Exposure														
Study ID	MU ID	Active Ingredient	Analytical Method Levels (ug/sample)[a]		Measured Residue						Inhalation Exposure		
					Front Section			Back Section					
			LOQ	LOD	Raw Exposure (ug)[b]	Field Fort. Adj. Factor[c]	Adj. Exp.[d]	Raw Exposure (ug)[b]	Field Fort. Adj. Factor[c]	Adj. Exp.[d]	Breath. Rate (LPM)	Pump Flow Rate (LPM)	Total (ug)[e]
AHE55	A1	Malathion	0.01	0.003	0.2472	0.853	0.2896	< LOD	--	0.0015	8.3	2.01	1.21
	A2	Carbaryl	0.01	0.003	0.1407	0.944	0.1419	< LOD	--	0.0015	8.3	2.01	0.59
	A3				1.330	0.913	1.457	< LOD	--	0.0015	8.3	2.06	5.88
	A4				0.1086	0.994	0.1097	< LOD	--	0.0015	8.3	2.02	0.46
	A5				0.3103	0.913	0.3395	< LOD	--	0.0015	8.3	2.02	1.41
AHE56	A1	Malathion	0.01	0.003	0.0267	0.784	0.0341	< LOD	--	0.0015	8.3	1.99	0.15
	A2				0.1900	0.784	0.2423	< LOD	--	0.0015	8.3	2.04	0.99
	A3				0.3800	0.832	0.4567	< LOD	--	0.0015	8.3	2.04	1.87
	A4	Carbaryl	0.01	0.003	0.0224	0.975	0.0227	< LOD	--	0.0015	8.3	1.97	0.10
	A5				0.4271	0.914	0.4379	< LOQ	--	0.005	8.3	2.04	1.92
AHE57	A1	Chlorothalonil	0.005	0.0015	0.0364	0.979	0.0367	< LOD	--	0.00075	8.3	2.03	0.16
	A2				0.0302	0.979	0.0304	< LOD	--	0.00075	8.3	1.99	0.13
	A3				0.0273	0.979	0.0279	< LOD	--	0.00075	8.3	2.04	0.12
	A4				0.1642	0.979	0.1652	< LOQ	--	0.0025	8.3	2.01	0.71
	A5				0.315	0.803	0.3923	< LOQ	--	0.0025	8.3	2.05	1.60
AHE58	A1	Malathion	0.005	0.0015	0.8096	0.952	0.8508	< LOD	--	0.00075	8.3	2.00	3.54
	A2				1.471	0.952	1.544	< LOD	--	0.00075	8.3	2.00	6.39
	A3				0.1092	1.11	0.0982	< LOQ	--	0.0025	8.3	1.95	0.43
	A4				1.161	0.952	1.218	< LOD	--	0.00075	8.3	2.00	5.06
	A5				0.0799	1.11	0.0720	< LOD	--	0.00075	8.3	2.00	0.30
AHE59	A1	Carbaryl	0.01	0.003	0.3517	1.07	0.3290	< LOD	--	0.0015	8.3	2.07	1.33
	A2				Invalid sample – sample time unknown.								
	A3				0.3486	1.07	0.3262	< LOD	--	0.0015	8.3	2.02	1.35
	A4				0.3086	1.07	0.2888	< LOD	--	0.0015	8.3	2.02	1.20

[a] When < LOQ or < LOD is reported, ½ LOQ or ½ LOD is used.
[b] Calculated from chromatogram peak response (e.g., ug/mL)
[c] From Supplemental Tables Q-S.
[d] Adjusted Exposure = Raw Exposure ÷ FF Adjustment Factor
[e] Total Exposure = [Adjusted front section + Adjusted back section] * [Breathing Rate ÷ Pump Flow Rate]

