Agricultural Handlers Exposure Task Force (AHETF)

VOLUME VII

Reference Materials

Cited in Other Volumes

April 7, 2008

TABLE OF CONTENTS

Volume VII, Part A:

Summary of Agricultural Expert Information for Airblast Application Scenarios: 2007 to 2008, February 14, 2008

Summary of Agricultural Expert Information for Airblast Application Scenarios: 2007 to 2008

Prepared By: Eric Bruce
February 13, 2008

Entries are presented by U.S. Growing Region (EPA).

Region I (Northeast)

Name: **Grzegorz (Greg) Krawczyk**
Position: **Extension Tree Fruit Entomologist, Pennsylvania State University, Biglerville, PA**
Experience: **10 years**

Discussed: Airblast applications in South Central Pennsylvania: apples, peaches, cherries, pears, nectarines.

- All of these crops are commonly treated by airblast.
- Currently the vast majority, probably >90%, use enclosed cabs, due to the necessity for use of some products such as OP's. Larger operations often have a variety of equipment, so may use open cab for some products. Open cab applicators often wear air-pilot type uniform as PPE.
- Dormant applications are made in most orchards, mainly as pre-bud-break application of fungicide (e.g., copper) and oils. These are no more than one or two out of 10-14 applications total during the year.
- Most use conventional equipment. Perhaps 10 or 20% have a smart sprayer. A few have a tower sprayer, which are still relatively unusual, but maybe becoming more common. There is less waste and it works well on trellised apples, which are definitely increasing in acreage.
- All of the sprayers function similarly. Some are PTO-driven, some are independently powered. Tank sizes are generally 300 to 500 gal; 400 gal is probably most common.
- All parameters that can impact drift are important, such as temperature and humidity, which effect droplet size and drying; foliar density, which effects spray volume; and the placement of nozzles. Tower sprayers have an advantage in controlling drift.
- These factors would not be important with closed cabs unless filtration is malfunctioning, etc. In that case exposure will be mainly in the mix/load activities, or possibly inadequate filtration. Exiting the cab for repair or adjustment is possible, but is unusual.
- Airblast use and equipment are probably similar to the above throughout much of the eastern growing regions. The west coast may be different, but it's not certain.

Name: **Scott Guiser**
Position: **Cooperative Extension Educator, Penn State College of Agricultural Sciences, Bucks County, PA**
Experience: **30 years**

Discussed: Airblast applications in Eastern Pennsylvania: apples, peaches, strawberry, pumpkin, which are the largest crops in the area.

- All of these crops are sprayed with airblast equipment.
- Appears to be about 50/50 use of closed and open cabs, although closed cabs may now be more common than open.
- Dormant applications generally only in tree fruit crops, and usually just one dormant application per season, a small portion of total applications. A full dormant application is necessary for peaches, which can be spring or fall. For apples, an application is made in late winter/early spring.
- There do not seem to be any "alternative" sprayers in the area; conventional airblast equipment is used.
- For vegetable crops, sprayers are smaller, perhaps 150 gallons. Nozzle orientation is more to the side and lower, rather than upward, when spraying pumpkins with airblast. Spray tanks are bigger for tree fruits, but 300 gallons is the largest seen in the area. Rigs are typical PTO driven and towed.
- The amount of PPE used has the most impact on exposure potential by reducing exposure due to drift. Nozzle types may also have an effect by influencing droplet size and/or trajectory, but it's uncertain what that effect is.
- These parameters are probably not important to exposure if closed cabs are used. In that case, the mixing/loading is most important to exposure.

Name: **Bob Pollock**
Position: **Cooperative Extension Director, Penn State College of Agricultural Sciences, Indiana County, PA**
Experience: **25 years**

Discussed: Airblast applications in Western Pennsylvania crops - apples, peaches, Xmas trees, vines, vegetables, small grains, corn, and soybean.

- Airblast applications are common in apples, peaches, XMAS trees, vines
- At least 90% use a cab of some sort. Of these, perhaps 50% use a true closed cab. Closed cabs are increasing, and are now more common for row crops than fruit.
- As growers upgrade equipment, most new equipment includes a closed cab. This makes the applicators job easier & more comfortable, since it is common to do this job all day. This would include A/C, filtration, GPS, stereo, etc. Over time, closed cabs will become the general rule.

- Dormant applications are made, particularly in Xmas trees pre-bud-break. Most orchard growers do make at least one dormant application, but this generally amounts to <10% of their overall spray program.
- Airblast equipment used in tree crops is generally conventional. Electrostatic sprayers are gaining acceptance but mainly in row crop non-airblast applications so far.
- Airblast sprayers are essentially the same – PTO drive, pull-behind, or 3-point hitch. Most growers use small to mid-size rigs due to hilly terrain. A 500 gallon tank is probably the absolute maximum.
- The key parameter impacting exposure is weather; wind can cause drift of spray onto applicator. Also, many do not wear gloves when fixing equipment or nozzles. These are the main points of exposure.
- A properly functioning enclosed cab could make drift a non-issue. Exposure during fixing equipment is still the same, though.

Name: **Craig E. Altemose**
Position: **County Extension Agent, Penn State College of Agricultural Sciences, Bellefont, Pennsylvania**
Experience: **30 years**

Discussed: Airblast applications in central Pennsylvania: mostly agronomic crops, some tree fruit.

- Mainly just peaches and apples are treated by airblast.
- Both types of cabs can be found. Units tend to last for a long time. Newer tractors more typically have enclosed cabs.
- There do not seem to be any true dormant applications. Not aware of any non-foliar applications.
- Equipment all seems to be conventional. Not aware of any smart sprayers or other variations.
- The sprayers are basically the same in terms of function. Those observed have been all PTO-driven using a 3-point hitch. Tank size is generally 400-500 gal, with a few 300 gal.
- Parameters related to spraying are of minor importance to exposure compared to safety equipment, more of which is needed for open cab. This includes respirator and a hat, though not necessarily hooded jacket.
- With enclosed cabs, none of these should be of much significance, although note that sprayers wear less PPE when using an enclosed cab.
- With enclosed cabs, it's possible an applicator may open a vent window. Also, entering and exiting cab are important, although it is pretty rare for an applicator to exit a cab once moving.

Name: **Deborah I. Breth**
Position: **Area Extension Educator, Cornell Cooperative Extension, Orleans County, Albion New York**
Experience: **20 years**

Discussed: Airblast applications in NW New York: mainly apples, cherries, plums.

- These crop types are commonly treated by airblast.
- Both cab types are commonly performed, although closed-cab applications are probably in the majority at this point.
- In apples, there is typically a fungicide application when getting to green tip, technically not dormant or non-foliar since the target is growing leaf material. In peaches a dormant application is made somewhat earlier for leaf curl.
- Overall, conventional equipment makes up perhaps three-fourths of the total. There are a few tower sprayers, which are air-assisted, and just a couple of tunnel sprayers. There are no electrostatic sprayers.
- Most sprayers have top-nozzle shut-off. Some have smart spray technology, including tower sprayers. Some have adjustable fans and some have flip-over nozzles for spraying at two volumes. Airblast units can be PTO or engine driven, towed behind a tractor. The engine driven ones tend to be used on larger orchards and may be older. These are sometimes needed for large processing trees, as they can adjust RPM and fan speed better. They are generally 400-500 gallons. Smaller operations tend to have more PTO-driven units, a small portion of which is below the 400-500 gal range.
- Wind direction is the main factor impacting exposure, and compliance with PPE requirements. Spray technique is also important, i.e., making turns into the wind, turning off just before row end. It's also important not to spray at too low a volume since finer droplets increase drift.
- With enclosed cabs, these factors are not as important, although a closed cab does not guarantee filtration, especially after years of use, so drift issues may still apply to some extent. In this case, exposure is mainly from entry and exit. Also, how PPE is managed is important, such as avoiding contamination of the inside of the cab by PPE that is removed.

Name: **Kevin Iungerman**
Position: **Regional fruit specialist, Cornell Cooperative Extension, New York (Albany, Clinton, Essex, Saratoga, and Washington Counties)**
Experience: **15 years**

Discussed: Airblast applications in Northeast New York crops: apples, some vegetables, strawberry, and blueberry.

- Airblast applications are mainly in apples. Blueberry/raspberry growers also use airblast. Some apple growers also have some pears or tart cherries which are also treated by airblast.
- Closed cabs have become more common, and may be the majority at this point. The other half (or slightly less) typically have no cab at all and the sprayer uses PPE for protection. Closed cabs not necessarily being used by the largest growers, who typically have a mixture of equipment and may use an open cab for significant spraying.
- Most orchard growers apply a first spray pre-bud-break in March or April. Berry growers spray sulfur, also pre-bud break, somewhat earlier than orchards. Overall, these applications are typically only one out several applications over a season. Total sprays may be 5 to 15, depending on the type of management program, the weather, etc.
- Conventional airblast equipment is by far the most common. There is some limited use of smart-sprayer technology, which automatically does not spray when a gap in the orchard is detected. There is no over-the-row spraying in grapes, although modified booms are used for some over-the-row applications in berries.
- Sprayers are mostly the same; either PTO-driven or independently powered. Sprays have become more concentrated, allowing downsize of equipment. Now, 100-200 gallon tanks are most common, which are typically PTO-driven. The independently-powered machines are generally used with larger tanks and/or more dilute sprays.
- Obviously wind speed is a big issue in drift exposure. The education process is very important in helping handlers avoid exposure, e.g., in using a respirator. Most exposure seems to be during mixing and loading.
- Drift may not be an issue with closed cabs, although there are some materials for which you should use a respirator even inside an enclosed cab. This decreases exposure even more.

Name: **Juliet Carroll, Ph.D.**
Position: **Extension Plant Pathologist, New York State Agricultural Experiment Station, Geneva, NY**.
Experience: **Not obtained.**

Discussed: Airblast applications to tree fruit and vines in the northeastern states.

- Growers use traditional airblast equipment; most commonly use a pull-behind, Rears-type sprayer.
- Most growers make most of their own applications rather than use contract applicators.
- Closed cab tractors are preferred, but often cannot be used due to tree spacing or the grower cannot to purchase them.
- Dormant oil sprays are used in tree fruit orchards, but are only common when insect pressure is higher in from previous season. Most years, less than 10% of the annual sprays would be dormant sprays.
- Spray volume varies by grower preference, tree spacing, and foliage density
- Younger orchards require less volume

Name: **Art Angello, Ph.D.**
Position: **Extension Entomologist, New York State Agricultural Experiment Station, Geneva, NY.**
Experience: **Not obtained.**

Discussed: Airblast applications to tree fruit and vines in the northeastern states.

