NPDES PESTICIDES PERMIT UPDATE

As of November 1, 2011, point source discharges from the applications of pesticides to waters of the state require National Pollutant Discharge Elimination System (NPDES) Permits, as required by the Clean Water Act. These discharges include applications of pesticides to, over, or near waters of the state. The Hawaii Department of Health (DOH), Clean Water Branch (CWB) is responsible for implementation of the NPDES pesticides permit program in the State of Hawaii.

Currently, applications to, over, or near waters of the state without a NPDES permit would be in violation of the Clean Water Act. (cont. p. 2)

Renewed

For growers of non-bearing sugarcane—use of the pesticide GoalTender Herbicide (Dow AgroSciences; EPA Reg. No. 62719-447)—requires having a copy of HI-060003, valid 12/7/2011–12/6/2016—some notes: • One year to harvest. • Chemigation prohibited. • Do not apply more than 8 pt. per acre per crop as a result of multiple applications. • Do not harvest for food or feed within one year of application. • This is an agricultural pesticide and so the Worker Protection Standard applies.

For managers of forests, forest margins, and access roads and trails—use of the pesticide Escort XP Herbicide (Du Pont; EPA Reg. No. 352-439)—requires having a copy of HI-060004, valid 12/7/2011–12/6/2016—some notes: • Spot application. Apply to leaves, exposed rhizomes, and cut surfaces or stalks and rhizomes. • Broadcast application prohibited. • Do not apply using high-volume power sprayers. • Chemigation prohibited. • Avoid run-off or overspray onto soil. • Avoid spray drift near streams or irrigation ditches.

NOTE: To navigate to an article from the Table of Contents, just left-click on its title.
SPRAYER CLEANING AND MAINTENANCE (recertification)

Sprayers are an essential piece of equipment to most pesticide applicators. Keeping sprayers clean and well maintained is important for efficient application and trouble-free operation. A clean sprayer is also essential if it is used for pesticide products that can damage other plants (e.g., herbicides) or react with the most recently applied pesticide. A sprayer that is not ready for use, fails during a job, or damages sensitive plants, can cost time and money, produce irregular or unsatisfactory results, and reduce customer satisfaction. This article discusses cleaning, inspecting, and maintaining spray equipment.

Read the label

Review the label of the pesticide most recently applied before starting to clean the sprayer. Look for information on:

- how to properly dispose of unused pesticide product
- the need for any special cleaning instructions
- what personal protective equipment (PPE) is required to safely clean the sprayer.

Rinsing

Try to mix and load the right amount of pesticide for the job so that the tank is empty for cleaning. Rinsing is done to remove any large areas or concentrated deposits of the pesticide product still on or in the sprayer. Ideally it is done by circulating water through the sprayer, then applying it to the site listed on the label of the product just used. Several rinses using about 10 percent of the sprayer volume is better than just filling the tank once and emptying it. Apply the rinsate (rinse water) to
the crop, or object, or site on the label, if possible. **Wear the required PPE when rinsing, draining, cleaning, and maintaining the equipment.**

If the rinse water must be disposed of somewhere else, choose a place where it will not contaminate clean water supplies, other crops or plants, or where large puddles would form. The tank should be drained in a manner consistent with the pesticide label, and not just poured on the ground.

To wash the outside of the sprayer, it is best to have a supply of water on the sprayer and rinse it down in the field. Do not create puddles that might tempt children, pets, livestock, or wildlife.

**Draining**

As with rinsing, the ideal place to drain the spray equipment is at the application site listed on the label. The drain hole should be at the lowest point on the tank and/or the tank tilted, if possible, so it drains completely.

**Cleaning**

After the sprayer has been rinsed and drained, both the inside and outside portions must be cleaned, or decontaminated. It is not necessary to fill the tank with cleaning solution, use only enough to fill the lines and provide some agitation. Run the solution through the boom (if present) and out through the nozzles.

Choose a cleaning agent based on the formulation of the pesticide being removed (see Table). Different agents clean in different ways. Some penetrate and dissolve pesticide residues so they can be removed in the rinsate. Commercial tank cleaning agents and detergents are effective with both water- and oil-soluble herbicides and are often recommended by the pesticide manufacturer.

Some cleaning agents and ammonia raise the pH of the rinsate. This makes some products, like the sulfonylurea herbicides (e.g. Landmark XP, Prospective, Throttle XP, League, Certainty) more water soluble and easier to remove from the sprayer. Chlorine bleach also speeds up the breakdown of sulfonylurea herbicides. However, it is not as effective in dissolving and eliminating them from spray tanks as ammonia solutions. Fuel oil or kerosene can remove oil-soluble herbicides, but the oily residue needs to be removed with a detergent. Run cleaning solution throughout the sprayer, including the agitation system and the

**WARNING**

Do not mix chlorine bleach with ammonia or liquid fertilizers that contain ammonia. The chlorine and ammonia will form chlorine gas, which is toxic and can cause eye, nose, throat, and lung irritation.
return lines. Rinse the whole system with water until it comes out of the nozzles clean.

**Inspection**

The sprayer is ready for inspection after the final rinse. Always wear required PPE even though the sprayer is supposedly clean. There still may be residue in or on the equipment. Look for the following:

- mismatched or worn nozzles
- damaged nozzle screens
- damaged strainer screens
- cracks, leaks, and overall pump performance
- hose condition, especially brittleness or cracks
- condition of valves—identify possible leaks or areas where seals may be loose
- boom structure (if present)—identify cracks that must be fixed.