Table S - 24. Dermal and Inhalation Exposures																		
Study ID	MU ID	AaiH (lbs)[c]	BW (kg)	Dermal[a,b]											Inhalation		
				Inner WBD (µg)	Hand (µg)		Head (µg)		Total Exposure				Unit Exposure (ug/lb ai)[f]		Total		UE (ug/lb ai)[f]
									(µg)[d]		(µg/kg)[e]				(ug)[g]	(µg/kg)[e]	
					Non-MEA	MEA	Non-MEA	MEA	Non-MEA	MEA	Non-MEA	MEA	Non-MEA	MEA			
AHE55	A1	8	112	139.1	211.2	422	0.89	1.78	351	563	3.13	5.03	43.9	70.4	1.21	0.011	0.151
	A2	15	94	47.9	85.09	170	0.89	1.78	134	220	1.43	2.34	8.9	14.7	0.59	0.006	0.0396
	A3	24	106	73.7	402.1	804	7.17	14.40	483	892	4.56	8.42	20.1	37.2	5.88	0.055	0.245
	A4	40	93	1.0	11.88	23.8	0.27	0.54	13.2	25.3	0.14	0.27	0.33	0.63	0.46	0.005	0.0115
	A5	75	92	39.0	50.67	101	0.89	1.78	90.5	142	0.98	1.54	1.2	1.9	1.41	0.015	0.0187
AHE56	A1	7.9	107	40.2	1.67	3.4	0.24	0.48	42.1	44.1	0.39	0.41	5.3	5.6	0.15	0.001	0.0188
	A2	15.8	92	31.6	18.93	37.8	0.8	1.60	51.3	71.0	0.56	0.77	3.2	4.5	0.99	0.011	0.0628
	A3	24.6	102	44.7	7.49	15	0.8	1.60	52.9	61.2	0.52	0.60	2.2	2.5	1.87	0.018	0.0759
	A4	50.5	95	10.6	31.28	62.6	0.24	0.48	42.1	73.7	0.45	0.78	0.83	1.5	0.10	0.001	0.002
	A5	75.7	91	1540	812.8	1626	0.8	1.60	2354	3168	25.75	34.81	31.1	41.8	1.92	0.021	0.0254
AHE57	A1	10.8	70	12.7	7.16	14.4	0.24	0.48	20.1	27.6	0.29	0.39	1.9	2.6	0.16	0.002	0.0144
	A2	16.9	70	7.5	0.65	1.3	0.24	0.48	8.4	9.3	0.12	0.13	0.50	0.55	0.13	0.002	0.0078
	A3	27.6	103	43.8	9.29	18.6	2.66	5.40	55.8	67.8	0.54	0.66	2.0	2.5	0.12	0.001	0.0042
	A4	40.7	143	17.5	16.88	33.8	0.24	0.48	34.6	51.8	0.24	0.36	0.85	1.3	0.71	0.005	0.0173
	A5	90.3	91	61.3	20.62	41.2	0.8	1.60	82.7	104	0.90	1.14	0.92	1.2	1.60	0.018	0.0177
AHE58	A1	63.5	77	43.8	91.89	184	4.79	9.60	141	237	1.83	3.08	2.2	3.7	3.54	0.046	0.0557
	A2	34.4	72	6.7	29.59	59.2	0.80	1.60	37.1	67.5	0.51	0.94	1.1	2.0	6.39	0.089	0.186
	A3	23.0	76	4.3	2.63	5.2	0.24	0.48	7.1	10.0	0.09	0.13	0.31	0.43	0.43	0.006	0.0187
	A4	59.2	83	9.3	10.67	21.2	2.45	4.80	22.3	35.3	0.27	0.43	0.38	0.60	5.06	0.061	0.0855
	A5	7.3	108	115.4	21.31	42.8	0.24	0.48	138	159	1.28	1.47	18.9	21.8	0.30	0.003	0.0414
AHE59	A1	15.8	75	1.8	8.61	17.2	0.24	0.48	10.6	19.5	0.14	0.26	0.67	1.2	1.33	0.018	0.0840
	A2	9.4	115	0.7	22.35	44.6	0.80	1.60	23.8	46.9	0.21	0.41	2.5	5.0	Invalid sample		
	A3	15.9	85	85.8	114.9	230	0.80	1.60	202	318	2.38	3.74	12.7	20.0	1.35	0.016	0.0848
	A4	34.5	67	15.7	1312	2624	0.80	1.60	1329	2641	19.84	39.42	38.5	76.6	1.20	0.018	0.0347

[a] See Supplemental Tables T-V.
[b] MEA = method efficiency adjusted; 50% method efficiency assumed – "Non-MEA" measurement multiplied by 2.
[c] See Supplemental Table F.
[d] Total Dermal Exposure = Inner Dosimeter + Hands + Head.
[e] Total Exposure (µg) ÷ Body Weight (kg)
[f] Unit Exposure (µg/lb ai) = Exposure (µg) ÷ AaiH (lbs).
[g] See Supplemental Table W.