- Growers use traditional airblast equipment; most commonly use a pull-behind, Rears-type sprayer.
- Most growers make most of their own applications rather than use contract applicators.
- Closed cab tractors are preferred, but often cannot be used due to tree spacing or the grower cannot to purchase them.
- Dormant oil sprays are used in tree fruit orchards, but are only common when insect pressure is higher in from previous season. Most years, less than 10% of the annual sprays would be dormant sprays.
    - Apples receive 8 to 15 foliar spays per year and 1 or 2 dormant sprays.
    - Pears are same as apples but less foliar sprays.
    - Cherries have 5 to 6 foliar sprays and 1 dormant spray.
    - Peaches have 6 to 9 foliar sprays and 1 dormant spray for leaf curl (with higher volumes for dormant sprays).
- Spray volume varies by grower preference, tree spacing, and foliage density
- Younger orchards require less volume

Name: **Andrew Landers, Ph.D.**
Position: **Application specialist, Cornell University, New York State Agricultural Experiment Station, Geneva, NY.**
Experience: **36 years**

Discussed: Airblast applications to vines in the northeastern states and California and Oregon.

Following are the questions and answers to which he responded.

- Grape vines across USA are treated by enclosed cabs 75% or open cabs 25%
- Closed cabs chosen because:
  a) modern design of tractors, usually drivers/machinery dealer/increasing profit/peer pressure leads to utilizing modern tractors with cabs, and
  b) personal preference – comfort.
- Some open cabs are found on old, traditional plantings mainly due to lack of income for investment and old trees with low branches, narrow spaces for cabs to pass under.
- Some older, smaller vineyards used for juice production tend to have open tractors, again due to lack of income.
- Some new, small vineyards, of which there are many new start-ups of less than 5 acres, tend to use their capital on vineyard establishment rather than cab tractors.
- In most vineyards trailed sprayers are most common on the larger (over 25 acre vineyards); in most small vineyards, and on slopes, we see small mounted machines.
- Traditional juice varieties, Concord/Niagara are sprayed at 50 gpa in early season, 100 gpa in full canopy; modern wine grape varieties, viniferas: 35 gpa early season, 50 -75 full canopy
- Trellis crops such as vines in the North East: 100-300 gallon capacities in trailed types, 50 -100 gallons for mounted types, both with 24-30" fans. In apple orchards I see plenty of big engine mounted sprayers with big 48" fans.
- Vines in CA I see about 50% airblast and 50% directed deposition sprayers, but again tank sizes are similar to N East
- In grapes a single row airblast will average 3 acres/hour over the season. So a 10 hour day of spraying =30 acres.
- Vines commonly have 9 feet row spacing. Occasionally 7 feet is seen and in Napa I have seen a few vineyards with 4 feet rows. (Interestingly all applying the same label rate per acre, irrespective of canopy volume/acre – this is a major point of interest!)
- In CA, I would say 50% of vineyards are sprayed with over-the-row sprayers (or drop nozzles), although probably 75% + of the vine area. In the North East I would say 10% of vineyards, but growing rapidly – this is the growth area of sprayers
- Many trellis crop growers use the dreaded canon sprayer, an airblast with a chimney to blast over 20'+ wide areas – this is an area to consider.
- Dormant sprays are not normally done in grape vines
- I am concerned that if only cabs/ tank size/ row numbers/ traditional airblast are used as criteria, then the results maybe very different for modern directed deposition sprayers in grapes, particularly when we see the concentrated plume from a multi-row sprayer covering the cab of a harvester being used as the spraying vehicle.

Name: **Hans Walter-Peterson**
Position: **Viticulture Extension Educator, Finger Lakes Grape Program, Cornell Cooperative Extension**
Experience: **6½ years in viticulture extension in New York**

Discussed: Spraying equipment, growers, and workers for grapes in New York.

- Airblast applications are common in grapes and there is some use of alternative spray techniques, but it is a minority for sure.
- There is a small number of growers using multi-row equipment with directed, wrap-around style sprays and covered boom (or curtain, or tunnel) sprayers. This number will likely increase over the next several years.
- Most applications are performed by hired hands or the farm owner. Very few commercial applications, but some small growers contract with a larger grower to spray their small plots.
- Handlers are mostly English-speaking, but there are likely some Hispanics.
- Hispanics might be less comfortable with the dressing/undressing procedures, but he expects there will be some growers who would be cooperative with regard to volunteering for studies.
- Remuneration of $150-200 seems appropriate, depending upon the amount of time required of the owner and/or workers.

Name: **Steven McKay**
Position: **Pesticide Safety Trainer, Cornell Cooperative Extension agent, Columbia County, New York**
Experience: **28 years**

Discussed: Spraying equipment, growers, and workers for grapes in 5-county area in southern NY

- About 70% of grape crop is treated by airblast and all applications are foliar.
- About half the applications are made with closed cabs.
- No wrap-around sprayers in his area, but some are used in the western part of the state (but they are not common).
- Lots of small, family operated farms and only 2 corporate farms in his area.
- Applications are generally made by the farm owner himself, sometimes by employees, and very rarely by commercial applicators.
- Applicator usually mixes/loads for himself.
- Very rarely would we find a handler who does not read either English or Spanish, however in orchards where more airblast applications are made there might be some.
- Has a general concern about proper use of PPE and that appropriate gloves and respirators are often not available locally (mainly acquired by mail order) which can impact handler safety.

Name: **Mike Fargione**
Position: **Extension Educator, Cornell Cooperative Extension agent, Ulster County, New York**
Experience: **10 Years**

Discussed: Spraying equipment, growers, and workers for apples, pears, and peaches in southern NY.

- Some tower sprayers and some smart sprayers used.
- Orchards are mostly family operated with an average size of 60 A, and only a few above 200 A.
- Most farms with 20 – 30 A will have just one applicator and the largest growers might have 6 – 7 applicators maximum.
- Most airblast applications are performed by the grower himself or an employee; rarely by commercial applicators.
- Majority applicators mix/load themselves, rarely a certified applicator or WPS trained handler may mix/load for other applicators.
- Applicators and mixer/loaders are certified applicators or have had WPS handler training and work under supervision of a certified applicator. All applicators and mixer/loaders can speak English.

Name: **Ed Hanbach**
Position: **NYSDEC Region 8 Pesticide Supervisor/ Statewide Worker Protection Coordinator, Bath, NY**
Experience: **26 years with the Department of Environmental Conservation and 8.5 years in private pesticide industry**

Discussed: Grower and worker characteristics in the DEC Region 8 area.

Growers:

- Southern Tier-Field Crops/Dairy/Vegetables (Chip Potatoes) - some migrant workers.
- Middle Tier- primarily Grapes and Vegetables- most grape growers are family farms. Some corporate owned or winery owned with vineyard managers.
- Northern Tier- Apples and other tree fruit - mostly family owned, but some very large corporate farms in excess of 2000acres / 200 plus workers.

Growers - family farms need to be certified to purchase and use restricted -use pesticides. Corporate farms must employ certified applicators.

Migrant Workers:

- Southern Tier- Milking -dairy operations/ harvesting vegetables and chip potatoes
- Middle Tier- workers harvest, trim vines and harvest....some applicators- -primarily apply herbicides
- Northern Tier- workers trimming trees, harvesting and some pesticide applications including herbicide applications and airblast spraying.
- Workers tend to return to the same farm from year to year or have become citizens over time.

Worker Protections afforded through the Federal Worker Protection Standard (WPS) and NY State outreach and enforcement activities related to WPS by pesticide specialists Statewide.

Name: **Jim Bittner**
Position: **Apple and Cherry Grower, Buffalo, New York**

Discussed: AHETF plans for recruiting growers, non-coercion statements, recruiting workers, and compensation.

- Understood the need for data and felt our procedures were totally appropriate.
- Not all growers in his area would have the same feeling – in his words "others trust nobody" and would not want to cooperate.

Region II (Southeast)

Name: **Keith Yoder, Ph.D.**
Position: **Professor of Plant Pathology, Virginia Tech College of Agriculture and Life Sciences, Winchester, VA**
Experience: **30 years**

Discussed: Airblast applications in Virginia tree fruit: mostly apples, some peaches, cherries, plums, and pears.

- Almost all acreage of these crops are sprayed by airblast.
- There are both closed and open cabs. Closed cabs may constitute the majority, but the proportion seems to be pretty stable now. Spray suits are generally worn regardless of cab type. If no cab, then spray helmets with charcoal filtration are generally added, possibly with other PPE. Use of protective measures seems to be increasing with educational outreach, and also that younger workers seem more conscious of the dangers.

- There is typically one spray performed without foliage. May not be truly dormant, as application may take place at leaf fall or pre-bud-swell. Mid-winter sprays are not typical, but are recommended for leaf curl in peaches, weather permitting. In general, there is one non-foliar application out of a regime of perhaps 8 to 12 full applications per season.
- Conventional airblast is mostly used, and there are some smart sprayers. Some sprayers are trucks, but most are pulled by tractor and have PTO drive or independent power. Growers often make "alternate-middle" applications (or "half-applications"), in which every other row is sprayed, to decrease spraying overall. For example, if a 7-day interval is recommended for a product, a grower may do an alternate-middle application every 5 days. This increases the number of times a grower would enter the field, but the spray interval from the perspective of each row is increased from 7 to 10 days.
- Airblast sprayers are generally the same. Tank sizes appear to be 400 to 500 gallons, regardless of whether driven or towed.
- There are no application parameters that should affect exposure if the worker is protected, as he is required to be, by the label and WPS protective measures.
- Same answer for closed cab situations. Exposure will be mainly from mixing and loading of powder formulations. Exiting the equipment is very rare once spraying is underway.

Name: **Timothy Brenneman, Ph.D.**
Position: **Professor, University of Georgia, Tifton, GA specializing in epidemiology and control of pecan diseases and soilborne peanut diseases.**
Experience: **Not obtained.**

Discussed: Airblast applications to pecan trees.