Suggested modifications that might come in handy include:

- shut-off valves on either side of the pump to help with pump removal and repair
- shut-off valves at the boom
- shut-off valves at the tank
- additional pressure gauges
- installing flow meters
- installing tank level indicators
- bypass and agitation lines
- engine kill-switches
- additional lines to aid in cleaning (i.e. broadjets for spraying out rinsate as opposed to using the smaller-bore boom nozzles)

**Maintenance**

Maintaining pesticide application equipment is a continuous process. It includes regular inspection of all components. Also check the sprayer before each use. Wear appropriate PPE if you will be touching the equipment.

**Spray tanks.** Tanks are made of non-absorptive materials such as stainless or galvanized steel, fiberglass, or plastic, including polyethyl-
ene and polypropylene. They usually do not retain residues after cleaning. However, fiberglass tank linings can absorb pesticides if damaged. Cracked or chipped epoxy coating on galvanized tanks should be repaired with epoxy material to keep metal from corroding. Periodically check tanks for cracks, rust, or corrosion that could cause leaks. Make sure the spray tank is securely fastened to the sprayer. (see References)

**Pump and pump seals.** All parts of the pump must be in good condition. Seals, “O” rings, or cup washers of leather or synthetic material can dry out and shrink if the sprayer has not been in use for a period of time. The solvents in some pesticide formulations can damage pump seals, resulting in leaks or inefficient pump operation.

**Hoses.** Replace cracked or leaking hoses. Since they cannot be completely decontaminated, dispose of them properly. Do not reuse old hoses for other purposes. (see References)

**Line strainers and screens.** Always use strainers and screens to filter out debris that can plug nozzles and reduce sprayer efficiency. Clean or replace strainers or screens as needed.

**Pressure gauges.** Pressure of the fluid in the spray system is measured by a pressure gauge. If it is located between the pressure regulator and the nozzles, it measures the spray pressure through the nozzles. A change in pressure may indicate a malfunction and can affect spray efficiency. For example, an increase or decrease in pressure will affect the amount of pesticide being applied, droplet size, and possibly the spray pattern.

**Fittings and clamps.** Loose or cracked fittings are a common source of leaks. Replace worn or cracked fittings or corroded clamps. Make sure fittings and clamps are tight prior to using the sprayer and check for leaks when the system is under pressure.

**Nozzle tips and strainers.** Check nozzles routinely to make sure they are not plugged. If nozzle flow is less than expected, clean them and try again. Using abrasive formulations, such as wettable powders, can make the hole in the nozzle larger. This can result in an irregular spray pattern and application of more product than calculated. Replace worn nozzles when wear causes flow to exceed that of a new tip by five to ten percent.

Example: a nozzle tip is supposed to provide 50 ounces of flow per minute at 30 pounds per square inch (psi). For a 10 percent (0.10) error range, just multiply 50 x 0.10 = 5 ounces. Now both add and
subtract 5 ounces from 50. The results are 55 and 45. If the flow range is between 55 and 45 ounces, it is acceptable. Anything above or below this range indicates the nozzle tips should probably be replaced.

References
Poly tanks http://ppp.purdue.edu/pubs/ppp-77.pdf
Hoses http://www.ppp.purdue.edu/Pubs/PPP-89.pdf

This article is based on the Montana State University Extension publication by Reeves Petroff and Greg Johnson, “Maintenance, Cleaning and Storage of Ground Sprayers” and is available online at http://msuextension.org/publications/

| Table. Cleaning Solutions for Pesticides (from Montana State University, MT198917AG) |
|---------------------------------|---------------------------------|---------------------------------|
| Pesticide Used                  | 25 Gallon Cleaning Solution     | 2.5 Gallons Cleaning Solution   | Instructions                                      |
| Hormone herbicides, ester form, (brush killers, dicamba MCPA) | 1 qt household ammonia           | ½ cup household ammonia         | Agitate solution 10-15 min, flush small amount through system and let remainder stand over-night. Flush and rinse with clean water |
|                                 | or 2 lb trisodium phosphate     | or ¼ lb trisodium phosphate     | Same as above except let stand for at least 2 hours |
|                                 | or ½ lb fine activated charcoal + ½ cup powdered detergent | or 2 tbsp fine activated charcoal and 1-2 oz powdered detergent* | Agitate, operate sprayer for 2 min, let remainder stand for 10 min, then flush through sprayer. Rinse with clean water. |
| Hormone herbicides, ester form (2,4-D, brush killers, MCPA) | 1 lb washing soda (sal soda) + 1 gal kerosene + ¼ lb powdered detergent | 4 oz washing soda (sal soda) + 1 ½ cups kerosene + 1 tbsp powdered detergent | Rinse inside of tank and flush small amount through system. Let stand at least 2 hours. Flush and rinse with clean water. |
| Other herbicides               | ¼ lb powdered detergent         | 1 tbsp powdered detergent       | Rinse with clean water before and after using sudsy solutions. |
| (atrazine, simazine, alachlor) |                                 |                                 |                                     |
| Insecticides**, fungicides      | ¼ lb powdered detergent         | 1 tbsp powdered detergent       | Agitate, flush and/or rinse. |

The Pesticide Label October December 2011 Page 6
PROTECTING STORED CHEMICALS FROM NATURAL DISASTERS
(recertification)

The Hawaiian Islands are surrounded by thousands of miles of ocean. Hurricanes, earthquakes, volcanic eruptions, tsunamis, and flooding caused by heavy rains or high tides, are a constant threat. Any of these disasters can create hazardous conditions for stored pesticides and other chemicals. High winds and earthquakes can damage or destroy storage areas, topple shelving, and damage or scatter pesticides containers and their contents. Heavy rains, floodwaters, and high tides can destroy paper or cardboard packaging and carry pesticide products away with them. Tsunamis and volcanic lava destroy everything in their path.