Table S - 25. Select Excerpts from Field Observations			
Study ID	**MU ID**	**Airblast cab entrances/exits (#)**	**Observation**
AHE55	A1	4	1113: "Worker in cab while mix/load is performed."
			1231: "…brushes up against treated foliage due to narrow rows"
			1322: "…again brushing up against treated foliage."
			1422: "…again brushing up against treated foliage…"
	A2	16	1207: "…exits cab with gloves on, then turns valve…"
			1232: "…exits cab with gloves on, picks up a plastic pipe…"
			1245: "…exits cab after putting gloves on…"
			1412: "…exits cab wearing gloves…"
	A3	10	1032: "…exits cab…no gloves worn since no contact with equipment."
			1144: "…exits cab without gloves…shuts the door…contacting the side edge."
			1214: "…opens door with bare hands…"
	A4	4	1032: "Mixing completed. Worker did not exit cab."
			1124: "Worker remains inside cab as water was added, then test substance."
			1213: "Puts gloves on, then exits cab."
	A5	8	1032: "…exits cab wearing gloves. Opens up back of sprayer…"
			1529: "…exits cab. Not wearing gloves."
AHE56	A1	12	0833: "Donning gloves while exiting cab…"
			0911: "Out of tractor with gloves on…"
			0934: "Donned gloves while exiting tractor…"
	A2	14	1119: "…exited cab, donned gloves."
			1149: "Exited cab, wearing fresh gloves…"
	A3	16	1137: "Climbed out of truck with gloves on…"
			1141: "Climbed up on flat bed…"
			1322: "…donned clean gloves, exited cab."
			1335: "Out of truck and puts on gloves to jump start the sprayer engine."
			1340: "Exited cab with gloves on…leaning against sprayer"
			1347: "Out of cab, gloves on…holds onto…other application equipment."
	A4	6	0134: "…at mixing/loading site. Stays inside cab…"
			0300: "Exited tractor with gloves donned."
			0346: "Waits inside the cab…during M/L."
			0405: "Donned gloves and exited cab."
			0447: "Donned gloves before exiting tractor."
	A5	22	0640: "Waited inside truck during M/L."
			0710: "…gets out of the truck to adjust spray pressure while wearing gloves."
			0742: "Rain had started…"
			0835-0843: "Donned clean gloves. Left shirt sleeve cuff is open…states that the button popped off…clean out spray