- Growers use traditional airblast equipment but also truck mounted sprayers for mature plantations.
- Both closed and open cab tractors are used in the plantations, but open cabs are used for mowing and ground applications. All airblast spray operations are done with closed cabs
- The common application volumes are 75 - 125 gpa for growers in South Georgia. Most applicators drive at about 2 mph and cover about 40 acres day.
- Workdays are commonly 8 – 121 hours and many growers will spray early in the morning or during the night when winds speed tend to be lower.
- Farm sizes are quite variable. He estimates the average in his area is 100 acres, but 10 – 20 acres is quite common with an occasional 200 acre farm. Owner/operators typically make their own sprays; contract custom applicators are not common.
- A very low percentage of applicators would be Hispanic who speaks only Spanish. Most pecan growers own and operate their farms.
- Most mixer/loaders and applicators are men; female applicators are not common.

- Most applicators are certified applicators since they must have a license to purchase the chemicals.
- All mixer/loaders and applicators receive WPS training.

Name: **Ray Smith, Ph.D.**
Position: **Agricultural researcher, Southeast Ag Research, Chula, GA**
Experience: **Not obtained.**

Discussed: Airblast applications to peaches and pecans in the southeastern states.

- Peach growers use traditional airblast equipment; most commonly use a pull-behind, Rears-type sprayer.
- Peach growers prefer closed cab tractors because of the hot climate in South Georgia and adjoining states, but open cab tractors are common for smaller orchard growers.
- Pecan growers use traditional equipment for younger trees but often use truck-mounted sprayers for mature trees. Mature, bearing trees represent the majority of sprays.
- Most peach and pecan growers make most of their own applications rather than use contract applicators.
- Peaches in Georgia and adjoining states generally receive 7-8 cover sprays and 1 dormant spray where scale or insect populations are present.
- Spray volume varies by grower preference, tree spacing, and foliage density
- Younger orchards require less volume
- Pecan growers make fewer sprays and do not make dormant sprays.
    - Pecans are a relatively low margin crop
    - Growers do not spray unless they know a pest will injure the nut crop
    - More commonly, the grower sprays to apply micronutrients

Region III (Peninsular Southeast)

Name: **Withheld**
Position: **Multi-County Citrus Extension Agent, University of Florida/Polk and Hillsborough Counties Cooperative Extension Service**
Experience: **Not obtained.**

Discussed: Applications to citrus trees in Florida.

- Growers use traditional airblast equipment; most commonly a pull-behind, Rears-type sprayer. Both closed and open cab tractors are used, but closed cabs are the most common because of the hot climate in Florida.

- There are various sizes of tractors and sprayers. The tractors are mostly up to 90 hp with few over 100 hp. The sprayers are mostly 500-1,000 gallon tanks. The size concerns are related to the weight of the unit as opposed to the cost of the equipment.
- The common application volumes are 125 – 250 gpa. Higher volumes are used for full coverage. Although 500 gpa was common for sprayers in the past, there are no applications used at 500 gpa today.
- Most growers of medium to large acreages use contract applicators to make sprays. It is common for workers to work 8 - 9 hours per day but longer hours are more common when a contract applicator wants to complete a job and not have to return to the grove the next day.
- It is common to average about 20 acres per day. The maximum for the largest rigs is about 50 acres per day.
- Farm sizes are quite variable, so no size is common. Many growers will work less than 100 acres. But large commercial growers may control hundreds or thousands of acres. Groves with 300 – 500 acres require a full-time employee. The number of employees actually making sprays depends on the size of the operation.
- Except for large commercial orchards, it is not common for mixer/loaders and applicators to not speak English and only speak Spanish. Although this is common for harvesting crews, it is not common for mixer/loaders and applicators since the supervisor must be able to communicate effectively with them.
- Most mixer/loaders and applicators are men; female applicators are not common.
- In Florida nearly all mixer/loaders and applicators receive annual WPS training. Growers routinely require their employees to attend annual Extension Pesticide and Agricultural Safety Programs in their counties.
- It would be nearly impossible to obtain an accurate list of pesticide handlers to try to recruit them to participate in a research exposure study. It might be possible to obtain a publicly available list of landowners claiming agricultural use for the county appraiser record, but this would not provide information about the number of employees who are handlers, or the current level of activity relating to agricultural production.

Name: **Withheld**
Position: **Owner/operator of a Grove Caretaker Service, Winter Haven, Florida**
Experience: **Not obtained.**

Discussed: Airblast applications to citrus trees.

- Growers use traditional airblast equipment; most commonly use a pull-behind, Rears-type sprayer. Most sprayers are PTO driven (~80%) but you see a few old self-propelled FMC types around.
- Both closed and open cab tractors are used, but closed cabs are the most common (90% or more) because of the hot climate in Florida.
- There are various sizes of tractors and sprayers. His sprayers are mostly 1,000 gallon tanks, but smaller custom operator firms may use 500 gallon.

- The common application volumes are 100 gpa for custom applicators. Higher volumes are used for full coverage.
- Most growers of medium to large acreages use contract applicators to make sprays. It is common for workers to work 8 - 10 hours per day but longer hours are more common when a contract applicator wants to complete a job and not have to return to the grove the next day.
- He reports his applicators spray 40 – 60 acres per day on their best days. The amount varies with the distance to the refill station and time it takes to get to the client fields from the company location.
- Farm sizes are quite variable, so no size is common. Many growers have 10, 20, or 40 acres in the Winter Haven area. But large commercial growers may control hundreds or thousands of acres. Most of the new large scale operations are in South Florida.
- Except for large commercial orchards, it is not common for mixer/loaders and applicators to not speak English and only speak Spanish. Although this is common for harvesting crews, it is not common for mixer/loaders and applicators since the supervisor must be able to communicate effectively with them.
- Most mixer/loaders and applicators are men; female applicators are not common.

Name: **Withheld**
Position: **Owner/operator of a Grove Caretaker Service, Hillsborough County, Florida**
Experience: **Not obtained.**

Discussed: Airblast applications to citrus trees in Florida.

- Growers use traditional airblast equipment; most commonly use a pull-behind, Rears-type sprayer. He sees a few old self-propelled FMC types around.
- Both closed and open cab tractors are used, but closed cabs are the most common.
- There are various sizes of tractors and sprayers. His tractors are 4-wheel drive with 75 or 80 hp. His sprayers are mostly 500 gallon tanks.
- The common application volumes are 100 gpa for his clients and sprays about 35 – 40 acres per day.
- Farm sizes are quite variable. His customers range from 10 - 80 acres.
- His firm has no mixer/loaders and applicators that do not speak English and only speak Spanish.
- Most mixer/loaders and applicators are men; female applicators are not common.
- Aerial applications are not common for citrus crops.

Name: **Withheld**
Position: **Owner/operator of a Grove Service Company and grove owner, Orlando, Florida**
Experience: **Not obtained.**

Discussed: Airblast applications to citrus trees in Florida.

- Growers use traditional airblast equipment; most commonly use a PTO driven, pull-behind, Rears-type sprayer.
- Both closed and open cab tractors are used, but closed cabs are the most common.
- There are various sizes of tractors and sprayers. His tractors are 4-wheel drive with 90 or 100 hp. His sprayers are mostly 1,000 gallon tanks.
- The common application volumes are 100 gpa for his clients and spray about 50 acres per day, but may reach 80 acres per day with speed sprayers and early season applications requiring less volume.
- Farm sizes are quite variable. For his customers 200 + acres are common.
- His firm has no mixer/loaders and applicators that not speak English and only speak Spanish.
- Most mixer/loaders and applicators are men; female applicators are not common.
- His firm does not spray pesticides, only micronutrients and foliar fertilizers.

Name: **Withheld**
Position: **Operations Manager of a Grove caretaker company and grove owner, Lake Alfred, Florida**
Experience: **Not obtained.**

Discussed: Airblast applications to citrus trees in Florida.

- Growers use traditional airblast equipment; most commonly use a PTO driven, pull-behind, Rears-type sprayer. Both closed and open cab tractors are used, but closed cabs are the most common. Even small growers have closed cabs, <25% open cabs.
- There are various sizes of tractors and sprayers. His tractors are 4-wheel drive with 75 or 105 hp. 100 hp is about as large as he sees in the groves. His sprayers are mostly 1,000 gallon tanks but 1,000 gallon tanks are common for custom applicators and large growers (~50:50 for 500 and 1,000 gallon tanks).
- The common application volumes are 125 gpa for his clients and sprays about 25 - 30 acres per day.
- Workdays are commonly 10 – 11 hours; 6 hours in the tractor, 4 hours filling the tank.
- Farm sizes are quite variable. For his service, 1,000 acres is common. His biggest customer manages 4,000 acres.
- His firm uses Hispanic mixer/loaders and applicators but most speak English but may only read Spanish.
- Most mixer/loaders and applicators are men; female applicators are not common.

Region V (Upper Midwest)

Name: **Mike Ellis, Ph.D.**
Position: **Ohio State University Extension Plant Pathologist**
Experience: **Not obtained.**

Discussed: Airblast applications to tree fruit orchards.

- Growers use traditional airblast equipment; most commonly use a pull-behind, Rears-type sprayer.
- Growers make most of their own applications rather than use contract applicators.
- Open and closed cab tractors are both common. Most growers prefer closed cabs, but do not use them in narrow row plantings, especially apples, when fruit hangs down between rows and would be injured by the cab.
- Dormant applications were a minor part of the spray program: generally only 1 dormant oil spray, but definitely never more than 2.
- All growers want complete coverage of foliage. In the Midwest, 50-100 gallons per acre is the common spray volume; higher volumes require more time to spray and more trips to refill tank.
- Commonly, 5-6 cover sprays are made during the active growing season with most during the period after fruit set. Seven – ten day intervals are common for most diseases and insects.
- Spraying orchards is necessary to control insects and diseases but growers do not make unnecessary applications because
    - Costs are high for equipment, fuel, chemicals, labor
    - Potential to injure the crop
    - Injury to the trees, especially root injury during wet periods of summer and frozen ground in winter
    - Timing of sprays determined by pest populations and predator populations for insects and mites.