If you store pesticides, fertilizer, solvents, fuel, or other chemicals, you need an emergency plan. Some natural disasters, such as hurricanes and high tides, usually give some warning, but earthquakes and flash floods do not. The National Weather Service (NOAA) http://www.prh.noaa.gov/hnl/ and the Pacific Tsunami Warning Center http://ptwc.weather.gov/ issue warnings but if the event is close, an earthquake near the Big Island for example, response time will be short. What points should you consider before and after a disaster? Here are some suggestions on how to best protect your chemicals and prevent possible contamination of the surrounding environment.

Before a natural disaster occurs

- Have a plan for what to do before a natural disaster and immediately afterwards.
- Locate chemical storage downwind and away from human habitation or environmentally sensitive areas.
- Do not site buildings in vulnerable areas, such as floodplains, exposed sites, or near tide lines.
- Choose or design storage buildings that can withstand high winds and water. Some pre-fabricated buildings are sturdy and especially designed to resist chemical storage problems. Good drainage around buildings is important for carrying off floodwaters.
- Make sure the building is well marked as a chemical storage building.
Shelving should be anchored to prevent it from falling over during an earthquake or if wind or water enters the building.

Make an inventory of chemicals on site and their amounts. This information is important for possible reporting requirements, to alert emergency responders, and for insurance purposes.

If the amounts of certain chemicals on your property meet or exceed their Threshold Planning Quantity, you are required to contact the appropriate county and state agencies (see http://pestworld.stjohn.hawaii.edu/studypackets/Pesticides_HEPCRA.pdf), or call (808) 586-4249.

Put the inventory and your disaster plan in a safe place.

Preparing for an imminent natural disaster

- Try to move chemicals to a safer location, if necessary.
- Do not move incompatible items into the same building (e.g. animal feed and pesticides).
- Minimize water damage by moving chemicals off floors, or to higher shelves.
- Try to protect product labels and labeling from damage.
- Turn off the building’s electricity.
- Plug drains if you think chemicals may escape through them into the environment.
- Do not leave chemicals in vehicles or application equipment.
- Secure all windows and lock doors.

Actions to take after a natural disaster

- Check the building for water or wind damage and possible toxic fumes.
- If the building is damaged, don’t enter it without personal protective equipment.
- If you know containers have been damaged, do not enter the building. **If chemicals have been released, call 911 first.**
- Call the Office of Hazard Evaluation and Emergency Response in Honolulu (808) 586-4249 to determine if a chemical release is large enough to require verbal and written reporting.
- If containers have been washed or blown out of the building, keep humans and animals out of the area to prevent exposure. Get help cleaning up the area to prevent further contamination.
- Check all pastures and feeding areas before releasing animals or pets after a disaster.

If released chemicals are an existing or imminent danger to humans or the environment, call 911.
References
Virginia Pesticide Safety Education Program. “Protecting your chemical storage area from storms and floods.” Virginia Cooperative Extension Service.

NANOPESTICIDES

What is Nanotechnology?
We hear the term nanotechnology frequently but may not know what it really means. Nanotechnology [editor’s italics] is the understanding and control of matter at dimensions of approximately one to 100 nanometers. A nanometer is one billionth of a meter. Or, to put it another way, there are 25,400,000 nanometers in an inch.

Nano-sized materials or nanomaterials can have fundamentally different physical properties than their larger-sized counterparts, and these differences often enable nanoscale materials to be used in new and valuable ways. Some examples include invisible sunscreens, stronger golf clubs, and water- and stain-resistant clothing.

Many public inquiries EPA has received concern the use of pesticides allegedly containing nanoscale materials, such as nanosilver, to control microorganisms on surfaces. However, not all products containing silver, whether nanoscale or not, are pesticides. Any product – in any form – that makes claims to control pests must first be evaluated and registered by EPA to ensure it meets Agency human health and environmental safety standards before it can be distributed or sold lawfully.

Background on Nanotechnology in Pesticides
The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and EPA’s implementing regulations provide an effective framework for
Nanoscale material is an active or inert ingredient of a pesticide and any component parts thereof intentionally produced to have at least one dimension that measures between approximately 1 and 100 nanometers.

regulating pesticide products that contain a nanoscale material. Currently, the Office of Pesticide Programs (OPP) describes a nanoscale material as an active or inert ingredient of a pesticide and any component parts thereof intentionally produced to have at least one dimension that measures between approximately 1 and 100 nanometers.

The special properties that make nanoscale materials of potentially great benefit also can present new challenges for risk assessment and decision-making. For instance, their small size may allow them to pass through cell membranes or the blood-brain barrier, possibly resulting in unintended effects.