Table S - 25. Select Excerpts from Field Observations			
Study ID	**MU ID**	**Airblast cab entrances/exits (#)**	**Observation**
			nozzles…reached down into nozzle area with right arm up to arm pit…lean on fan casing…clean the top spray nozzles"
			1017: "…out of truck wearing gloves."
			1025: "…continued to blow out spray nozzles…left shirt sleeve opening near mid-forearm, exposing the dosimeter."
			1059: "With only left glove on, climbed on flat-bed near sprayer…"
			1230: "…left lower sleeve was soiled and the edge of the right lower sleeve was soiled."
AHE57	A1	4	1430: "Arrived at mix/load area and got out of the cab with fresh gloves."
			1528: "Put on clean gloves when he left the tractor…"
	A2	4	0710: "…stayed inside cab…"
			0829: "Dons gloves before entering cab and discards gloves outside the cab."
	A3	6	1403: "…shirts sleeve unbuttoned…also unbuttoned…above waist."
			1534: "…exited the cab with clean gloves on."
			1648: "…drop of spray…landed on his hand…wiped his hand on right pant leg."
	A4	8	1534: "Donned nitrile gloves and stood near tractor…"
			1710: "Exited tractor with clean gloves…reentered cab…again exited tractor…inner dosimeter is exposed on his back…near his waist…"
	A5	6	0630: "…exited tractor with clean gloves."
			0806: "…got out of the cab with clean gloves."
AHE58	A1	14	1005-1012: "A1 stepped out of tractor…donned face mask and glove and goggles."
			1035: "…got out to adjust nozzles."
			1122: "A1 occasionally opened back window of cab to give instructions to mixer."
			1315: "Donned glove, goggles. Turned off nozzles…"
	A2	8	0948: "Mixer overfilled tank. Two-three gallons spilled at top of tank. Re-entered tractor. Did not step in spill."
	A3	10	Nothing noteworthy.
	A4	12	0330: "Entered field for bathroom break. Refused hand wash."
			0338: "Adjusted agitation…after donning gloves."
			0345: "…got out of cab…to check pressure and agitation…Wore safety glasses and gloves."
	A5	4	0814: "Turned off water near tank with bare hand…"
			0930: "Touched inner dosimeter (cuff) with bare hand."
AHE59	A1	10	Gen. obs.: "…did not wear the chemical resistant gloves during the mixing/loading process…"
			0858: "Climbed back into cab, opened door with bare hands."
			0951: "Opened cab door and tied ribbon marker to tree (observer unable to determine whether gloves worn during this process)."
	A2	4	Gen. obs.: "The applicator was not observed to handle anything except the door and door handle…Door opened with bare hand."
			1000: "Arrives at mixing/loading station remained sitting inside cab."

Table S - 25. Select Excerpts from Field Observations			
Study ID	**MU ID**	**Airblast cab entrances/exits (#)**	**Observation**
	A3	12	0821: "Put on chemical resistant gloves and goes to airblast sprayer…"
			0828: "Remained in cab during loading."
			0956: "Opened truck door with bare hands…"
			1209: "Exited tractor cab and wiped nose with bare hand."
			1248: "Placed gloved hand on lever...Touched another valve on spray tank with gloved hand."
	A4	26	Gen. obs.: "Exchange of tractor and sprayer…"
			0822: "Inner dosimeter cuff is observed at right wrist, out from right shirt sleeve. Long sleeve shirt is not tucked into pants.
			0833: "Spoke to mixer loader through opened back window of tractor cab. Closed window"
			1102: "…exited cab and with bare hands picked up a marker from ground…"
			1320: "Exited cab, walked back to sprayer and with bare hands, turned lever…"
			1432: "Walked to front of spray tank and with bare hand turned lever…"
			1500: "Opened rear window…"
			1549: "…walked back to sprayer and with bare hands, turned off a couple nozzles…"

Table S - 26. Protocol Amendments and Deviations			
Study ID	**Summary of Amendments**	**Summary of Deviations**	
		Field Phase	**Analytical Phase**
AHE55	The study report indicates that the protocol was amended/changed three times prior to execution of the field phase, however it did not summarize these changes. The IIRB Correspondence Report shows only one amendment, to address EPA and HSRB comments following the June 2008 HSRB meeting.	Reported: • On two occasions MUs were selected randomly using a coin flip rather than writing names and picking from hats, per AHETF protocol. Unreported: • Rather than growers being reimbursed for the pesticide used in the study as required by section 2.4 of the protocol, the Local Site Coordinator purchased the product and delivered it to the application sites. • The witness for the consent process for a non-reader was selected by the prospective subject, contrary to the protocol requirement that the witness should not have an association with the grower or worker. • Despite protocol indicating that wearing chemical-resistant gloves while outside the cab would be enforced, observations indicate that this occurred. • 4 of 5 MUs did not achieve 4 hours of "spray time".	None reported
AHE56	The study report indicates that the protocol was amended/changed twice prior to execution of the field phase, however it did not summarize these changes. The IIRB Correspondence Report shows only one amendment, to address EPA and HSRB comments following the June 2008 HSRB meeting.	Reported: • The original list of eligible growers was exhausted before successfully recruiting enough workers for monitoring. Two growers ultimately monitored were referred to the AHETF by other growers, and did not appear on the eligible grower list. This was a reported deviation since the protocol did not provide guidance on recruitment beyond eligible growers list. • Informed consent form signed by MU A5 after donning inner dosimeter garment. • Travel fortification samples were not prepared until monitoring day 4. • MU A4 took bathroom break without handwash	• OVS sampling tubes Set 2 was above 15% criteria (reported 22.02%) for back-calculation value at 5.0 ng/mL standard. • Travel spikes analyzed inadvertently. • For Set 2a OVS samples, 3.0 mL aliquot was used instead of 4.0 mL (deviation reported in IIRB correspondence, but not within Appendix B of AHE56 study report).