Name: **Withheld, Ph.D.**
Position: **Horticultural Research Station Coordinator, Michigan**
Experience: **3 years**

Discussed: Airblast applications to cherries in MI; mostly in upper MI along west shore of Lake MI. (Oceana Co., Mason Co., Benzie Co., Manistee, Co., Grand Traverse, Co., Leelanau Co. (largest production county).

- Cherries are commonly treated by airblast in Michigan
- 60% open cabs; 40% closed cab (50% of the acreage sprayed use closed cabs due to big growers).

- 90% foliar applications; some dormant applications for cherry bacterial canker (use copper).
- Conventional 60% (conventional tractor pulled and truck mounted airblast sprayers are used) ; 40% use curtain sprayers.
- Airblast equipment are basically the same, except air from curtain sprayer penetrates the canopy more than for conventional airblast sprayer.
- Drift and wind would impact exposure, but exposure would be reduced with closed cabs.

Name: **Withheld, Ph.D.**
Position: **Research and Extension Center, Michigan**
Experience: **15 years**

Discussed: Airblast applications to peaches in MI; fresh market acreage centered in 4 counties; Van Buren, Allegan, Berrien, Kent, Oceana. Ottawa, Muskegon, and Oceana counties grow peaches for processing.

- Peaches are commonly sprayed by airblast in MI.
- 70% closed; 30% open. Truck mounted closed cab air blast sprayers are not that common.
- 8% dormant airblast sprays. One type of dormant spray on peaches is for peach leaf curl. This can be done in spring before bud opening or in the fall (at 50% leaf fall).
- About 70% of the time conventional airblast sprayers; ~ 30% air curtain and proptec (controlled droplet technology).
- Airblast equipment function essentially the same, except air curtain sprayers use less volume water/acre.
- Exposure is influenced by the following:
    1. Wind conditions
    2. Amount of protective clothing; whether or not applicator wears protective gear (goggles, respirator, helmet)
    3. Whether the applicators wear Tyvek coveralls or how they handle gloves when putting them on.
- Spray drift is not a factor with closed cabs, however, leaving the cab for adjustment of equipment could increase exposure.

Region VI / VIII (South Central)

Name: **Julian Sauls, Ph.D.**
Position: **Professor and Extension Horticulturalist for Texas Agrilife Extension Service, Westlaco, TX**
Experience: **35 years**

Discussed: Airblast applications in citrus in Texas.

- Dr. Sauls said that he was the only citrus extension specialist in Texas.
- Citrus is commonly sprayed with airblast equipment.
- All are pulled with a closed cab tractors.
- No dormant Applications (citrus are evergreen)
- Conventional airblast sprayers predominate. Usually 500 gallon spray tanks. PTO driven fans or fans that run off of diesel engine (self contained).
- All airblast sprayers are essentially the same.
- Exposure is impacted by:
  1. Windy in south Texas. Turing into wind would impact exposure greatly for open cab equipment.
  2. Tree size would not impact exposure unless small trees are being sprayed. This is because the applicator would have to spray both sides of the small tree and would be spraying much longer than for large trees.
- These parameters would probably not be important when using closed cabs. Would depend on how good the air conditioning and filtration system is working.

Name: **Withheld, Ph.D.**
Position: **Professor and Extension Horticulturalist, Texas**
Experience: **25 years**

Discussed: Airblast applications in pecans in Texas.

- Pecans are commonly treated by airblast.
- 90% are pulled with a closed cab tractor.
- None when dormant.
- There are all sizes and makes of airblast sprayers, however, most (roughly 70%) have 500-1000 gallon spray tanks. Roughly 30% have spray tanks <500 gallons. About 40% have their own motors to run the fan and about 60% are PTO driven.
- Most sprayers are essentially the same. Expert has not seen any alternative sprayers. There are some electrostatic airblast sprayers, but they are not good to use when the disease pressure demands a lot of spraying (such as wet humid conditions).
- Wind and wind direction will impact exposure. Large pecan trees may present more exposure since more time spent in orchard spraying large pecan trees.

- Wind would not be a factor with closed cabs. Amount of exposure would depend on how good the air filtration system for the closed cab functioned.

NOTE: Two other county extension agents in Texas were contacted and we were referred to the two experts just discussed. Therefore, no other Texas experts were pursued.

Name: **Jim Criswell, Ph.D.**
Position: **Pesticide Coordinator and Extension Specialist, Oklahoma State University, Stillwater, OK**
Experience: **28 years**

Discussed: Oklahoma crops where airblast sprayers are used: pecans, small amount of peaches, grapes, large nurseries, a few ranches.

- These crops are commonly treated by airblast.
- 80%-90% by open cab - open cabs increase ability to get under trees.
- most are foliar, some dormant just when buds are opening in spring (at bud break).
- Conventional = 40% typical orchard sprayer that directs spray out of both sides of airblast sprayer. 60% alternative airblast sprayer that has a hood over the spray and can move the air stream up at a 45 degree angle. This is still an airblast sprayer but designed a bit different to reach taller trees by focusing the spray and directing it upward.
- All airblast sprayers function basically the same.
- Spraying downwind could increase exposure. Amount of protective clothing is also important. Long sleeved shirt and long pants will mitigate some exposure.
- If the filtration system was working OK, exposure will be reduced for closed cab situations.

Name: **Withheld, Ph.D.**
Position: **University Extension Agent, Oklahoma**
Experience: **2.5 years**

Discussed: Airblast applications in pecans in Oklahoma, several counties.

- Pecans are commonly treated by airblast
- Mostly with closed cabs
- Mostly foliar applications
- Mostly with conventional airblast equipment which are basically the same
- Air speed and direction might influence exposure (OK is a windy state)
- But, wind would not be a factor with closed cabs

Region VIII / IX (Southwest)

Name: **William D. Cox**
Position: **Agricultural Researcher, Coxco Ag Services, Inc., Las Cruces, N.M**
Experience: **Not obtained.**

Discussed: Airblast applications in New Mexico.

- Enclosed cab spray tractors are used exclusively in this area. There might be someone using an open cab tractor for air blast spraying but I haven't seen it. 100% closed cab.
- The primary reason is worker safety. A secondary reason is worker comfort. Common sense and our desire to keep our help both healthy and happy is why we don't use open cab spray tractors.
- The only crops we spray with air blast sprayers here are pecans. We use either 50gpa or 100gpa with 100gpa being the most common.
- Pull behind units (self powered) are the most popular. We use either 500 or 1000 gallon tanks.
- Depending on water availability, a worker could spray 75-100 acres of pecans per day. In this area, it is rare that we ever spray our pecans more than 2 or 3 times in an entire season with pesticides. Most of the spraying is done to supply foliar nutrients.
- The common row spacing for pecans in this area is either 30 or 35 feet.

Region 10 (West)

Name: **Steve Vasquez**
Position: **University of California Cooperative Extension, Fresno County, California**
Experience: **10 Years with UC (12 total in grapes)**

Discussed: Airblast applications to grapes in Fresno County.

- Raisin grapes are commonly treated with sulfur dust, but this is not by airblast. Airblast applications of other pesticides to raisin grapes are not common.
- Some airblast applications are made to wine and table grapes, sometimes several times during the growing season and depending on disease pressure and grape cultivar.
- Both open and enclosed cabs are used, but can't estimate relative prevalence.
- Essentially no dormant applications are made in the valley, applications occur throughout the season from bud break until fruit harvest in table grapes and until veraison (berry softening) in raisins and wine grapes.

- Most airblast equipment are conventional pull-behind sprayers, but some electrostatic sprayers are used to minimize drift and focus pesticide material in the fruiting zone (but not in raisin grapes).
- Crop height depends on grape type and trellis system, generally 4 to 8 feet. Table and raisin grapes tend to have taller trellis systems and wine grapes tend to have trellis systems that are less expansive.
- Napa/Sonoma counties may have different practices, so they should be contacted separately.

Name: **Rhonda Smith**
Position: **University of California Cooperative Extension, Sonoma County, California**
Experience: **21 Years**

Discussed: Airblast applications to wine grapes in Somona County.

- Grapes in Somoma County are almost exclusively for wine and other trellis crops grown commercially are very rare.
- Wine grapes are commonly treated by airblast.
- Approximately 50% by closed cabs, perhaps as much as 60%.
- Vast majority of applications are non-dormant. Some dormant applications are made, but several airblast applications are typically made throughout the growing season.
- Conventional airblast equipment (radial fan, nozzles) is most common, perhaps representing 95% of applications. Alternatives include various boom set-ups and electrostatic sprayers (low volume, ≤ 50 GPA). Boom systems include 5-row sprayers that have drop-down sections with horizontal nozzles that spray the sides of the vines as well as ATV-mounted rigs that resemble an inverted-U with horizontal nozzles that spray each side of one vine row.
- Conventional airblast sprayers are essentially all the same. Most often with tanks of ≤ 100 gallons, but probably with a maximum of 300 gallons. Typical volume sprayed ranges from 40 to 150 gallons.
- Impression is that tank sizes and GPA are higher for table grapes in Central Valley of CA: tanks greater than 300 gallons are common and spray volume of at least 150 GPA is typical.
- Wine grapes are vertically managed making the rows skinny and a very dense hedge. Height is generally 5 to 8 feet.
- Table grapes in Central Valley are managed much differently, rows are much wider with vigorous vine growth at the top (more like a mushroom or a tree). This explains why higher spray volumes are used for table grapes.

Name: **Don Arburua**
Position: **Pest Control Advisor, Stanislaus Farm Supply, Merced, CA**
Experience: **18 years**

Discussed: Airblast applications in almonds and prunes in CA

- These crops are commonly treated with airblast sprayers
- Approximately 99% of the applications are done with a closed cab. Closed cabs are used so none or less PPE is required.
- Non-dormant applications are done approximately 10 to 1 over dormant applications. Non-dormant applications include bloom sprays. During these applications there is very little or no foliage. True dormant applications are not done every year. Usually every two to three years.
- Conventional airblast equipment is used most often. Some small trees may be treated with a hand wand. Also, aerial (fixed and rotary wing) applications may be used when conditions dictate.
- The air blast sprayers observed are essentially the same. There are a very few that use electrostatic nozzles at 40 gallons per acre but all the experts applications are done with conventional nozzles at 100 gallons per acre.
- Wind and driving into the spray would be the main factors impacting exposure for open cab situations. Growers will use more than one sprayer at a time in an orchard. On rare occasions having multiple sprayers may increase exposure potential but sprayers usually are not close to each other.
- These parameters are probably not important with closed cabs.