How to Register a Product That May Contain Nanomaterials

Among its many potential applications, nanotechnology can be used to develop products that control pests, such as microorganisms on surfaces. EPA regulates products intended to control pests under the authority of FIFRA. EPA has in place a rigorous evaluation and registration (i.e., licensing) program for all pesticides that are distributed or sold in the United States.

Producers of pesticide products must submit scientific and technical data for EPA review to ensure that the use of a pesticide will not generally cause unreasonable adverse effects on human health or the environment.

EPA strongly recommends that companies contact EPA’s pesticide registration Ombudsmen to arrange a pre-application conference as early as possible in the development of any pesticide that would be a product of nanotechnology or that would contain nanoscale material. During pre-application conferences, a company should provide EPA with information on:

- how the pesticide is made,
- how it is proposed to be used, and
- how people and the environment may be exposed to the product.

EPA addresses these basic questions in the evaluation of any pesticide—regardless of the materials and methods by which it is made. However, because nanoscale materials may have special properties,
EPA’s data requirements may need to be tailored to the specific characteristics of the product under consideration.

The Nanotechnology Industries Association has stated that use of the term “adverse” regarding possible effects of nanoparticles may have a stigmatizing effect on the industry. They also say (editor’s addition) the requirement that a pesticide with an active ingredient currently accepted by EPA needs to be reregistered solely because it contains nanomaterial imparts an unfair bias against the product. [http://www.nanotechia.org/global-news/epa-closing-in-on-nanopesticide-reporting-policy](http://www.nanotechia.org/global-news/epa-closing-in-on-nanopesticide-reporting-policy).

### Pesticidal Applications of Nanotechnology

The use of nanoscale materials in pesticide products and treated articles may allow for more effective targeting of pests, use of smaller quantities of a pesticide, and minimizing the frequency of spray-applied surface disinfection. These could contribute to improved human and environmental safety and could lower pest control costs. For example, as a materials preservative, nanosilver should maintain its ability to reduce the number of odor causing bacteria longer and require smaller quantities than other silver preservatives due to an expected gradual and controlled release of silver ions from nanosilver as opposed to the rapid release of for example, silver ions from a zeolite structure or the immediate dissolution of a silver salt.

A number of organizations have considered whether the small size of nanoscale materials or the unique or enhanced properties of nanoscale materials may, under specific conditions, pose new or increased hazards to humans and the environment. Government, academic, and private sector scientists in multiple countries are performing research into the human health effects of diverse nanoscale materials, resulting in a substantial and rapidly growing body of scientific evidence. Recently, governmental and expert peer review organizations have reviewed and summarized this evidence and offered views about the implications of this evidence for environmental and human health and safety.

The above was extracted with minor revisions from the EPA website, “Regulating Pesticides that use Nanotechnology,” at [http://www.epa.gov/pesticides/regulating/nanotechnology.html](http://www.epa.gov/pesticides/regulating/nanotechnology.html) (accessed on 8 September 2011).

### Nanopesticides:

1. Better targeting of pests
2. Lower dosages
3. Fewer applications for surface disinfections
4. Health risk unknown as particles may be able to enter cells or cross the blood-brain barrier
PESTICIDE RISK ASSESSMENT

A previous article, “How We Interpret Risk” (http://pestworld.stjohn.hawaii.edu/pat/sepsep11.pdf), suggested that experts and the general public have different definitions of risk. Experts tend to be more objective and science-based. Conversely, most people define risk based on intuition and emotion and are often influenced by their peers and media reporting.

Risks for early humans were immediate: food, clothing, shelter, and protection from wild animals. Risks in modern society and how we respond to them, however, can have long-term consequences. This article looks at how experts try to objectively evaluate the potential risk of pesticides to humans and the environment.

Background

All people are exposed to some level of man-made chemicals in their diet. Therefore, it is important to know the potential risks of pesticide residues in food. Evaluation of the potential risks of pesticides in food and water began in the 1940s. In the 1950s risk assessors looked at pesticide handlers and workers exposed in the field. These assessments were mainly limited to men aged 20 to 50. Risk assessors in the 1980s changed their focus to the home and workplace. They may have underestimated the amount of risk in these areas by assuming it would be lower than for fieldworkers. Residential sites, however, include children and the sick and elderly, who may be more sensitive to pesticides.

The U.S. Congress has passed important legislation to protect health and the environment. In 1947 the Insecticide Act was replaced by the Federal Insecticide, Fungicide, and Rodenticide Act. FIFRA required all pesticides to be registered with the USDA. In 1954 the Miller amendment to the Federal Food, Drug, and Cosmetic Act (FFDCA) required that tolerances be established on all agricultural commodities. In 1958 another amendment to the FFDCA, the Delaney Clause, prohibited the use of any food additive shown to cause cancer in man or experimental animals. Pesticide residues tend to be more concentrated in processed foods (e.g. tomato paste) than in the raw commodity (e.g. fresh tomatoes).

In 1962, “Silent Spring” by Rachel Carson affected how most Americans think of pesticides. Some truth mixed with strong emotion led to bans or restrictions on the use of many pesticides. In 1970 the EPA was
created to regulate pesticides instead of the USDA. One of EPA’s first actions was to ban the use of DDT in the U.S.

A major change to FIFRA by Congress in 1972 made manufacturers responsible for demonstrating that their product would not cause “unreasonable adverse effects on human health or the environment.” At the same time, general and restricted use classifications were adopted. Regulatory decisions, however, were expected to balance restrictions related to potential health or environmental risk against the potential benefits of pesticide use. This process is called risk/benefit analysis.