Table S - 26. Protocol Amendments and Deviations			
Study ID	**Summary of Amendments**	**Summary of Deviations**	
		Field Phase	**Analytical Phase**
		sample being taken. • Air flow rotometer measurement taken after removal of sampling gear from workers. Unreported: • No MU achieved 4 hours of "spray time".	
AHE57	The study report indicates that the protocol was amended/changed twice prior to execution of the field phase. One amendment was to address EPA and HSRB comments following the October 2008 HSRB meeting. The second amendment was to edit a sentence on purity analysis.	Reported: • One subject applied 10.68 lbs (1.68 lbs above stratum 5-9 lbs); was monitored for 2 hours (the protocol prescribes a minimum of 4 hours of application time); and applied only 2 tank loads (the protocol prescribes a minimum of 3 tank loads). Unreported: • Two subjects applied amounts outside the desired AaiH stratum. • No subject achieved 4 hours of "spray time".	• Inner dosimeter controls and LOQ concurrent recovery samples were diluted to 5 mL while field samples were diluted to 10 mL (samples supposed to be treated in same manner). • Protocol lists method titles that were not used. • Aliquot deviation in Method ARTF-0001 for 2-piece cotton inner dosimeters. • Back-calculated calibration standard values for the 0.001 ug/mL OVS sample and the 0.005 ug/mL face/neck wipe standard deviated from the theoretical value by more than 20% (reported in IIRB correspondence, not in study report).
AHE58	1 • Inclusion criteria added to allow for workers who normally wear two layers of clothing, provided the worker is willing to substitute the normally worn inner layer with the AHETF-provided one-piece dosimeter. • Recruitment area expanded to any county in CA or WA if protocol-specified counties do not provide sufficient number of eligible growers. • Removed efficient configuration requirement if recruitment area is	Reported: • Inner dosimeters were not folded after administration of field fortifications and prior to covering with cloth. • Low level field fortifications conducted in duplicate on day 4 instead of triplicate. • MU A5 monitored for 3 hours 8 minutes (less than prescribed 4 hours). • Field fortifications done at (known) levels different than specified in protocol.	• Concentrations of some field fortification solutions corrected for volume based on density, not gravimetrically, resulting in incorrect field fortification concentrations.

Table S - 26. Protocol Amendments and Deviations			
Study ID	**Summary of Amendments**	**Summary of Deviations**	
		Field Phase	**Analytical Phase**
	expanded. 2 Added a malathion product to possible test substances	Unreported: • Despite protocol indicating that wearing chemical-resistant gloves while outside the cab would be enforced, observations indicate that this occurred. • The following MUs handled amounts of active ingredient outside the desired range indicated in the protocol: MU A2, A3, A4.	
AHE59	Two carbaryl products were added to possible test substances	Reported: • Post-monitoring photographs of worker clothing were not taken. • Though use of two additional carbaryl products was approved by EPA and product risk statements (PRS) were IIRB approved before monitoring, the amendment (Amendment 1) adding the additional carbaryl products was not approved until after the monitoring had taken place. Unreported: • Despite protocol indicating that wearing chemical-resistant gloves while outside the cab would be enforced, observations indicate that this occurred. • The following MUs handled amounts of active ingredient outside the desired range indicated in the protocol: MU A2, A3. • Only 1 of 4 MUs achieved 4 hours of "spray time".	• Curve standard off by 25.89% more than 15% criteria) – not detailed in Appendix B of study report