Name: **Vern Crawford**
Position: **Pest Control Advisor, Wilbur-Ellis Co., Shafter, CA**
Experience: **40 years**

Discussed: Airblast applications in almonds, cherries, grapes in Kern County, CA

- All of these crops are commonly treated by airblast.
- All of his growers except one uses closed cab sprayers. The workers for the grower without closed cabs wear full PPE protection.
- All of his crops including grapes get a dormant application yearly. Grapes are sprayed just before or right at bud break to control a new mealy bug pest. Cherries 1 dormant application for every ~6 applications. Grapes 1 dormant application for every ~6 application. The number of applications per year on grapes varies. Some growers use sulfur to control powdery mildew and make less airblast applications. Growers using chemical fungicides can make applications every 7 to 14 days depending on the powdery mildew pressure. Almonds 1 dormant application to every ~5 applications

- Conventional air blast equipment is used. One applicator has air blast equipment that will turn on and off the spray when it detects foliage. This is only used when the trees are small. In grapes, span sprayers are used about 25% of the time. Growers are using these less than airblast because the airblast gets better coverage. The expert believes to get good coverage; the air within the canopy needs to be displaced. Span sprayers blow directly towards each other and have a harder time displacing the air. The number of span sprayers is decreasing. Some growers use small Toyota or other brand small pickups to pull there sprayers. The cabs on these trucks are sealed and filtered. They are used in orchards not vineyards. When trees get big, many growers are applying with air-blast sprayers to reach the lower ~75% of the tree and having aerial applications done to reach the upper portion of the tree.
- Air blast sprayers are essentially the same. The expert thinks of air-blast sprayers in two types; PTO driven and engine driven.
- Exposure will be impacted by wind shifts or driving into the wind, spray rigs passing each other in the field, repairing or filling the spray rig, and tank cleaning.
- Closed cabs would mitigate most of the exposure but not the direct contact.

Name: **Michael Miller**
Position: **Agricultural Researcher, Excel Research, Madera, CA**
Experience: **20 years**

Discussed: San Joaquin Valley of California; all tree and vine crops.

- Orchard and vine crops are commonly treated by airblast.
- In vines: 70% closed, 30% open cabs. In trees; 30% closed, 70% open.
- Vines: almost never get a dormant application; thus 95-100% are foliar applications. Trees: most do get dormant sprays. Typically 1 to 2 dormant sprays and 4 to 7 foliar sprays.
- Sometimes applications are made by fixed-wing aircraft, occasionally helicopter.
- Airblast sprayers function similarly; some are PTO-driven and some are operated by gas or diesel motors.
- Exposure can be influenced by dilute vs concentrate (gallons per acre); nozzle configuration and type; and pressure.
- These parameters are probably not important for closed cab situations.
- About 70% of vine acreage is treated by airblast.

Name: **John Corkins, M.S.,**
Position: **Agricultural Researcher (Research For Hire), Pest Control Advisor, and Orchard Grower, Porterville, CA**
Experience: **32 years**

Discussed: EPA Region 10 (CA and AZ); all crops including orchard (citrus, olive, nuts) and trellis crops (grapes).

- Crops in this area are commonly treated by airblast.
- CA farmers are moving towards closed cabs. Ten years ago, it was about a 75/25 split between open and closed cab. Now it's about 50/50.
- Every acre gets 1 dormant application (although not all grapes get dormant treatments) whereas they get multiple foliar applications. In general, 70% of the airblast applications in CA are foliar applications.
- There are really no alternatives to conventional airblast that are used commercially.
- They are function all about the same.
- Gallons per acre, tractor speed can influence exposure.
- These parameters would be less important with closed cabs.
- John has been involved in discussions with the state of California recently about the use of closed cab tractors and the issue of certification. The main issue to how to determine whether the air filtration system is adequate to qualify as a WPS closed-system. Not all closed cab tractors have charcoal filtration and even those that do can become overloaded, reducing the effectiveness of providing clean air to the applicator.

Name: **Withheld**
Position: **Agricultural Researcher, California**
Experience: **Not obtained.**

Discussed: Typical tree heights for mature crops in CA.

- Almonds - 20 – 25 feet
- Pistachios - 15 – 20 feet
- Walnuts - 30 – 40 feet
- Apples - 10 – 15 feet
- Pears - 15 – 20 feet
- Peaches - 15 – 20 feet
- Prunes - 15 – 20 feet

Name: **Grape and Prune Grower**
Position: **Central Valley, California**
Experience: **32 years**

Discussed: Airblast application in raisin and table grapes, and prunes, in CA.

- Both prunes and grapes (including all trellis systems) are treated by airblast.
- In grapes and prunes, about 70 – 80% of applications are done with closed cabs. In general, it is changing from open to closed cab as growers upgrade equipment.
- In grapes, no dormant applications are made. In pruned, generally 1 formant versus 2 – 3 foliar applications.
- Airblast is most often used – it is more efficient to spray concentrate and you can't spray concentrate with a boom sprayer.
- All sprayers are basically the same.
- Wind is the biggest factor impacting exposure. Turning methods also important.
- With closed cabs, these factors are not nearly as important. Air filtration system function and opening windows will be more important.

Name: **Tim Wagenleitner**
Position: **Grape Grower, Fresno County, California**
Experience: **40 years**

Discussed: Airblast application in raisin grapes in CA.

- Raisin grapes are commonly treated by airblast.
- 75% of applications are with closed cabs.
- No dormant applications to grapes.
- Conventional airblast sprayers are most common, some wrapping type boom sprayers (dilute).
- Most sprayers are essentially the same, but new technologies are now available with differences fan types, nozzle types, air flow devices, and multi-row sprayers.
- Wind is the only factor important to exposures with open cabs.
- With closed cabs, wind is not important. Instead, filling the tank, touching chemical bottles will be more important. Filtration system function is also important.
- There are lots of airblast sprayers in this area.

Region XI / XII (Northwest)

Name: **Mike Willett**
Position: **VP Scientific Affairs, Northwest Horticultural Council, Yakima, WA**
Experience: **17 years with Oregon State University/Washington State University Cooperative Extension as tree fruit pest management specialist. Past 10 years with the Northwest Horticultural Council.**

Discussed: Airblast applications in orchard and trellis crops in the Pacific Northwest.

- Orchards are commonly treated with airblast sprayers.
- Grapes and hops are commonly treated with airblast sprayers; not sure about caneberries.
- Almost all applications are made with open cab rigs (probably more than 95%) and this does not seem to be changing (cost is an issue).
- In orchards, practically all acres get one dormant application and generally 5 to 7 foliar applications.
- For trellis crops, suggest contacting someone else to discuss dormant vs. foliar applications.
- Most airblast sprayers are of classic design: radial fan with nozzles in airstream. There are very few alternatives, but some sheer nozzles (low volume) and downward directed-spray boom sprayers are used.
- Sprayer size varies somewhat: basic difference is engine driven vs. PTO-driven (which tend to be smaller). Growers have switched mostly to PTO sprayers when buying new equipment.

Name: **Vern Fischer, M.S.**
Position: **Agricultural Researcher (Columbia Ag Research), Orchard Grower, Mt. Hood, Oregon**
Experience: **18 years**

Discussed: Airblast applications in Oregon and Washington crops – orchards (apple, cherry, pear) and trellis (grapes, caneberries, blueberries, hops).

- Airblast application is common in orchards (pome, stone) and trellis (grape, caneberries, hops) crops.
- Closed cabs account for about 15% of applications in both crop types, but growing slowly. Choice is mainly an economic one (i.e., closed cabs tractors are expensive).
- Foliar applications are more common. In orchards: 2 dormant sprays and 5 cover sprays per year = 28% dormant. In trellis crops: 1 – 2 dormant and 5 cover per year = 14 to 28% dormant
- Orchard applications are generally 50 – 100 GPA for dormant sprays and 200 – 300 for foliar sprays.

- Trellis applications are generally 50 – 100 GPA, increasing gradually to 200 GPA as foliage increases.
- About 80% of applications in orchards use conventional, radial fan sprayers; the rest being "smart" tower sprayers and/or electrostatic sprayers. Alternatives selected for economics (less spray used) or to prevent non-target injury.
- Nearly all applications in trellis crops use conventional sprayers. There used to be some wrap-around type sprayers (homemade) in WA, but these are dying off.
- Sprayers are essentially all the same, but fan pitch in trellis rigs is different and moves less air.
- Wind is the major parameter that impacts exposure since it causes spray to drift onto worker. Canopy density also impacts exposure since drift is higher with less foliage. In trellis crops, exposure would be lower since spray is directed laterally, not vertically (again, drift is real issue).
- Same parameters impact exposure for closed cab situations, however mixing/loading would be more important (usually the same person).
- Typical crop heights are:
    - Caneberries: 5 feet
    - Grapes: 5 feet
    - Blueberries: 6 feet
    - Apples: 12 feet
    - Pears: 12 – 14 feet
    - Cherries: 14 – 16 feet
    - Hops: 20 – 25 feet at maturity

Name: **Mick Qualls, M.S.**
Position: **Agricultural Researcher, Qualls Agricultural Laboratory, Ephrata, Washington**
Experience: **16 years**

Discussed: Washington's Columbia River Basin; all tree and vine crops.

- Trees and vines are commonly treated with airblast sprayers.
- Approximately 10% of farms use closed-cab tractors. The reason this is a low number is due to the difficulty of using closed-cab tractors in the orchards – because of the tight plantings it is difficult for the tractors to fit in the rows
- Everyone does a dormant spray (1-2) and typically 15 to 20 foliar sprays per growing season.
- About 95% of applications use conventional airblast equipment. The other 5% would be made by aircraft.
- All sprayers are similar – and there are only 3 main manufacturers of these spray equipment used in WA: Rears and Turbo-mist account for about 95% of the sprayers; Miller would be the third.
- Exposure can be influenced by gallons per acre (spray volume); pressure; and whether safety equipment (PPE) is being worn.

- However, these factors would not be important in closed cab situations.
- Pome fruit are commonly treated by airblast in WA (apples are usually on wider spacing and are larger trees, making it easier to drive the closed cab tractor).