In the late 1980s the emphasis moved from only assessing the toxicity of a pesticide. Evaluations were to include: 1) an assessment of exposure, 2) a measure of uncertainty, and 3) an assessment of potential risk. In 1993 EPA offered incentives to manufacturers that wanted to register reduced-risk and low-risk pesticides.

The Food Quality Protection Act (FQPA) was passed in 1996, amending FFDCA and FIFRA. It created a single, health-based standard for all pesticides on all foods. It mandates that tolerances for foods must be “safe.” FQPA defines safe as:

“. . . a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information.”

This FQPA mandate changed the EPA risk assessment process. EPA must now consider:

- aggregate exposure to a given chemical from non-occupational sources
- combining risk assessments for groups of chemicals with common modes of action
- providing additional protection for infants and children
- giving limited consideration to the benefits of a chemical

Risk assessment—A multi-step process

Risk assessment is intended to provide the pesticide industry and the general public with the standards and methods to estimate the level of risk posed by a pesticide. It is a science-based, decision-making process that tries to incorporate tested knowledge with inherent uncertainties. Risk characterization is part of this assessment. It is a prediction of the
chance of adverse human health effects from the combination of a pesticide’s toxicity and a person’s exposure to it. Risk management makes decisions and judgments on the acceptability of the levels of risk described in the risk assessment and the risk characterization process. For example, after assessing the risk of a certain pesticide product, the following risk management approaches could be used to reduce its danger to humans:

- not register the pesticide
- restrict its use to certified applicators
- lower application rates
- reduce the number of applications
- increase the time between applications
- increase the reentry internal (REI)
- increase the pre-harvest interval (PHI)
- use alternative application methods

These measures would be introduced by changes in the label. They would reduce the amount of pesticide used, lower the potential of exposure for farm workers and the general public, or both.

Human risk assessment is basically a three-step process:

- a toxicity assessment to evaluate the potential toxicity or hazard of a chemical
- an exposure assessment to estimate potential human exposure to the chemical
- a risk characterization to evaluate the potential risk of the chemical to humans

Risk management is based on the results of these findings.

**Toxicity assessment**

The toxicity of a pesticide has to be assessed to determine its potential to harm humans. This is done with carefully controlled experimental tests on animals. These studies determine the toxicity of the pesticide. The doses applied to the animal will include levels far above those humans would generally be exposed to.

In toxicology, “the dose makes the poison.” Toxicologists determine at what dosage an organism will show a response. This response will only occur at or above a specific dose, called the threshold dose. One of the most important parts of these studies is finding the No Observed Ad-

If a pesticide is determined to have a high level of risk, what are some of EPA’s options?

**HUMAN RISK ASSESSMENT**

the toxicity of a pesticide + its exposure assessments + an evaluation of its potential risk to humans
verse Effect Level (NOAEL). The NOAEL is the highest dose that does not cause any harmful effect. On the other hand, the lowest dose that still causes an adverse response is called the Lowest Observed Adverse Effect Level (LOAEL). The threshold dose is somewhere between the NOAEL and the LOAEL.

To err on the side of caution, risk assessors usually assume adverse effects in test animals will also occur in humans. They also assume humans may be up to 10 times more sensitive to the chemical than the most sensitive animal species tested. High doses of pesticide are used since only a limited number of animals can be tested. All of these actions increase the chance that an effect will be observed. Because of the uncertainties in animal testing, therefore, it is difficult to determine if the effects are real or artificial.

**Dietary exposure assessment**

The general public probably gets most of its pesticide exposure from their diet. Dietary exposure is a measure of the amount of pesticide residue on or in the food and the amount that is consumed. USDA and the Food and Drug Administration (FDA) measure residue on foods and USDA estimates the amount of food people consume.

EPA sets tolerances for each pesticide on commodities the pesticide is labeled for. A tolerance is the maximum level of a pesticide, its metabolites, or both, that can be legally present in or on a commodity such as fresh or processed foods, animal feed, meat, milk, and eggs. Since tolerances are based on the maximum application rates, maximum number of applications, and the shortest pre-harvest interval, they represent the maximum residue levels possible if the label directions are followed. This represents a “conservative” worst-case scenario. A more realistic estimate would come from a normal use pattern of pesticide application and the resulting residues.

USDA and the FDA routinely collect and analyze foods for pesticide residues. One of the most useful is the USDA Pesticide Data Program. It provides residue data on foods “as eaten,” so is more suitable for use in risk assessment.

The “Perceptions of Risk” article in our September 2011 newsletter said that people in general dread the risk of future harm more than immediate consequences. So, they would be more concerned about long-term (chronic) exposure to pesticides than short-term (acute) injury. To estimate chronic exposure, data are used that assume 100 percent of the
crops for which the pesticide is registered are treated and that the pesticide residues are present at tolerance levels. They also assume that post-harvest storage, handling, processing, or cooking does not reduce residues. A counterbalancing method would consider the actual way pesticides are generally applied and what the anticipated levels of residue would then be.

At present, there are no reliable databases containing the level of pesticide residues in drinking water.

**Occupational exposure assessment**

*Worker exposure* includes those who formulate or package pesticide products in factories; those who mix, load, and apply pesticides; and those who come into contact with pesticides during their work. Worker exposure can be reduced by following label directions, wearing proper PPE, and practicing good hygiene.