Name: **JoAnne Smith, M.S.**
Position: **Agricultural Researcher, Smith Biologicals, Idaho**
Experience: **Not obtained.**

Discussed: Airblast applications in orchards.

- Don't have many closed cab rigs in use in orchards.

Name: **Withheld**
Position: **Fruit tree expert at pesticide manufacturer**
Experience: **Not obtained.**

Discussed: Airblast applications to apples in NE and PNW.

- Apples are commonly treated by airblast.
- 70% with closed cabs, 30% with open cabs
- 75% foliar applications, 25% dormant applications
- Mostly conventional airblast equipment, but 15% use electrostatic nozzles
- Exposure potential will be influenced by environmental Conditions (i.e., wind speed, temperature, etc.), operator safety, and spray volume.
- These factors will be important during closed cab situations as well, but to a much lesser degree.

Volume VII, Part B:

Report of workplace meetings with citrus and pecan growers and employees. July 2007. Prepared for the Agricultural Handlers Exposure Task Force, 8 August 2007

Report on Workplace Meetings with Citrus and Pecan Growers and Employees

E. Bruce, L. Smith, V. Standart
August 8, 2007

I. Summary

Eric Bruce, Larry Smith and Vicky Standart met with citrus and pecan employees and growers in Haines City, FL and Ray City, GA, respectively, on July 26, 2007. The purpose of the meetings was three-fold: 1) to test a new process for organizing local workplace meetings, 2) to obtain worker and grower input about the proposed ethics-related components of AHETF worker exposure studies (AHE44 and AHE54), and 3) solicit evaluation of the documents presented at the meetings. Attendance was disappointing, although not unexpected due to the heavy workload this time of year in citrus and pecans. Nonetheless the attendees were generally cooperative and attentive and most responded to the feedback form.

This report describes how the meetings were coordinated, the presentation and materials provided, and a summary of findings. Also included are options for addressing the HSRB requirement of conducting these types of meetings and estimates of cost.

II. General

Larry Smith coordinated the meetings through Ray Smith of Southeast Ag. Ray contacted both citrus and pecan growers and explained to them the purpose of the meetings. He invited the growers and their employees, and encouraged them to invite any others who they believed would have an interest in attending.

Five individuals attended the citrus meeting and were comprised of employees, growers and those who were both managers/operators and custom applicators. Nine individuals attended the pecan meeting and were comprised mostly of growers, but some were also managers/operators. No attendees of the pecan meeting were classified as employees only. This was not surprising because most of the pecan growers own relatively small acreages and do not use employees to spray the trees.

A complimentary meal and a $25 gift certificate were provided to each attendee. All attendees spoke English and one employee also spoke Spanish. One worker was a non-reader. No women attended.

III. Description of the presentation

The meeting program was comprised of: 1) a formal Power Point presentation 2) handouts bound in a booklet comprised of eight sections and provided to each attendee and 3) a feedback form for each worker to fill out. Questions and comments were encouraged throughout the presentation and discussion. The meetings lasted about 1.5 hours.

The formal presentation focused on ethics-related procedures proposed in AHE44 and AHE54 (closed cab airblast studies), including the recruitment and consent process. The sections of the handout booklet corresponded to the topics discussed in the formal presentation but provided more detail. After each topic was discussed, the attendees were asked to refer to the appropriate section of the feedback form and answer the questions related to the topic just discussed. Although the meeting was slanted toward airblast application, much of the input obtained is applicable to ethics-related procedures proposed for AHETF's overall research program.

Several topics discussed pertained to specific areas of the consent form, such as remuneration, confidentiality, pregnancy testing, etc. The consent form itself was not discussed in detail due to time constraints, but feedback such as its understandability, length, etc., was solicited at the end of the formal presentation. That is, attendees were asked to take approximately ten minutes to review the consent form and provide general feedback. Although some provided useful comments, it was clear that, in general, attendee interest had diminished considerably by that point.

IV. Findings

A. Organizing meetings

As previously stated, one of the objectives of these visits was to test a new process for organizing such workplace meetings. The following conclusions were drawn and they reinforce previously held opinions:

- Workplace meetings should be scheduled during growers' least busy period of the crop season (unlike these meetings which were driven by the need to collect study-specific feedback on protocols which were to be submitted in July).
    - The meetings were scheduled during a very busy time for citrus and pecan work and this affected attendance. In FL (citrus workers), we held a breakfast meeting and some of the growers and employees who did attend were clearly preoccupied with getting back to work. It is likely that they would have done a more thorough job of completing the feedback form and interacting more if they were not so busy. In GA (pecan workers), a dozen workers were

expected to attend a dinner meeting and only nine showed up. This may be due to holding the meeting during the growing season.

- Meetings should be coordinated through a third party, such as a local site coordinator

    - It was evident that the success of these meetings depends on a third party coordinator such as Southeast Ag. This individual knows the local agronomics, he knows (or knows of) local organizations and individual contacts, he is respected within the community, and is more likely to persuade attendance. In particular, Southeast Ag got an influential local pecan grower to agree to participate and to solicit others to attend.

    - The meetings would have been less well attended, if at all, had AHETF attempted to contact these growers directly. This is because, in most cases, there is no existing relationship with these individual growers or operators, and AHETF would likely be viewed as suspicious. An exception in which direct AHETF contact might work is a case in which the AHETF is already known to certain individuals or organizations.

B. Useful worker-related information

There was general consensus among the attendees on the ethics-related topics. Examples include:

- No one knew of organizations (local or national) representing the interest of workers (exception: one worker suggested the Citrus Advisory Board might represent worker interests)
- During the recruitment process, AHETF should definitely talk to growers before talking to the growers' employees
- The payment for participation was about right for the inconveniences described and the amount would not coerce participation.
- There were no particular concerns with the steps to assure worker confidentiality

A summary is attached which provides a full listing of questions from the feedback form and responses to them.

C. Ways to improve the documents used in the presentation

Attendees were asked to evaluate the documents for clarity, understandability, applicability, etc. In addition, ways to improve the documents and overall presentation were noted by Eric, Larry and Vicky based on questions raised by the attendees during

the meeting and some of their responses on the feedback form. The following are examples:

- "Worker Type" on first page of feedback form needs further explanation. Some attendees were known to be employees but they recorded some other "worker type".
- Topic 4 – change "uncomfortable" to "embarrassed". The term "uncomfortable" can have different meanings, and the intent of the question was "embarrassment".
- State in the recruitment flyer that worker participation will only be for one day and emphasize how the worker will benefit by participating.

Ways to improve the formal presentation, the handouts and feedback forms were noted. Copies of the documents used for these meetings are attached to this report.

V. Managing the HSRB requirement of community workplace input

The HSRB requires community involvement as part of the AHETF field study program. Ideas on how best to meet this requirement will evolve as we become more experienced in this area. Currently, the following two options can be considered:

- Option 1: Hold local meetings for every site-specific study within a scenario. Local input can then be directly associated with the locale in which a particular study is conducted.

- Option 2: Collectively and in advance, hold local meetings independent of specific studies or scenarios. The goal would be to get broader input on ethics-related items such as study procedures, the flyer, consent form, etc. Such input would not be expected to vary from site to site. The advantage of this approach is the number of site visits would be reduced. However, it is also recognized, that there may be some studies with specific issues that do need to be discussed locally, and such situations would be handled on a case-by-case basis.

Other, cost-effective approaches are worth consideration. For example, more workers could be contacted if AHETF coordinates its community input recruitment with the state Pesticide Safety Education Programs in regions of the country where AHED scenarios requiring data are prevalent. These programs typically interact with workers directly through county meetings and training sessions. Growers frequently encourage their workers to attend such meetings in order to comply with WPS training requirements. It is likely that worker input for multiple AHED scenarios would be obtained at meetings being held in high density agricultural areas.

VI. Cost projections

Several sources of expense are included in the planning and conduct of these meetings. The following estimates are based on the cost of the meetings in Florida and Georgia (considered one site).

- The local site coordinator will be compensated for his time and expenses in coordinating the meetings. For example, Southeast Ag will invoice the AHETF for its part in coordinating the citrus and pecan meetings which took place in essentially one location. The costs will vary according to the difficulty associated with recruiting workers; however, based on this case, $1,500 is a reasonable estimate.

- Two consultants should be scheduled for each meeting. One would conduct the meeting in English, and the other would be available to conduct the meeting in Spanish. Assuming the time and travel for a consultant to work these two meetings will be typical of future meetings, then approximately $4,000 can be anticipated per consultant. This is based on approximately $1,000 in expenses and 20 hours of billing.

- Individual $25 gift cards and complimentary meals should also be considered. The cost of these items for the citrus and pecan meetings totaled approximately $750 ($350 for gift cards and $400 for meals).

- Each booklet costs approximately $8-$10 to produce, assuming a similar format with color copy content. Twenty-five were made for this set of meetings ($250).

Assuming the above expenses and two consultants per site-visit, the overall cost of conducting meetings at one site is estimated to be $10,000 to $12,000. It is currently estimated that up to 50[1] site-specific studies will be conducted. Thus, the overall cost for Option 1 (holding local meetings for each site-specific study) is estimated to be $600,000. If Option 2 is considered, some level of non-duplication of efforts might be achieved thereby reducing the overall costs.

[1] Based on information in the Governing Document, Version 0 (Final Report) dated May 21, 2007.