A worker exposure assessment is more valuable if described clearly and accurately. Several factors affect exposure:

- duration and frequency of exposure
- PPE used
- pesticide product formulation
- route of exposure
- quantity of pesticide handled
- type of mixing and loading operations
- type of application equipment
- environmental conditions
- type of work performed after the reentry interval

A worker who mixes and loads a concentrated product during the day has a different level of exposure than one who applies the dilute solution all day, or workers that don’t enter the field until several days later. Several methods are used to measure a worker’s daily exposure to a pesticide product. *Dosimetry* estimates the amount of pesticide that contacts clothing, skin, and/or the breathing zone of the worker. *Biological monitoring* estimates the total amount of pesticide actually absorbed by the worker by all routes: oral, dermal, and inhalation. A urine test is the most common method of biological monitoring.
Residential exposure assessment

People apply pesticides to their lawns, gardens, and ornamental plantings, as well as to their pets, carpets, cupboards, bedding (e.g. bedbugs), etc. Residential assessments evaluate human exposure to these pesticides. Measuring exposure is difficult for several reasons. First, only a portion of an applied pesticide is potentially transferable. Second, the amount of residue that can be transferred during contact or by other routes decreases as time passes.

Indoor exposure assessments are further complicated by the variety of application methods used. These include crack and crevice, carpet, room foggers, dusting pets with flea powder, and using moth repellent. People are not likely to contact residues behind cabinets, but carpet, vinyl upholstery or counter top contact is more likely.

Residential exposure depends on several factors. The very young and the elderly are considered more sensitive to pesticide exposure than other age groups. Unlike the workplace with its repetitive activities, different members of a household will contact treated areas for different lengths of time and with different parts of their body. For example, an infant may crawl naked on a treated carpet, a teenager may play football on a recently sprayed lawn, and an adult may contact a pesticide used in their kitchen.

The physical and chemical properties of pesticides differ. This can determine how apt they are to transfer to humans, for how long, and by what route (e.g. oral, inhalation, skin, etc.). Pesticides are often applied improperly by homeowners who do not read, or ignore label directions. This can create illegal residue levels.

Risk characterization

The last step in risk assessment is risk characterization, the integration of toxicological data with exposure data to estimate the level of human risk. Risk characterization also includes things that were assumed or uncertain in the risk evaluation.

Most toxic products have a threshold, below which harmful effects will not occur. Therefore, risk assessments are usually made using a Margin of Exposure (MOE) or a Reference Dose (RfD). In the MOE, the estimated human exposure is compared to the lowest NOAEL from an appropriate toxicology study:

\[ MOE = \frac{\text{No Observed Adverse Effect}}{\text{Estimated Human Exposure}}. \]
For example: if the NOAEL is 30 mg/kg/day and the estimated human exposure is 0.5 mg/kg/day, the MOE is 60 (30 ÷ 0.5 = 60). The greater the MOE, the greater the degree of safety. In general, a MOE should be at least 100 if the NOAEL is derived from an animal study. It should be at least 10 if the NOAEL is derived from human data. A MOE of 100 means that the estimated level of human exposure is 100 times lower than the highest dose that produced no adverse effects in the toxicology study. Important factors to consider when selecting an appropriate toxicology study include:

- the animal model used
- type of study
- study design
- route of administering the chemical
- duration of the study

The Reference Dose (RfD) approach is similar to the MOE, but the estimated human exposure level is compared to the appropriate RfD, not the NOAEL. A chronic RfD is the level to which a human can be exposed every day for a lifetime without experiencing adverse effects. There is now an acute RfD, which is an estimate of the amount of pesticide to which an individual can be exposed in one day without experiencing adverse health effects.

RfDs are calculated by dividing the lowest NOAEL from an appropriate toxicology study on the most sensitive animal species (or human) by the appropriate uncertainty (safety) factors.

\[
\text{RfD} = \frac{\text{No Observed Adverse Effect Level}}{\text{Uncertainty Factors}}
\]

Uncertainty factors are established by EPA. Usually, factors of 10x each are used for comparing animal test results to humans (differences between species) and humans to humans (differences within the species). This would result in a total uncertainty factor of 100 (10 x 10). Other uncertainty factors can be applied if there is no appropriate NOAEL, toxicity information is incomplete, or to protect infants and children. The total uncertainty factor can range from 10x if the NOAEL is derived from a human study, to 10,000x, though it rarely exceeds 1,000x. Dividing the NOAEL by these uncertainty factors helps assure that exposure to the chemical at a dose of less than or equal to the RfD will not pose a significant human risk.
Unacceptable MOEs or estimated exposures greater than the RfD indicate that:

- a more refined exposure assessment needs to be completed
- mitigation measures need to be used (e.g. different pesticide formulation, longer REI)
- the product should not be registered
- the product should be taken off the market (if previously registered)

Cancer-causing chemicals are not considered to have threshold effects. Any exposure is considered to have the potential to cause cancer. Therefore, the assessment gives an estimate, expressed as a probability, of the risk of cancer resulting from exposure to the pesticide. A calculated risk of $1 \times 10^{-6}$ (1 in 1,000,000) means a person would have no more than a one-in-a-million chance of developing cancer above the general population.