Volume VII, Part C:

E^{x}ponent®, Inc., Confidential Client Advisory: Preliminary Evaluation of the PHED Data for Closed Cab Airblast Application for Inclusion in AHED®, June 12, 2007

Center for Chemical Regulation and Food Safety

Exponent®

Confidential Client Advisory: Preliminary Evaluation of the PHED Data for Closed Cab Airblast Application for Inclusion in AHED®

Confidential Client Advisory: Preliminary Evaluation of the PHED Data for Closed Cab Airblast Application for Inclusion in AHED®

Prepared for
Agricultural Handlers Exposure Task Force, LLC
c/o Johnson Management and Consulting
1720 Prospect Drive
Macon, MO 63552

Prepared by
E^x^ponent®, Inc.
Center for Chemical Regulation and Food Safety
1730 Rhodes Island Avenue, NW
Suite 1100
Washington, DC 20036

June 12, 2007

WD00847.000 A0T0 0607 0002

Contents

List of Tables

Page

EXECUTIVE SUMMARY

This document presents a preliminary evaluation of the existing exposure data in the Pesticide Handlers Exposure Database (PHED) for potential use in developing dermal unit exposures for closed cab airblast applicators. First, EPA's PHED analysis and unit exposure estimates for the scenario of interest are confirmed, and the quality of EPA's unit exposure estimates is discussed. Next, the existing PHED data are reviewed in the context of the AHETF criteria for suitability in a generic handler exposure database, and recommendations are made regarding the suitability of the existing PHED data for inclusion in the new Agricultural Handlers Exposure Database (AHED®). The criteria are briefly stated as follows:

- Dermal exposure data for individual monitoring units must meet minimum data quality guidelines and must be available for all major body areas, including hands and head (i.e., "complete" data sets only)
- The monitoring period should be at least half of a normal work period duration or half the default acreage for the scenario of interest.
- The non-detect/less than LOQ values in the data set must account for less than either 20% (AHETF criterion) or 40% (AEATF criterion) of the total dermal exposure.
- If the previous two criteria are not met, the LOQs must be no more than 1 ng/cm² for dermal exposures and no more than 100 ppb for hand exposures (which is equivalent to approximately 50 µg for a typical 500 mL hand wash sample).

The application of these AHETF criteria, which are related to exposure results but not necessarily to study design, availability of raw data, or other criteria, had a large impact on the potential acceptability of PHED data for this scenario for inclusion in AHED. The step-by-step application of these criteria is detailed in this document.

When the first criterion was applied, only PHED data from studies 460 were identified as candidates for potential inclusion in AHED. As the other criteria were applied, only one complete monitoring unit in PHED Study 460 passed. However, the exposure recorded for this monitoring unit is high compared to the three other records from Study 460, which may indicate a potential incident during monitoring, so the original study report must be consulted. Further evaluation of monitoring unit 0460*D*03 is recommended.

CONFIRMATION OF EPA PHED SUBSETS AND DERMAL UNIT EXPOSURES FOR CLOSED CAB AIRBLAST APPLICATION

EPA has evaluated the data in PHED and calculated unit exposure estimates for closed cab airblast application (PHED Surrogate Exposure Guide Scenario #12). The dermal unit exposure is 0.019 mg/lb ai for long pants, long-sleeved shirt (LP/LS) with gloves, and there are no data for the "no gloves" scenario. EPA's unit exposure estimates for this scenario are based on Grade A and B data, as classified in PHED by EPA.[1]

The EPA Subset for Dermal Data of Grade A and B

Specifications for EPA's subset for dermal data of grade A and B are summarized below. In addition, the dermal unit exposure (except the hands) is derived as shown in the exposure analysis below.

Subset Specifications for CLOSEDAIRDERMAB.APPL

With Dermal Grade Uncovered Equal to "A" "B" or
With Dermal Grade Covered Equal to "A" "B"
Subset originated from CLOSEDAIR.APPL
With Application Method Equal to 1 and
With Cab Type Equal to 3 or Equal to 4
Subset originated from APPL.FILE

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES
SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	DISTRIB. TYPE	MICROGRAMS PER LB AI SPRAYED Median	Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	Lognormal	2.405	9.269	186.7612	3.3373	20
NECK.FRONT	Lognormal	.5775	.936	96.5812	.653	20
NECK.BACK	Lognormal	.1485	.3795	172.6482	.1877	20
UPPER ARMS	Other	.291	.7469	108.6089	.5098	30
CHEST	Other	.355	1.2543	118.3927	.7449	30
BACK	Other	.355	.9112	108.604	.6219	30
FOREARMS	Other	.242	.726	156.3499	.3357	30
THIGHS	Other	.382	2.4957	315.0419	.7696	30
LOWER LEGS	Other	.238	.6585	107.6689	.4411	30
FEET						0
HANDS	Lognormal	12.024	17.3027	80.5395	12.8759	20
TOTAL DERM:	18.9169	17.018	34.6798		20.4769	

95% C.I. on Mean: Dermal: [-287.4651, 356.8247]

Number of Records: 30
Data File: APPLICATOR Subset Name: CLOSEDAIRDERMAB.APPL

[1] The PHED grading criteria are as follows: Grade A PHED data have lab recoveries of 90-110%, coefficient of variation (CV) for lab recovery of ≤15% and field recoveries of 70-120%. Grade B PHED data have lab recoveries of 80-110%, CV for lab recovery of ≤25% and field recoveries of 50-120%. Exposure data in PHED are corrected for field recoveries.

The dermal unit exposures estimated from the data subset consisting of dermal data of grade A and B confirms EPA's estimated unit exposures for head/neck (0.00418 mg/lb ai) and rest of body (0.00186 mg/lb ai) (calculated by summing the underlined values above). Because this dataset contains 20-30 dermal data records for various body parts of grade A or B, EPA considers the PHED Surrogate Exposure Guide dermal unit exposure estimates for head/neck and the rest of the body to be of "high confidence." However, EPA also notes the "not surprising" number of non-detects for this closed cab scenario.

The EPA Subsets for Hand Data of Grade A and B

Specifications for EPA's subset for hand data of grade A and B are summarized below. In addition, the hand unit exposure – both without and with gloves – is derived as shown in the analysis below.

```
                Subset Specifications for CLOSEDAIRHANDAB.APPL

With Hand Grade Equal to "A" "B"
Subset originated from CLOSEDAIR.APPL
With Application Method Equal to 1 and
With Cab Type Equal to 3 or Equal to 4
Subset originated from APPL.FILE
```

Unit Exposure for Ungloved Hands

```
             SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES
SCENARIO: Long pants, long sleeves, no gloves
 PATCH        DISTRIB.               MICROGRAMS PER LB AI SPRAYED
 LOCATION       TYPE       Median       Mean     Coef of Var  Geo. Mean    Obs.
HANDS                                                                        0

                                     Number of Records: 20
Data File: APPLICATOR                Subset Name: CLOSEDAIRHANDAB.APPL
```

Although there are 20 data records of grade A or B in this scenario, all of these data are for applicators wearing gloves. There are no data for the no gloves scenario. Because there are no data for this scenario, EPA considers the non-existent unit exposure estimate for ungloved hands to be of "low confidence."

Unit Exposure for Gloved Hands

```
             SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES
SCENARIO: Long pants, long sleeves, gloves
 PATCH        DISTRIB.               MICROGRAMS PER LB AI SPRAYED
 LOCATION       TYPE       Median       Mean     Coef of Var  Geo. Mean    Obs.
HANDS        Lognormal        12.024     17.3027     80.5395     12.8759     20

                                     Number of Records: 20
Data File: APPLICATOR                Subset Name: CLOSEDAIRHANDAB.APPL
```

The exposure estimated from the data subset consisting of hand data of grade A and B confirms EPA's estimated unit exposures for gloved hands (0.0129 mg/lb ai). Because this dataset contains 20 data records for gloved hands of grade A or B, EPA considers the unit exposure

estimate for gloved hands to be of "high confidence." Although it isn't necessarily true for all of the monitoring units in this scenario, for at least some of them it is stated in the PHED comments field that study participants wore gloves when entering and leaving the cab or when "handling residues," which is consistent with requirements under the Worker Protection Standard (WPS). Perhaps it is for this reason that EPA consistently uses the "gloved" scenario in occupational exposure assessments for the closed cab airblast application, because the toxicity of the active substance is such that gloves are generally required when the operator is outside the cab for compounds with closed cabs requirements.

Confirmation of PHED Scenario 12 Unit Exposure Estimates

AHETF was able to reproduce the PHED datasets and confirm EPA's unit exposures for closed cab airblast application (Scenario #12 in the PHED Surrogate Exposure Guide).

EVALUATION OF PHED DATA ACCORDING TO AHETF CRITERIA

Starting with the PHED data used by EPA in estimating the unit exposures for closed cab airblast application identified in the previous section, the following AHETF criteria have been applied to determine which of these data might be suitable for inclusion in a generic handler exposure database.

1. Monitoring units must be classified in PHED as having all dermal and hand exposure data of grade A and B concurrently.[2] The PHED criteria for grade A and B data are as follows:
    - Grade A:
        - Recoveries of lab spikes are 90-110% with the precision value (coefficient of variation; CV) of ≤15%, and
        - Recoveries of field fortification samples are 70-120%.
    - Grade B:
        - Recoveries of lab spikes are 80-110% with a CV of ≤25%, and
        - Recoveries of field fortification samples are 50-120%.

2. Monitoring units must include a minimum of 10 dermal patch dosimeters attached inside of normal work clothing (chest, back, both upper arms, both lower arms, both upper legs, and both lower legs), as well as hand (cotton gloves can substitute for hand wash) and head/face exposure data.

3. Dermal sampling times for each monitoring unit must be approximately one-half of the typical work day for the scenario of interest or longer. This criterion was developed to increase the confidence that any analytical results that are below the LOQ results from low exposure potential rather than insufficient sampling duration.

4. The number of non-detect/less than LOQ samples cannot contribute more than 20% (AHETF criterion) or 40% (AEATF criterion) of the total dermal exposure. (Note: For this analysis of the closed cab airblast application scenario, the AHETF criterion is applied.)

5. If the third and fourth criteria are not met, the LOQs must be less than 1 ng/cm² for dermal exposure and 100 ppb for hand exposure, which is equivalent to approximately 50 µg for a typical 500 mL hand wash sample.

[2] There are slight differences in the data grading criteria between PHED and the AHETF. However, the information in PHED includes only the grade of the data, and the actual information on lab recoveries, field recoveries and coefficients of variation cannot be obtained practically. Therefore, for the purposes of this preliminary evaluation of PHED data for potential inclusion in AHED, the PHED data grades are used in lieu of applying the AHETF data grading criteria.

The application of the AHETF criteria to the PHED data for closed cab airblast application is discussed below.

AHETF Criterion 1. Grade A or B Dermal and Hand Data

The first criterion is that AHETF will consider only those monitoring units which have dermal and hand data of grade A or B. The datasets created in the above section fulfill this criterion.

AHETF Criterion 2. Monitoring Units Must Consist of "Complete" Dermal Data

As stated previously, the AHETF criterion for a "complete" monitoring unit is one which has patch dosimetry exposure data for 10 body parts (chest, back, both upper arms, both lower arms, both upper legs, both lower legs) as well as exposure data for the head and hands. Appendix A contains a list of the PHED monitoring units which contain data of grade A or B for the closed cab airblast application scenario.