### Aggregate Risk Assessment

People can be exposed to pesticides by inhaling, ingesting, or absorbing them. Pesticides are present in the air and water, and on various surfaces around us as well as in and on our food. The Food Quality Protection Act now requires EPA to evaluate the potential aggregate risk for people exposed to one or more sources at the same time.

To do this, EPA uses a “risk cup” analogy. All the pesticide residues that a person might be exposed to from all sources (diet, water, residential uses) without significant risk go into this cup. The size of the cup depends on the toxicity of the pesticide and the appropriate uncertainty and safety factors. The supposition is that when the estimated exposure from a pesticide or group of pesticides exceeds the capacity of the risk cup, the pesticide or group of pesticides fails to meet FQPA’s safety standard. This analogy can be applied to the combined risk assessment conducted on a single chemical, or to numerous chemical with common mechanisms of toxicity (i.e., cumulative risk assessment). This complex approach to pesticide risk assessment is time and resource intensive. There will always be uncertainty factors and missing data. Pesticide risk
management must take this into consideration in its attempt to lessen risk.

Conclusion

The risk of harm to humans from pesticides depends on both exposure to the pesticide and its toxicity. Measuring both includes some uncertainty, so risk assessments commonly use very conservative assumptions to assure adequate margins of safety. The risk assessment process is generally tiered. It ranges from assessments based on limited data with very conservative assumptions, to assessments with extensive data and a solid understanding of the pesticide and its effects on humans.

The latest risk assessment methodologies assess exposure and risk to infants, children, and those who work with and around pesticides. The “risk cup” model is being used more often as the general population becomes increasingly concerned over pesticide risk.

The world is not risk free. Recognition of the risks associated with pesticide use is important to informed decision-making regarding the levels of risk acceptable to society. To minimize adverse risk to human health and the environment, the manufacture, use, and disposal of pesticides depends on good risk assessments, product labeling, government enforcement, and applicator and consumer education. Responsible management of pesticide risks allows optimal benefits in terms of public health, safety, and prosperity.

References

Risk cup [http://ipm.ncsu.edu/srpsec/fqpa.pdf](http://ipm.ncsu.edu/srpsec/fqpa.pdf)

This article was based on a Purdue University Extension publication by Fred Whitford and others, titled “Pesticides and Human Health Risk Assessment: Policies, Processes, and Procedures. This publication, PPP-48, can be purchased for $1.00 or downloaded for free at [http://www.ag.purdue.edu/btmy/extension/pages/PPP.aspx](http://www.ag.purdue.edu/btmy/extension/pages/PPP.aspx)
PROTECTING PETS AND DOMESTIC ANIMALS
(recertification)

Common pets found in or near residences or other buildings include several types of mammals, birds, reptiles, amphibians, and fish. Associated with pets and domestic animals are their food and water supplies, bedding, pens, equipment, and toys.

Most animals are susceptible to injury by various pesticides, some even at low doses. Fish and birds are among the most susceptible. Cats are very sensitive because they are metabolically unable to detoxify many types of pesticides. Low levels of pesticide exposure may affect young animals and older or sick animals even if they have no effect on adult or healthy animals. If cats and dogs lie on the treated ground or other treated surfaces and then groom and clean themselves by licking, the potential for exposure to certain pesticide residues greatly increases.

To provide protection for pets and domestic animals, have their owners remove them from the area before making a pesticide application. Keep animals away until the spray dries and you thoroughly ventilate the area. Do not apply pesticides on or near animal food or water. If the animals are returned to the treated area, owners should suspend the application of any ectoparasite systemic medications until they check with a veterinarian.

Pets and domestic animals can be the source of some pest problems. For instance, dogs and cats often bring fleas into buildings. Animal feces provide food and breeding sites for several fly species. Pet and livestock food left in an animal dish or feeder can attract mice and rats (and other animals) as well as cockroaches, flies, and ants. Animal water dishes may provide the water needed by some pests. Look for these types of conditions when performing pest management in an area where people keep pets or livestock. Evaluate and, if necessary, suggest modifications of the feeding routine, housing arrangement, and sanitation practices to reduce pest problems.

A recent article in the Honolulu Star-Advertiser (23 Sept. 2011) by Associated Press writer Mike Stobbe bore the headline, “Bedbug poisons are worse than their targets, study says.” The first sentence was, “Bedbugs don’t make you sick, but the poisons used to kill them can.” This probably referred to current knowledge that bed bugs do not carry disease, but pesticides can make you ill. The headline, however, did not reflect the overall findings of the study.

Contributing factors were identified in 50% of the 111 cases of insecticide illness. Factors that most frequently contributed to the illnesses were: 1) excessive insecticide application (18%), 2) failure to wash or change pesticide-treated bedding (16%), and lack of notification of a pesticide application (11%).

The news article was based on a recent report from the Centers of Disease Control and Prevention (see References). The CDC surveyed 12 states from 2003 through 2010 and found 111 reports of illnesses in 7 states related to insecticides used against bed bugs. More than 80% of these illnesses were considered mild: headache, dizziness, chest pain or shortness of breath, nausea or vomiting.

Of the 111 reports, most occurred in private residences (93%) and in 39% of these cases the pesticides were applied by the occupants. Thirteen cases (12%) were work-related. These occurred among three pesticide applicators and eight other workers that entered rooms unaware of recent pesticide applications.

There was one death, a 65-year-old woman. The following is directly from the CDC report and offers an extreme example:

“The one fatality . . . had a history of renal failure, myocardial infarction and placement of two coronary stents, type II diabetes, hyperlipidemia, hypertension, and depression. She was taking at least 10 medications at the time of exposure. After she complained to her husband about bed bugs, he applied an insecticide to their home interior baseboards, walls, and the area surrounding the bed, and a different insecticide to the mattress and box springs. Neither of these products are registered for use on bed bugs. Nine cans of insecticide fogger were released in the home the same day. Approximately 2 days later, insecticides were reapplied to the mattress, box springs, and surrounding areas, and nine cans of another fogger were released in the home. On both days the insecticides were applied, the couple left their home for 3–4 hours before reentering. Label instructions on the foggers to air out the treated area for 30 minutes with doors and windows open were not followed on
either day. On the day of the second application, the woman applied a bedbug and flea insecticide to her arms, sores on her chest, and on her hair before covering it with a plastic cap. She also applied the insecticide to her hair the day before the second application. Two days following the second application, her husband found her nonresponsive. She was taken to the hospital and remained on a ventilator for 9 days until she died.”

*Note: All insecticides contained either pyrethrins, pyrethroids, or both.

Rising bed bug populations and infestations have been reported nationally and internationally since 2003. Insecticides containing pyrethroids and pyrethrins are commonly used against bed bugs and their increased use is leading to insecticide resistance. CDC, EPA, and others are concerned that this resistance might result in an increased misuse of pesticides. When the efficiency of a pesticide declines, people tend to increase the amount they use, use it more often, or use it in other ways not allowed by the product label. The misuse statement on every EPA-registered pesticide label states, “It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.”

Editorial Note. There were at least four limitations to the CDC study: 1) acute illnesses might not have been reported if the symptoms were mild, or if neither a medical facility nor poison control center were contacted; 2) a lack of information may have led to the illness not being classified as being pesticide-related; 3) false positives may have occurred when illnesses with similar symptoms were thought to be caused by bed bug treatments—only 16% of the 111 cases in this study were categorized as either definite or probable; and 4) contributing factors were identified for only 50% of the cases, so more information might have changed interpretations made in this report.

One implication of this study according to CDC was that the inappropriate use of insecticides to control bed bugs can cause harm. Therefore, media campaigns to reduce insecticide-related illnesses should focus on nonchemical methods of control, prevention of bed bug infestations, and the prudent use of effective insecticides. The summary further stated that insecticide labels that were easier to read and understand might prevent illnesses associated with bed bug control.

References

CDC article [http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6037a1.htm? s_cid=mm6037a1_x](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6037a1.htm? s_cid=mm6037a1_x)

EPA website [http://www.epa.gov/bedbugs/#treat](http://www.epa.gov/bedbugs/#treat)
ILLUSTRATED GLOSSARY
Terms from Pesticide Labels

Mil: A unit of length equal to 0.001 of an inch (0.0245 mm), used in measuring the diameter of wires or thickness of material sold in sheets.

Label example: Applicators and other handlers must wear chemical-resistant gloves – EPA chemical-resistant category B (e.g., barrier laminate or butyl rubber ≥14 mils).

Acid equivalent: When referring to certain herbicides, acid equivalent is the specific portion of the active ingredient that reacts with and injures the weed’s living tissues. “Parent acid” is what chemists call this truly active portion of the active ingredient. If you study the ending of the active ingredient’s chemical name on the herbicide label, you may see “. . . ester” or “. . . amine salt”. Neither the ester portion nor the amine portion count when chemists calculate the acid equivalent. Since the parent acid is so important, an herbicide label typically specifies its concentration as the acid equivalent in a note directly below the ingredients statement (as shown at left).

Label example: Contains 4 pounds peer US gallon of the active ingredient glyphosate, in the form of its isopropyl amine salt. Equivalent to 3 pounds per US gallon of the acid, glyphosate.

Mesh: An arrangement of interlocking metal links or wires with evenly spaced, uniform small openings between, as used in sieves, screens, etc. A common standard is the Tyler mesh size, which is equivalent to the number of openings per linear inch of mesh. Since size openings depend on the thickness of the wire, mesh openings are usually determined by referring to the appropriate chart.

Label example: Use screens no finer than 50 mesh in nozzles and in-line strainers.
Parts-per: Parts-per is a way of quantifying very low concentrations of substances. For example, one part per million (ppm, \(10^{-6}\)) is equivalent to 1.0 milligram of something per liter of liquid (mg/L), or 1.0 milligram of something per kilogram of a solid substance (mg/kg).

Label example: An approved assay indicates that the 2,4-D concentration is 100 ppb (0.1 ppm) or less at the water intake.

\[\text{ppb = parts per billion (10}^{-9}\text{), or 1,000 times less than a part per million, (10}^{-6}\text{)}\]

Erosion control practices: Practices that prevent or control the unintended movement of soil by wind or water (e.g., buffer strips, conservation tillage, contour plowing, cover crops, etc.).

Label example: Runoff of this product will be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours. Sound erosion control practices will reduce this product's contribution to surface water contamination.

The definitions in this glossary are intended to help understand the terms used on pesticide labels. Other definitions may be available for these terms. Mention of a trademark, company, or proprietary name is not an endorsement and does not imply a recommendation to the exclusion of other companies or products.
The Pesticide Label

October–December 2011

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