The Table in Appendix A illustrates that there are no "complete" monitoring units for the no glove scenario, while there are 4 "complete" monitoring units for the gloves scenario (listed below) from PHED Study 460. Data for the head are lacking in PHED Study 523; otherwise the monitoring units would be complete.

Complete Monitoring Units – Closed Cab Airblast Application (Gloves Scenario)

0460*D*01
0460*D*02
0460*D*03
0460*D*04

The remaining criteria will be applied only to these 4 monitoring units. There is no need to further consider the incomplete monitoring units.

AHETF Criterion 3. Minimum Dermal Sampling Time

The question now becomes whether the complete data records for the gloves scenario meet the AHETF criterion of being representative of typical work practices, i.e., a dermal sampling time of approximately 4 hours or longer, based on one-half the typical work period of about 8 hours for orchard or vineyard spraying. The list below shows the pounds AI handled in each "complete" PHED monitoring unit, the dermal sampling time for each monitoring unit, and the number of acres treated by each monitoring unit.

Record I.D.	Dermal Smpl Time (hrs)	Total AI Applied (lb)	Total Number of Acres
0460*D*01	5.050	6.7500	36.0000
0460*D*02	3.720	5.0600	30.0000
0460*D*03	5.150	6.7500	36.0000
0460*D*04	4.770	6.7500	37.0000

The 4 complete monitoring units in Study 460 meet the dermal sampling time criterion for inclusion in a generic exposure database because the monitoring periods range from 3.7 to 5.2 hours. Furthermore, the four participants in Study 460 treated 30-37 acres, which is quite close to the EPA default for tree and orchard crops (40 acres at about 150 gallons/acre; EPA Policy 9.1). Amounts applied are fairly low (5-7 lb ai) due to the application rate of 0.1875 lb ai/A. Table 2 summarizes the application of this criterion to the complete monitoring units.

AHETF Criterion 4. Maximum Contribution of Non-Detects to Exposure

The AHETF criterion states that dermal exposures due to non-detect analytical results should not account for more than 20% of the dermal exposure. This criterion relates to the level of exposure attributed to the non-detects assuming exposure at one-half the limit of quantitation (LOQ) for each non-quantifiable analytical result. This criterion is not applied to the number of samples. Table 1 summarizes the exposure for each body part – as calculated according to PHED algorithms – for each complete monitoring unit. Shaded cells in the table indicate exposures calculated assuming exposure at one-half the LOQ. Table 2 summarizes the application of this criterion to the complete monitoring units.

With the exception of one complete monitoring unit, non-detects contribute the majority (62%-92%) of estimated exposures for all complete monitoring units in Study 460. For the one exception (0460*D*03), high exposures to the head and upper leg patches dominate the total exposure, and just 12.4% of the total exposure is due to non-detects. On the other hand, these isolated high results might be an artifact of the patch dosimetry method used in this 1988 study. It is recognized that a small splash on a patch can produce wildly exaggerated exposure estimates when scaled up to the entire body part.

AHETF Criterion 5. Maximum Limits of Quantitation

As originally stated, this AHETF criterion is to be applied in the event that criteria 3 and 4 are not met. For this evaluation, the criterion is applied to all complete monitoring units regardless of whether or not they meet criteria 3 and 4. The LOQ for dermal samples should be below 1 ng/cm² (0.001 µg/cm²), and the LOQ for hand samples should be below 50 µg (assuming typical 500 ml wash and LOQ in wash solution of 100 ppb).

For Study 460, the LOQ for dermal exposures (11 ng/cm²) is greater than the target, while the LOQ for hand exposures (40 µg) is below the target. Table 2 summarizes the application of this criterion to the complete monitoring units.

The relatively high dermal LOQ in Study 460 has an interesting effect on the total estimated exposures. If the LOQ were the desired 1 ng/cm² rather than the 11 ng/cm², exposures and unit exposures for the monitoring units with predominant non-detect exposure contribution would decrease to 39%-59%. The exposure for 0460*D*03 would decrease only slightly, to just 7%. The results from Study 460 are strongly influenced by the LOQ for dermal exposures. Furthermore, although the 40 µg/sample LOQ for hand exposures meets the criterion of 50 µg/sample, the non-detect estimates for the hands account for 19%-27% of the total exposure for

the three predominantly non-detect results. This casts further doubt on the reliability of these monitoring units.

These findings lead to the conclusion that the single monitoring unit 0460*D*03 should be considered for evaluation for inclusion in AHED. However, for this study conducted in 1988, this recommendation should be taken with a note of caution, as the high exposures to the head and upper legs may be a result of small isolated splashes on those patches rather than an indication of actual high exposures to those body parts.

CONCLUSION

Table 2 illustrates the application of the AHETF criteria to the four complete monitoring units from Study 460 in PHED for this scenario. While four PHED data records for closed cab airblast application in Study 460 meet the criterion for dermal sampling time, just one (0460*D*03) meets the criterion for the contribution of non-detects to the total exposure. Because the dermal LOQ in Study 460 is relatively high, the estimated exposures for the three monitoring units with mostly non-detect analytical results are strongly affected by the LOQ. Consequently, the data for these three monitoring units should not be considered for potential inclusion in AHED.

PHED Study 460 was conducted in 1988 and was therefore not conducted according to GLP regulations. According to an October, 2003, study details report written for the AHETF Joint Regulatory Committee on this study (AHETF Study 502-A-2), the sprayer used in PHED Study 460 was an International Vilute Sprayer pulled by a Massey-Ferguson tractor with a closed cab, filtered air and closed windows. Thus, there is reasonable confirmation that closed cabs were used for these monitoring units.

Although one monitoring unit (0460*D*03) passes the AHETF criteria, it isn't certain that it would be considered suitable for acquisition. The very high exposures to the head and upper legs for this monitoring unit may be the result of isolated splashes on those patches rather than an indication of actual high exposures to those body parts. The original study report for PHED Study 460 should be reviewed to determine what occurred during the monitoring of 0460*D*03 to result in the high exposure for this monitoring unit before any final recommendation regarding its acquisition can be made.

Table 1. Dermal Exposure by Body Part, with Calculation of Percent Attributed to Non-Detects

PHED Monitoring Unit ID	Head (µg)	Neck Front (µg)	Neck Back (µg)	Hands (µg)	Upper Arm RT (µg)	Upper Arm LT (µg)	Forearm RT (µg)	Forearm LT (µg)	Chest (µg)	Back (µg)	Upper Legs RT (µg)	Upper Legs LT (µg)	Lower Legs RT (µg)	Lower Legs LT (µg)	Total Exposure (µg)	Percent from <LOQs
0460*D*01	10.400	1.200	2.640	40.000	8.003	8.003	3.328	3.328	19.525	19.525	10.505	10.505	6.545	6.545	150.050	90.5%
0460*D*02	10.400	1.200	0.880	40.000	8.003	8.003	3.328	3.328	19.525	19.525	10.505	10.505	6.545	6.545	148.290	91.6%
0460*D*03	497.900	2.700	17.820	40.000	8.003	8.003	3.328	3.328	19.525	19.525	185.270	106.960	6.545	6.545	925.450	12.4%
0460*D*04	7.150	6.900	12.320	40.000	8.003	8.003	10.890	3.328	19.525	19.525	10.505	49.660	6.545	6.545	208.898	61.8%

Table 2. Application of AHETF Criteria to Complete Monitoring Units in PHED for Closed Cab Airblast Application (Gloves Scenario)

PHED Monitoring Unit ID	Pounds AI Handled	Dermal Sampling Time		LOQs as % of Exposure		Dermal LOQ		Hand LOQ		Evaluate for Inclusion in AHED?
		(hr)	> ~4 hr?	%	<20%?	ng/cm²	<1 ng/cm²	(µg)	<50 µg?	
0460*D*01	6.75	5.05	✓	90.5%		11		40	✓	
0460*D*02	5.06	3.72	✓	91.6%		11		40	✓	
0460*D*03	6.75	5.15	✓	12.4%	✓	11		40	✓	✓
0460*D*04	6.75	4.77	✓	61.8%		11		40	✓	

APPENDIX A

Closed Cab Airblast Application - Summary of Available PHED Data of Grade A or B and Determination of Complete Monitoring Units

PHED Monitoring Unit ID	Head	Upper Arms	Lower Arms	Chest	Back	Upper Legs	Lower Legs	Hands		Complete Monitoring Unit	
								Gloves	No Gloves	Gloves	No Gloves
0460*D*01	X	X	X	X	X	X	X	X		X	
0460*D*02	X	X	X	X	X	X	X	X		X	
0460*D*03	X	X	X	X	X	X	X	X		X	
0460*D*04	X	X	X	X	X	X	X	X		X	
0523*AA*01		X	X	X	X	X	X	X			
0523*AB*01		X	X	X	X	X	X	X			
0523*AC*01		X	X	X	X	X	X	X			
0523*AD*01		X	X	X	X	X	X	X			
0523*AE*01		X	X	X	X	X	X	X			
0523*AF*01		X	X	X	X	X	X	X			
0523*AG*01		X	X	X	X	X	X	X			
0523*AH*01		X	X	X	X	X	X	X			
0523*AI*01		X	X	X	X	X	X	X			
0523*AJ*01		X	X	X	X	X	X	X			
0523*AK*01		X	X	X	X	X	X	X			
0523*AL*01		X	X	X	X	X	X	X			
0523*AM*01		X	X	X	X	X	X	X			
0523*AN*01		X	X	X	X	X	X	X			
0523*AO*01		X	X	X	X	X	X	X			
0523*AP*01		X	X	X	X	X	X	X			
1000*B*01		X	X	X	X	X	X				
1000*B*02		X	X	X	X	X	X				
1000*B*03		X	X	X	X	X	X				
1000*B*04		X	X	X	X	X	X				
1000*B*05		X	X	X	X	X	X				
1007*A*01		X	X	X	X	X	X				
1007*A*02		X	X	X	X	X	X				
1007*A*03		X	X	X	X	X	X				
1007*A*04		X	X	X	X	X	X				
1007*A*05		X	X	X	X	X	X				